CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 6/13/13 TIME: 1427 OBSERVER: Conor Blanchet

PROXIMAL TO PROJECT COMPONENT: GEN-TIE ROW

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0620264 North: 3621299

BEARING (degrees) to PROJECT COMPONENT: Within ROW

DISTANCE (meters) to PROJECT COMPONENT: W/i ROW

CARCASS DESCRIPTION

SPECIES: Western Zebra-tailed Lizard

SEX (*circle*): M F [✓ U] AGE (*circle*): A J [✓ U] Tag/Band Number: ____

CONDITION (*circle*): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:

WATER TRUCK CRUSHING

OBSERVABLE INJURIES:

CONSISTENT WITH CRUSHING

SUBSTRATE/GROUND COVER (*at carcass location*): SAND

DISPOSITION OF CARCASS[1] (*circle*): left in place [✓ removed] collected for trials collected for other: ____

SHIPPED TO:

[name of institution] ____

[physical address] ____

[phone/email] ____

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 102

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: Easterly SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 0312 Photo 2 0314

Landscape: Photo 3 0309 Photo 4 0316

PHOTO NOTES:

CB CAMERA

NOTIFICATION[3]:

DATE: 6/13/13 TIME: 1927

NAME: PAT GOLDEN AGENCY/ASSOCIATION: HERITAGE

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

0309

0310

0312

0314

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 9-06-13 TIME: 0910 OBSERVER: William Van Vleet

PROXIMAL TO PROJECT COMPONENT: Block 5

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0622297 North: 3624219

BEARING (degrees) to PROJECT COMPONENT: ____

DISTANCE (meters) to PROJECT COMPONENT: <1

CARCASS DESCRIPTION

SPECIES: California Kingsnake, Lampropeltis getula californiae

SEX (circle): M F [✓ U] AGE (circle): A [✓ J] U Tag/Band Number: n/a

CONDITION (circle): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ <1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:

Squished by ATV

OBSERVABLE INJURIES:

none

SUBSTRATE/GROUND COVER (at carcass location): bare ground

DISPOSITION OF CARCASS[1] (circle): left in place [✓ removed] collected for trials collected for other: ____

SHIPPED TO:

[name of institution] ____

[physical address] ____

[phone/email] ____

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 94

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: N W SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 436 Photo 2 946

Landscape: Photo 3 252 Photo 4 226

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 9-6-13 TIME: 0930

NAME: Pat Golden AGENCY/ASSOCIATION: Heritage Environmental consulting

NOTES:

---

[1] Permit required to handle bird carcasses.

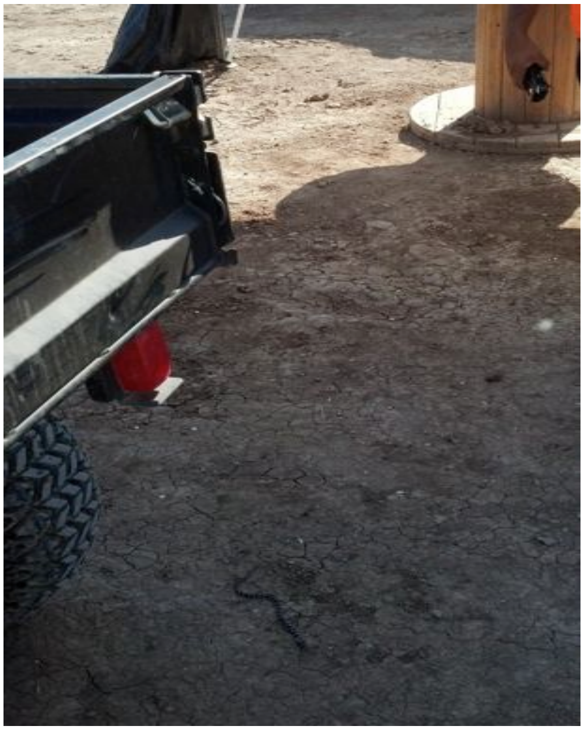
[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

(Picture 430)

(Picture 946)

(Picture 252)



(Picture 226)

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 9-18-13 TIME: 0920 OBSERVER: SM

PROXIMAL TO PROJECT COMPONENT: next to safety trailer

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0620724 North: 3624163

BEARING (degrees) to PROJECT COMPONENT: 270°

DISTANCE (meters) to PROJECT COMPONENT: 3m

CARCASS DESCRIPTION

SPECIES: unknown mouse spp.

SEX (*circle*): M F [✓ U] AGE (*circle*): [✓ A] J U Tag/Band Number: ___________

CONDITION (*circle*): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:

unknown

OBSERVABLE INJURIES:

head & upper torso smashed

SUBSTRATE/GROUND COVER (*at carcass location*): bare ground, dirt

DISPOSITION OF CARCASS[1] (*circle*): left in place [✓ removed] collected for trials collected for other: ___________

SHIPPED TO:

[name of institution] ___________

[physical address] ___________

[phone/email] ___________

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 84°

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: N/A SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]**:**

Close Up: Photo 1 B-306 Photo 2 B-307

Landscape: Photo 3 B-308 Photo 4 B-309

PHOTO NOTES:

B-308 is facing west towards safety trailer
B-309 is facing NE towards other trailer

NOTIFICATION[3]**:**

DATE: 9-18-13 TIME: 1900

NAME: Pat Golden AGENCY/ASSOCIATION: Heritage Environmental

NOTES:

emailed PDF report to him at 1900

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

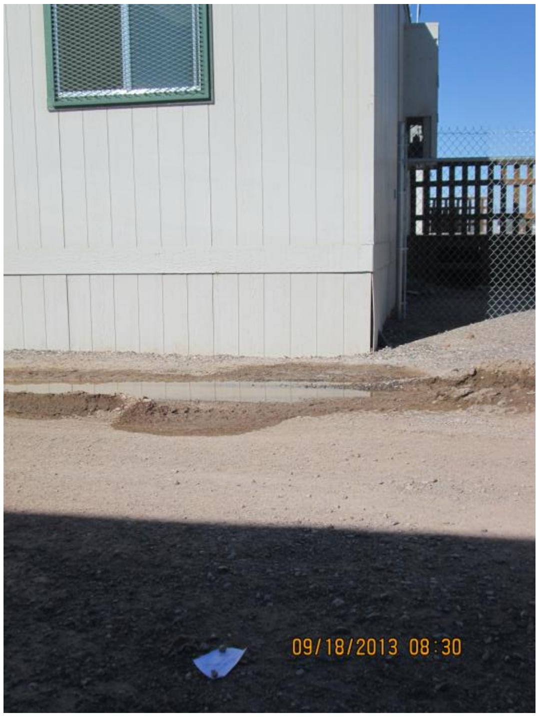
[3] Indicate who was notified of the event, date, time, etc.


SPENCER
MORRISON
9-18-13
0920
09/18/2013 08:30

B-306


SPENCER
MORRISON
9-18-13
0920
09/18/2013 08:30

B-307



B-308

B-309

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 4/10/13 TIME: 10:15 OBSERVER: SY

PROXIMAL TO PROJECT COMPONENT: Gen-tie

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 620314 North: 3621240

BEARING (degrees) to PROJECT COMPONENT: n/a

DISTANCE (meters) to PROJECT COMPONENT: 0

CARCASS DESCRIPTION

SPECIES: Desert Iguana

SEX (*circle*): M F [✓ U] AGE (*circle*): [✓ A] J U Tag/Band Number: n/a

CONDITION (*circle*): intact scavenged dismembered feather spot [✓ injured]

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): >1 1 2 3 4 5 6 7 7+ [✓ n/a]

CAUSE OF DEATH:
n/a

OBSERVABLE INJURIES:
Entrapped in compacted sand in rd.; apparent injury to rear left leg.

SUBSTRATE/GROUND COVER (*at carcass location*): sand

DISPOSITION OF CARCASS[1] (*circle*): [✓ left in place] removed collected for trials collected for other: (freed from sand)

SHIPPED TO:
[name of institution] n/a
[physical address]
[phone/email]

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 19°C

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: NW SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]**:**

Close Up: Photo 1 S40047 Photo 2 S40046

Landscape: Photo 3 S40049 2) N Photo 4 S40050

PHOTO NOTES:

NOTIFICATION[3]**:**

DATE: 4/10/13 TIME: 10:20

NAME: Kim Marzden AGENCY/ASSOCIATION: BLM

NOTES:

Left VM for K. Marzden.

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

Photo 1

Photo 2 – File Error

Photo 3

Photo 4

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 4/16/13 TIME: 1123 OBSERVER: CONOR BLANCHET

PROXIMAL TO PROJECT COMPONENT: 3A. WESTERN EDGE

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0619661 North: 3624368

BEARING (degrees) to PROJECT COMPONENT: 90°

DISTANCE (meters) to PROJECT COMPONENT: 2 m

CARCASS DESCRIPTION

SPECIES: COMMON NIGHTHAWK

SEX (*circle*): M F [✓ U] AGE (*circle*): A J [✓ U] Tag/Band Number: ____

CONDITION (*circle*): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:

UNKNOWN

OBSERVABLE INJURIES:

BROKEN (R) WING

SUBSTRATE/GROUND COVER (*at carcass location*): DISTURBED EARTH

DISPOSITION OF CARCASS[1] (*circle*): [✓ left in place] removed collected for trials collected for other: ____

SHIPPED TO:

[name of institution] ____

[physical address] ____

[phone/email] ____

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 71°F

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: E SPEED (mph, *circle*): 0-10 [✓ 10-20] 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

HIGH WIND

PHOTOGRAPHS[2]:

Close Up: Photo 1 103-0091 Photo 2 103-0093

Landscape: Photo 3 103-0091 Photo 4 103-0090

PHOTO NOTES:

PINK CAMERA

NOTIFICATION[3]:

DATE: 4/15/13 TIME: 1330

NAME: PAT GOLDEN AGENCY/ASSOCIATION: CDF&G

NOTES:

SAME INDIVIDUAL REPORTED INJURED ON 4-15-13. MOVED <1m SINCE LAST OBSERVATION.

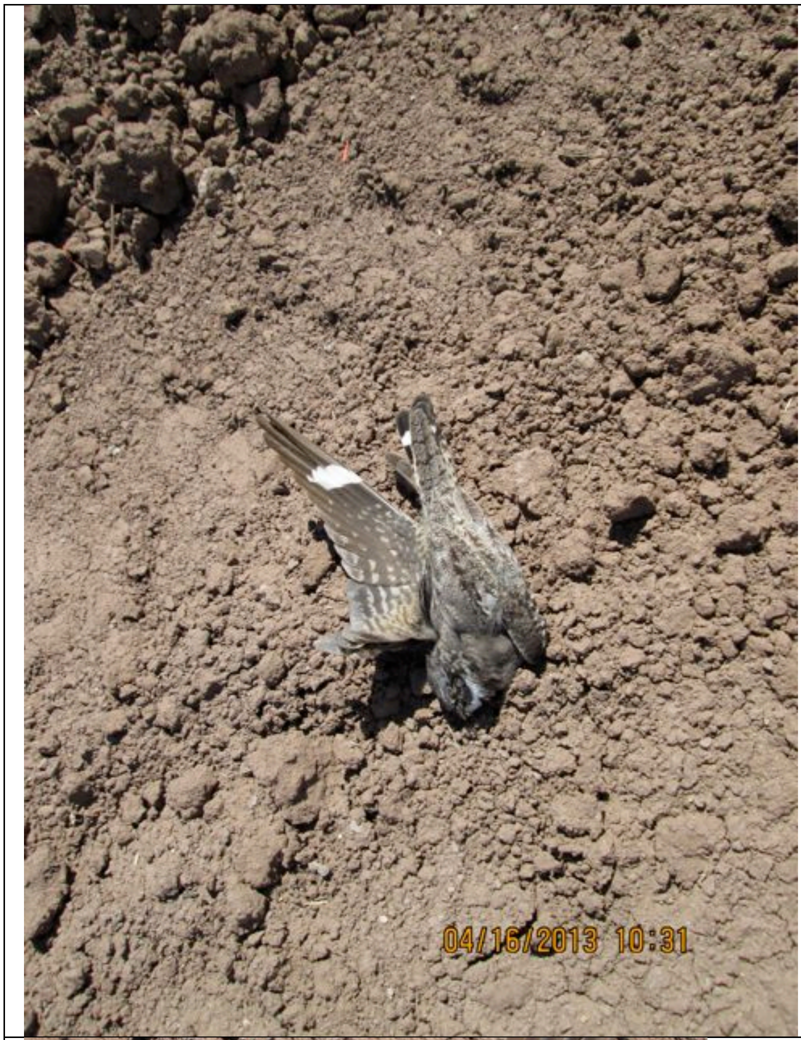
---

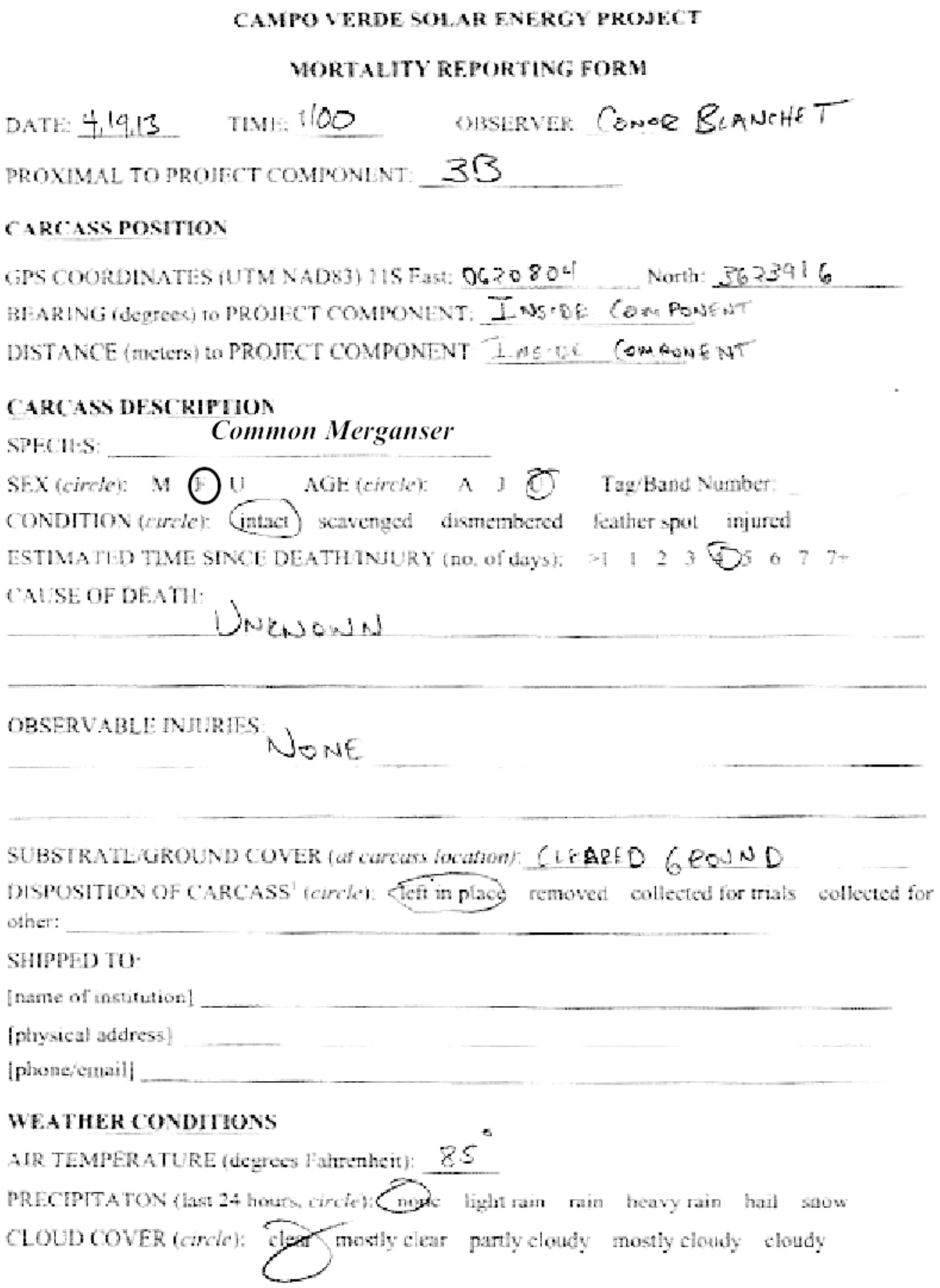
[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

	103-0089 Pink Camera
	103-0090 Pink Camera

 04/16/2013 10:31	103-0091 Pink Camera
 04/16/2013 10:32	103-0093 Pink Camera



CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 4.19.13 TIME: 1100 OBSERVER: CONOR BLANCHET

PROXIMAL TO PROJECT COMPONENT: 3B

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0620804 North: 3623916

BEARING (degrees) to PROJECT COMPONENT: INSIDE COMPONENT

DISTANCE (meters) to PROJECT COMPONENT: INSIDE COMPONENT

CARCASS DESCRIPTION

SPECIES: *Common Merganser*

SEX (*circle*): M [✓ F] U AGE (*circle*): A J [✓ U] Tag/Band Number:

CONDITION (*circle*): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): >1 1 2 3 [✓ 4] 5 6 7 7+

CAUSE OF DEATH: UNKNOWN

OBSERVABLE INJURIES: NONE

SUBSTRATE/GROUND COVER (*at carcass location*): CLEARED GROUND

DISPOSITION OF CARCASS[1] (*circle*): [✓ left in place] removed collected for trials collected for other:

SHIPPED TO:

[name of institution]

[physical address]

[phone/email]

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 85°

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: East SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]**:**

Close Up: Photo 1 103-0095 Photo 2 103-0094

Landscape: Photo 3 103-0096 Photo 4 103-0097

PHOTO NOTES:

PINK CAMERA

NOTIFICATION[3]**:**

DATE: *4/19/13* TIME: *1152*

NAME: *Scott Yanco* AGENCY/ASSOCIATION: *Heritage*

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

 04/19/2013 08:40	103-0094 Pink Camera
 04/19/2013 08:40	103-0095 Pink Camera

	103-0096 Pink Camera
	103-0097 Pink Camera

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 4/25/13 TIME: 1345 OBSERVER: P. Golden

PROXIMAL TO PROJECT COMPONENT: Pad 10 (Structure 10)

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 620226 North: 3621347

BEARING (degrees) to PROJECT COMPONENT: On

DISTANCE (meters) to PROJECT COMPONENT: On

CARCASS DESCRIPTION

SPECIES: Desert iguana

SEX (*circle*): M F [✓ U] AGE (*circle*): [✓ A] J U Tag/Band Number: N/A

CONDITION (*circle*): intact scavenged [✓ dismembered] feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:

Bull dozer (Sub surface)

OBSERVABLE INJURIES:

Severed body

SUBSTRATE/GROUND COVER (*at carcass location*): Sand / Bladed

DISPOSITION OF CARCASS[1] (*circle*): left in place removed collected for trials collected for other: Buried on pad

SHIPPED TO:

[name of institution] ______

[physical address] ______

[phone/email] ______

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 98

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: W SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 12 Photo 2 ______

Landscape: Photo 3 ______ Photo 4 ______

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 4/28/13 TIME: ______

NAME: Kim Marsden AGENCY/ASSOCIATION: BLM

Magdalena Rodriguez CDFW

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 4/26/13 TIME: 1025 OBSERVER: P. Golden

PROXIMAL TO PROJECT COMPONENT: Pad 9 (Structure 9)

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 620099 North: 3621458

BEARING (degrees) to PROJECT COMPONENT: On

DISTANCE (meters) to PROJECT COMPONENT: On

CARCASS DESCRIPTION

SPECIES: Desert Iguana

SEX (*circle*): M F [✓ U] AGE (*circle*): [✓ A] J U Tag/Band Number: —

CONDITION (*circle*): intact scavenged [✓ dismembered] feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ <1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:
Bulldozer (Sub Surface)

OBSERVABLE INJURIES:
Body severed

SUBSTRATE/GROUND COVER (*at carcass location*): Sand (Bladed)

DISPOSITION OF CARCASS[1] (*circle*): [✓ left in place] removed collected for trials collected for other: Bladed

SHIPPED TO:
[name of institution]
[physical address]
[phone/email]

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 78

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): clear [✓ mostly clear] partly cloudy mostly cloudy cloudy

WIND DIRECTION: W SPEED (mph, *circle*): 0-10 [✓ 10-20] 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 15 Photo 2 _______

Landscape: Photo 3 _______ Photo 4 _______

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 4/28/13 TIME: _______

NAME: Kim Marsden AGENCY/ASSOCIATION: BLM
Magdalena Rodriquez CDFW

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 4/27/13 TIME: 0805 OBSERVER: P. Goldon

PROXIMAL TO PROJECT COMPONENT: Pad 8 (Structure 8)

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 619934 North: 3621636

BEARING (degrees) to PROJECT COMPONENT: On

DISTANCE (meters) to PROJECT COMPONENT: On

CARCASS DESCRIPTION

SPECIES: Shovel-nosed snake

SEX (*circle*): M F [✓ U] AGE (*circle*): [✓ A] J U Tag/Band Number: —

CONDITION (*circle*): intact scavenged [✓ dismembered] feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:
Bull dozer (sub surface)

OBSERVABLE INJURIES:
Head severed

SUBSTRATE/GROUND COVER (*at carcass location*): Sand / Bladed

DISPOSITION OF CARCASS[1] (*circle*): [✓ left in place] removed collected for trials collected for other: Buried

SHIPPED TO:

[name of institution]

[physical address]

[phone/email]

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 75

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: — SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]**:**

Close Up: Photo 1 15 Photo 2 ________

Landscape: Photo 3 ________ Photo 4 ________

PHOTO NOTES:

NOTIFICATION[3]**:**

DATE: 4/28/13 TIME: ________

NAME: Kim Marsden AGENCY/ASSOCIATION: BLM

Magdalena Rodriguez CDFW

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 9/28/13 TIME: 0957 OBSERVER: P. Golder

PROXIMAL TO PROJECT COMPONENT: on access road on Pad 10

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 620230 North: 3621337

BEARING (degrees) to PROJECT COMPONENT: Pad 10

DISTANCE (meters) to PROJECT COMPONENT: Pad 10

CARCASS DESCRIPTION

SPECIES: Flat-tailed horned Lizard

SEX (*circle*): M [✓ F] U AGE (*circle*): [✓ A] J U Tag/Band Number: —

CONDITION (*circle*): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ ≥1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:
Vehicle ran over

OBSERVABLE INJURIES:
Flattened

SUBSTRATE/GROUND COVER (*at carcass location*): Sandy access road

DISPOSITION OF CARCASS[1] (*circle*): left in place [✓ removed] collected for trials collected for other: Buried 10 m west on pad 10

SHIPPED TO:

[name of institution] ____

[physical address] ____

[phone/email] ____

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 94°F

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: O SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 22 Photo 2 ________

Landscape: Photo 3 23 Photo 4 ________

PHOTO NOTES:

Creosotebush scrub surrounding

NOTIFICATION[3]:

DATE: 4/29/13 TIME: 10:30

NAME: Kim Marsden
Magdalena Rodriguez
AGENCY/ASSOCIATION: BLM
CDFW

NOTES:

Van proceded down road minutes after survey was completed. FTHL wandered onto road & was run over

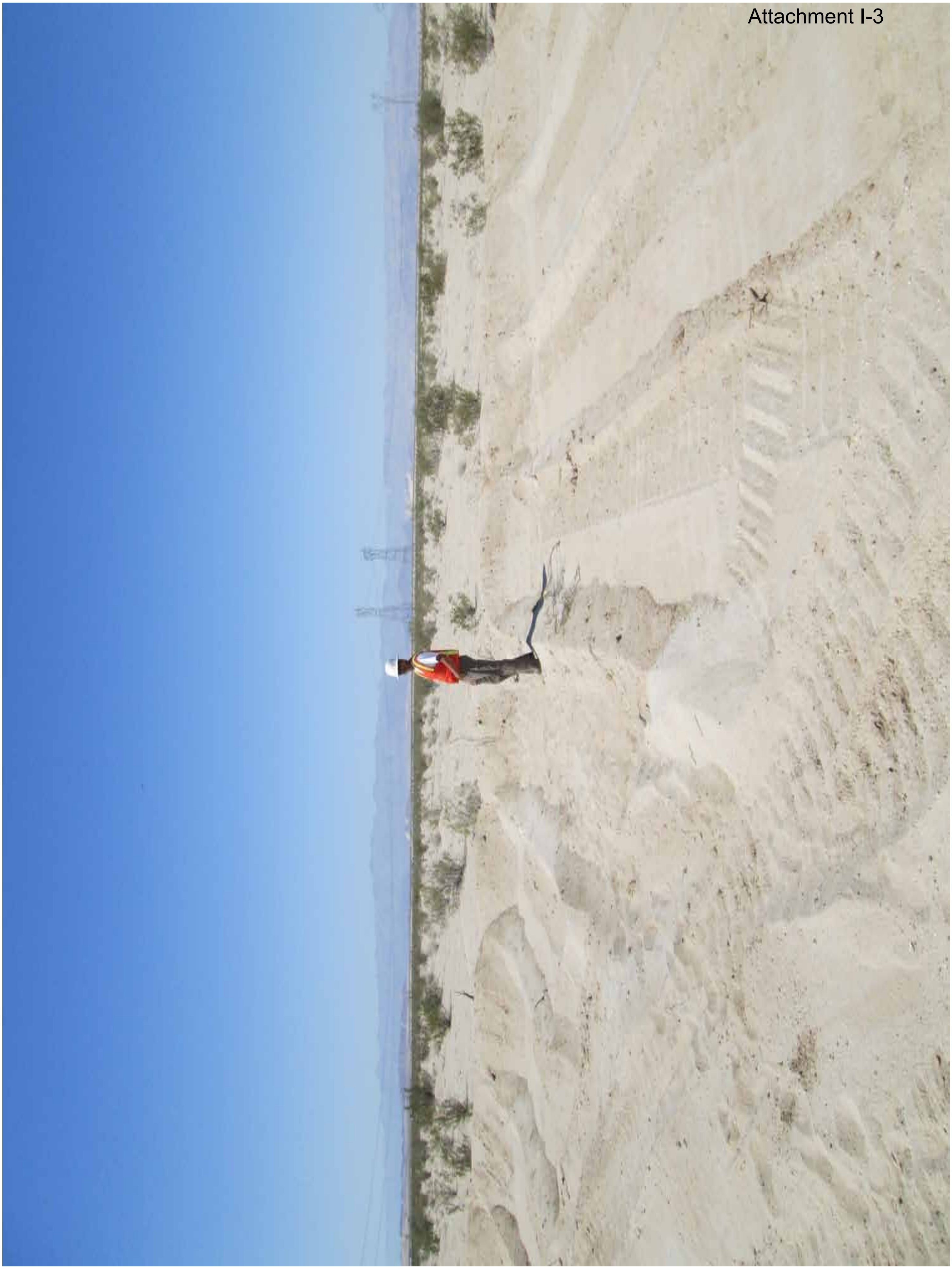
Agencies contacted at 10:30 (Kim + Magdalena)
Contacted Keith Grant onsite immediately.

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

Additional Documentation Attachment to Comment 2-F1
Attachment I-3



CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 4/30/13 TIME: 1120 OBSERVER: S. Yanco

PROXIMAL TO PROJECT COMPONENT: Gen-tie Access Rd.

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0619934 North: 3621680

BEARING (degrees) to PROJECT COMPONENT: n/a

DISTANCE (meters) to PROJECT COMPONENT: 0

CARCASS DESCRIPTION

SPECIES: Western zebra-tailed lizard (Callisaurus draconoides)

SEX (circle): M [✓ F] U AGE (circle): [✓ A] J U Tag/Band Number: n/a

CONDITION (circle): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:
Likely crushed by vehicle – located in tire track of water truck, still a few muscle twitches when discovered.

OBSERVABLE INJURIES:
Distended rear left leg, trauma to head

SUBSTRATE/GROUND COVER (at carcass location): sand – disturbed

DISPOSITION OF CARCASS[1] (circle): left in place removed collected for trials collected for other: buried on site.

SHIPPED TO:

[name of institution] n/a

[physical address] n/a

[phone/email] n/a

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 100

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: WSW SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

Hot + calm last 2 days.

PHOTOGRAPHS[2]:

Close Up: Photo 1 024 Photo 2 n/a

Landscape: Photo 3 025 Photo 4 n/a

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 4/30/13 TIME: 1145

NAME: P. Golden AGENCY/ASSOCIATION: Heritage EC

NOTES:

Will forward to CDFW + BLM.

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

Photo 1

Photo 2

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 5/2/13 TIME: 1440 OBSERVER: S. Yanco

PROXIMAL TO PROJECT COMPONENT: Gen-tie access rd.

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 620258 North: 3621316

BEARING (degrees) to PROJECT COMPONENT: n/a

DISTANCE (meters) to PROJECT COMPONENT: 0

CARCASS DESCRIPTION

SPECIES: Flat-tailed horned lizard

SEX (circle): M F [✓ U] AGE (circle): [✓ A] J U Tag/Band Number: n/a

CONDITION (circle): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:
Apparent crushing injury to head

OBSERVABLE INJURIES:
Head crush, left leg trauma

SUBSTRATE/GROUND COVER (at carcass location): compacted sand

DISPOSITION OF CARCASS[1] (circle): left in place removed collected for trials [✓ collected for other]: possible curation

SHIPPED TO:
[name of institution] awaiting direction from CDFW
[physical address]
[phone/email]

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 32° C

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: N SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 28 Photo 2 29
Landscape: Photo 3 30 Photo 4 31

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 5/2/13 TIME: 1445
NAME: K, Grant / P. Golden AGENCY/ASSOCIATION: EGI / Heritage

NOTES:

Located immediately following survey of rd – apparently crushed by water truck.

K. Grant notified P. Godfrey. S. Yanco will forward to BLM + CDFW

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

Photo 28

Photo 29

Photo 30

Photo 31

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 5-3-2013 TIME: 1414 OBSERVER: Will Van Vleet

PROXIMAL TO PROJECT COMPONENT: Block 1N/2A, near module Box

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0619592 North: 362 3665

BEARING (degrees) to PROJECT COMPONENT: 0

DISTANCE (meters) to PROJECT COMPONENT: 1< meter

CARCASS DESCRIPTION

SPECIES: Desert cotton tail (rabbit)

SEX (circle): M F [✓ U] AGE (circle): A [✓ J] U Tag/Band Number: none

CONDITION (circle): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): >1 [✓ 1] 2 3 4 5 6 7 7+

CAUSE OF DEATH:
unknown

OBSERVABLE INJURIES:
slight cut on body

SUBSTRATE/GROUND COVER (at carcass location): bare ground

DISPOSITION OF CARCASS[1] (circle): left in place [✓ removed] collected for trials collected for other: barried on site, south East of location

SHIPPED TO:

[name of institution]

[physical address]

[phone/email]

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 93°

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): clear [✓ mostly clear] partly cloudy mostly cloudy cloudy

WIND DIRECTION: North SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 R-0102 Photo 2 R-0103

Landscape: Photo 3 R-0104 Photo 4 R-0105

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 5-3-2013 TIME: 1745

NAME: Pat Golden AGENCY/ASSOCIATION: Heritage Environmental

NOTES:

Email sent to Pat to be forwarded to USF.WS.

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

R-0102

R-0103

R-0104

R-0105

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 5-28-13 TIME: 11:15 OBSERVER: JMS

PROXIMAL TO PROJECT COMPONENT: Vault #2 Block 3A

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0620034 North: 3625111

BEARING (degrees) to PROJECT COMPONENT: inside block 3

DISTANCE (meters) to PROJECT COMPONENT: ____

CARCASS DESCRIPTION

SPECIES: Variable Groundsnake

SEX (circle): M F [✓ U] AGE (circle): A J [✓ U] Tag/Band Number: ____

CONDITION (circle): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): >1 [✓ 1] 2 3 4 5 6 7 7+

CAUSE OF DEATH:

Probable predation

OBSERVABLE INJURIES:

Signifizant trauma (apparent bite marks) on side of snake's body

SUBSTRATE/GROUND COVER (at carcass location): compacted dirt

DISPOSITION OF CARCASS¹ (circle): left in place [✓ removed] collected for trials collected for other: ____

SHIPPED TO:

[name of institution] ____

[physical address] ____

[phone/email] ____

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 88

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): clear mostly clear [✓ partly cloudy] mostly cloudy cloudy

WIND DIRECTION: W SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 4164 Photo 2 4165

Landscape: Photo 3 4166 Photo 4 4161

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 5-28-13 TIME: 1115

NAME: Pat Golden/Scott Yanco AGENCY/ASSOCIATION: Heritage Environmental

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

	4164
	4165

	4166
	4161

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 5-31-13 TIME: 0814 OBSERVER: JMS

PROXIMAL TO PROJECT COMPONENT: On road between 1N and 2A

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 6198865 North: 3623668

BEARING (degrees) to PROJECT COMPONENT: [illegible] [illegible] Between 1N and 2A

DISTANCE (meters) to PROJECT COMPONENT: at midpoint of 1N.

CARCASS DESCRIPTION

SPECIES: Desert Cottontail (3 individuals)

SEX (circle): M F [✓ U] AGE (circle): A [✓ J] U Tag/Band Number: n/a

CONDITION (circle): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): >1 1 2 3 4 5 6 7 [✓ 7+]

CAUSE OF DEATH:

Unknown

OBSERVABLE INJURIES:

n/a

SUBSTRATE/GROUND COVER (at carcass location): Compacted dirt

DISPOSITION OF CARCASS[1] (circle): left in place [✓ removed] collected for trials collected for other:

SHIPPED TO:

[name of institution]

[physical address]

[phone/email]

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 88°

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: W SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 4186 Photo 2 4188

Landscape: Photo 3 _______ Photo 4 _______

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 5-31-13 TIME: 0820

NAME: Pat Golden AGENCY/ASSOCIATION: Heritage Environmental

NOTES:

---

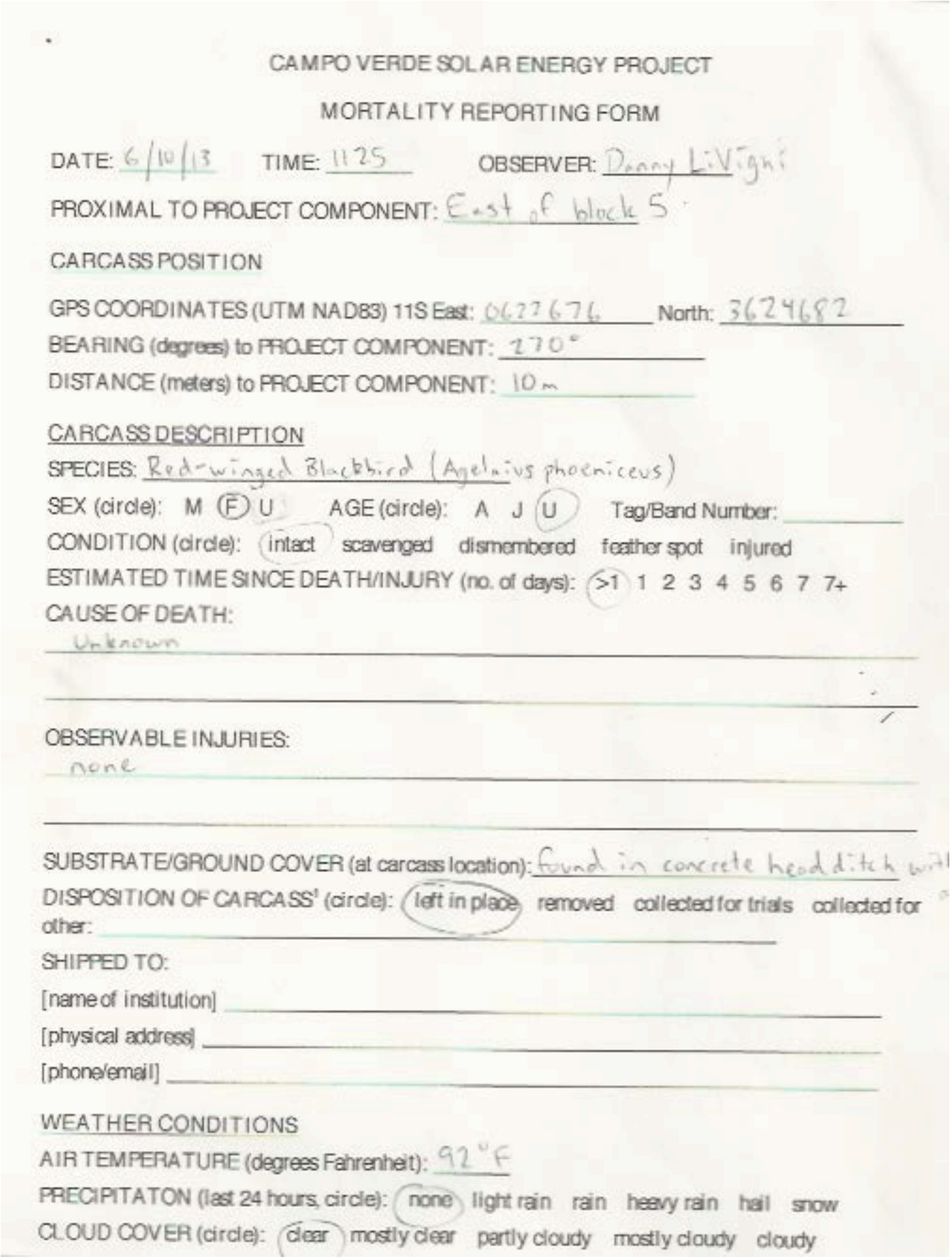
[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

	4186
	4188

	4185
	4187



CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 6/10/13 TIME: 1125 OBSERVER: Danny LiVigni

PROXIMAL TO PROJECT COMPONENT: East of block 5

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0627676 North: 3624682

BEARING (degrees) to PROJECT COMPONENT: 270°

DISTANCE (meters) to PROJECT COMPONENT: 10 m

CARCASS DESCRIPTION

SPECIES: Red-winged Blackbird (Agelaius phoeniceus)

SEX (circle): M [✓ F] U AGE (circle): A J [✓ U] Tag/Band Number: ________

CONDITION (circle): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:

Unknown

OBSERVABLE INJURIES:

none

SUBSTRATE/GROUND COVER (at carcass location): found in concrete head ditch wit

DISPOSITION OF CARCASS¹ (circle): [✓ left in place] removed collected for trials collected for other: ________

SHIPPED TO:

[name of institution] ________

[physical address] ________

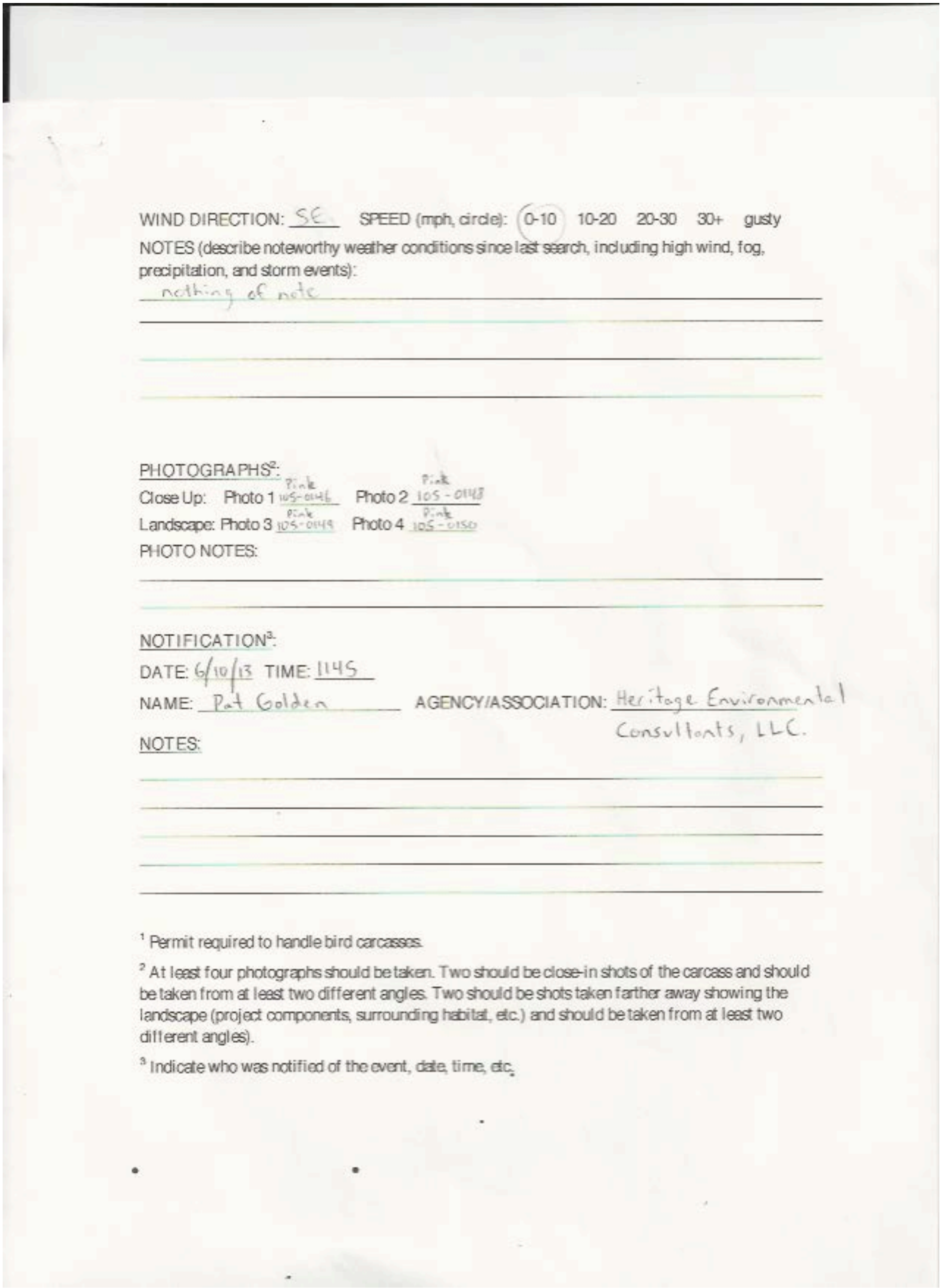
[phone/email] ________

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 92°F

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy



WIND DIRECTION: SE SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

nothing of note

PHOTOGRAPHS[2]:

Close Up: Photo 1 Pink 105-0146 Photo 2 Pink 105-0148

Landscape: Photo 3 Pink 105-0149 Photo 4 Pink 105-0150

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 6/10/13 TIME: 1145

NAME: Pat Golden AGENCY/ASSOCIATION: Heritage Environmental Consultants, LLC.

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

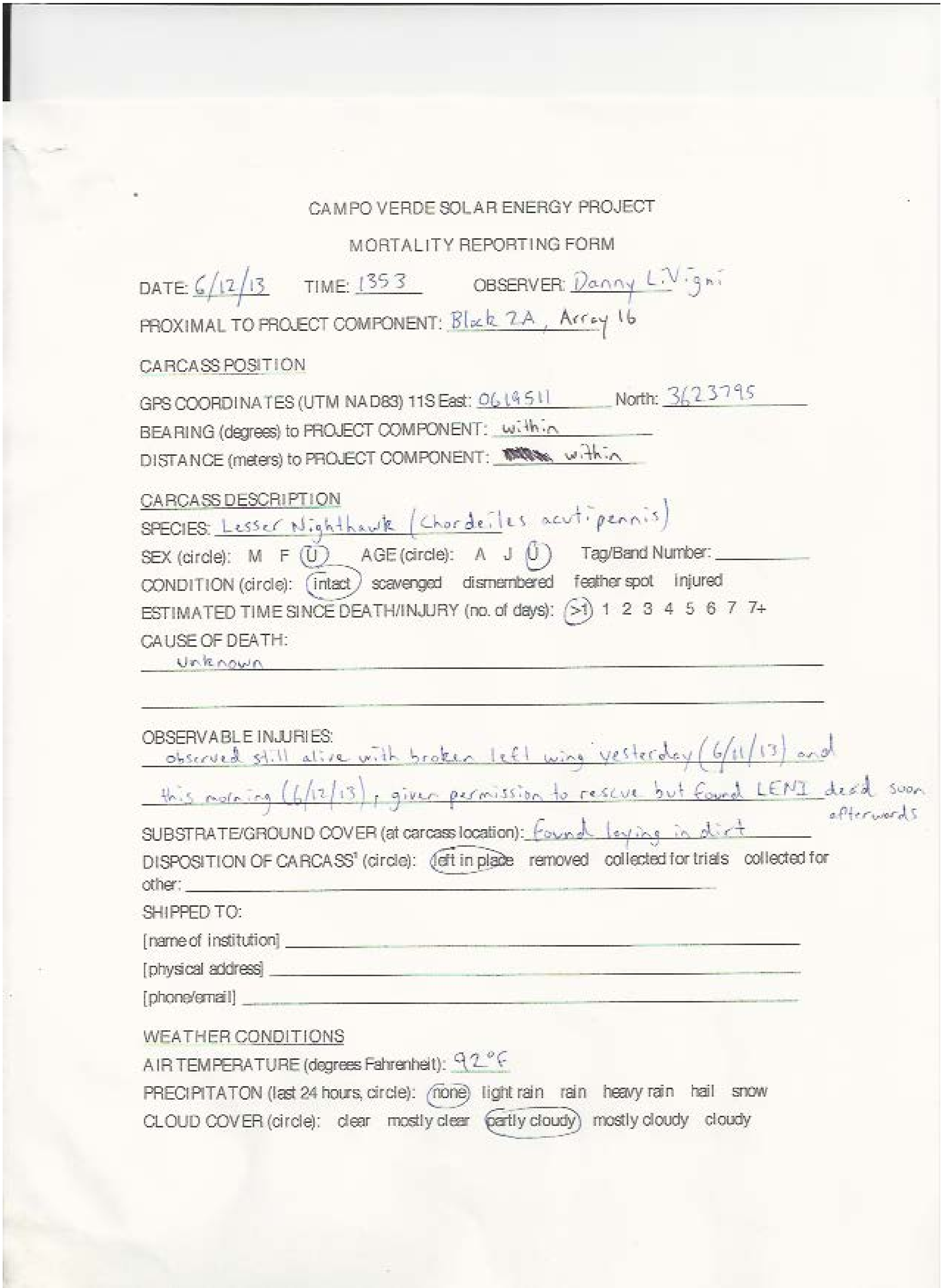
[3] Indicate who was notified of the event, date, time, etc.

Pink 105-0146

Pink 105-0148

Pink 105-0149

Pink 105-0150



CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 6/12/13 TIME: 1353 OBSERVER: Danny LiVigni

PROXIMAL TO PROJECT COMPONENT: Block 2A, Array 16

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0619511 North: 3623795

BEARING (degrees) to PROJECT COMPONENT: within

DISTANCE (meters) to PROJECT COMPONENT: within

CARCASS DESCRIPTION

SPECIES: Lesser Nighthawk (Chordeiles acutipennis)

SEX (circle): M F [✓ U] AGE (circle): A J [✓ U] Tag/Band Number: ________

CONDITION (circle): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:

Unknown

OBSERVABLE INJURIES:

observed still alive with broken left wing yesterday (6/11/13) and this morning (6/12/13), given permission to rescue but found LENI dead soon afterwards

SUBSTRATE/GROUND COVER (at carcass location): Found laying in dirt

DISPOSITION OF CARCASS¹ (circle): [✓ left in place] removed collected for trials collected for other: ________

SHIPPED TO:

[name of institution] ________

[physical address] ________

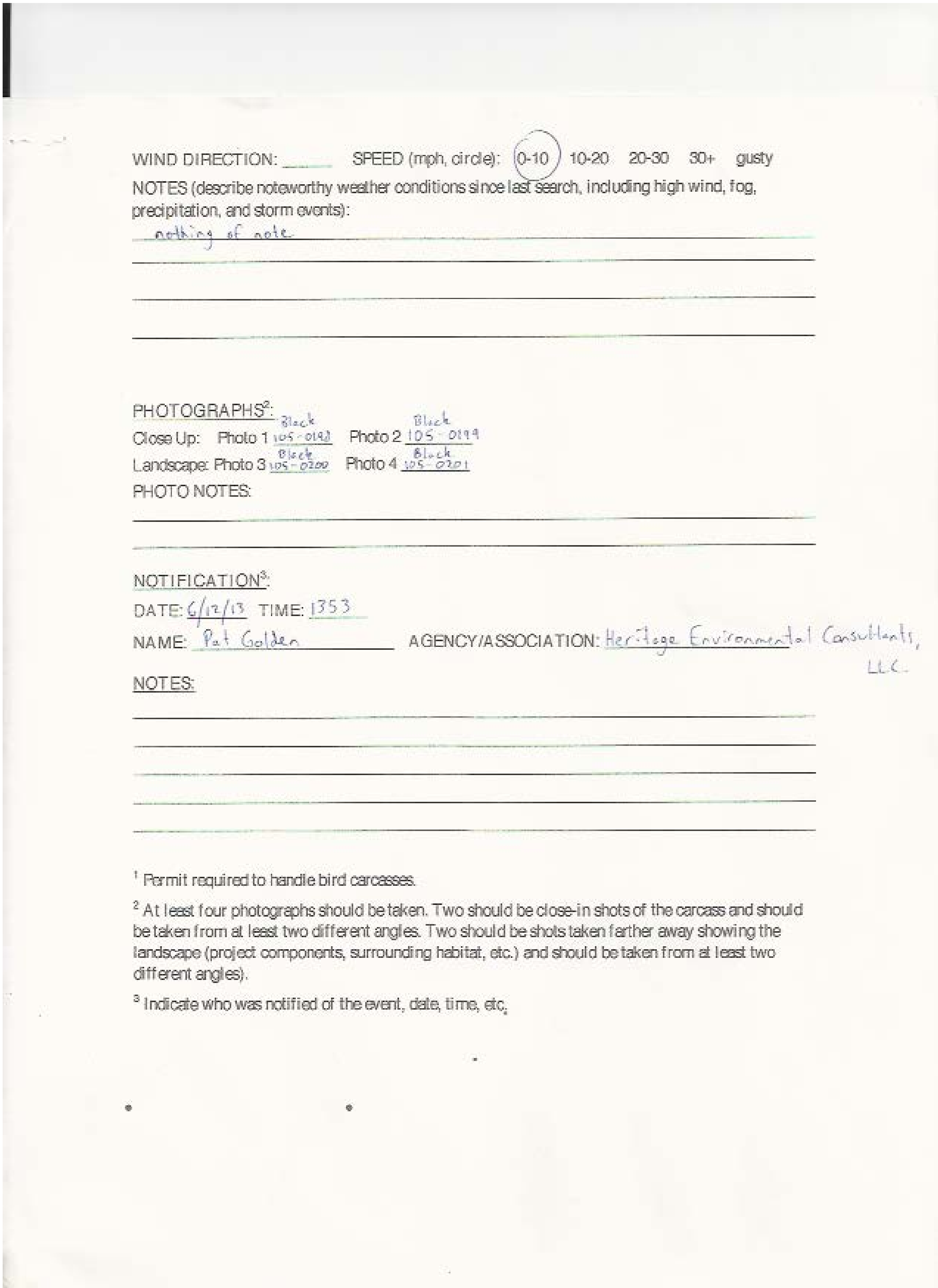
[phone/email] ________

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 92°F

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): clear mostly clear [✓ partly cloudy] mostly cloudy cloudy



WIND DIRECTION: ______ SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

nothing of note

PHOTOGRAPHS[2]:

Close Up: Photo 1 Black 105-0198 Photo 2 Black 105-0199

Landscape: Photo 3 Black 105-0200 Photo 4 Black 105-0201

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 6/12/13 TIME: 1353

NAME: Pat Golden AGENCY/ASSOCIATION: Heritage Environmental Consultants, LLC

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

Black 105-0198

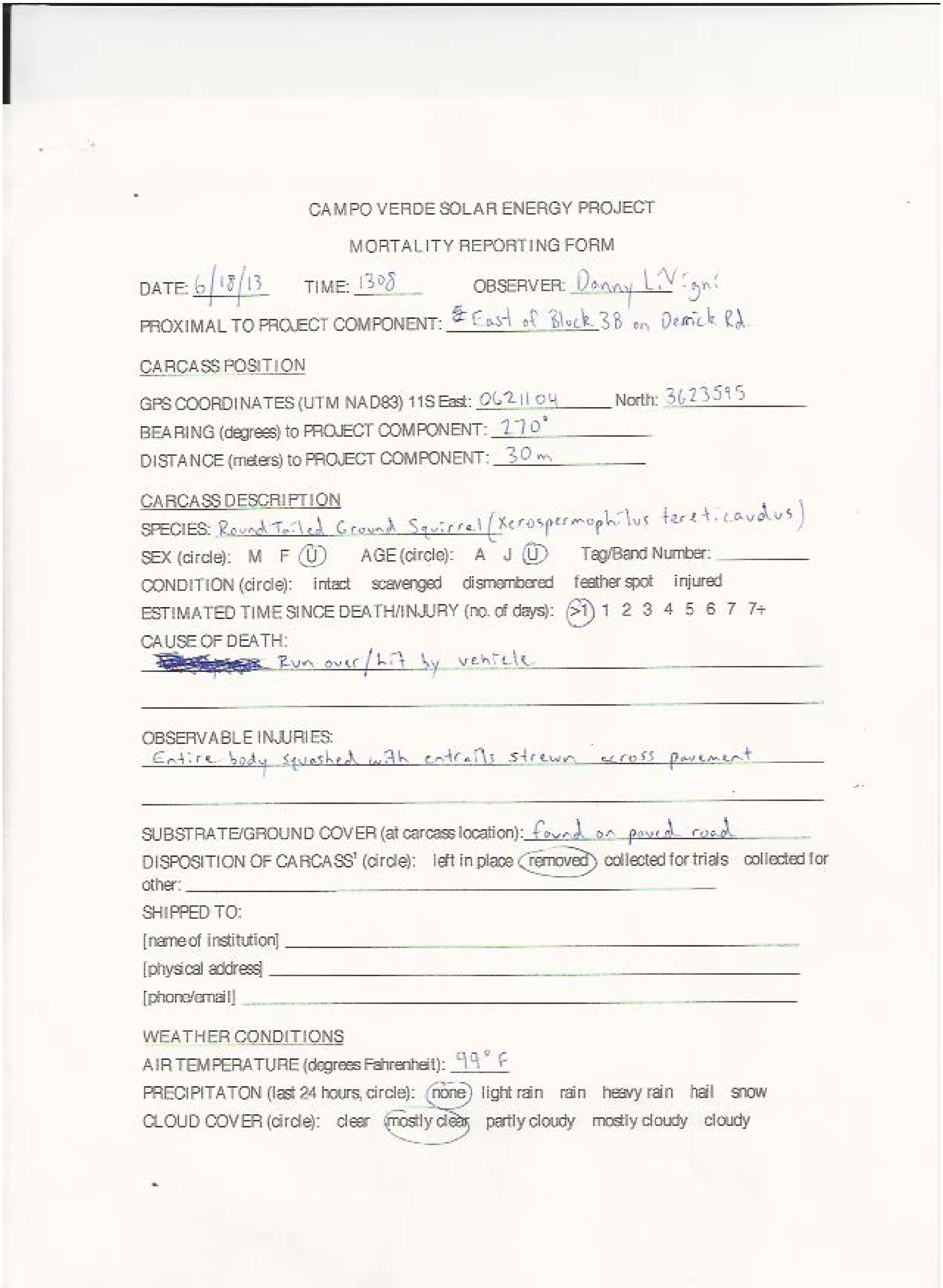
DANNY LIVIGNI
6/12/13 @ 1353
Lesser Nighthawk
(Chordeiles acutipennis)

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Black 105-0199

Black 105-0200

Black 105-0201



CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 6/18/13 TIME: 1308 OBSERVER: Danny LiVigni

PROXIMAL TO PROJECT COMPONENT: East of Block 3B on Derrick Rd.

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0621104 North: 3623595

BEARING (degrees) to PROJECT COMPONENT: 270°

DISTANCE (meters) to PROJECT COMPONENT: 30 m

CARCASS DESCRIPTION

SPECIES: Round Tailed Ground Squirrel (Xerospermophilus tereticaudus)

SEX (circle): M F [✓ U] AGE (circle): A J [✓ U] Tag/Band Number: ______

CONDITION (circle): intact scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:

[redacted] Run over/hit by vehicle

OBSERVABLE INJURIES:

Entire body squashed with entrails strewn across pavement

SUBSTRATE/GROUND COVER (at carcass location): found on paved road

DISPOSITION OF CARCASS¹ (circle): left in place [✓ removed] collected for trials collected for other: ______

SHIPPED TO:

[name of institution] ______

[physical address] ______

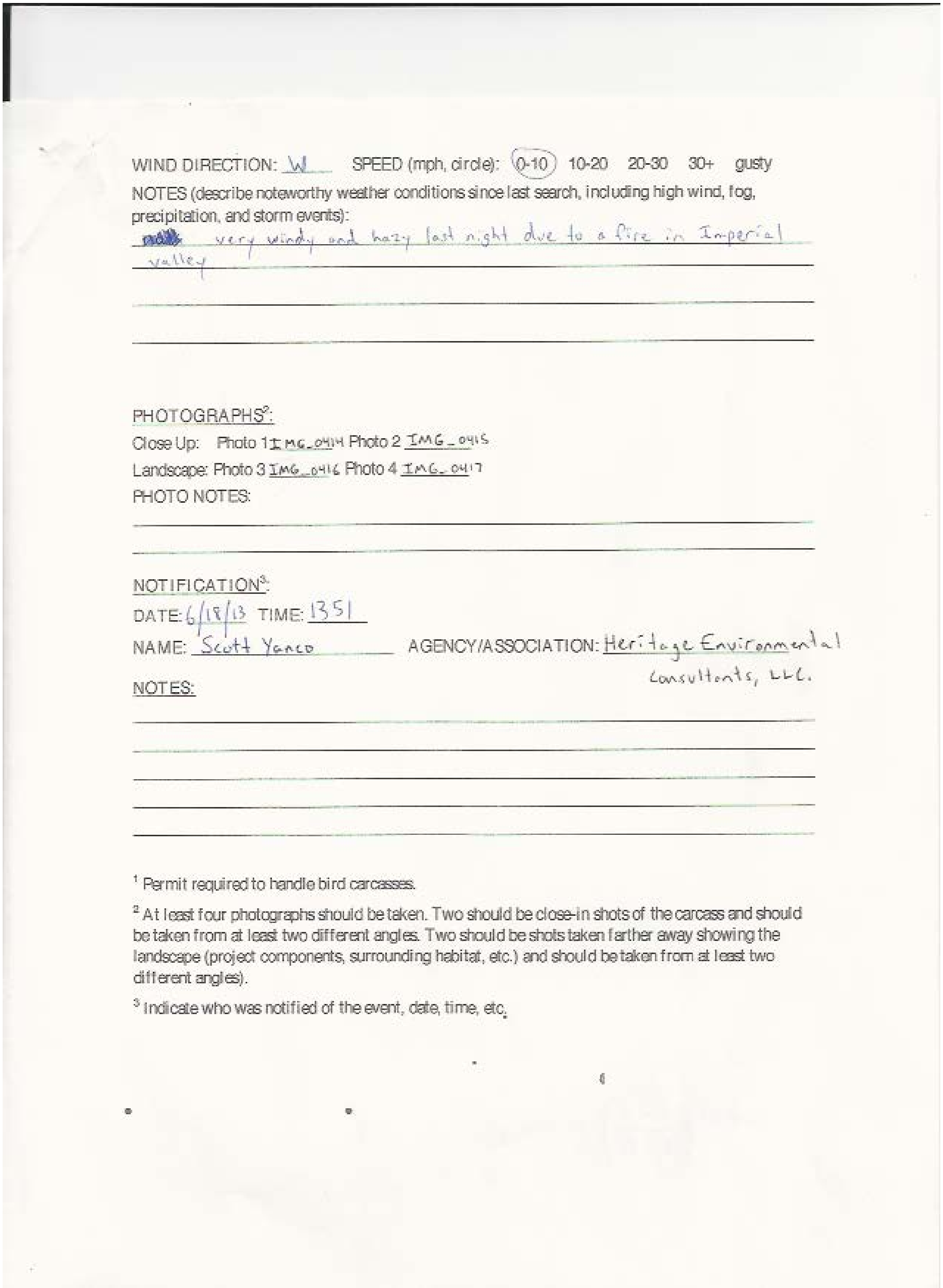
[phone/email] ______

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 99° F

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): clear [✓ mostly clear] partly cloudy mostly cloudy cloudy



WIND DIRECTION: W SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

very windy and hazy last night due to a fire in Imperial valley

PHOTOGRAPHS[2]:

Close Up: Photo 1 IMG_0414 Photo 2 IMG_0415

Landscape: Photo 3 IMG_0416 Photo 4 IMG_0417

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 6/18/13 TIME: 1351

NAME: Scott Yanco AGENCY/ASSOCIATION: Heritage Environmental Consultants, LLC.

NOTES:

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

IMG_0414

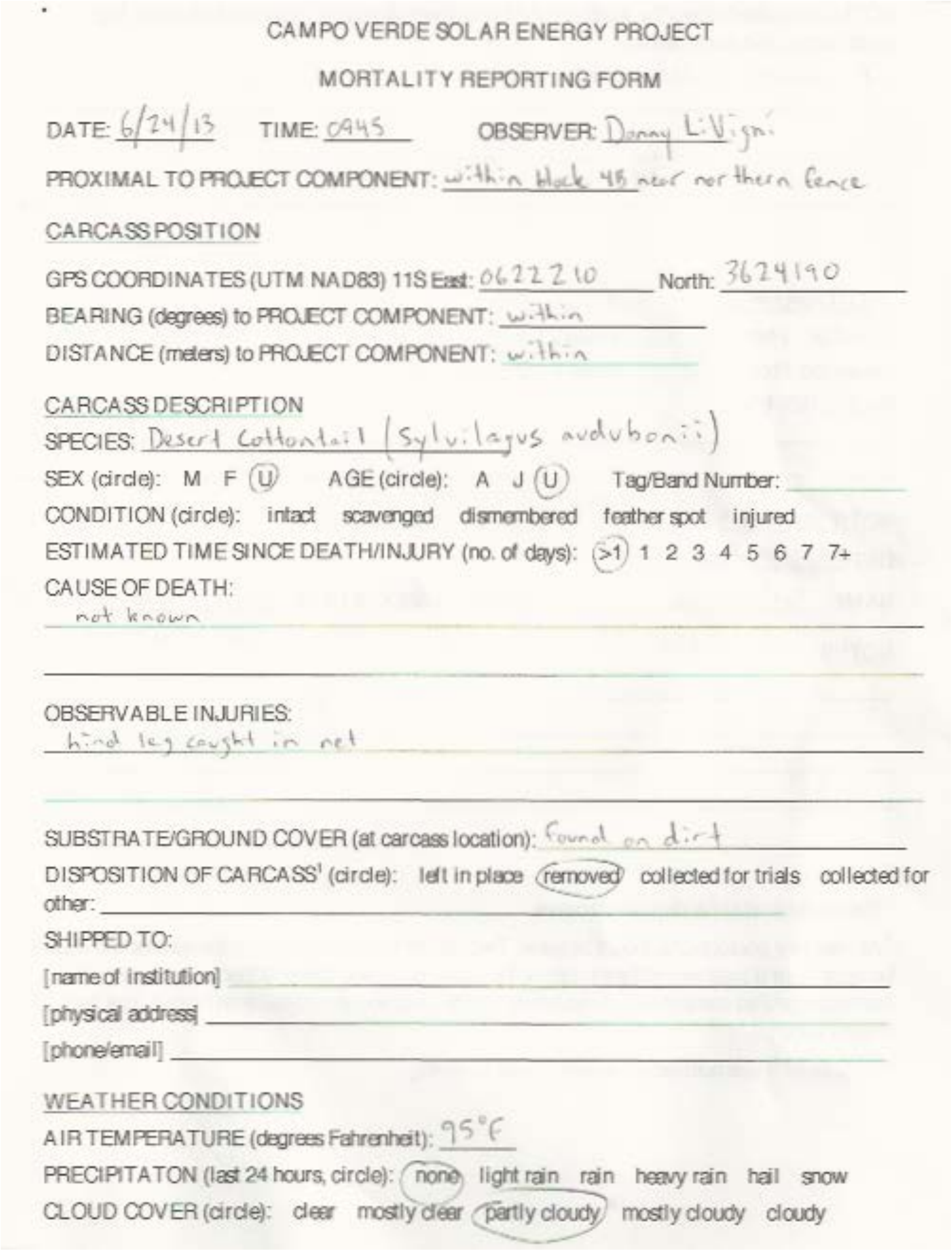

DANNY LIVIGN
6/18/13 @ 1308
Round-Tailed Ground Squi
(Xerospermophilus tereticaudus)

IMG_0415


DANNY LIVIGNI
6/18/13 @ 1308
Round-Tailed Ground Sq
(Xerospermophilus tereticaudus)

IMG_0416

IMG_0417



CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 6/24/13 TIME: 0945 OBSERVER: Danny LiVigni

PROXIMAL TO PROJECT COMPONENT: within block 4B near northern fence

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0622210 North: 3624190

BEARING (degrees) to PROJECT COMPONENT: within

DISTANCE (meters) to PROJECT COMPONENT: within

CARCASS DESCRIPTION

SPECIES: Desert Cottontail (Sylvilagus audubonii)

SEX (circle): M F [✓ U] AGE (circle): A J [✓ U] Tag/Band Number:

CONDITION (circle): intact scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:

not known

OBSERVABLE INJURIES:

hind leg caught in net

SUBSTRATE/GROUND COVER (at carcass location): found on dirt

DISPOSITION OF CARCASS[1] (circle): left in place [✓ removed] collected for trials collected for other:

SHIPPED TO:

[name of institution]

[physical address]

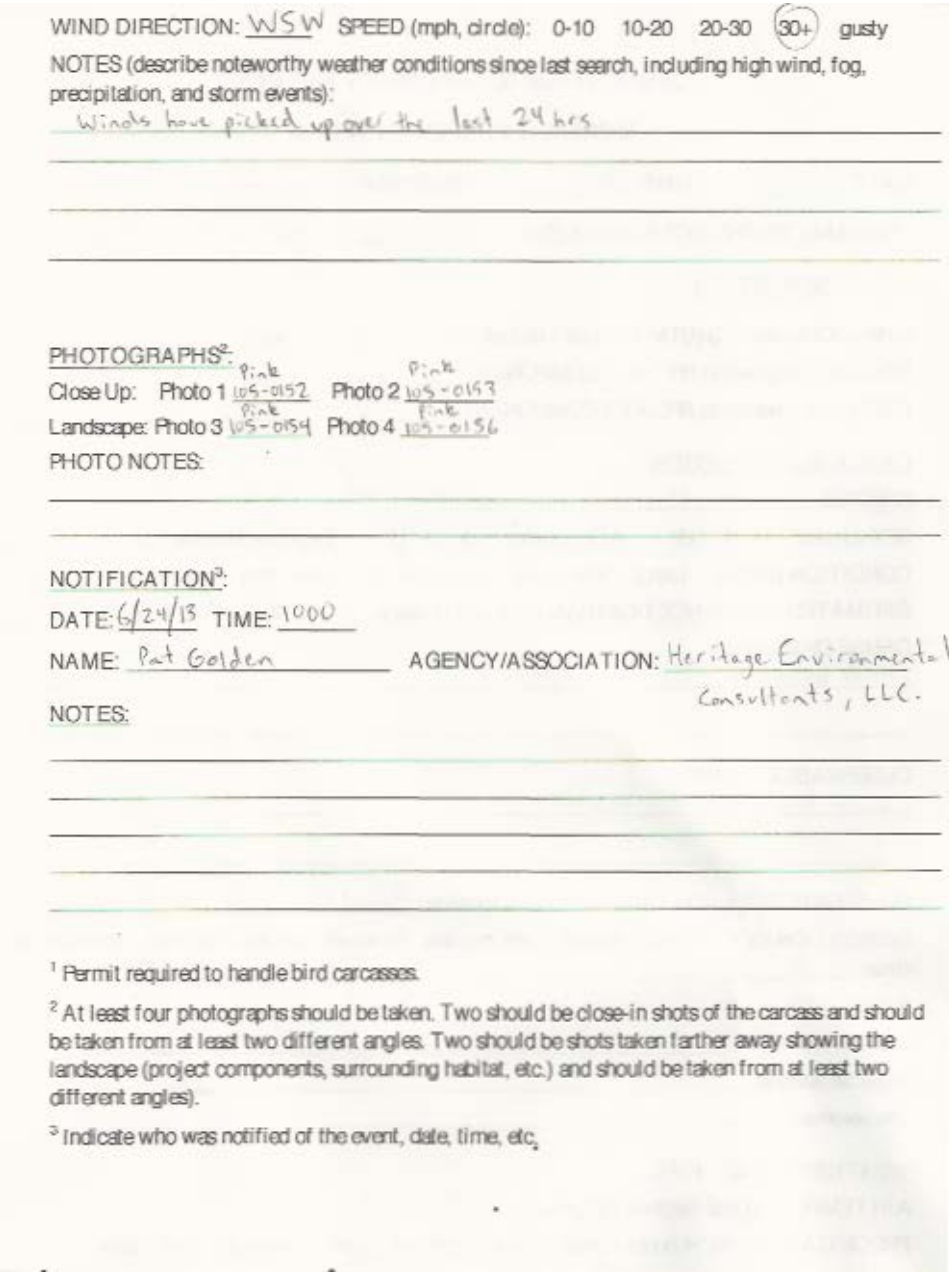
[phone/email]

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 95°F

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): clear mostly clear [✓ partly cloudy] mostly cloudy cloudy



WIND DIRECTION: WSW SPEED (mph, circle): 0-10 10-20 20-30 [✓ 30+] gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

Winds have picked up over the last 24 hrs

PHOTOGRAPHS[2]:

Close Up: Photo 1 Pink 105-0152 Photo 2 Pink 105-0153

Landscape: Photo 3 Pink 105-0154 Photo 4 Pink 105-0156

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 6/24/13 TIME: 1000

NAME: Pat Golden AGENCY/ASSOCIATION: Heritage Environmental Consultants, LLC.

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

Pink 105-0152

Pink 105-0153

Pink 105-0154

Pink 105-0156

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 6/25/13 TIME: 1300 OBSERVER: TMN

PROXIMAL TO PROJECT COMPONENT: IN

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 50619945 North: 3624003

BEARING (degrees) to PROJECT COMPONENT: ____

DISTANCE (meters) to PROJECT COMPONENT: ____

CARCASS DESCRIPTION

SPECIES: rabbit

SEX (circle): M F [✓ U] AGE (circle): A J [✓ U] Tag/Band Number: ____

CONDITION (circle): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): >1 1 [✓ 2] 3 4 5 6 7 7+

CAUSE OF DEATH:

unknown

OBSERVABLE INJURIES:

~~unk~~none

SUBSTRATE/GROUND COVER (at carcass location): vault floor

DISPOSITION OF CARCASS¹ (circle): left in place [✓ removed] collected for trials collected for other: ____

SHIPPED TO:

[name of institution] ____

[physical address] ____

[phone/email] ____

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 98°

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): clear [✓ mostly clear] partly cloudy mostly cloudy cloudy

WIND DIRECTION: ENE SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 105-0159 Photo 2 105-0160

Landscape: Photo 3 105-0157 Photo 4 105-0161

PHOTO NOTES:

pink camera

NOTIFICATION[3]:

DATE: ______ TIME: ______

NAME: Pat AGENCY/ASSOCIATION: ______

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

105-0157 pink camera

105-0159 pink camera

105-0160 pink camera

105-0161 pink camera

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 7-12-13 TIME: 1400 OBSERVER: Tyler Morrison

PROXIMAL TO PROJECT COMPONENT: ARRAY 2 of Block 3A

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0620035 North: 3625162

BEARING (degrees) to PROJECT COMPONENT: ____

DISTANCE (meters) to PROJECT COMPONENT: <1m from array table

CARCASS DESCRIPTION

SPECIES: Lesser Nighthawk

SEX (circle): M F [✓ U] AGE (circle): [✓ A] J U Tag/Band Number: —

CONDITION (circle): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): >1 1 2 3 4 [✓ 5] 6 7 7+

CAUSE OF DEATH:

Unknown

OBSERVABLE INJURIES:

Too old to discern

SUBSTRATE/GROUND COVER (at carcass location): Bare dirt

DISPOSITION OF CARCASS[1] (circle): [✓ left in place] removed collected for trials collected for other: ____

SHIPPED TO:

[name of institution] ____

[physical address] ____

[phone/email] ____

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 100

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: — SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

None

PHOTOGRAPHS[2]:

Close Up: Photo 1 631 Photo 2 028

Landscape: Photo 3 535 Photo 4 985

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 7-12-13 TIME: 1420

NAME: Patrick Golden AGENCY/ASSOCIATION: Heritage Env. Consultants

NOTES:

Email sent to Pat to be forwarded

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

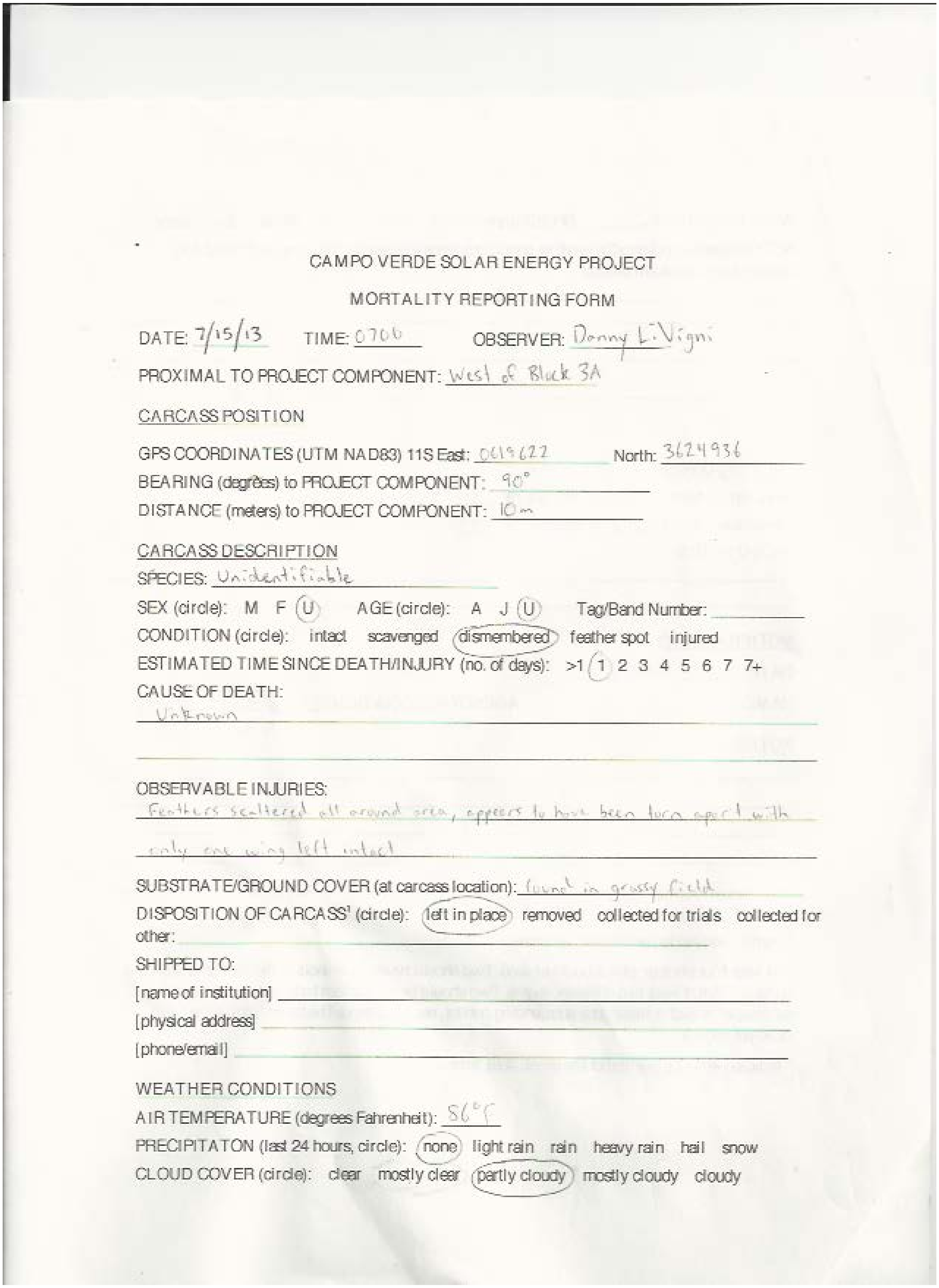
[3] Indicate who was notified of the event, date, time, etc.

Photo #631

Photo #028

Photo #535

Photo #985



CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 7/15/13 TIME: 0700 OBSERVER: Danny LiVigni

PROXIMAL TO PROJECT COMPONENT: West of Block 3A

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0619622 North: 3624936

BEARING (degrees) to PROJECT COMPONENT: 90°

DISTANCE (meters) to PROJECT COMPONENT: 10 m

CARCASS DESCRIPTION

SPECIES: Unidentifiable

SEX (circle): M F [✓ U] AGE (circle): A J [✓ U] Tag/Band Number: ______

CONDITION (circle): intact scavenged [✓ dismembered] feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): >1 [✓ 1] 2 3 4 5 6 7 7+

CAUSE OF DEATH:

Unknown

OBSERVABLE INJURIES:

Feathers scattered all around area, appears to have been torn apart with only one wing left intact

SUBSTRATE/GROUND COVER (at carcass location): found in grassy field

DISPOSITION OF CARCASS[1] (circle): [✓ left in place] removed collected for trials collected for other: ______

SHIPPED TO:

[name of institution] ______

[physical address] ______

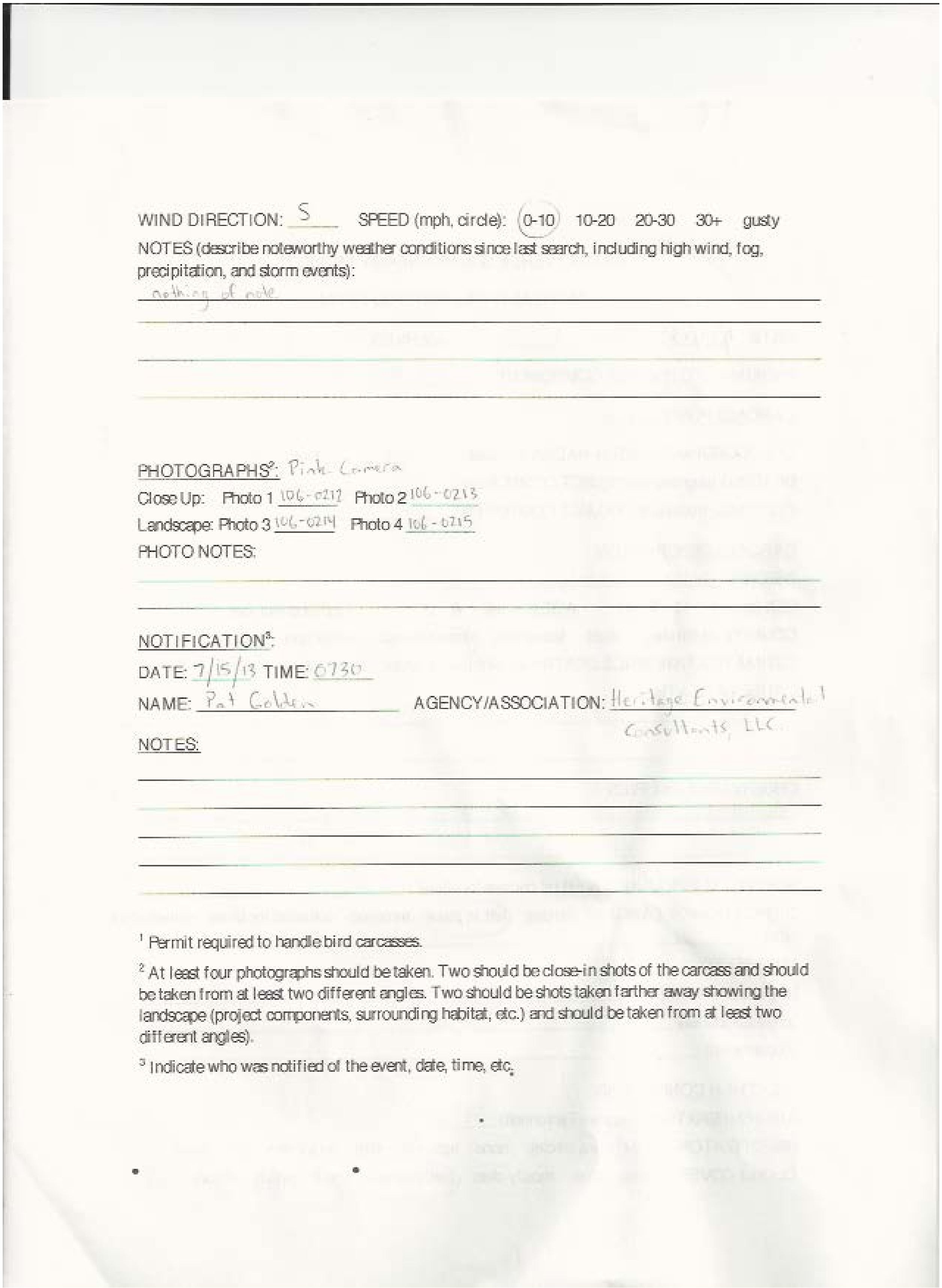
[phone/email] ______

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 86°F

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): clear mostly clear [✓ partly cloudy] mostly cloudy cloudy



WIND DIRECTION: S SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

nothing of note

PHOTOGRAPHS[2]: Pink Camera

Close Up: Photo 1 106-0212 Photo 2 106-0213

Landscape: Photo 3 106-0214 Photo 4 106-0215

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 7/15/13 TIME: 0730

NAME: Pat Golden AGENCY/ASSOCIATION: Heritage Environmental Consultants, LLC

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

Pink 106-0212

Pink 106-0213

Pink 106-0214

Pink 106-0215

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 7-16-13 TIME: 0945 OBSERVER: JMS

PROXIMAL TO PROJECT COMPONENT: ______

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 619251 North: 3623333

BEARING (degrees) to PROJECT COMPONENT: 90° Shelter 15 in Block 2

DISTANCE (meters) to PROJECT COMPONENT: 70 m

CARCASS DESCRIPTION

SPECIES: Brown Pelican

SEX (circle): M F [✓ U] AGE (circle): [✓ A] J U Tag/Band Number: N/A

CONDITION (circle): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): >1 1 [✓ 2] 3 4 5 6 7 7+

CAUSE OF DEATH:
Unknown

OBSERVABLE INJURIES:
None

SUBSTRATE/GROUND COVER (at carcass location): Compacted dirt

DISPOSITION OF CARCASS¹ (circle): [✓ left in place] removed collected for trials collected for other: ______

SHIPPED TO:
[name of institution] ______
[physical address] ______
[phone/email] ______

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 96°

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): clear mostly clear partly cloudy [✓ mostly cloudy] cloudy

WIND DIRECTION: E SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 IMG_4367 Photo 2 IMG_4370

Landscape: Photo 3 4369 Photo 4 4369

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 7-16-13 TIME 0905

NAME: Pat Golden AGENCY/ASSOCIATION: Heritage Environmental

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

4367	
4370	

4368	
4369	

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 8/6/13 TIME: 930 OBSERVER: JKR

PROXIMAL TO PROJECT COMPONENT: 3B

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0621080 North: 3623547

BEARING (degrees) to PROJECT COMPONENT: 270°

DISTANCE (meters) to PROJECT COMPONENT: 5m to fence
15m to panels

CARCASS DESCRIPTION

SPECIES: Burrowing Owl Athene cunicularia

SEX (circle): M F [✓ U] AGE (circle): A [✓ J] U Tag/Band Number: ____

CONDITION (circle): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): >1 1 2 3 4 5 6 7 [✓ 7+]

CAUSE OF DEATH:
unknown

OBSERVABLE INJURIES:
none

SUBSTRATE/GROUND COVER (at carcass location): bare ground

DISPOSITION OF CARCASS[1] (circle): [✓ left in place] removed collected for trials collected for other: ____

SHIPPED TO:
[name of institution] ____
[physical address] ____
[phone/email] ____

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 88°

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): clear [✓ mostly clear] partly cloudy mostly cloudy cloudy

WIND DIRECTION: ______ SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 B-~~[illegible]~~ 0247 Photo 2 B-0248

Landscape: Photo 3 B-0249 Photo 4 B-0250

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 8/6/13 TIME: 0930

NAME: Pat Golden AGENCY/ASSOCIATION: Heritage

NOTES:

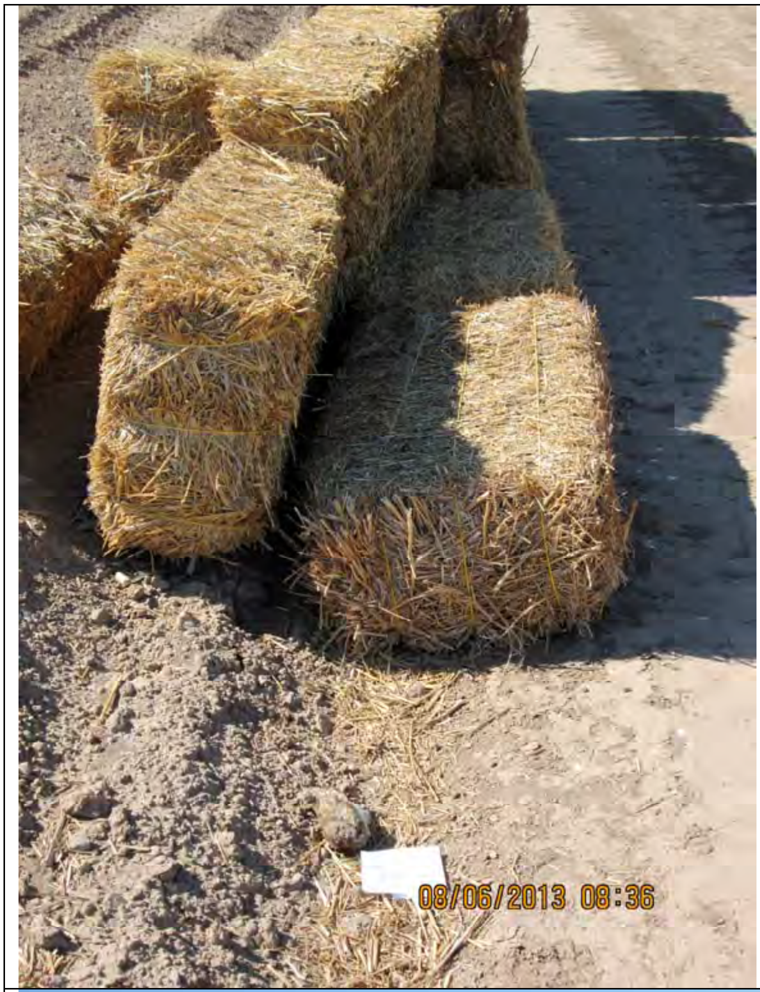
---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

	BUOW B-0247
	B-0248

 08/06/2013 08:36	B-0249
 08/06/2013 08:37	B-0250

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 8/28/13 TIME: 0802 OBSERVER: Tyler Morrison

PROXIMAL TO PROJECT COMPONENT: Inside guard shack in 1S

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0620409 North: 3622605

BEARING (degrees) to PROJECT COMPONENT: 90° to 1S gate

DISTANCE (meters) to PROJECT COMPONENT: 15 meters

CARCASS DESCRIPTION

SPECIES: Domestic Rat

SEX (circle): M F [✓ U] AGE (circle): [✓ A] J U Tag/Band Number: ___

CONDITION (circle): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:

Run over by car

OBSERVABLE INJURIES:

Innards on outside

SUBSTRATE/GROUND COVER (at carcass location): Hard dirt

DISPOSITION OF CARCASS[1] (circle): left in place [✓ removed] collected for trials collected for other: Buried

SHIPPED TO:

[name of institution] ___

[physical address] ___

[phone/email] ___

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 90°F

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): clear mostly clear partly cloudy mostly cloudy [✓ cloudy]

WIND DIRECTION: NA SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 103-9228 Photo 2 103-9230

Landscape: Photo 3 103-9231 Photo 4 103-9232

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 8-28-13 TIME: 0818

NAME: Patrick Golden AGENCY/ASSOCIATION: Heritage Enviranental

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

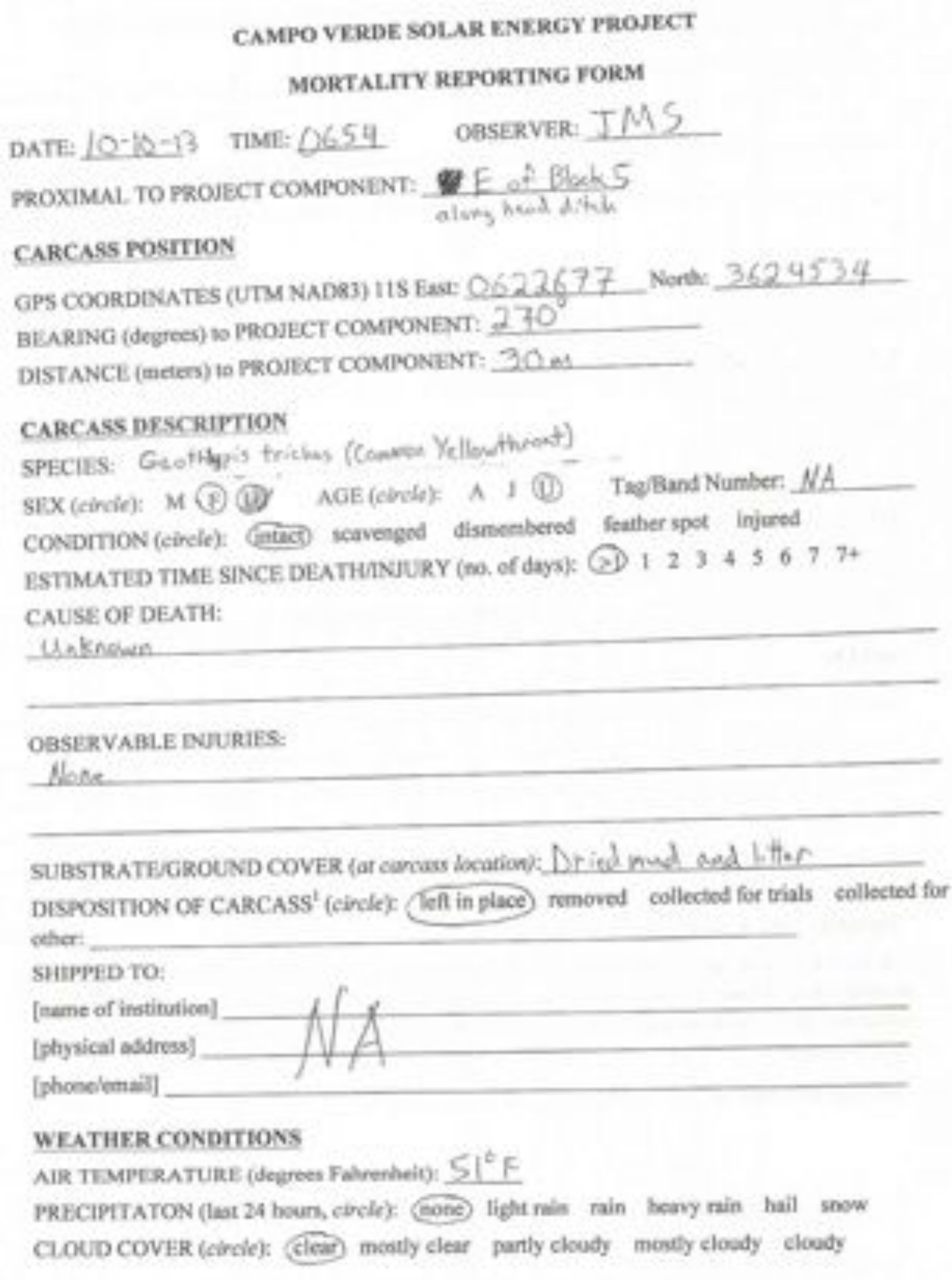
[3] Indicate who was notified of the event, date, time, etc.

IMG_9228

IMG_9230

IMG_9231

IMG_9232



CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 10-10-13 TIME: 0654 OBSERVER: JMS

PROXIMAL TO PROJECT COMPONENT: E of Block 5 along head ditch

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0622677 North: 3624534

BEARING (degrees) to PROJECT COMPONENT: 270°

DISTANCE (meters) to PROJECT COMPONENT: 30 m

CARCASS DESCRIPTION

SPECIES: Geothlypis trichas (Common Yellowthroat)

SEX (*circle*): M [✓ F] [✓ U] AGE (*circle*): A J [✓ U] Tag/Band Number: NA

CONDITION (*circle*): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ <1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:
Unknown

OBSERVABLE INJURIES:
None

SUBSTRATE/GROUND COVER (*at carcass location*): Dried mud and litter

DISPOSITION OF CARCASS[1] (*circle*): [✓ left in place] removed collected for trials collected for other:

SHIPPED TO:
[name of institution] NA
[physical address]
[phone/email]

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 51°F

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: W SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

High wind yesterday (45 mph gusts)

PHOTOGRAPHS[2]:

Close Up: Photo 1 IMG_4791 Photo 2 IMG_4793

Landscape: Photo 3 IMG_4795 Photo 4 IMG_4796

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 10-16-13 TIME: 0659

NAME: Pat Golden AGENCY/ASSOCIATION: Heritage Environmental

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

IMG_4791	
IMG_4793	

IMG_4795	
IMG_4796	

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 7/25/13 TIME: 1354 OBSERVER: P. Golden

PROXIMAL TO PROJECT COMPONENT: Pad 10 (Structure 10)

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 620225 North: 3621341

BEARING (degrees) to PROJECT COMPONENT: 0h

DISTANCE (meters) to PROJECT COMPONENT: 0n

CARCASS DESCRIPTION

SPECIES: Desert iguana

SEX (*circle*): M F [✓ U] AGE (*circle*): A [✓ J] U Tag/Band Number: 0

CONDITION (*circle*): intact scavenged [✓ dismembered] feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:
Bull dozer (Sub surface)

OBSERVABLE INJURIES:
Severed body

SUBSTRATE/GROUND COVER (*at carcass location*): Sand / Bladed

DISPOSITION OF CARCASS[1] (*circle*): [✓ left in place] removed collected for trials collected for other: Buried

SHIPPED TO:
[name of institution]
[physical address]
[phone/email]

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 98

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: W SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 13 Photo 2 ______

Landscape: Photo 3 ______ Photo 4 ______

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 4/28/13 TIME: ______

NAME: Kim Marsden AGENCY/ASSOCIATION: BLM

Magdalena Rodriguez CDFW

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 5/2/13 TIME: 1440 OBSERVER: S. Yanco

PROXIMAL TO PROJECT COMPONENT: Gen-tie access rd.

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 620258 North: 3621316

BEARING (degrees) to PROJECT COMPONENT: n/a

DISTANCE (meters) to PROJECT COMPONENT: 0

CARCASS DESCRIPTION

SPECIES: Flat-tailed horned lizard

SEX (circle): M F [✓ U] AGE (circle): [✓ A] J U Tag/Band Number: n/a

CONDITION (circle): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:
Apparent crushing injury to head

OBSERVABLE INJURIES:
Head crush, left leg trauma

SUBSTRATE/GROUND COVER (at carcass location): compacted sand

DISPOSITION OF CARCASS[1] (circle): left in place removed collected for trials [✓ collected for other]: possible curation

SHIPPED TO:
[name of institution] awaiting direction from CDFW
[physical address]
[phone/email]

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 32° C

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: N SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 28 Photo 2 29

Landscape: Photo 3 30 Photo 4 31

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 5/2/13 TIME: 1445

NAME: K. Grant / P. Golden AGENCY/ASSOCIATION: EGI / Heritage

NOTES:

Located immediately following survey ahead – apparently crushed by water truck.

K. Grant notified P. Godfrey. S. Yanco will forward to BLM + CDFW

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 5/4/13 TIME: 1233 OBSERVER: S. Yanco

PROXIMAL TO PROJECT COMPONENT: IID access route to gen-tie str. 5

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 619862 North: 3622315

BEARING (degrees) to PROJECT COMPONENT: n/a

DISTANCE (meters) to PROJECT COMPONENT: 0

CARCASS DESCRIPTION

SPECIES: Caprimulgidae sp.

SEX (circle): M F [✓ U] AGE (circle): [✓ A] J U Tag/Band Number: n/a

CONDITION (circle): intact [✓ scavenged] [✓ dismembered] feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): >1 1 2 [✓ 3 4 5] 6 7 7+

CAUSE OF DEATH:
unknown.

OBSERVABLE INJURIES:
body significantly decayed, damaged – lots of insects. Possibly brought to rd post mortem by scavenger/predator.

SUBSTRATE/GROUND COVER (at carcass location): Packed sand/silt (road)

DISPOSITION OF CARCASS[1] (circle): [✓ left in place] removed collected for trials collected for [✓ other]: moved to side of rd. (no permission to bury on IID)

SHIPPED TO:
[name of institution] n/a
[physical address]
[phone/email]

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 41°C

PRECIPITATON (last 24 hours, circle): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (circle): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

Photo 32

Photo 33

Photo 34

Photo 35

WIND DIRECTION: WNW SPEED (mph, circle): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

none

PHOTOGRAPHS[2]:

Close Up: Photo 1 32 Photo 2 33

Landscape: Photo 3 34 Photo 4 35

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 5/4 TIME: 245

NAME: P. Golden AGENCY/ASSOCIATION: Heritage EC

NOTES:

Reported by construction crews when first accessing site - no obvious sign of collision or crushing.

Will forward to CDFW/USFWS

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 3/12/13 TIME: 1647 OBSERVER: CONOR BLANCHET

PROXIMAL TO PROJECT COMPONENT: 1. NORTH

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0619866 North: 3623236

BEARING (degrees) to PROJECT COMPONENT: 0°

DISTANCE (meters) to PROJECT COMPONENT: 25m

CARCASS DESCRIPTION

SPECIES: Desert cottontail (Sylvagus audobonii) * 5 INDIVIDUALS. ALL WITHIN 10CM OF ONE ANOTHER

SEX (*circle*): M F [✓ U] AGE (*circle*): A [✓ J] U Tag/Band Number: ________

CONDITION (*circle*): intact scavenged dismembered feather spot [✓ injured]

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ <1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:

CRUSHING

OBSERVABLE INJURIES:

CRUSHING - RELATED INJURIES

SUBSTRATE/GROUND COVER (*at carcass location*): CLEARED GROUND/DIRT

DISPOSITION OF CARCASS[1] (*circle*): [✓ left in place] removed collected for trials collected for other: ________

SHIPPED TO:

[name of institution] ________

[physical address] ________

[phone/email] ________

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 84°F

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: S SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]:

Close Up: Photo 1 102-0112 Photo 2 102-0113

Landscape: Photo 3 02-0114 Photo 4 102-0115

PHOTO NOTES:

TAKEN WITH BLACK CAMERA

NOTIFICATION[3]:

DATE: _______ TIME: _______

NAME: ______________________ AGENCY/ASSOCIATION: ____________________

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

Photo 1. 102-0112. Close Up

Photo 2. 102-0113. Close Up

Photo 3. 102-0114. Distance

Photo 4. 102-0115. Distance

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 3/12/13 TIME: 1624 OBSERVER: CONOR BLANCHET

PROXIMAL TO PROJECT COMPONENT: 1 SOUTH

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0619760 North: 3623104

BEARING (degrees) to PROJECT COMPONENT: 180°

DISTANCE (meters) to PROJECT COMPONENT: 30 m

CARCASS DESCRIPTION

SPECIES: Desert cottontail (Sylvagis audobonii) *TWO INDIVIDUALS, BOTH JUVENILE, SAME LOCATION, <5CM APART

SEX (*circle*): M F [✓ U] AGE (*circle*): A [✓ J] U Tag/Band Number: ________

CONDITION (*circle*): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:

UNKNOWN

OBSERVABLE INJURIES:

NONE

SUBSTRATE/GROUND COVER (*at carcass location*): CLEAR GROUND/DIRT

DISPOSITION OF CARCASS[1] (*circle*): [✓ left in place] removed collected for trials collected for other: ________

SHIPPED TO:

[name of institution] ________

[physical address] ________

[phone/email] ________

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 84°F

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: S SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]**:**

Close Up: Photo 1 102-0110 Photo 2 102-0116

Landscape: Photo 3 102-0111 Photo 4 102-0117

PHOTO NOTES:

TAKEN WITH BLACK CAMERA

NOTIFICATION[3]**:**

DATE: ______ TIME: ______

NAME: ____________________ AGENCY/ASSOCIATION: ____________________

NOTES:

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

Photo 1. 102-0110. Close up

Photo 2. 102-0116. Close up.

Photo 3. 102-0111 Distance.

Photo 4. 102-0117 Distance.

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

FEDERAL FISH AND WILDLIFE PERMIT

2. AUTHORITY-STATUTES
16 USC 703-712

REGULATIONS
50 CFR Part 13
50 CFR 21.27

1. PERMITTEE

CAMPO VERDE SOLAR LLC
600 NORTH 18TH STREET
BIRMINGHAM, AL 35203
U.S.A.

3. NUMBER
MB25086B-0

4. RENEWABLE
☒ YES
☐ NO

5. MAY COPY
☒ YES
☐ NO

6. EFFECTIVE
09/12/2014

7. EXPIRES
03/12/2017

8. NAME AND TITLE OF PRINCIPAL OFFICER *(If #1 is a business)*
SUSAN B. COMENSKY
EXTERNAL AND REGULATORY AFFAIRS

9. TYPE OF PERMIT
MIGRATORY BIRD SPECIAL PURPOSE UTILITY PERMIT - SOLAR

10. LOCATION WHERE AUTHORIZED ACTIVITY MAY BE CONDUCTED
Records Location: 1148 Liebert Road El Centro, CA 92243
Carcasses Collection Location: 11S E 620265 N 3622752
Carcasses Stored: 1601 Drew Road, Unit 16 El Centro, CA 92243

11. CONDITIONS AND AUTHORIZATIONS:

A. GENERAL CONDITIONS SET OUT IN SUBPART D OF 50 CFR 13, AND SPECIFIC CONDITIONS CONTAINED IN FEDERAL REGULATIONS CITED IN BLOCK #2 ABOVE, ARE HEREBY MADE A PART OF THIS PERMIT. ALL ACTIVITIES AUTHORIZED HEREIN MUST BE CARRIED OUT IN ACCORD WITH AND FOR THE PURPOSES DESCRIBED IN THE APPLICATION SUBMITTED. CONTINUED VALIDITY, OR RENEWAL, OF THIS PERMIT IS SUBJECT TO COMPLETE AND TIMELY COMPLIANCE WITH ALL APPLICABLE CONDITIONS, INCLUDING THE FILING OF ALL REQUIRED INFORMATION AND REPORTS.

B. THE VALIDITY OF THIS PERMIT IS ALSO CONDITIONED UPON STRICT OBSERVANCE OF ALL APPLICABLE FOREIGN, STATE, LOCAL, TRIBAL, OR OTHER FEDERAL LAW.

C. VALID FOR USE BY PERMITTEE NAMED ABOVE.

This permit does not supersede any State Requirements. You are responsible for ensuring that you are in compliance with all State laws, including but not limited to California Fish and Game Code 3511 (fully protected species) 3503.5 and 3513. For additional information on State requirements please contact: California Department of Fish and Wildlife, Magdalena Rodriguez, 909-945-3294.

D. **Possession and transport.**

1) You and subpermittees are authorized to handle, collect, transport and temporarily possess carcasses and partial remains of birds protected under the Migratory Bird Treaty Act, **except Bald Eagles and Golden Eagles (Eagles)** and species listed as **Threatened or Endangered** under the U.S Endangered Species Act (see 50 CFR § 17.11), found at the location/property specified in Block 10 for monitoring bird mortality associated with operation of the solar facility. To accurately determine species fatality rates, the monitoring study must include standardized carcass searches, searcher efficiency trials, and carcass removal by scavenger trials. For **Eagles and federally listed Threatened or Endangered Species** you must call a U.S. Fish and Wildlife Service (Service), Office of Law Enforcement (OLE) special agent for instructions and approval before collecting or moving the carcass or its parts. It may be necessary to preserve the carcass or its parts onsite until an agent or other Service or State representative

☒ ADDITIONAL CONDITIONS AND AUTHORIZATIONS ALSO APPLY

12. REPORTING REQUIREMENTS
ANNUAL REPORT DUE: 01/31
You must submit an annual report to your Regional Migratory Bird Permit Office each year, even if you had no activity. Form: www.fws.gov/forms/3-202-17.pdf.

ISSUED BY
Heather Beele

TITLE
MIGRATORY BIRD PERMIT SPECIALIST

DATE
09/11/2014

arrives to collect it. **Your OLE point-of-contact is Resident Agent Erin Dean, email: erin_dean@fws.gov , phone: 310-328-1516**

2) Except for take caused by your infrastructure and operations, you may not collect or disturb and must immediately report to OLE any dead migratory birds that appear to have been poisoned, shot, or otherwise killed or injured as the result of potential criminal activity.

3) With prior approval from your Migratory Bird Permit Office, you are authorized to receive lawfully acquired carcasses and parts to use for standardized carcass searches, searcher efficiency trials, and carcass removal by scavenger trials from federally permitted rehabilitation centers or other lawful sources. You must maintain records of all acquisitions, including source (name of permittee and permit number), species, description (carcass or type of part), date of receipt, and final disposition.

E. **Data Collection.**

Mortality monitoring data should be compiled in the attached Excel spreadsheet and submitted to the Service on a monthly basis until directed differently by permit official. It includes but is not limited to the collection of the following information:

1) All relevant and applicable data associated with each carcass or part collection, or injured bird, should be recorded, including the information below. Required data are designated with an asterisk (*).

   a) discovery date*
   b) collection date*
   c) species*
   d) sex and age (juvenile/adult), if known
   e) condition of bird (alive or dead) *
   f) condition of carcass (entire, partial, scavenged)*
   g) description of carcass (e.g., intact, feather spot, headless, wing sheared, blood in mouth, entanglement)*
   h) interval since last search*
   i) observer*
   j) search method used, including opportunistic discovery of carcasses*
   k) weather conditions at likely time of death, if known*
   l) identifying information for the infrastructure element, e.g. solar panel, evaporation pond, fencing, building
   m) the GPS coordinates in decimal degrees for the location where carcass/part found*
   n) ground distance of carcass from pole, line, panel, or other structure (e.g pond or building)
   o) azimuth of carcass from solar panel or infrastructure (including GPS coordinates in decimal degrees), if known
   p) apparent cause of mortality/injury (collision, electrocution, drowned, other) *
   q) estimated date of mortality or estimate of time since death (e.g., <1 day, 1 day, 2-3 days)*
   r) habitat surrounding carcass (*e.g.*, desert, grassland, rural, urban, cropland, bare ground, tall grass)
   s) information on carcass or injured bird disposition*
   t) any special notes or additional information

2) All carcasses and partial remains that are collected should be digitally photographed, bagged, and labeled with the following information:
   1) date collected
   2) a unique specimen number
   3) the information listed in E(1)(l and m) above
   4) facility name

3) Migratory birds, **other than Eagles and federally listed Threatened or Endangered Species**, may be used for searcher efficiency trials and carcass removal trials AFTER a mortality report has been submitted to Regional Migratory Bird Permit Office per condition H(1)(e) documenting their death, all data collected in condition E(2), and the unique specimen number assigned to that carcass in condition E(3) above.

F. **Injured birds.** Injured migratory birds, including **eagles and federally listed threatened or endangered species,** must be transferred to a federally permitted migratory bird rehabilitator or a licensed veterinarian for care. Rehabilitation and/or veterinary costs are the utility's responsibility. See condition H for reporting instructions.

G. **Take and collection of live, non-injured migratory birds, eggs, or nests is not authorized by this permit.** In addition, this permit does not authorize the take, capture, harassment or disturbance of **eagles or federally listed endangered or threatened species** (see 50 CFR 17.11).

H. **Reporting.**

1) You must report bird injuries and deaths in accordance with the time frames specified below (a-c).

a. You must submit a written report of avian mortality and injury **monthly** to OLE, the Regional Migratory Bird Permit Office (RMBPO), the Ecological Service's Field Office (Field Office) and California Department of Fish and Wildlife (CDFW). Your report must include as much of the data listed in condition E above that is available for each incident. In addition, we request that you voluntarily report bat injury and mortality information.

- OLE SA: Your OLE point-of-contact is Resident Agent Erin Dean, (erin_dean@fws.gov , phone 310-328-1516)
- RMBPO: Heather Beeler (heather_beeler@fws.gov, phone: 916-414-6651)
- Field Office- Palm Springs: Pete Sorensen (pete_Sorensen@fws.gov, phone: 760-431-9440 x293)
- CDFW: Email to Armand Gonzales (Armand.Gonzales@wildlife.ca.gov), and Justin Garcia, (Justin.Garcia@wildlife.ca.gov)

b. In addition to the monthly reports, you must report any **bald eagle or golden eagle or threatened or endangered species** found dead or injured to the OLE and each contact listed in H(1)(a) immediately if possible, but no later than **24 hours after discovery.** Your report must include as much of the information from condition E that is available for each incident. A written mortality or injury report specific to the eagle or listed species must be submitted to all contacts listed in condition H(1)(a), to include the data in condition E, no later than **one week (7 days)** from the date of discovery of the carcass.

A list of Threatened and Endangered species by State may be found in the Service's Threatened and Endangered Species System (TESS) database at: <http://www.fws.gov/endangered>.

c. In the event that you discover 6 or more migratory birds that have been injured or killed within a 24 hour period, you must report the event to RMBPO and the Field Office listed in condition H(1)(a) above immediately if possible, but no later than the **next business day**. This summary must list the number of events by species. Within 14 days of carcass/injury discovery, a written mortality or injury report specific to the incident must be submitted to your FWS contacts, and should include as much of the data in E above as possible. This reporting requirement is intended to inform the Service of events or other variables that may have contributed to the mortality event.

2) You must submit an **Annual Report** of dead and injured birds, **including Eagles and Threatened and Endangered Species**, discovered and/or collected to your Migratory Bird Permit Office by January 31 following each calendar year in which the permit is in effect. Your written annual report is due by 1/31/14. The traditional report form 3-202-17 is available at <http://www.fws.gov/forms/3-202-17.pdf>. Please submit a Special Purpose

Utility Excel Data Sheet we provided in lieu of using form 3-202-17. All of the information requested on the 3-202-17 form, including the signed certification statement, must be included.

I. **Disposition of Carcasses and Parts.**

1) In accordance with Condition D(1) above, the Service will advise you on disposition of **Eagles and federally listed Threatened or Endangered Species** specimens. The special agent will advise if they will recover an eagle carcass or if you need to ship the carcass to the Service. With PRIOR written authorization from an OLE special agent, you may contact the U.S. Fish and Wildlife Service, National Eagle and Wildlife Property Repository (NER) at (303) 287-2110 for shipping instructions. The written authorization from the special agent must accompany the Eagle if it is shipped to the NER. Disposition must be reported in your annual report to your migratory bird permit issuing office.

2) Unless otherwise specified in this permit, **Migratory Bird carcasses** and parts (**other than Eagles and federally listed Threatened or Endangered Species**) collected during the calendar year (ending Dec 31) that have been documented in your records must be stored in the freezer at the facilities at the location specified in Block 10 **until January 15** of the following year in which they were collected. Unless otherwise specified by your migratory bird permit issuing office or OLE, after **January 15** and after your annual report has been submitted to the migratory bird permit issuing office (due January 31), carcasses and parts may be:

(a) used for searcher efficiency and scavenger removal trials; provided carcasses used in trials have been reported to the Service prior to use as outlined in Condition F and I(1)(c) above;

(b) turned over to the State wildlife agency for official purposes, or,

(c) donated to a public scientific or educational institution or to an individual or entity authorized by Federal permit to acquire and possess migratory bird specimens.

After all permit requirements have been met, carcasses and parts (**except Eagles and federally listed Threatened or Endangered species**) that you do not transfer to another authorized party must be disposed of by burial or incineration.

J. **Renewal**. In addition to an updated monitoring protocol, any request for renewal of this permit must include information on the fatality rates of affected species or fatality patterns, analysis of those rates/patterns, whether any adjustments or measures were taken to avoid or minimize mortalities, and if so, any preliminary results of those modifications.

K. **Subpermittees.** Any person who is employed by or under contract to the permittee for the activities specified in this permit, or is otherwise designated as a subpermittee in writing by the permittee may exercise the authority of this permit.

L. **Standard Conditions.** You and any subpermittees must comply with the attached **Standard Conditions for Migratory Bird Special Purpose Utility Salvage Permits. These standard conditions are a continuation of your permit conditions and must remain with your permit.**

This permit does not supersede any State Requirements. You are responsible for ensuring that you are in compliance with all State laws, including but not limited to California Fish and Game Code 3511 (fully protected species) 3503.5 and 3513. For additional information on State requirements please contact: California Department of Fish and Wildlife, Deborah Hawk, 760-872-1126.

This permit does not, nor shall it be construed to, authorize lethal take or injury of migratory birds or limit or preclude the U.S. Fish and Wildlife Service from exercising its authority under any law, statute, or regulation, or from taking enforcement action against any individual, company, or agency. This permit is not intended to relieve any individual, company, or agency of its obligations to comply with any applicable Federal, State, Tribal, or local law, statute, or regulation.

This permit may be amended at any time in response to changes in national guidance or take reported.

Attachment A. Standard Conditions

Migratory Bird Special Purpose
Utility Salvage Permits
50 CFR 21.27

All of the provisions and conditions of the governing regulations at 50 CFR part 13 and 50 CFR 21.27 are conditions of your permit. Failure to comply with the conditions of your permit could be cause for suspension of the permit. The standard conditions below are a continuation of your permit conditions and must remain with your permit. If you have any questions regarding these conditions, refer to the regulations or, if necessary, contact your migratory bird permit issuing office. For copies of the regulations and forms, or to obtain contact information for your issuing office, visit: http://www.fws.gov/migratorybirds/mbpermits.html.

1. **Personal use.** This permit does not authorize personal use of any migratory birds, parts, nests or eggs salvaged, transported, or temporarily possessed under the authority of this permit.

2. **Banded Birds** (carcasses collected and injured birds) must be reported to the U.S. Geological Survey Bird Banding Laboratory at 1-800-327-2263 or *http://www.reportband.gov*. Information provided must include, as accurately as possible, species of bird, band number, date recovered, recovery location, and name and contact information of the person who recovered the carcass or bird.

3. **Subpermittees.** A subpermittee is an individual to whom you have provided written authorization to conduct some or all of the permitted activities in your absence. Subpermittees must be at least 18 years of age. As the permittee, you are legally responsible for ensuring that anyone conducting activities under your permit is adequately trained and adheres to the terms of your permit. You are responsible for maintaining current records of who you have designated as a subpermittee, including copies of designation letters you have provided.

4. **Carrying your permit.** You and any subpermittees must carry a legible copy of this permit and display it upon request of any duly authorized federal, state or tribal officer whenever exercising its authority. Subpermittees must also carry your written subpermittee designation letter.

5. **Records.** You must maintain complete and accurate records of the activities conducted and the data collected under this permit. You must keep all required records and collected wildlife parts relating to permitted activities at the location you identified in writing to the migratory bird permit issuing office. (50 CFR 13.46 and 21.27)

6. **Site inspections.** Acceptance of this permit authorizes the Director's agent to enter the utility property at any reasonable hour as necessary to inspect the wildlife, records, facilities, property, and associated infrastructure for wildlife impacted by the utility, and for compliance with the terms of this permit and governing regulations. (50 CFR 13.47)

7. **Applicable laws.** You may not conduct the activities authorized by this permit if doing so would violate the laws of the applicable State, county, municipal or tribal government or any other applicable law.

8. **Other permissions.** This permit does not authorize salvage of specimens on Federal, State, tribal, or other public or private property without additional prior written permits or permission from the agency/landowner/custodian.

UltraSystems
environmental management planning

Memo

To: Magdalena Rodriguez (CDFG)

From: Stephen Blackwell, Senior Biologist (UltraSystems)

CC: Daniel Steward (BLM), Sharon Tyson (BLM), Pete Sorenson (USFWS),
and Patricia Valenzuela (Imperial County)

Date: 11/22/2011

Re: Imperial Solar Energy Center (ISEC) South – Burrowing Owl (BUOW) Mortality

---

On November 20, 2011 UltraSystems biologists conducted another 30-day Preconstruction Burrowing Owl Survey at the Imperial Solar Energy Center South (ISEC South) project, due to construction delays. A second preconstruction survey is necessary to meet 30-day permit requirements. This preconstruction survey was completed by UltraSystems biologists James Castle (Designated Biologist) and Charlene Burge (biological Monitor), in coordination with Marie Barrett (biological specialist) of Barrett Biological Services.

During the second round of pre-construction surveys (11/20/2011), one BUOW mortality was observed by the biologists on the northern edge of the project site. The mortality was located along a minor agricultural road. No evidence except feathers were present (See photo below). No determination as to cause of mortality was made by the biologists. The adjacent agricultural fields have been recently cultivated, where field equipment had turned up the edges into an unlined, shallow drainage ditch.

It should be noted that **no mobilization** has occurred on the ISEC South project site; therefore, **no equipment** is onsite.

An amended letter report for this most recent BUOW Preconstruction Survey is forthcoming, and will be sent to the agencies and Imperial County as soon as possible.

In addition to the wildlife species previously reported during the first 30-day Preconstruction Survey, four new raptor species, two songbird species, one fisher, and two game bird species were observed by the biologists, during this second survey.

The species include: Sharp-shinned Hawk, Peregrine Falcon, Ferruginous Hawk, Osprey, Verdin, King Fisher, Savannah Sparrow, Snow Goose and Canadian Goose.

Should you have any questions, please contact me at (949) 788-4900.

Stephen Blackwell
Senior Biologist

BUOW Kill – with Feather Remnants, observed on November 20, 2011.

GPS Coordinates: +32.67201, –15.65852 (+/– 13 feet)

Elevation: –30 feet

UltraSystems
environmental management planning

Memo

To: Magdalena Rodriguez, California Department of Fish and Game

From: Stephen Blackwell, Senior Biologist

cc: Daniel Steward, Bureau of Land Management
Sharon Tyson, Bureau of Land Management
Pete Sorenson, U.S. Fish and Wildlife Service
Patricia Valenzuela, Imperial County Planning Department

Date: 11/30/2011

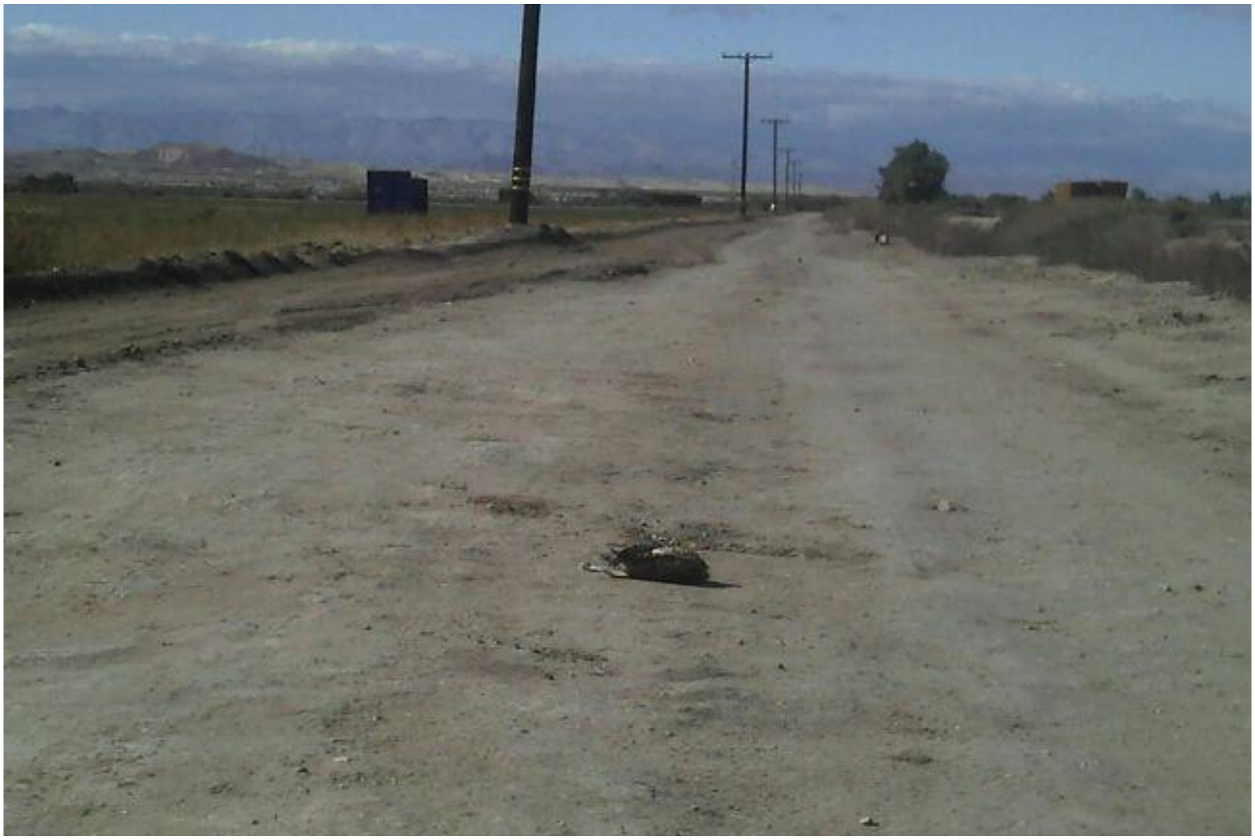
Re: Imperial Solar Energy Center (ISEC) South – Burrowing Owl (BUOW) Mortality

On November 27, 2011 the project Designated Biologist, Jim Castle (UltraSystems) was notified of a BUOW mortality at the ISEC South project by site security personnel. The mortality was discovered along a minor agricultural road. An assessment was completed by UltraSystems' biologist Michael Crouse (biological monitor) that included locating the discovery using GPS coordinates, and taking photographs. No determination as to cause of mortality could be ascertained by Mr. Crouse.

It should be noted that construction at ISEC South has not begun. Mobilization is expected to occur on or about December 6, 2011.

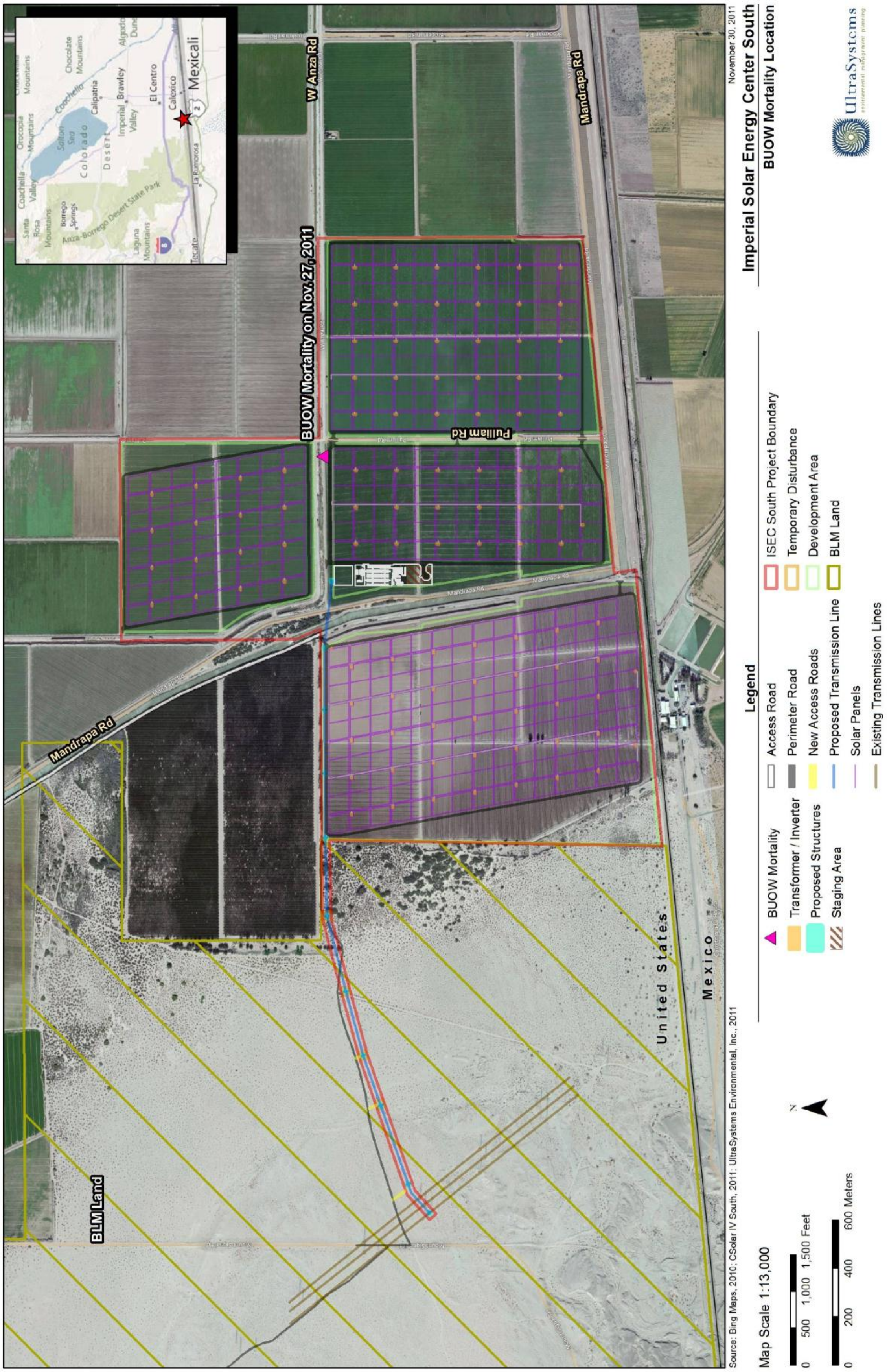
Should you have any questions, please contact me at (949) 788-4900.

BUOW Mortality – observed on November 27, 2011.



GPS Coordinates: 32 ° N 39.868 minutes, 115 ° W 39.424 minutes (road along central agricultural area).

Additional Documentation Attachment to Comment 2-F1
Attachment I-3



Imperial Solar Energy Center South
BUOW Mortality Location
November 30, 2011

Source: Bing Maps, 2010; CSolar IV South, 2011; UltraSystems Environmental, Inc., 2011

Public Interest Energy Research (PIER) Program
FINAL PROJECT REPORT

IMPROVING METHODS FOR ESTIMATING FATALITY OF BIRDS AND BATS AT WIND ENERGY FACILITIES

Prepared for: California Energy Commission

Prepared by: William Warren-Hicks, Ph.D., James Newman, Ph.D., Robert Wolpert, Ph.D., Brian Karas, and Loan Tran on behalf of California Wind Energy Association

FEBRUARY 2013
CEC-500-2012-086

Prepared by:

Primary Authors:
William Warren-Hicks, Ph.D., EcoStat, Inc.
James Newman, Ph.D., Normandeau Associates, Inc.
Robert Wolpert, Ph.D., Duke University
Brian Karas, EcoStat, Inc.
Loan Tran, EcoStat, Inc.

California Wind Energy Association
2560 Ninth Street #213-A
Berkeley, CA 94710
510-845-5077
www.calwea.org

Contract Number: PIR-08-028

Prepared for:

California Energy Commission

Joe O'Hagan
Project Manager

Linda Spiegel
Office Manager
Energy Generation Research Office

Laurie ten Hope
Deputy Director
Energy Research and Development

Robert P. Oglesby
Executive Director

DISCLAIMER

This report was prepared as the result of work sponsored by the California Energy Commission. It does not necessarily represent the views of the Energy Commission, its employees or the State of California. The Energy Commission, the State of California, its employees, contractors and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the California Energy Commission nor has the California Energy Commission passed upon the accuracy or adequacy of the information in this report.

ACKNOWLEDGEMENTS

This project was funded by the California Energy Commission's Public Interest Energy Research (PIER) Program under Award No. PIR-08-028, with matching funds provided by the U.S. Fish and Wildlife Service under Grant # F11AP00016/13410BG006. NextEra Energy Resources, LLC, provided substantial in-kind match support in the form of raw field survey datasets with accompanying avian and bat work study plans and monitoring reports, in-kind labor, extensive site access, and bird and bat carcasses. Acciona Energy North America Corporation also provided substantial in-kind match support in the form of raw field survey datasets with accompanying avian and bat work study plans and monitoring reports, in-kind labor, and site access. The Michigan Department of Community Health, the Texas Christian University Department of Biology, and the Idaho State Department of Agriculture provided additional bat carcasses. Cardno ENTRIX provided additional in-kind communications support, and the Altamont Pass Wind Resource Area Scientific Review Committee provided feedback on the research team's study design.

The authors thank Energy Commission staff Linda Spiegel for overseeing the project and Joe O'Hagan and John Mathias for managing it, as well as U.S. Fish and Wildlife Service staff Mark Miller, Jim Michaels, Mark Ostwald, Ken Berg, Steve Desimone, and Pamela Kosonen for the additional resources to expand this research. In addition to the primary authors listed, numerous staff and contractors of the California Wind Energy Association contributed to the project, including Executive Director Nancy Rader, Project Manager Heather Rhoads-Weaver, Editor Susan Savitt Schwartz, Siting Policy Director Ashley Richmond, and Assistant Project Managers Chris Amado and Alma Correa-Holmes. Additional EcoStat staff contributors included Song Qian, Sandra Menzel, Brandi Gartland, Casey Greenstein, Achille Clendenning, Andrea Torres, Jolie Hendrix, Felix Ratcliff, Derek Jansen, and Natalie Archambault. Additional Normandeau staff contributors included Crissy Sutter, Christian Newman, Alexis Hampton, and Jenny Carter.

The authors are grateful to their Project Advisory Committee members who spent a significant amount of time providing advice and reviewing documents: Dr. Eric Smith of Virginia Tech, Dick Anderson, formerly with the California Energy Commission, Bronwyn Hogan of U.S. Fish and Wildlife Service, Dr. John Hayes of the University of Florida, Kevin Martin of Terra-Gen Power, and Renee Culver of NextEra Energy Resources. The authors also appreciate the thoughtful review and comments from their peer reviewers: Dr. Lyman McDonald of Western EcoSystems Technology, Inc., and Dr. Amanda Hale of Texas Christian University.

PREFACE

The California Energy Commission Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program conducts public interest research, development, and demonstration (RD&D) projects to benefit California.

The PIER Program strives to conduct the most promising public interest energy research by partnering with RD&D entities, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following RD&D program areas:

- Buildings End-Use Energy Efficiency
- Energy Innovations Small Grants
- Energy-Related Environmental Research
- Energy Systems Integration
- Environmentally Preferred Advanced Generation
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies
- Transportation

Improving Methods for Estimating Fatality of Birds and Bats at Wind Energy Facilities is the final report for the Energy Commission, Project Award Number PIR-08-028, conducted by California Wind Energy Association (CalWEA). The information from this project contributes to PIER's Energy-Related Environmental Research Program.

For more information about the PIER Program, please visit the Energy Commission's website at www.energy.ca.gov/research/ or contact the Energy Commission at 916-654-4878.

ABSTRACT

The California Wind Energy Association (CalWEA) evaluated the procedures in the *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development* (the Guidelines) for estimating fatality of birds and bats associated with wind energy facilities. The research sought to improve the accuracy of methods for estimating the number of bird and bat fatalities by evaluating the effect of time dependency on the probability of scavenging and removal of bird and bat carcasses (carcass persistence) and detection by searchers (searcher proficiency).

Researchers used data collected from the Altamont Pass Wind Resource Area from January 7 to April 30, 2011, to calculate traditional carcass persistence and searcher proficiency functions and to create new functions in which searcher proficiency and carcass persistence are modeled as a function of time and carcass age. This study is the first to document quantitatively that searcher proficiency and carcass persistence are time-based processes. The report offers lessons and implications for experimental designs and the field monitoring recommendations provided in the Guidelines.

The study also investigated the fatality estimation equation provided in the Guidelines and three other prominent equations from the literature that are used to adjust fatality observations for searcher proficiency and carcass persistence. The report examines both the common and equation-specific assumptions inherent in these fatality estimators, evaluates them in light of data from the field experiment, and finds that each of the fatality estimation equations can result in positive or negative bias, depending on the length of search interval relative to carcass persistence time. A new equation incorporating carcass persistence from one search interval to the next is proposed. This project will help reduce conflict in the siting process and make sound wind project permitting decisions easier by improving the accuracy of fatality estimates and the ability to accurately compare them with those from other wind facilities.

Keywords: Estimation methods, birds and bats, wind energy facilities, time dependence, searcher proficiency, carcass persistence, monitoring design, equations, statistical bias

Please use the following citation for this report:

Warren-Hicks, William, James Newman, Robert Wolpert, Brian Karas, Loan Tran. (California Wind Energy Association.) 2013. ***Improving Methods for Estimating Fatality of Birds and Bats at Wind Energy Facilities.*** California Energy Commission. Publication Number: CEC-500-2012-086.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Introduction

Wind energy holds great promise as a clean, renewable energy resource, provided that siting and development can reasonably avoid or reduce impacts on already stressed wildlife resources. In 2007, the California Energy Commission and California Department of Fish and Game released *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development* (the Guidelines) to provide recommended procedures for assessing and minimizing impacts from wind energy development on birds and bats. The Guidelines provide an equation, attributed to Dr. Kenneth Pollock of North Carolina State University, that estimates the true number of fatalities at the wind facility from the number of bird or bat carcasses visually observed during a monitoring survey. The equation corrects for the inability of a searcher to locate all carcasses on the survey plot at the time of observation (searcher proficiency), and for the probability of removal by scavengers (such as crows and coyotes) or other processes before the time of observation (carcass persistence).

The California Wind Energy Association (CalWEA) rigorously evaluated the methods and procedures proposed by the Energy Commission for estimating the true number of fatalities of birds and bats (including the equation in the Guidelines) associated with collisions with wind turbines in California.

Purpose

This project sought to improve the accuracy of methods for estimating the number of bird and bat fatalities at wind energy facilities.

This report describes the sites selected for study, the experimental design for evaluating and testing approaches for estimating the true bird and bat fatalities at a wind facility from observational evidence of collision mortality, and the data collection procedures. This report also looks at the fatality estimation equation provided in the Guidelines and at three other prominent equations from the literature that are used to adjust mortality observations (hereafter referred to by their respective authors: Erickson & Johnson, Shoenfeld, and Huso). It examines the assumptions common to all four estimation equations as well as those assumptions specific to each. It then evaluates the validity of the assumptions with data from the field experiment, given various field conditions, and fatality observation parameters. Based on the field study findings and a thorough analysis of assumptions underlying the published equations, this report offers lessons and implications for experimental designs and the field monitoring recommendations provided in the Guidelines.

Objectives and Findings

The project was designed to meet the following objectives:

- Refine and test experimental designs, under representative actual field conditions, that accurately generate site-specific data for estimating survey error rates.

- Rigorously evaluate the ability of various equations to accurately estimate fatalities of birds and bats at a variety of wind energy facilities within California.

The Field Study: Design and Findings

CalWEA rigorously designed and implemented a field survey to collect site-specific data under a variety of environmental conditions. Researchers obtained bird and bat carcasses from various labs and agencies and placed them at selected locations within the Altamont Pass Wind Resource Area near Livermore, California. Over periods of up to 60 days, independent and experienced biologists without prior knowledge of carcass placements searched strings of turbines weekly and recorded the location of marked bird and bat carcasses that project field managers had placed in the study area, as well as carcasses not associated with the study. Project field managers recorded the movement and removal of trial bird and bat carcasses roughly every three days during the study when trial birds and bats were on the ground, so that the true number and location of the trial carcasses were known. Consistent with current practice, it was assumed that carcass persistence and detection rates for marked carcasses placed at the site are representative of rates for bird and bat fatalities otherwise occurring at the wind energy facility.

Researchers used data generated by the field study to calculate traditional carcass persistence and searcher proficiency functions and to create new functions in which both carcass persistence and proficiency are modeled as a function of time and carcass age. Of the 104 small bird carcasses placed in the field, 32 unique carcasses (31 percent) were found over the course of 223 search opportunities (number of placed carcasses times the number of searches in which a trial carcass was present). However, field biologists detected carcasses in only 17 percent of all small bird search opportunities. Of the 78 bat carcasses placed, 15 unique bat carcasses (19 percent) were found over the course of 248 search opportunities, but only 8.1 percent of search opportunities yielded detections. All six of the large birds were detected, with 68 percent of 31 search opportunities yielding detections.

Researchers examined the rate of carcass removal by scavengers in strings (a group or row of adjacent wind turbines), blocks of strings with similar ecological conditions, and the entire study area. They also examined relationships between carcass persistence and key variables. The carcass removal rate followed a Weibull distribution, with the highest removal rates early in the trial. Scavengers removed most small birds and bat carcasses within six weeks of placement. The data also show that it was common for a carcass to persist into subsequent search intervals beyond the interval during which it was deposited (called "bleed-through").

The study found both searcher proficiency and carcass persistence to depend on time. Other key findings with implications for selection of fatality-estimating equations and equation input variables include:

- Carcass persistence fits better with a Weibull distribution, where the attractiveness of a carcass to scavengers declines as it ages, than with an exponential distribution where fresh and old carcasses are equally likely to be attractive to scavengers.
- Vegetation height affects searcher proficiency. Therefore, when creating a survey design, researchers may want to consider random selection of turbines within blocks. The study found that topographical (for example, slope) and meteorological variables (for example, precipitation) were not correlated with mortality at the study site. They may be important predictors at other sites, however.
- Searcher proficiency was considerably lower for bats than for small birds during the study, pointing to the need for extensive long-term searcher proficiency trials for bats to ascertain if this holds true at other sites.
- Small bird carcasses are removed by scavengers more quickly than bat carcasses. This finding supports the need for long-term carcass persistence trials for both small birds and bats.

Evaluation of the Fatality Estimation Equations

As proposed, the second part of this project was to use the field study data to test how accurately the Pollock equation recommended in the Guidelines and the three other prominent equations estimate the true number of fatalities from observed fatalities. Because the equations assume that fatalities occur at random times, while this study involved placing all carcasses at the beginning of each experimental time block, a direct “test” of the equations using the study data was not appropriate. Instead, the authors analyzed the estimating equations (“estimators”) mathematically and tested the validity of their common and individual assumptions against the findings from the field study.

Key findings from this analysis were that:

- All of the four traditional fatality estimation equations examined assume constant searcher proficiency, rather than the observed condition that searcher proficiency is a function of time, as carcasses age. The inconsistent ability to detect a bird or bat over time can greatly affect the expected accuracy of resulting mortality estimates.
- Three of the equations examined (Erickson & Johnson, Shoenfeld, and Huso) assume an exponential distribution), whereas a Weibull statistical distribution fits the data best.
- Current estimators either assume that “bleed-through”– whether carcasses not removed during one search interval are considered “discoverable” during later searches – occurs all of the time or none of the time. Incorrect bleed-through assumptions can distort estimates.
- In the general case, and for exponential removal, the equations will generate mortality of the following order from lowest to highest: Erickson & Johnson < Shoenfeld < Pollock≤

Huso. When choosing a single equation, investigators should keep the expected rank order in mind.

- The degree of systematic error or "bias" among the equations is a function of many issues, but in all cases, it is a function of the inherent assumptions underlying the equation characteristics. Even when biased, if search intervals are *long* relative to mean persistence times, all four estimators give about the same answers. But if search intervals are *short* relative to mean persistence times, large differences among the equations are possible. In fact, with the condition of short interval relative to mean carcass persistence, the results of the equations could differ by a factor of 3 or 4.
- Even correcting for the biases, the relationship of the results of the estimators to true mortality is unknown. However, if the assumptions in the equations are wrong (that is, where exponential distributions and constant searcher proficiencies have been assumed), then the results of the equations could differ significantly from actual mortality.
- Short search intervals increase the chance of bias:
  (a) Short intervals do not allow the system to reach equilibrium, which is inconsistent with the Erickson & Johnson equation. Erickson & Johnson assume the number of carcasses remains relatively constant over the long-term.
  (b) The Huso and Pollock equations assume zero percent bleed-through; therefore, bias will occur if true bleed-through is greater than zero.
  (c) Shoenfeld assumes 100 percent bleed-through; therefore, bias will occur if true bleed-through is less than 100 percent.

- The new partially periodic equation proposed in this report allows for the estimation of a site-specific bleed-through rate. Paired with new field sampling procedures to generate time-dependent carcass persistence and searcher proficiency probabilities, this new equation will produce unbiased results using either short or long search intervals.

Conclusions and Recommendations

CalWEA's study provides new insights that could enhance the existing methods and procedures found in the Guidelines and other pre- and post-construction fatality monitoring guidelines used in the United States and internationally. Four major implications of this work and the corresponding recommendations are outlined here.

(1) Traditional fatality estimators do not account for time-dependence of carcass persistence and searcher proficiency, or for "bleed-through."

Recommendation: Use the proposed new Partial Periodic Estimator and integrated detection probability trial method (proposed in Appendices A and B, respectively).

(2) Traditional estimators can have high degrees of bias depending on the search interval, mean carcass persistence, and bleed-through rate of the field data collected.

Recommendation: Do not use traditional estimators in conditions that produce levels of bias that are unacceptable for the intended purpose. Caution is particularly warranted where short search intervals have been used.

(3) Use of traditional estimators has resulted in an unknown degree of bias in the literature.

Recommendation: Carefully consider the value of metrics like "industry average" before applying them in policy or project-specific decisions.

(4) Previously generated fatality estimates used for project evaluation or broader purposes could be recalculated using the proposed new Partial Periodic Estimator, provided the key input variables (search interval, mean carcass persistence, and so forth) can be collected from the original studies and reasonable assumptions made about searcher proficiency probability distributions and bleed-through values.

Recommendation: Going forward, use a standardized approach to generate unbiased, project-specific results that may be compared with each other, and to generate meaningful and unbiased industry averages and totals.

This project will help reduce conflict in the siting process and make sound wind project permitting decisions easier by:

- Providing guidance on methods for generating observer bias and carcass removal rates and reducing ambiguity in recommended avian study methods.
- Exploring time-dependent relationships, including observer bias and carcass removal.
- Providing guidance leading to improved field procedures for mortality monitoring and improving efficiency and efficacy of surveys.
- Enabling better forecasting of anticipated mortality at wind facilities based on site characteristics.

CHAPTER 1: Research Plan

Statement of Need

California pioneered large-scale wind energy development beginning in the 1970s. As a clean, renewable energy resource, wind energy holds great promise provided that it can be sited and developed in such a way as to reasonably avoid and (if necessary) mitigate impacts on already stressed wildlife resources. To this end, wind energy and wildlife stakeholders have collaborated to survey avian/bat activity and study the impacts of wind project operations, and policymakers have incorporated research protocols into the permitting process.

In 2007, the California Energy Commission (Energy Commission) and California Department of Fish and Game released *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development* (the Guidelines) to provide recommended protocols for assessing and minimizing impacts from wind energy development to birds and bats. The Guidelines recommend protocols for assessing, evaluating, and determining the effects of wind projects on birds and bats, and also recommend impact avoidance, minimization, and mitigation measures. In addition, the Guidelines provide an equation, suggested by Dr. Kenneth H. Pollock (personal communication, 2012), that can be used to adjust the number of bird or bat carcasses that are visually observed during an environmental monitoring survey of a wind facility, in an attempt to estimate the true fatalities at the wind facility. The equation, one of four analyzed in this report, adjusts for the inability of a searcher to locate all carcasses on the survey plot at the time of observation, and for the probability of removal by scavengers or other processes before the time of observation.

The California Wind Energy Association (CalWEA) received funding from the Energy Commission to rigorously evaluate the equations and associated procedures and studies recommended in the Guidelines for estimating fatalities of birds and bats associated with collisions with wind turbines in California. Information gathered from this study will apply to wind development projects in California, and the fundamental principles evaluated and discovered in this project may apply to wind development in other parts of the United States and internationally.

CalWEA's study provides new insights leading to improvements in the methods and procedures for estimating fatalities at wind facilities. This report offers recommendations on methods, including computations and data requirements, for estimating the true bird and bat fatalities at wind facilities. This section of the report details the goals of CalWEA's project and reviews statistical and ecological considerations in the project design.

Study Goal and Objectives

The overall goal of this project was to conduct research to improve the accuracy of methods for estimating the number of bird and bat fatalities at wind energy facilities. The project was designed to meet the following objectives:

1. Empirically test and calculate the influence of carcass removal and searcher proficiency under representative actual field conditions.

2. Mathematically evaluate the inherent characteristics and assumptions of existing equations to accurately estimate fatalities of birds and bats at representative wind energy facilities within California.

The study generated information to enable the evaluation of existing fatality estimation methods and the development of advanced models.

To meet the first project objective, CalWEA implemented a rigorously designed field survey at a wind facility within the Altamont Pass Wind Resources Area (APWRA) near Livermore, California. Site-specific data were collected under a variety of environmental conditions. Simply stated, birds and bats were placed at selected locations within the site. The implicit assumption in this approach is that marked birds and bats are representative of birds and bats killed at the wind facility. Over periods of up to 60 days, "blind" independent and experienced biologists without prior knowledge of carcass placements searched turbine strings and recorded the location of both marked bird and bat carcasses that project field managers had placed in the study area as well as carcasses not associated with the study.

Data generated during the experiment were collected and stored in a quality assured data set. The research team then analyzed the resulting data and evaluated the relationships among the number of found birds, bats, and environmental conditions over time. A description of the available statistical models evaluated in this study is found in the following discussion. The models and methods were evaluated for their inherent ability to accurately estimate the true number of bird and bat carcasses.

Once the study team evaluated the data, tested existing models and created new models, the team developed general guidance for (1) generating site-specific data used to parameterize equations, (2) selecting existing or new equations based on site-specific conditions, and (3) interpreting the results generated by the statistical methods.

This project provides insights into several other issues that are important to risk assessments of wind facilities. Specifically, this project generates information that can be used to:

- Evaluate existing fatality estimation methods.
- Test and evaluate the shape of carcass persistence curves (those not removed by scavenging, weather and other processes) under a variety of environmental conditions, as represented during the January – April grass height and weather conditions at the Altamont.
- Evaluate the effect of time-dependency on the probability of bird and bat carcass persistence and on the probability of detection by searchers (searcher proficiency).
- Develop recommendations for advanced models that link observational data with measurements of ecological conditions.

Success Measures

This project succeeded by achieving the following goals.

- Evaluation of the existing fatality equations provides practitioners information useful for choosing an estimating equation, and an understanding of the advantages and disadvantages of various equations with differing survey designs.
- Data generated from the project are of such quality that guidance for implementing site-specific studies leading to effective fatality adjustment procedures can be developed.
- Peer-reviewed publications can be generated that enhance the existing state of the science.
- Effective communication of the project findings was undertaken.
- Observational data at the planned wind turbine strings were obtained in a cost-effective manner within the timeframe of the project.

The following narrative discusses the statistical and ecological issues that influenced the design of the study, and presents the experimental design.

Statistical Considerations in the Experimental Design

Although standardized long-term monitoring procedures are available in the literature, there is currently no standard operating procedure for generating and evaluating data used to estimate fatalities at wind project sites. Statistical simulations of this issue have been conducted (*e.g.*, Huso 2010). In practice within the industry, searcher bias and scavenger removal studies are generally implemented in conjunction with long-term monitoring studies. However, based on an informal review and the experience of the authors of this report, there is little consistency in survey design and analysis of the resulting data among agencies, industry, or their consultants. Searcher bias studies are typically implemented independently from studies of removal by scavenging and other processes, and the study timeframes generally differ. In some cases, searcher bias studies are conducted once under site-specific conditions, and are not repeated during the course of a year. Carcass persistence studies are generally implemented over a few days to several weeks; however, the study time period is not standardized within the industry.

For both study types, fresh (or sometimes frozen) carcasses of various sizes are placed on an experimental plot at the beginning of the experiment. During searcher bias experiments, searchers search plots where trial carcasses have been placed and record the number of carcasses found. The searcher proficiency rate is then calculated and recorded. During scavenger removal studies, the known locations of the carcasses are observed frequently and removals are noted. Analysis of the resulting data generally provides a simple constant representing the probability that a bird or bat is removed by scavenging and other processes, although some time-series models resulting in the probability of scavenger removal as a function of time have been proposed (Smallwood 2007).

There is little consistency across searcher bias and scavenger removal studies in terms of plot area, number of carcasses used, carcass species, number of searchers tested, size of carcasses used, habitat considerations, or study timeframes. The relationship between searcher proficiency and carcass persistence is not evaluated. Finally, the monitoring techniques employed during the searcher studies (*e.g.*, random searches, transect searches, search interval, etc.) are sometimes inconsistent with those employed during long-term site-specific monitoring studies at operating wind turbine facilities.

A number of equations are found in the peer-reviewed literature for adjusting the observable fatality counts to estimate the true number of killed birds and bats. This report reviews selected equations found in the literature, compares the properties of each of the estimators, and provides recommendations for improving their accuracy. The equations were chosen based on a review of literature that indicated that these equations have been commonly used within the wind industry. The equations are heavily cited in past and current peer-reviewed literature.

Ecological Considerations in the Experimental Design

The following discussion reviews the importance of key ecological variables in the estimation of survey error. In addition, key procedural and other experimental design variables are described.

Ecological Variation

Ecological variation associated with specific wind energy development sites within the State of California was an important consideration in the design of the experiments. Variation in habitat condition was considered a key variable affecting the change in survey error among locations. Variation in vegetation type and density, scavenger species and associated activity levels, climate conditions, geographic conditions associated with turbine placement, and a host of other site-specific variables also could influence the overall survey error rate for a specific site.

Size of the Carcasses

Carcass size is a key variable that influences both searcher detection proficiency and carcass persistence. Generally, larger birds (*e.g.*, golden eagles) are easier to see and are considered to have smaller survey error rates than smaller birds (or bats). The smaller birds (or bats) are more difficult to see over large distances, and may be more easily covered by vegetation. Also, smaller carcasses are more subject to removal by scavengers (see references found at http://www.altamontsrc.org/alt_rl.php).

The study's experiments were focused on smaller birds and bats based on the assumption that those carcasses are harder to find and therefore will have higher error rates. Carcasses representing similar size classes were used in the experiments.

Scavenger Type and Density

The activity level of scavengers at the test site(s) was an important consideration in the selection of the locations in which the experiments were conducted. Types of scavengers noted at the Altamont include birds (*e.g.*, ravens, crows, golden eagles, turkey vultures), and mammals (*e.g.*, foxes, coyotes, bobcats, raccoons, skunks, opossums, shrews, deer mice). Although scavenger activity was not monitored, the large number of scavenger species at the Altamont is expected to be representative of wind facilities across the United States.

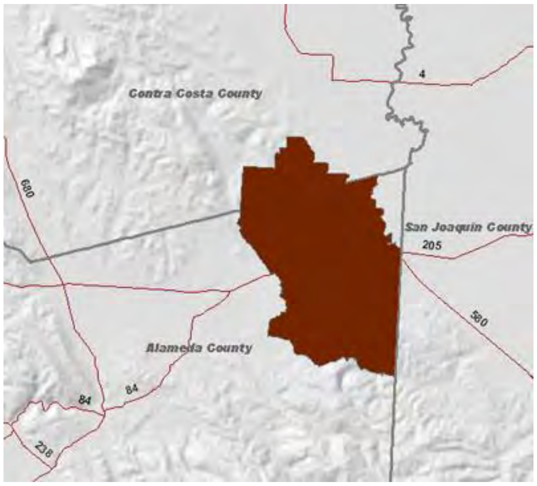
CHAPTER 2: Field Sampling Procedures and Results

As discussed in detail below, field sampling involved marking bird and bat carcasses, placing them randomly at turbine strings at an operating wind farm, and collecting information on carcass persistence and searcher proficiency. Turbine strings were selected to represent varied environmental conditions, including vegetation type and height and slope.

Description of Study Area

The field study was conducted in NextEra Energy's Contra Costa County portion of the Altamont Pass Wind Resource Area (APWRA), which is located in north-central California approximately 56 miles (908 kilometers) east of San Francisco (Figure 1). Steady winds of 15–30 miles (25–45 kilometers) per hour blow across the APWRA during the mid-afternoon and evening periods between April and September, when 70–80 percent of the wind turbine power is generated in the APWRA (Smallwood and Thelander 2004).

Figure 1: Location of Altamont Pass Wind Resource Area (APWRA)



Source: NextEra Energy Resources

The Altamont landscape consists of rolling hills ranging mostly between 150 and 300 feet (61-91 m) in elevation above sea level. Permits have been granted for a total of 5,400 wind turbines in the APWRA, rated at a capacity of approximately 580 megawatts (MW), distributed over 50,000 acres (150 square kilometers) of rolling grassland hills and valleys. Turbines are arrayed along ridgelines and other geographic features. The actual number of turbines available at any one time for power generation is thought to range from 4,500 to 5,000.

The APWRA supports a broad diversity of resident, migratory, and wintering bird species that regularly move through the wind turbine area (Orloff and Flannery 1996). Diurnal raptors (eagles and hawks), in particular, use the prevailing winds and updrafts for soaring and gliding during daily movement, foraging, and migration. Multiple studies of avian fatality at the APWRA show that golden eagles, red-tailed hawks, American kestrels, burrowing owls, barn owls, and a diverse mix of small birds and non-raptor species have been killed in turbine-related incidents (Howell and DiDonato 1991; Orloff and Flannery 1996; Howell 1997; Smallwood and Thelander 2004). All native species are protected by either federal and state wildlife legislation or both.

From an experimental perspective, the geographical unit of interest at the Altamont is a turbine string (a line of turbines). More than 400 of these strings have been monitored on a regular basis. The monitored strings are located over the extent of the APWRA, and therefore cover a variety of vegetation types and topological conditions.[1] Figure 2 shows the heterogeneity of the habitats around the field study wind turbines and strings.

Figure 2: Searching in Tall Grass and Short Grass

Photo Credit: EcoStat, Inc.

Overview of Field Sampling Procedures

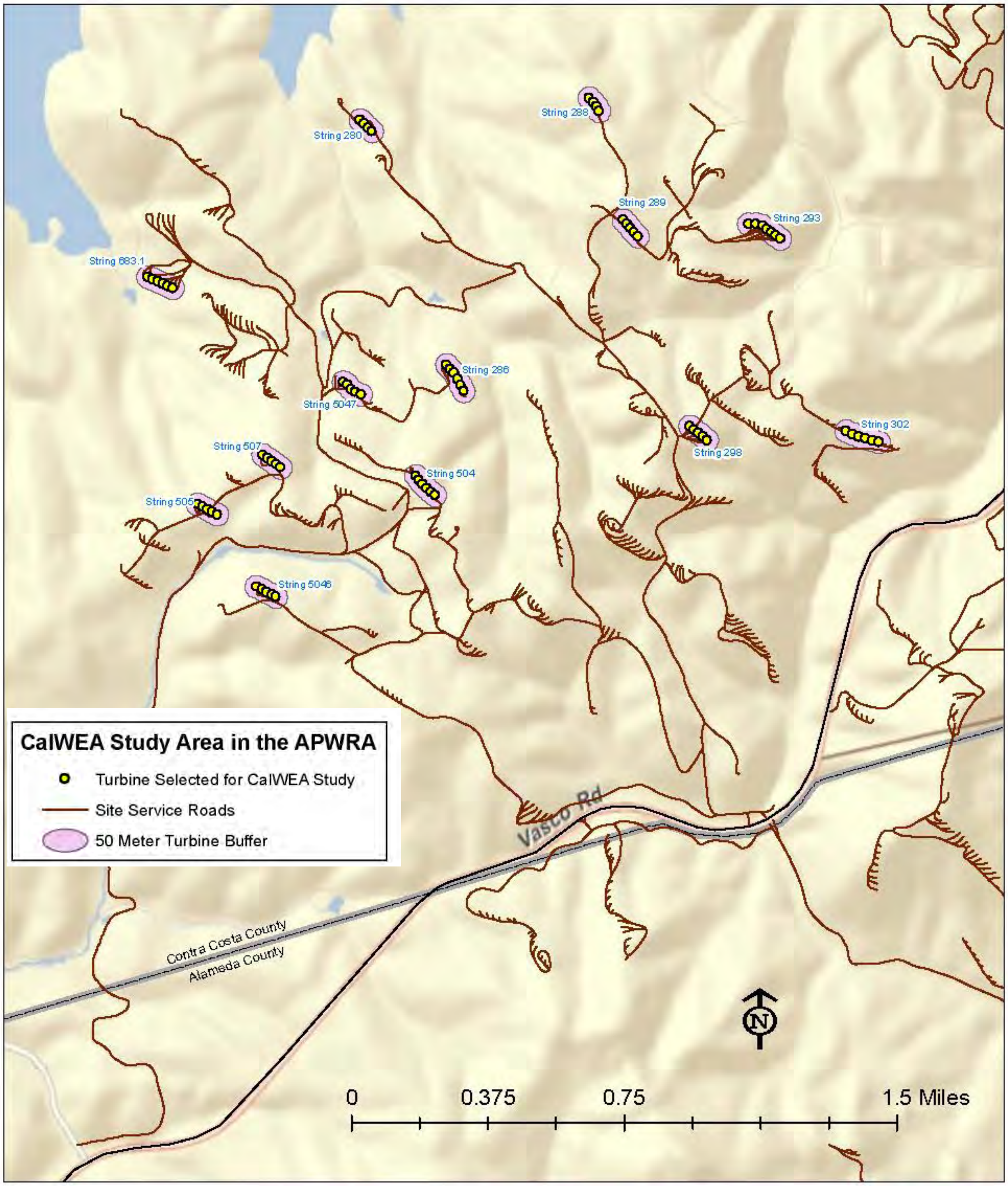
Figure 3 shows the turbine strings where the field study was conducted. A total of 13 strings (four to seven turbines per string) were searched from January to April 2011. Strings were selected primarily so that search plots would not be mutually visible to ensure that searchers did not know the location of trial carcasses. Strings were also selected to represent the range of topological conditions and vegetation types in the Altamont. Strings were grouped into four blocks in which carcasses were concurrently placed and then monitored for four to six weeks. Blocks also served as a surrogate for vegetation and meteorological conditions over time. All strings monitored during the study's field trials as detailed below were located in the APWRA north of Vasco Road.

Before conducting the field study, a pilot study was conducted. This pilot study phase was used to test the work flow to fit the project resources and schedule and to test the field methods. The first block (Block 1) of the study area was used for the pilot study. Most of the same personnel were employed for block 1 as for other blocks. Block 1 was conducted at the same study site as the other blocks but with four strings instead of three. After the pilot study, the number of strings per block was set to three, and the number of placed trial carcasses was set to six bats and eight small birds per string.

---

[1] The natural communities and land cover types identified in the Natural Community Conservation Plan (NCCP) for the APWRA include agricultural land, annual grassland, alkali grassland, seasonal wetlands, alkali wetlands, perennial wetlands and ponds, riparian woodland and streams, chaparral, oak woodland, and conifer forest.

Figure 3: Field Study Wind Turbine Strings



Source: NextEra Energy Resources

Project field managers marked and randomly placed birds and bats and oversaw the recording of the carcasses and reporting of the data collected. The project field managers visited the strings every two days in order to verify the presence or absence of individual birds and bats. All birds and bats were uniquely marked, and any displacement of a bird or bat from the original location was observed and the new location noted for future reference. At the location of each bird or bat, project field managers took measurements of vegetation height. Project field manager observations provided an independent measure of the "true" number of birds and bats available for detection. Generally, six bats and eight birds were placed along each string. Halfway through the study, one large-sized bird was placed at each string within the block along with the standard six bats and eight small birds.

Once a week, a field technician searched an area around the study strings at a typical sampling walking pace, looking for any bird or bat carcasses.[2] On a typical day, a field technician conducted two string searches, averaging two to three hours per string, covering three to six acres. The field technicians were ignorant of the presence or absence of birds and bats at any specific string location. The field technicians recorded the position of observed carcasses. Project field manager status checks were timed to include checks on days that field technicians searched study strings in order to establish the true presence of carcasses available for detection by the field technicians. (To minimize false negative detections while maintaining field technician "blindness," a cryptic system of marking carcass positions for project field managers was used.) Table 1 lists the field equipment used by the 11 field staff employed in the study.

Table 1: Equipment Used in the Field Study

Study Field Equipment	
4WD Trucks	Compasses
Clipboards	Cell phones
Data forms	Maps
Pen/Pencil/Sharpies	Hard hats
Camera/Scale card/Memory cards	Backpacks
Global Positioning System receivers (4m accuracy)	Yardsticks
Range finders	Markers (wooden stakes)

Source: EcoStat, Inc.

The Data Dictionary in Appendix C lists all the variables recorded, including weather information collected from January 1, 2011 through May 1, 2011 from the weather station at the Livermore, California, airport, and topographical variables recorded at each sampling location.

---

[2] Variable walking speed and direction across or along the ridge were not taken into account in this study, but would be interesting to consider in a future study.

Specific Study Sampling Procedures

Three procedures comprised the field study sampling methods:

- The placement of carcasses at study strings by project field managers.
- Blind carcass searches of study strings by field technicians.
- Status checks of placed carcasses at study strings by project field managers.

Carcass Placement

The purpose of the carcass placement procedure is to generate known random positions of marked carcasses at study strings.

Sources of Carcasses

Carcasses were provided by the following. For a variety of reasons, not all carcasses received were used during the field study.

- ***Bat*** carcasses: the Michigan Department of Community Health, Lansing, Michigan; Texas Christian University Department of Biology, Fort Worth, Texas; the Idaho State Department of Agriculture, Boise, Idaho.
- ***Brown-headed cowbird*** (*Molothrus ater*) carcasses: TW Biological Services, Fillmore, California; U.S. Department of Agriculture Animal and Plant Health Inspection Service/Wildlife Service, National Wildlife Research Center, Bismarck, North Dakota; Griffith Wildlife Biology, Calumet, Michigan.
- ***Large bird*** carcasses: Altamont Infrastructure Company, Livermore, California.

Carcass Position

The search area was defined by a 50 meter buffer created around turbines at study strings. A grid of 10-meter by 10-meter cells was projected over this search area. Topographical information was recorded for each cell (see Data Dictionary, Appendix C).

Grid cells were randomly selected for carcass placement. After grid cell selection, a project field manager would go to the approximate position of the selected grid cell and toss the marked carcass. The precise location of the carcass was recorded, including distance and bearing to the nearest turbine including the Global Positioning System (GPS) coordinates. In addition, the vegetation height immediately around the carcass position was measured. To help the project field managers find these selected carcass positions on future visits, a marker (small wooden stake) was cryptically placed 10 meters away from the carcass in such a way that a line segment was created by the position of the nearest turbine, carcass, and the marker.

Marked Carcasses

In order to maximize the project field managers' ability to identify individual trial carcasses, trial bird and bat carcasses were marked. Bird carcasses had a small amount of black tape attached to each leg marked with a unique obscured carcass identification number. In addition, the tips of the trial birds' flight feathers were cut. The tips of the trial bat carcasses' wings were taped and marked with a unique carcass identification number.

Table 2 shows the schedule for monitoring of the strings. The project field managers placed six bats and eight brown-headed cowbirds – referred to below as "small birds" – at each string, and placed one additional large bird at each string in Blocks 3 and 4. The goal was to run each block experiment for a six-week period, but logistical constraints sometimes shortened the time period, so that the actual durations ranged from 29 to 47 days. The first block experiment started on January 7, 2011, and the last block experiment ended on April 30, 2011.

Table 2: Summary of Sampling Design

Block #	String #	Turbine Address Range	Small bird carcasses placed at start of trial	Bat carcasses placed at start of trial[1]	Incidentally found carcasses added to study[2]	Trial dates (2011)	Trial Length (days)
1	280	2206-2209	8	6	2	Jan 7-Feb 12	36
1	288	2038-2041	8	6	0	Jan 7-Feb 17	41
1	293	2075-2081	8	6	1	Jan 14-Feb 21	38
1	302	2166-2171	8	6	2	Jan 7-Feb 17	41
Block 1 Subtotal			32	24	5	Jan 7-Feb 21	45
2	298	2757-2761	8	6	1	Feb 18-Apr 4	45
2	683.1	2347-2354	8	6	10	Feb 18-Apr 4	45
2	5046	2542-2546	8	6	1	Feb 18-Mar 21	31
Block 2 Subtotal			24	18	12	Feb 18-Apr 4	45
3	286	2317-2322	9	6	2	Mar 11-Apr 22	42
3	289	2099-2103	9	6	0	Mar 11-Apr 22	42
3	507	2458-2463	9	6	0	Mar 11-Apr 27	47
Block 3 Subtotal			27[3]	18	2	Mar 11-Apr 27	47
4	504	2418-2423	9[4]	6	0	Apr 1-30	29
4	505	2514-2518	9[5]	6	0	Apr 1-30	29
4	5047	2377-2381	9[4]	6	2	Apr 1-30	29
Block 4 Subtotal			27	18	2	Apr 1-30	29
TOTAL, All Blocks			**90**	**78**	**21**	**Jan 7-Apr 30**	**113**

[1] *Species included big brown bats, little brown bats, silver-haired bats, unidentified* Pipistrellus, *and unidentified* Myotis *bats.*

[2] *Mix of small and large birds (no bats), including some skeletal remains [note: evidence of skeletal remains are not used in the calculations presented in this report].*

[3] *One complete red-tailed hawk carcass placed at each string in Block 3.*

[4] *One complete common raven carcass placed at this string.*

[5] *One complete California gull placed at this string.*

Source: EcoStat, Inc.

Carcass Searches

The purpose of the carcass search procedure was to generate detection events of placed carcasses over time.

Field Technician Searches

Each study string was searched six times (once a week) over as many as six weeks. Each string search was conducted by one field technician who searched the entire 50-meter buffered search area using parallel transects, with an inter-transect distance of 6 to 8 meters depending on vegetation height and terrain (Figures 4, 5, and 6). Strict survey blindness was maintained by having each field technician search every study string only once over each six-week period, instructing the field technicians to not communicate found carcasses with each other, and to keep the number and position of marked carcasses a secret. Field technicians used range finders, compasses, and hand-held GPS receivers to navigate the search plots.

Figure 4: Conducting a Search

Photo Credit: EcoStat, Inc.

Figure 5: Searching in Short Grass

Photo Credit: EcoStat, Inc.

Figure 6: Searching in Tall Grass

Photo Credit: EcoStat, Inc.

In general, winter in the APWRA exhibits short vegetation starting to green due to rain. As temperature rises and precipitation continues, vegetation height increases and peaks in May.

Carcass Records

When a field technician detected a complete or partial carcass, or a collection of 10 or more feathers, a carcass record was created (Figures 7 and 8). In addition to placed marked carcasses, field technicians also found "natural" or incidental fatalities, which were also recorded. The Data Dictionary (Appendix C, Table C-1) lists all the variables contained in the final data set, including the data field technicians recorded when a carcass was found.

Figure 7: Fresh Bird Carcass

Photo Credit: EcoStat, Inc.

Figure 8: Partially Removed Carcass

Photo Credit: EcoStat, Inc.

Carcass Status Checks

The purpose of the carcass status check procedure is to rigorously verify the true status (presence, position, and condition) of known marked carcasses, both placed and incidentally found, at study strings.

Status Checks

Project field managers checked the status of all known carcasses every 48 hours and on days that field technician searches occurred (Figure 9). A project field manager found the last known location of a carcass utilizing a range finder, a compass, a GPS receiver, and a carcass marker. If an unknown carcass was found during a status check, the project field manager would collect and record data on its position and condition. (See Appendix C for complete list of data recorded for unknown carcasses.)

Project Field Manager Detection Types

Project field managers used range finders, compasses, and GPS receivers to find the approximate location of a placed carcass. If the carcass was not immediately detected, the carcass marker was sought out. The marker and turbine indicated a more precise carcass position. If the carcass was still not found, the position, the marker and turbine address became the point of origin for an intensive survey around this carcass to investigate if the carcass had been moved by scavengers, degraded due to abiotic weathering processes such as wind and rain, or was removed. This intensive survey was typically conducted as a flushing search, a tight spiral transect out to 20 meters from the assumed last carcass position and again back to the point of origin reversing direction to maximize the view shed around obstructions such has high vegetation and rocks.

In addition to finding a placed carcass by its GPS position, marker, or a flushing search, new carcasses or carcass positions were found incidentally when project field managers walked between carcass positions or by field technicians during their carcass searches.

Figure 9: Project Field Manager Conducting a Status Check

Photo Credit: EcoStat, Inc.

Fractured Position, New, and Unknown Carcass Identification Numbers

Carcass scavenging sometimes fractured the carcass sign into multiple positions. If these carcass parts were distinct and more than 10 meters away from the initial carcass position, an additional carcass position was established and identified by a lettered suffix added to the carcass identification number (*e.g.,* 0121B). These newly established carcass positions were then checked along with other known carcass positions.

Occasionally new fatalities were found by field technicians during carcass searches or when Project field managers conducted status checks. These new carcasses were identified with a carcass identification number including the string number, the letter U, and the number of new fatalities found at that string (*e.g.,* 302U-01). These new fatalities were checked along with all other known carcass positions.

Sometimes a marked carcass was found but its carcass identification number was unknown because the identifying tape was missing due to scavenging actions. These unknown marked carcasses were identified with a carcass identification number including the string number, the letter M, and the number of marked carcasses found at that string (302M-01). These unknown marked carcass positions were checked along with all other known carcass positions. Later a known carcass identification number was assigned to the carcass position based on its proximity to plausible known marked carcass positions.

Negative Detections

In order to maximize the certainty of a carcass position's removal, project field managers checked the negative presence (absence) multiple times before recording the removal of a carcass position. After a project field manager conducted three consecutive status checks, including flushing searches, with negative presence outcomes, the carcass position was declared removed and no longer part of future status checks. Once the carcass was confirmed removed, the time of removal was set consistent with the first observation time (this time is needed for the determination of the carcass persistence curve).

Quality Assurance/Quality Control

High frequency of data entry and field checks helped to assure the data was accurate:

- Data sheets from field technicians were collected after they completed their searches the same day and checked for completeness. The positions of any fatalities they found were also verified in the field on the same day by project field managers.
- Project field managers entered data into an Excel spreadsheet two to three times a week, because the data was needed to determine the status checks schedule.

If any questions arose when entering data, the data was rectified by asking the observer, using photos and GIS.

Results of the Field Sampling

Carcass Detections

Table 2 shows the number of trials in which a bird or bat carcass was truly on the ground, and a searcher had a chance of detecting the carcass. Carcasses that persisted over time contributed more to the number of trials than those that were removed from the study quickly.

Differences in the habitat types of the blocks may account for differences in carcass persistence, as well as the number of days on which a search occurred. Blocks are representative of changes in grass height over time; however, blocks were not selected based on specific ecological or habitat conditions. The chance of detecting a bird or bat was not equal for each search, and was found to be a function of vegetation height and carcass age. Topographical variables (*e.g.*, slope) and meteorological variables (*e.g.*, precipitation) were evaluated in addition to vegetation height, but were not found to be correlated to mortality at this site.

Table 3 summarizes the percentage of search opportunities with carcasses detected over the entire study. In practice, a single trial is implemented in which a fixed number of carcasses are observed. Each carcass has one chance of observation.

Table 2: Percent of Birds and Bats Observed for Each Block

Block	Species	Number of individual observations where the carcass was truly present[1]	Percent Detected	Average Vegetation Height (inches)
1	Bat	83	16.9	2.2
2	Bat	63	4.8	3.4
3	Bat	60	1.7	5.6
4	Bat	42	4.8	7.6
1	Small Bird	72	18.1	2.6
2	Small Bird	63	17.5	3.5
3	Small Bird	38	7.9	6.1
4	Small Bird	50	22.0	6.1
3	Large Bird	17	58.8	6.3
4	Large Bird	14	78.6	8.4

[1] Note: individual carcasses could have several chances for observation during the study

Source: EcoStat, Inc.

Table 3: Percent of Birds and Bats Observed in Study

Species	Number of individual observations where the carcass was truly present[1]	Average Vegetation Height (inches)	Percent Detected
Bat	248	4.3	8.1
Small Birds	223	4.2	17.0
Large Birds	31	7.2	67.7

[1] Note: individual carcasses could have several chances for observation during the study

Photo Credit: EcoStat, Inc.

Table 4 shows the chance that a carcass was observed on the first observation date. The number of bat carcasses observed on the first observation date is 14 percent. Note that the percentages observed on the first date are larger than found over all possible observation dates. This finding could be linked to increased difficulty with observing older carcasses.

Table 4: Percent of Birds and Bats Observed on First Observation Date

	Percent Detected
Bat	**14.1**
Small Birds	**22.1**
Large Birds	**83.3**

Source: EcoStat, Inc.

Table 5 shows average vegetation height by month and block. The vegetation in the study area is predominantly grass, with an average height of 2.7 inches (maximum 10 inches) at the start of the study in January and an average height of 6.4 inches (maximum 23 inches) at the end of the study in April.

Table 5: Average Vegetation Height (inches) Observed by Month and Block

	Jan 2011	Feb 2011	Mar 2011	Apr 2011
Block 1	2.7	2.3		
Block 2		2.3	3.2	4.3
Block 3			3.3	5.9
Block 4				6.4

Source: EcoStat, Inc.

Table 6 shows the number of individual carcasses detected for each block over the course of the entire study.

Table 6: Percent of Unique Carcasses Detected per Block (7-day interval)

	Found			Placed			Percent Detected		
Block #	Bats	Small Birds	Large Birds	Bats	Small Birds	Large Birds	Bats	Small Birds	Large Birds
1	10	11	-	24	32	-	41.7	40.6	-
2	3	8	-	18	24	-	16.7	29.2	-
3	1	3	3	18	24	3	5.6	12.5	100
4	1	10	3	18	24	3	5.6	37.5	100
Total	**15**	**32**	**6**	**78**	**104**	**6**	**19.2**	**30.8**	**100**

Source: EcoStat, Inc.

Carcass Persistence Probability

In this section, the scavenging rate at the level of string, block, and entire study area is examined. Relationships between carcass persistence and key covariates, such as vegetation height, are also examined. The persistence of a carcass on the field was modeled using a two-parameter Weibull distribution with the following model structure.

The density function for Weibull[3] distributed carcass persistence times is the following:

$$p(t_i|\alpha,\lambda_i) = \alpha {t_i}^{\alpha-1} \exp(\lambda_i - \exp(\lambda_i)\, {t_i}^{\alpha})$$

Where λ is the scale parameter, t_i is the time of event i, and α is the shape parameter of the Weibull probability density function.

The corresponding carcass persistence function can be written as follows:

$$S(t_i|\alpha,\lambda_i) = \exp(-\exp(\lambda_i)\lambda_i^{\alpha})$$

Where S is the probability of carcass persistence (survival or non-removal from the field), and t_i is the time (days) that the carcass was observed on the field since the start of the study.

If covariates (*i.e.*, grass height, distance to bird or bat from the searcher, topographical features, etc.) are linked to λ with $\lambda_i = x_i'\beta$, where x_i is a vector of covariates corresponding to the *i*th observation (here, an observation is a survey date) and β is a vector of random parameters, the log-likelihood function is written as:

$$l(\alpha,\beta|t,x) = \sum_{i=1}^{n} v_i(\log(\alpha) + (\alpha-1)\log(t_i) + x_i'\beta) - \exp(x_i'\beta)\, t_i^{\alpha}$$

The above model was implemented using a Bayesian paradigm with prior distributions:

$$\beta\text{: N}(0,10000)$$

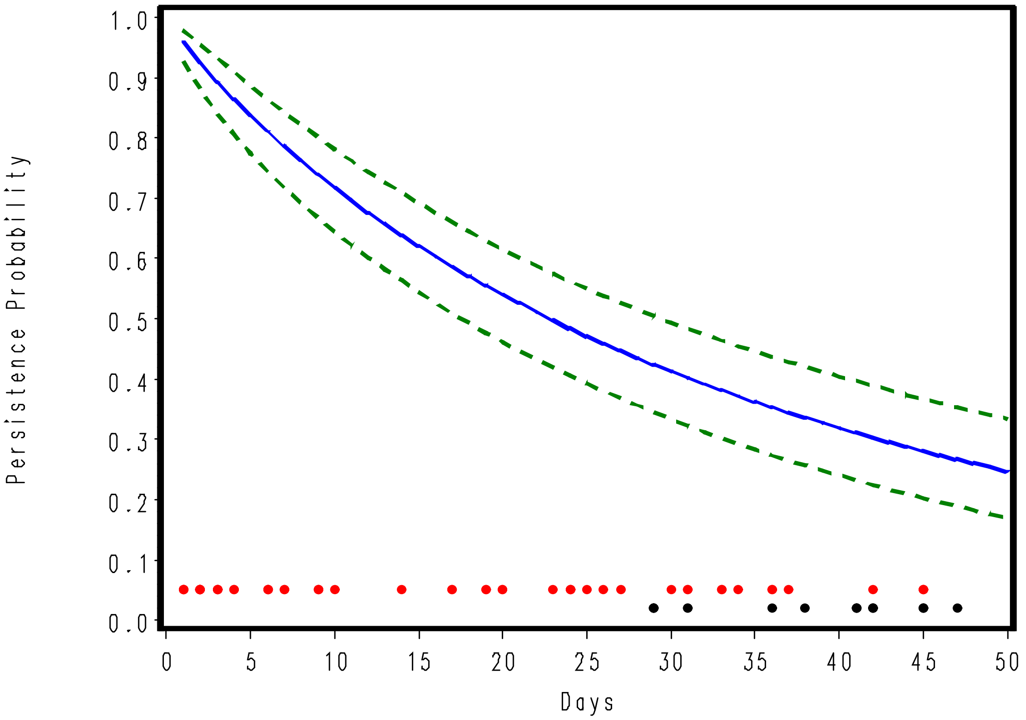
$$\alpha\text{: Gamma}(0.001, 0.001)$$

Also, in some cases, the model was implemented without λ linked to covariates. Note that v indicates whether the observation is an actual failure time (v=1) or a censoring time (v=0). An observation is considered censored if the event of interest (in this case, the carcass is removed) does not occur within the timeframe of the study. A censored observation is defined as a record where the event (removal), has yet to occur (but, may occur if the record was tracked through time for a longer period). Results of the carcass persistence modeling exercise are shown below in Figures 10-13. These graphical presentations of the carcass persistence curves display the variability in probability within the data base. The curves are not adjusted for grass height, or other possible covariates.

---

[3] The Weibull distribution is a continuous probability distribution used in survival analysis, which involves the modeling of time to event data.

Figure 10: Carcass Persistence Probability for All Bats in the Study



With 90 percent Credible Intervals, dashed line

Two-Parameter Weibull Survival Model

Red dots indicate a removal; Black dots indicate a censored[4] record
Note: A single bat can be viewed more than once during the course of the study

Source: EcoStat, Inc.

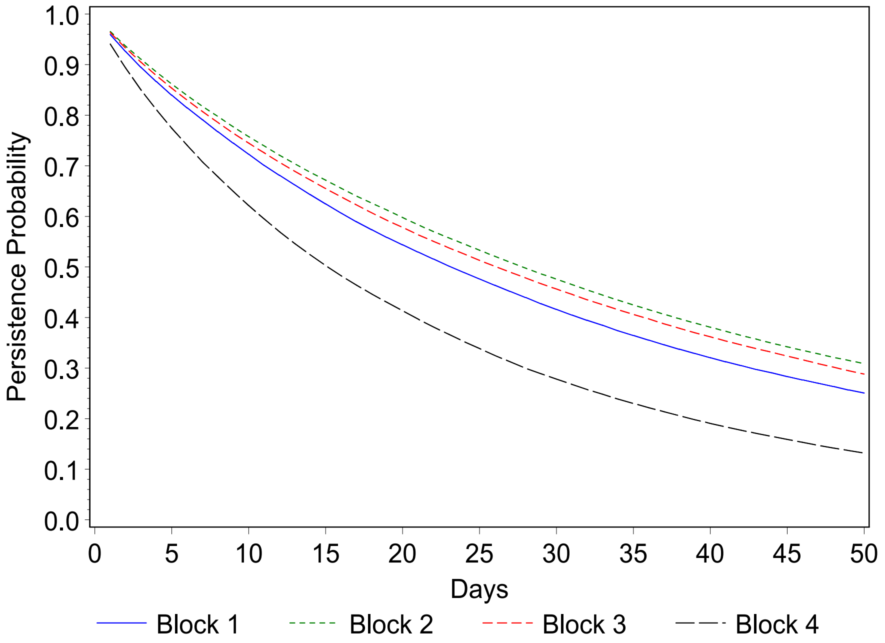
The carcass removal rate was high over the first two weeks and then the removal rate exponentially decreased. Red dots in Figure 10 indicate a constant rate of removal. Approximately 30 percent of bats were not removed (black dots).

Changes to grass height and other biological metrics over the study period may explain some of the differences in Figure 11. (However, no formal analysis of this subject is possible due to lack of rigorous field measurements). The statistical model does not result in a probability curve for large birds due to the low removal rate (one carcass).

---

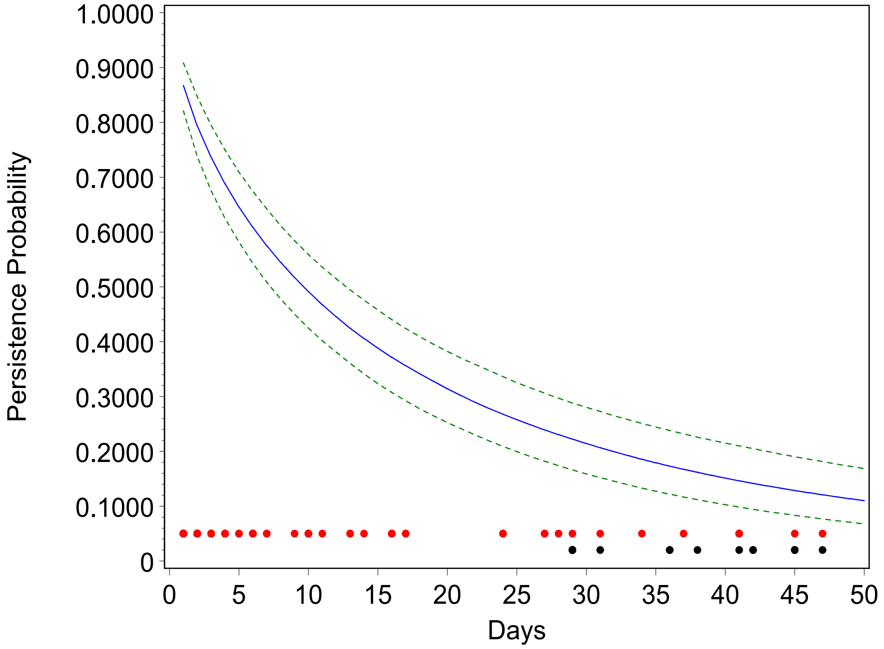
[4] "Censored" means that the carcass remained on the ground (was not removed) when the trial ended.

Figure 11: Block-Specific Persistence Probability for All Bats in the Study



Source: EcoStat, Inc.

Figure 12: Persistence Probability for Small Birds in the Study

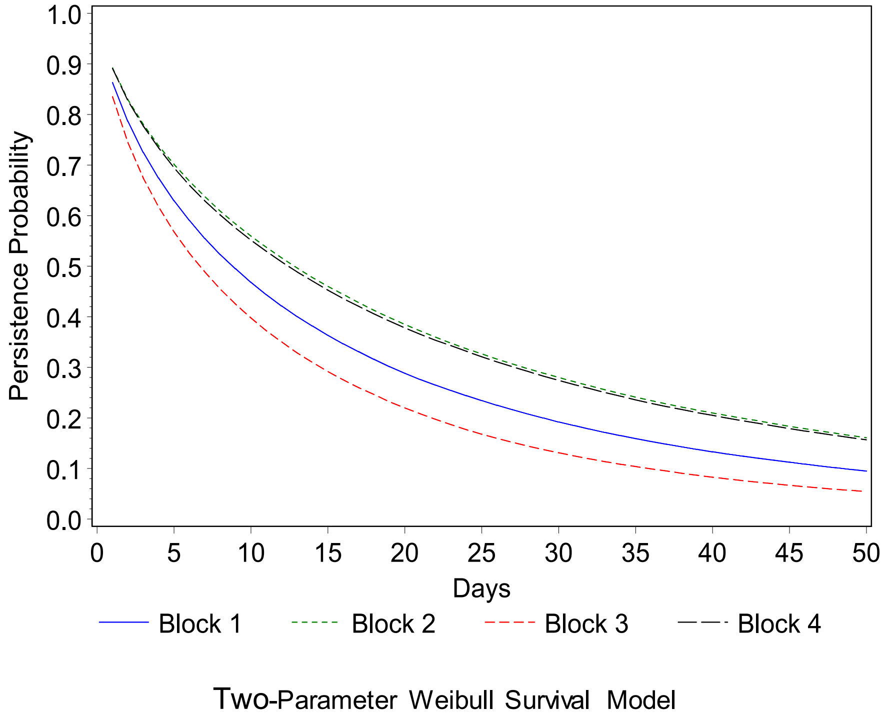


Dashed lines show 90 percent credible intervals

Red dots indicate a removal; Black dots indicate a censored record

Source: EcoStat, Inc.

Figure 13: Block Specific Persistence Probability for Small Birds in the Study



Source: EcoStat, Inc.

These curves confirm that the rates of carcass removal were greater in the first two weeks, and that most carcasses were removed within six weeks.

Searcher Proficiency

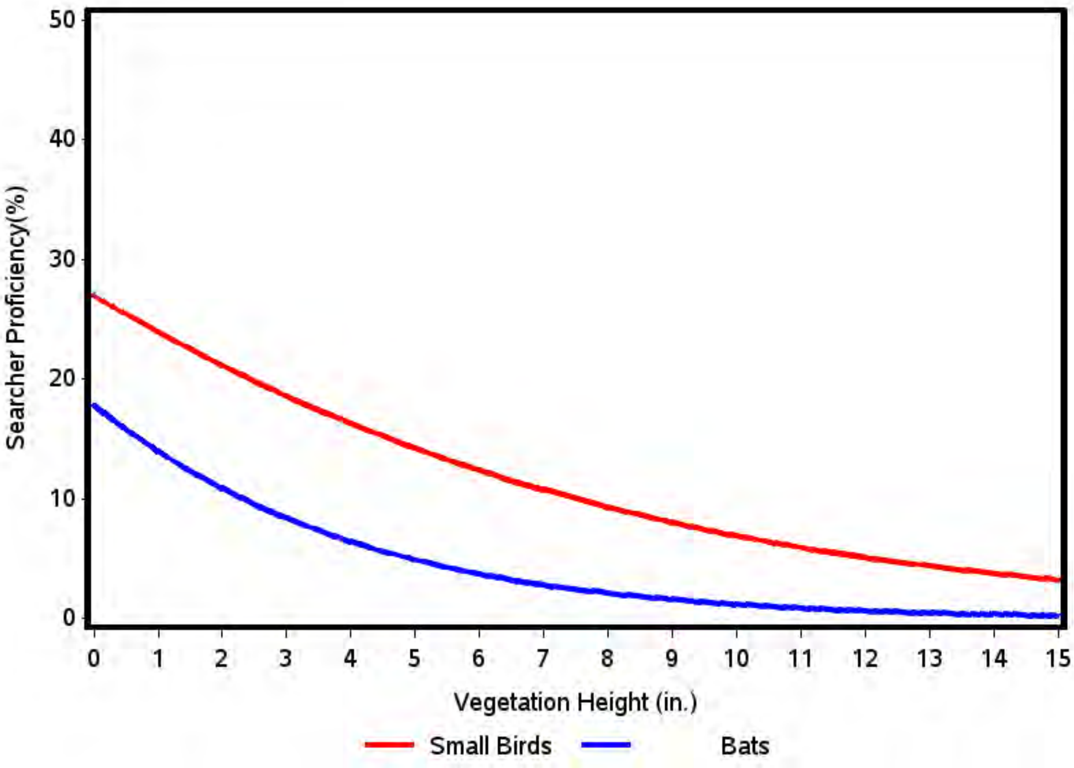
The magnitude of the searcher proficiency rate will be site specific, and will be a function of environmental and topological variables. In this study, searcher proficiency was significantly related to vegetation height (Figure 14). In addition to showing that searcher proficiency is a time-dependent process, Figures 14 and 15 clearly indicate that the shape of the searcher proficiency curves (with time and vegetation height) differ for birds and bats, and for small and large birds.

A key contribution of this study is the findings associated with bats. Statistics derived from this study indicate that, on average, searcher proficiency of bats is roughly half that of small birds. Large birds in this study were detected approximately 70 percent of the time. From a specific carcass perspective, approximately 30 percent of all small birds in the study were detected at least once, while only 19 percent of the bats were detected at least once.

The above rates for small birds are consistent with published literature values. For bats, however, the incorporation of time-based functions of searcher proficiency will have a significant impact on the resulting bat fatality estimation.

In this study, the searcher proficiency for small birds and bats was found to be similar after approximately 25 days, with the largest difference seen initially after carcass placement when the carcasses were fresh. An approximate 15 percent difference is seen between searcher proficiency in birds and bats with fresh carcasses. The searcher proficiency for birds and bats approached 2 percent after 30 days. This finding has implications for interval length in post-monitoring studies, where this study points to shorter intervals in order to maximize the chance of detecting a carcass on the ground.

Figure 14: Searcher Proficiency as Function of Vegetation Height for Brown-Headed Cowbirds and Bats, Integrated Across All Other Possible Covariates

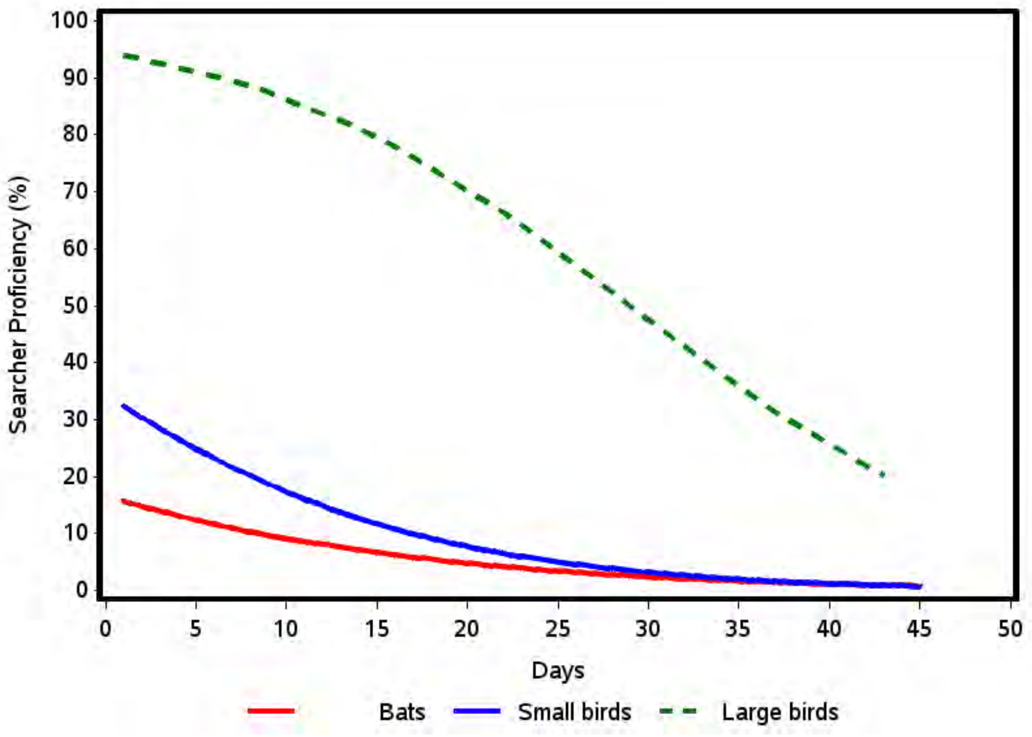


Source: EcoStat, Inc.

Bats are harder to find than birds, and all carcasses have low probability (less than 10 percent) of detection by field technicians after three weeks. The study's finding that carcasses have the highest chance of being detected during the first two weeks has implications for study design. (Note that Figure 15 includes carcasses that have been scavenged but not removed.)

Table 7 presents the distance between the observed bird or bat, and the field technician. Statistics are calculated for the entire study, using all possible observations. Smaller carcasses are clearly shown to be found closer to the observer, on average. The distance sighted suggests that transects should be closer together; this study shows that 6 to 8 meters (a standard distance used by many investigators) is too far apart for many small bird and bat detections.

Figure 15: Searcher Proficiency of Small Birds and Bats Over Time, Integrated Over All Other Covariates



Source: EcoStat, Inc.

Table 7: Distance Between Observed Carcass and Field Technician

Species	Minimum Distance (meters)	Mean Distance (meters)	Maximum Distance (meters)
Bat	1.0	1.7	8.0
Small Birds	1.0	2.2	10.0
Large Birds	1.0	9.0	41.0

Source: EcoStat, Inc.

One problem with most estimators is that they must address a mix of species and ages of carcasses, which is complex. The time and age of carcasses matter for detection; the data reveal an often overlooked time dependency to searcher bias, combined with persistence.

Questions that could be explored with further research include whether increasing the searcher time per string (decreasing walking speed) results in higher detection rates, and whether it would be better to search one area thoroughly or search more areas.

CHAPTER 3: Fatality Estimation Equation Analysis

The objective of this section of the compare commonly used equations. Based on the assumptions underlying each equation, and the mathematics inherent in the equations, computer simulation is used to compare and contrast the expected true fatality rates among the equations evaluated. The equations are explored and evaluated using the concept of statistical bias and variance.

Description of Analysis

Estimating the true (or actual) fatalities of a specific species of bird or bat, related to a particular wind power generating facility during a specified time period, is a challenging task. Typical data supporting such estimates consist of collections $\{C_{ij}\}$ of counts of carcasses discovered by search teams in delineated search areas near a number of turbines (here indexed by i) at the end of successive search periods (here indexed by j), of varying length $\{I_{ij}\}$ (in days).

The simplest approach to estimating the total number M_{ij} of fatalities due to turbine i in time period j would be the raw count, $\widehat{M}_{ij} = C_{ij}$. This would be exactly correct under the simplistic assumptions:

- S_1 Each period begins with no carcasses in the search area;
- S_2 Each fatality caused by turbine j during period i leads to a (unique, single) carcass in the study area;
- S_3 There are no other sources of carcasses in the study area;
- S_4 Each carcass remains throughout the period;
- S_5 The search team discovers and removes every carcass.

Under these assumptions the total number M_{ij} of fatalities could be estimated perfectly by

$$\widehat{M}_{ij} := C_{ij}.^{5}$$

Each of the assumptions above is false to at least some degree, leading C_{ij} to be a badly distorted estimate of M_{ij}. Some of the reasons include:

- Experiments (for example, see http://www.altamontsrc.org/alt_rl.php) have shown that search teams usually discover only a fraction of existing carcasses (estimates ranging from 13 percent to 88 percent have been reported in the literature), violating S_5. The undiscovered carcasses will be present in the search area at the beginning of the subsequent period, violating S_1.
- Fatalities from turbine j may lead to carcasses outside the search area, violating S_2.

---

[5] Note the equals sign (=) indicates "defined as."

- Carcasses from fatalities caused by another turbine or from an unrelated source may fall into the search area, or carcasses from fatalities preceding the test period may persist into the period, violating S_3.
- Scavengers may remove carcasses before they are discovered by the search team, or carcasses may degrade so much that they elude discovery, violating S_4.

A number of authors have published more sophisticated estimation formulas for the number M_{ij} of birds or bats killed, intended to correct the biases induced by these issues. The following discussion is intended to explain the implicit assumptions that underlie four of these formulas, illustrating how they differ, and to offer suggestions for choosing among them or alternatives for the purpose of making reliable estimates of fatality.

The Estimating Equations

The authors study fatality by constructing a mathematical model in which the number C_{ij} of turbine-related carcasses discovered in the i^{th} spatial region at the end of the j^{th} temporal period is treated as a random variable. Each of the estimation formulas considered here begins as an equation expressing the *expected number* of carcasses counted, $\mathrm{E}[C_{ij}]$, as a function of the actual number M_{ij} of fatalities and of some other factors (or estimates of them), under some assumptions about how scavenging and fatality proceed. This section considers what implicit assumptions lie behind these equations, offering some perspective on them and also some generalizations.

The authors differ in their choice of which letters to use as variable names for which quantities. To simplify comparing their estimation formulas, this report assigns common notation for all of them. Upper-case letters denote quantities which are (or could be, in principle) observed; lower-case letters denote model parameters. Table 8 presents the notation used here. "Hatted" quantities such as "$\widehat{M}_{ij}$" denote estimates of the corresponding quantities.

Even though observations are taken only at a few discrete times, it is useful to think of fatality and removal as processes that occur progressively over the time interval. Time is treated as a continuously-varying quantity t, measured in days, ranging from zero to I_{ij} during each study interval. The instantaneous rates of fatality and removal, and the levels of searcher proficiency, may vary in time and may depend on a variety of covariates. In a more detailed modeling effort the proficiency s_{ij} (the probability of discovery of a particular carcass) would depend on the searcher's skill, the time lapse from fatality to search, and various covariates including the vegetation height and lighting conditions. Carcass removal rates r_{ij} would also change as carcasses age, and might depend on other covariates, leading to time and covariate dependence for persistence probabilities p_{ij} and average durations t_{ij}.

Table 8: Common Notation for Observable Quantities (Upper Case) and Parameter Values (Lower Case) for All Estimation Formulas

At turbine i in time interval j		
C_{ij}	(count)	= number of carcasses counted
I_{ij}	(search interval)	= search interval length (in days)
M_{ij}	(mortality)	= true number of carcasses during interval
p_{ij}	(persistence probability)	= probability a carcass remains unremoved until next search
r_{ij}	(removal rate)	= probability per day of carcass removal by scavengers and other processes
s_{ij}	(search proficiency)	= probability a carcass will be discovered
t_{ij}	(persistence time)	= average number of days a carcass remains unremoved

Source: Dr. Robert Wolpert

In this discussion, each of these parameters is treated as constant during each search interval, set to their $average$ values in region i and epoch j. Models reflecting their dependence on time and covariates are under development and will be described elsewhere.

Common Assumptions

All four of the estimation equations below embody some common simplifying assumptions, most of them approximately correct or easily addressed:

A_1: Each fatality caused by turbine j during period i leads to a carcass in the study area.

- In each of the approaches below this can be relaxed by including an additional factor $1/\hat{\pi}_{ij}$, where $\hat{\pi}_{ij}$ is an estimate of the fraction π_{ij} of carcasses from the j^{th} turbine that fall into the study area during the i^{th} time period. Most authors adjust for this.

A_2: There are no other sources of carcasses in the study area.

- Searchers are trained to distinguish turbine fatalities from others, and search areas are sufficiently widely separated to ensure that few if any inappropriate carcasses will be counted.

A_3: Carcass arrival times are uniformly distributed over the interval $[0, I_{ij}]$.

- Actual fatality rates will vary over time due to diurnal patterns, weather dependence, migratory patterns, and for other reasons, but the effects should average out over time with no significant effect on estimates.

A_4: Quantities that vary over the time interval or that depend on covariates are adequately represented by their average values.

- This leads to considerable simplification, and holds approximately if the variation is small. See Discussion below for notes on how it may affect estimates if variation is not small, and on how it could be addressed.

Implicit assumptions specific to each particular estimation approach are described below.

Erickson & Johnson's Equation

An early attempt to reduce bias, attributed by Shoenfeld (2004, Equation (2)) to Erickson, Strickland, Johnson and Kern (1998) and by Huso (2011, §3.2) to Johnson, Erickson, Strickland, Shepherd, Shepherd and Sarappo (2003) is

$$\widehat{M}_{ij}^{\mathrm{EJ}} = \frac{C_{ij} I_{ij}}{\hat{s}_{ij} \hat{t}_{ij}}. \tag{1}$$

If, on average, carcasses persist unremoved for only a fraction $t_{ij} < I_{ij}$ of the search interval, and if the search team's proficiency is $s_{ij} < 1$, it is reasonable to expect them to only discover a portion

$$C_{ij} \approx (t_{ij}/I_{ij})(s_{ij})M_{ij}$$

of the carcasses, leading to the estimator (1) when the uncertain quantities s_{ij} and t_{ij} are replaced with estimates and the equation is solved to construct an estimate of M_{ij}.

Exploring this in more detail, in the absence of intervention (*i.e.*, removal of carcasses by searchers) and under unchanging conditions, the long-term average number of carcasses present on the ground in the study area would reach a steady state with no systematic increase or decrease; denote the average number of carcasses at steady state by g_{ij}^{∞}. Since each of those carcasses is present for an average of t_{ij} days, the average daily fatality rate necessary to maintain that equilibrium is $m_{ij} = g_{ij}^{\infty}/t_{ij}$, so

$$g_{ij}^{\infty} = m_{ij} t_{ij}.$$

On average the total fatality in a period of I_{ij} days is $M_{ij} \approx m_{ij} I_{ij}$, so

$$g_{ij}^{\infty} \approx (M_{ij}/I_{ij}) t_{ij}$$

and on average a search team that succeeds in discovering carcasses with probability $s_{ij} < 1$ (the team's proficiency) would discover a fraction s_{ij} of these,

$$\mathrm{E}[C_{ij}] \equiv s_{ij} g_{ij}^{\infty} = M_{ij} s_{ij} t_{ij}/I_{ij}. \tag{2}$$

Replacing s_{ij} and t_{ij} by their estimates $\hat{s}_{ij}$ and $\hat{t}_{ij}$ and solving for M_{ij} leads to estimator (1), $\widehat{M}_{ij}^{\mathrm{EJ}} = (C_{ij}I_{ij})/(\hat{s}_{ij}\hat{t}_{ij})$. Because of its steady-state assumption, the validity of Erickson and Johnson's estimator $\widehat{M}_{ij}^{\mathrm{EJ}}$ (1) requires the additional assumption:

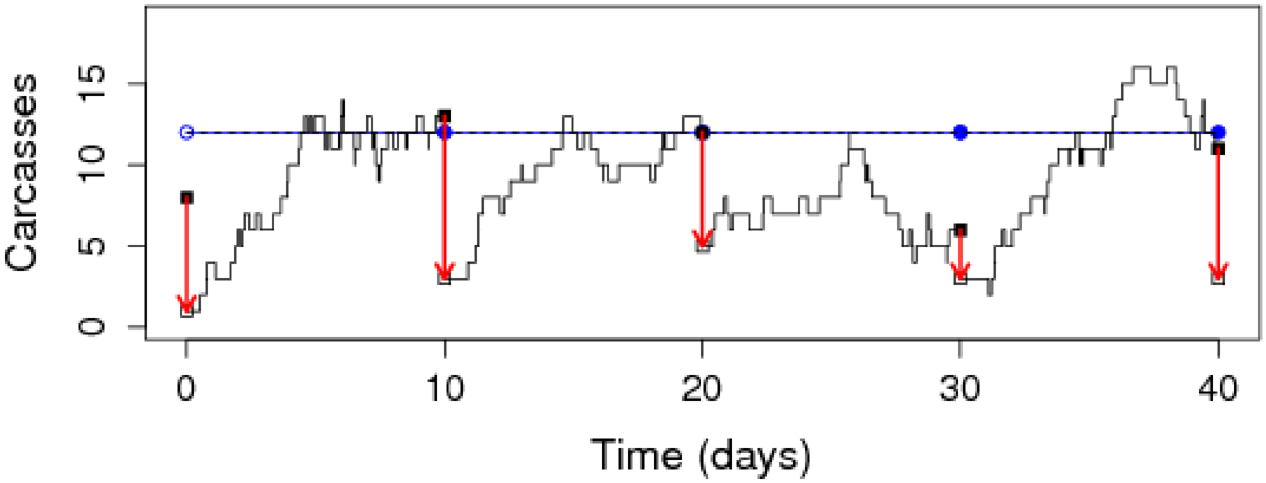
$\mathrm{A}_1^{\mathrm{EJ}}$:The system is in equilibrium at each search.

This will hold approximately whenever $I_{ij} \gg t_{ij}$, since the removal process then brings the system to equilibrium quickly, but in general it will be violated by any intervention such as the removal of discovered carcasses by search teams. If $\mathrm{A}_1^{\mathrm{EJ}}$: fails (as in Figure 16) because of interventions that remove carcasses, then $C_{ij} < s_{ij}g_{ij}^{\infty}$ on average, leading to systematic underestimation with $\widehat{M}_{ij}^{\mathrm{EJ}} < M_{ij}$ (see Discussion below).

Figure 16 illustrates four $I_{ij} = 10$-day periods. Simulated counts $G_{ij}(t)$of carcasses currently in the study area are shown as a stair-step curve, for Poisson fatality at constant average daily rate $m_{ij} = 3\mathrm{d}^{-1}$ and exponential persistence times averaging $t_{ij} = 4\mathrm{d}$. The equilibrium average value $g_{ij}^{\infty} = m_{ij}t_{ij} = 12$ is shown as a horizontal line.

The curve $G_{ij}(t)$ increases by one with each new fatality (at random times chosen uniformly from each interval $[0, I_{ij}]$), decreases by one with each removal by scavengers (after independent exponentially-distributed persistence times), and decreases at the time of each search by the number of carcasses discovered and removed. Search team proficiency for the simulation is $s_{ij} = 0.70$. Search team carcass counts appear as downward arrows, and undiscovered carcasses remain for the subsequent search period.

Figure 16: Steady-State Value $g_{ij}^{\infty} = 12$ for Erickson & Johnson's Estimator $\widehat{M}_{ij}^{\mathrm{EJ}}$ (1)



Horizontal line, beginning and ending each period at open and filled circles, respectively. One draw from random distribution (stair-step, beginning and ending each period at open and closed squares, respectively) is also shown, with discovered carcasses removed (in violation of $\mathrm{A}_1^{\mathrm{EJ}}$).

Source: Dr. Robert Wolpert

A Variation: Shoenfeld's Periodic Equation

Huso (2011, §3.2) attributes to Dr. Peter S. Shoenfeld (2004) the "modified" estimation formula

$$\widehat{M}^{s}_{ij} = \frac{C_{ij} I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}}\left[\frac{e^{I_{ij}/\hat{t}_{ij}} - 1 + \hat{s}_{ij}}{e^{I_{ij}/\hat{t}_{ij}} - 1}\right] \qquad (3)$$

Shoenfeld describes this estimator as a "periodic" variation on (1), specifically intended to address that estimator's systematic underestimation, which he suggests is about 15–20 percent in practice. The next section reviews the assumptions implicit in Equation (3).

Each period begins with carcasses that were *not* discovered and removed by the previous search team still on the ground. As the number t of days into the period increases, the number of carcasses $G_{ij}(t)$ is increased by new fatalities and decreased by the removal process, with expected value $g_{ij}(t) = \mathrm{E}\left[G_{ij}(t)\right]$ tending toward the equilibrium limit g^{∞}_{ij}. Under the assumptions listed below, the mean satisfies a linear Ordinary Differential Equation:

$$\frac{d}{dt} g_{ij}(t) = m_{ij} - r_{ij} g_{ij}(t) = m_{ij} - g_{ij}(t)/t_{ij} \qquad (4a)$$

where $m_{ij} = M_{ij}/I_{ij}$ is the daily fatality rate and $t_{ij} = 1/r_{ij}$ is the average persistence time. The well-known solution with initial value g^{0}_{ij} is

$$g_{ij}(t) = g^{0}_{ij} e^{-t/t_{ij}} + m_{ij} t_{ij}\left(1 - e^{-t/t_{ij}}\right), \qquad (4b)$$

which begins at $g_{ij}(0) = g^{0}_{ij}$ and converges exponentially at rate $1/t_{ij}$ to the equilibrium value of $g^{\infty}_{ij} = m_{ij} t_{ij}$. The value at the time of the search ending the j^{th} time period is $g_{ij}\left(I_{ij}\right)$.

Shoenfeld's idea is to use this relation *periodically* for search scenarios where the search intervals, search proficiencies, and removal rates are approximately constant for consecutive time periods. In that case each period will end on average with the same number $\mathfrak{g}_i = g_{ij}\left(I_{ij}\right)$ of carcasses as the preceding period. By periodicity, each must begin on average with $g^{0}_{ij} = \left(1 - s_{ij}\right)\mathfrak{g}_i$ carcasses, those undiscovered by the previous search team, leading to the equation

$$\mathfrak{g}_i = \left(1 - s_{ij}\right)\mathfrak{g}_i e^{-I_{ij}/t_{ij}} + m_{ij} t_{ij}\left(1 - e^{-I_{ij}/t_{ij}}\right). \qquad (5)$$

Collecting terms, this is easily solved for:

$$\mathfrak{g}_i = \frac{m_{ij} t_{ij}\left(1 - e^{-I_{ij}/t_{ij}}\right)}{1 - \left(1 - s_{ij}\right)e^{-I_{ij}/t_{ij}}} = \frac{M_{ij} t_{ij}}{I_{ij}} \frac{e^{I_{ij}/t_{ij}} - 1}{e^{I_{ij}/t_{ij}} - 1 + s_{ij}}$$

(using $m_{ij} = M_{ij}/I_{ij}$ for the average daily fatality). The expected carcass count will be less by a factor of the proficiency s_{ij},

$$\mathrm{E}\left[C_{ij}\right] = M_{ij} \frac{s_{ij} t_{ij}}{I_{ij}}\left[\frac{e^{I_{ij}/t_{ij}} - 1}{e^{I_{ij}/t_{ij}} - 1 + s_{ij}}\right].$$

Solving for M_{ij} and replacing s_{ij} and t_{ij} with their estimates leads to Shoenfeld's (2004, Equation (1)) estimation equation,

$$\widehat{M}^{s}_{ij} = \frac{C_{ij} I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}}\left[\frac{e^{I_{ij}/\hat{t}_{ij}} - 1 + \hat{s}_{ij}}{e^{I_{ij}/\hat{t}_{ij}} - 1}\right].$$

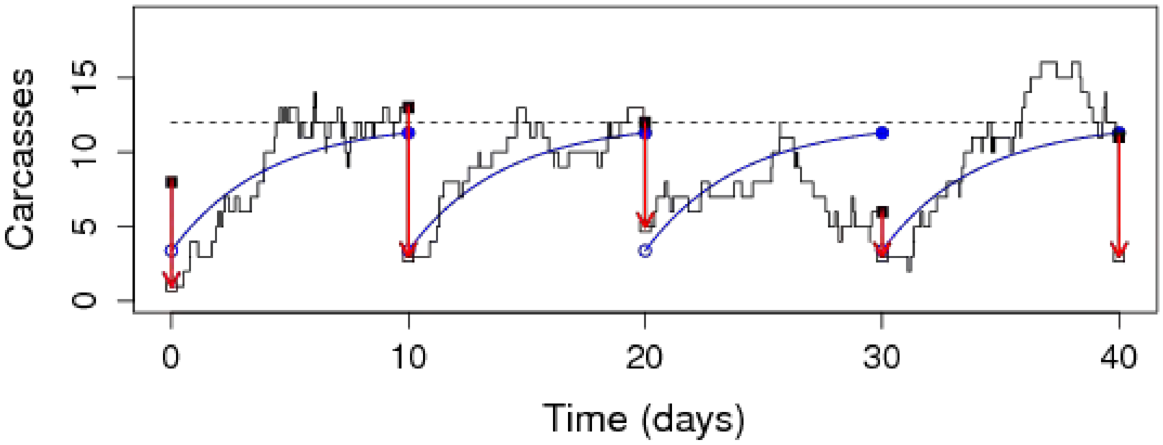
Shoenfeld's periodic approach was based on three new assumptions (as inferred from the characteristics of the equation):

A^{S}_{1}: Carcass persistence times have exponential distributions.

A^{S}_{2}: All carcasses (both old and new) have the same probabilities of discovery s_{ij}.

A^{S}_{3}: The lengths I_{ij}, rates of mortality m_{ij} and removal r_{ij}, and the proficiencies s_{ij} are approximately constant over consecutive time intervals.

Figure 17: Mean Function $g_{ij}(t)$ for Shoenfeld's "Periodic" Estimator $\widehat{M}^{s}_{ij}$ (3)



Smooth solid curve, beginning and ending each period at open and filled circles, respectively

Steady-state limit (dashed curve at $g^{\infty}_{ij} = 12$), and one draw from random distribution (stair-step, beginning and ending each period at open and closed squares, respectively) are also shown. True mortality rate is $m_{ij} = 3\mathrm{d}^{-1}$, persistence is $t_{ij} = 4\mathrm{d}$, and searcher proficiency is $s_{ij} = 0.70$.

Source: Dr. Robert Wolpert

Assumption A^{S}_{1} was needed to justify the Ordinary Differential Equation (4). Assumption A^{S}_{2} ensures that undiscovered carcasses from an earlier period are just as likely to be removed by scavengers and weathering or discovered by future search teams as are fresh carcasses (see Discussion below), justifying their inclusion for the current period. Assumption A^{S}_{3} justifies the recursion of Equation (5).

If the sampling intervals I_{ij} are long compared to the average removal times t_{ij}, then the last factor in square brackets above is close to one and (3) reduces to (1), so $\widehat{M}^{s}_{ij} \approx \widehat{M}^{\mathrm{EJ}}_{ij}$. If searches are more frequent, so search intervals I_{ij} are not long compared to residence times t_{ij}, then the estimate $\widehat{M}^{\mathrm{S}}_{ij}$ of (3) always exceeds $\widehat{M}^{\mathrm{EJ}}_{ij}$ of (1), to compensate for the smaller number of carcasses on the ground following the previous search.

Figure 17 illustrates the model implicit in Shoenfeld's estimation equation for four I_{ij} = 10-day periods. The mean value $g_{ij}(t)$for the count $G_{ij}(t)$ of carcasses in the region is shown as a solid curve, beginning and ending each search period with an open or filled circle respectively, approaching but not quite attaining the steady-state $g^{\infty}_{ij} = 12$ shown as a dashed line. One random draw of the numbers $G_{ij}(t)$ of carcasses currently in the study area is shown as a stair-step curve for constant daily mortality rate $m_{ij} = 3\mathrm{d}^{-1}$ and persistence times $t_{ij} = 4\mathrm{d}$. Search team carcass counts appear as downward arrows; undiscovered carcasses remain for subsequent search period. As before, search team proficiency is $s_{ij} = 0.70$.

Pollock's Equation

It is worth questioning *why* in practice search teams find only a modest fraction s_{ij} of carcasses. Under Shoenfeld's assumption $\mathrm{A}^{\mathrm{S}}_2$ the undiscovered carcasses are no harder or easier to find than those that were discovered— discovery failures are entirely random. But another possibility to consider is that some carcasses are more difficult to find than others, perhaps because they fell in deeper grass, or in an area with poorer light or less contrast, and that search teams find all of the most accessible carcasses. If so, then carcasses remaining on the ground after a search should *not* be included among those that might be found during subsequent periods. The next equations considered are based on an assumption that each period begins with no discoverable carcasses present.

The estimator recommended in Guidelines, suggested by Dr. Kenneth H. Pollock of North Carolina State University (2007), is

$$\widehat{M}^{\mathrm{P}}_{ij} = \frac{C_{ij}}{\hat{p}_{ij}\hat{s}_{ij}}. \qquad (6)$$

This is the estimator one would derive from a model in which the expected carcass count for the j^{th} period could be expressed as the product $\mathrm{E}[C_{ij}] = M_{ij}p_{ij}s_{ij}$ of the mortality count M_{ij}, reduced by the "persistence probability" p_{ij} and the searcher proficiency s_{ij}.

The difficulty in interpreting this equation and assessing its validity lies with interpreting the persistence probability parameter "p_{ij}", described by this study as the "probability that a carcass persists and is observable until the next search" and by the Guidelines as the "probability that a carcass has not been removed in an interval." Because some carcasses appear much earlier in the interval than others, some will be subject to removal by scavengers and weathering for longer times than others and so some will face a higher probability of removal.

Exponential Persistence Times

If persistence times have *exponential* distributions, then the probability of persisting unremoved from any time $0 \le t \le I_{ij}$ to the end of the interval is $\mathsf{P}[\tau_k > (I_{ij} - t)] = e^{-r_{ij}(I_{ij}-t)}$. Under

Common Assumption A3 of uniformly-distributed arrival times, the average probability p_{ij} that a carcass persists until the next search at time I_{ij} and the average persistence time t_{ij} is given by

$$p_{ij} = \frac{1}{I_{ij}} \int_0^{I_{ij}} e^{-r_{ij}(I_{ij}-t)}\, dt = \frac{1}{r_{ij}I_{ij}} \left[1 - e^{-r_{ij}I_{ij}}\right] \qquad (7a)$$

$$t_{ij} = \int_0^{\infty} e^{-r_{ij}\tau}\, d\tau \quad = 1/r_{ij.} \qquad (7b)$$

Combining these with (6), Pollock's estimator for exponential persistence is

$$\widehat{M}_{ij}^{\mathrm{P:E}} = \frac{C_{ij}}{\hat{p}_{ij}\hat{s}_{ij}} = \frac{C_{ij}I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}} \left[1 - e^{-I_{ij}/\hat{t}_{ij}}\right]^{-1} \quad \text{(with exponential persistence).} \qquad (7c)$$

Weibull Persistence Times

For exponentially-distributed persistence times, the probability of a carcass's removal during a day (assuming it is still present at the start of that day) does not vary with the age of the carcass. This feature of the distribution, sometimes called "memorylessness" and sometimes called "constant hazard", may not be realistic if older carcasses appear less attractive to scavengers. An alternative probability distribution commonly used to model failure times with decreasing hazard is the *Weibull* family.

Pollock's estimator $\widehat{M}_{ij}^{\mathrm{P}}$ of Equation (6) can be used with a Weibull probability distribution for persistence times exhibiting decreasing hazard, by introducing a new parameter $\alpha > 0$ (the Weibull "shape" parameter). The case $\alpha = 1$ reduces to the exponential distribution as before, but for $0 < \alpha < 1$ the hazard (*i.e.*, removal rate) falls off like the power $r_{ij} \propto \tau^{\alpha-1}$ with increasing persistence time τ. The persistence distribution is then given by

$$\mathrm{P}[\tau > t] = e^{-(r_{ij}t)^{\alpha}}, \ \mathrm{t} > 0$$

with average persistence probability and average persistence time given by

$$p_{ij} = \frac{1}{I_{ij}} \int_0^{I_{ij}} e^{-[r_{ij}(I_{ij}-t)]^{\alpha}}\, dt \ = \frac{1}{r_{ij}I_{ij}} P\left(\frac{1}{\alpha}, \left[\Gamma\left(1 + \frac{1}{\alpha}\right) r_{ij}I_{ij}\right]^{\alpha}\right), \qquad (8a)$$

$$t_{ij} = \int_0^{\infty} e^{-[r_{ij}\tau]^{\alpha}} d\tau \ = \Gamma\left(1 + \frac{1}{\alpha}\right)/r_{ij} \qquad (8b)$$

where $\Gamma(a)$ and $P(a,x)$ denote the Gamma and incomplete Gamma functions, respectively (Abramowitz and Stegun, 1964, §6.5). The resulting estimator from (6) is

$$\widehat{M}_{ij}^{\mathrm{P:W}} = \frac{C_{ij}}{\hat{p}_{ij}\hat{s}_{ij}} = \frac{C_{ij}I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}} P\left(\frac{1}{\alpha}, \left[\Gamma\left(1 + \frac{1}{\alpha}\right) I_{ij}/\hat{t}_{ij}\right]^{\alpha}\right)^{-1} \text{(with Weibull persistence),} \qquad (8c)$$

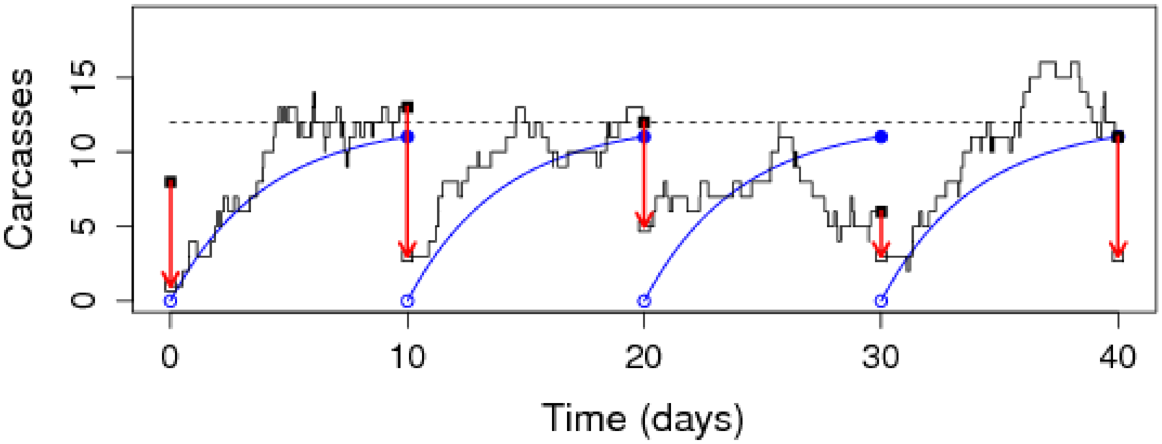
not much less tractable than the exponential version (7c).

Other interpretations of p_{ij} (for example, the probability a carcass present at the beginning of the interval will persist to the end) or other persistence distributions lead to different expressions and may require different assumptions for validity. For any persistence distribution, Pollock's estimator requires the assumption:

A_1^P: Each period begins with no discoverable carcasses.
If A_1^P: fails then $\widehat{M}_{ij}^P$ will consistently overestimate M_{ij}.

Figures 18 and 19 illustrate the model implicit for $\widehat{M}_{ij}^P$ with exponential persistence for four I_{ij} = 10-day periods. The mean value $g_{ij}(t)$ for the count $G_{ij}(t)$ of carcasses in the region is shown in each as a solid curve, beginning each search period with an open circle at $g_{ij}(t) = 0$ and ending each at a filled circle somewhat below the steady-state level of $g_{ij}^{\infty} = 12$, indicated by a dashed line. One random draw of the numbers $G_{ij}(t)$ of carcasses currently in the study area is shown as a stair-step curve for constant mortality rate $m_{ij} = 3\text{d}^{-1}$ and mean persistence times $t_{ij} = 4\text{d}$. Search team carcass counts appear as downward arrows, for proficiency is $s_{ij} = 0.70$. Following searches undiscovered carcasses remain discoverable for future searches in Figure 18, in violation of A_1^P, to illustrate possible bias, but search intervals are sufficiently long ($I_{ij} = 2.5t_{ij}$) that estimator $\widehat{M}_{ij}^P$ has a bias of only 2.5 percent.

Figure 18: Mean Function $g_{ij}(t)$ for Pollock's Estimator $\widehat{M}_{ij}^P$ (7c) with Exponential Carcass Persistence Distributions



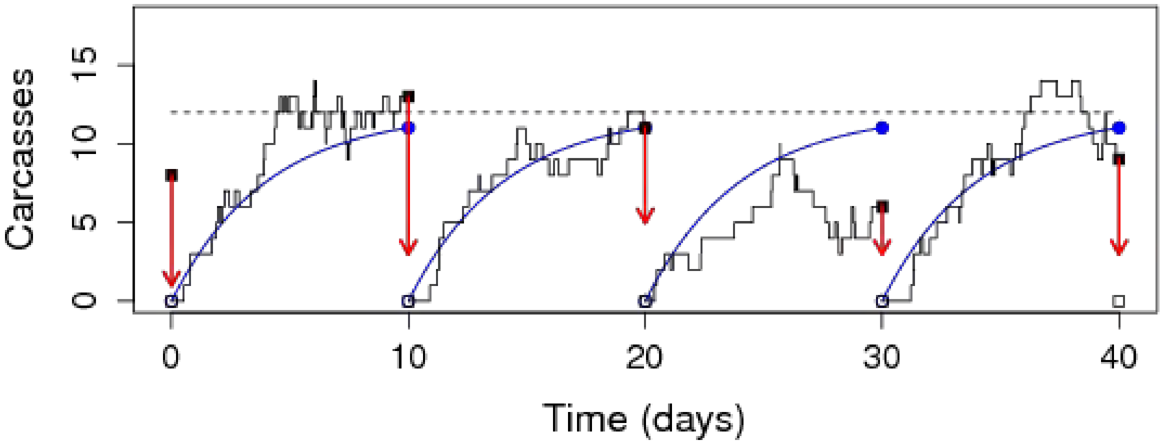
Smooth solid curve, beginning each search period with an open circle at $g_{ij}(t) = 0$ and ending each period at a filled circle

Steady state limit (dashed curve at $g_{ij}^{\infty} = 12$), and one draw from random distribution (stair-step, beginning and ending each period at open and closed squares, respectively) are also shown. True mortality rate is $m_{ij} \equiv 3\text{d}^{-1}$, persistence is $t_{ij} = 4\text{d}$, and search team proficiency is $s_{ij} = 0.70$. Undiscovered carcasses are allowed to remain following searches, in violation of A_1^P.

Source: Dr. Robert Wolpert

For contrast, all carcasses are removed following searches in Figure 19, consistent with A_1^P.

Figure 19: Simulation Illustrating $\widehat{M}_{ij}^{\mathrm{P}}$ (7c) with Exponential Persistence Distributions with Carcasses Removed Following Searches, so $\mathrm{A}_1^{\mathrm{P}}$ Holds



Source: Dr. Robert Wolpert

Huso's Equation

Huso (2011) expresses the concern that in some study designs the interval I_{ij} between successive searches may far exceed the expected persistence time t_{ij} of carcasses. In that case she proposes to reduce the value used for I_{ij} to an "effective" time interval length $\tilde{I}_{ij} < I_{ij}$, sufficiently long that the random persistence times $\{\tau_k\}$ (with mean t_{ij}) will only exceed this effective time with small probability $\mathsf{P}[\tau_k > \tilde{I}_{ij}] \le 1\,percent$, and regard the carcass count as appropriate for just the last $\tilde{I}_{ij}$ days of the interval. The resulting estimate is then scaled by the factor $(I_{ij}/\tilde{I}_{ij})$ to achieve an estimate $\widehat{M}_{ij}^{\mathrm{H}}$ for the full interval of I_{ij} days. Under her assumption of exponential distributions for persistence times $\{\tau_k\}$, $\hat{I}_{ij} \equiv \hat{t}_{ij}\log(100)$ (about 4.6 times the estimated mean persistence time $\hat{t}_{ij}$), leading to Huso's estimator

$$\widehat{M}_{ij}^{\mathrm{H}} = \begin{cases} \dfrac{c_{ij}I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}\left(1-e^{-I_{ij}/\hat{t}_{ij}}\right)} & I_{ij} < \hat{I}_{ij} \\ \dfrac{c_{ij}I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}(0.99)} & I_{ij} > \hat{I}_{ij} \end{cases} = \frac{c_{ij}I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}\left[0.99 \wedge \left(1-e^{-I_{ij}/\hat{t}_{ij}}\right)\right]}. \tag{9}$$

This is expressed quite differently, but is mathematically identical to the "Proposed Estimator" of (Huso, 2011, §3.2, $p.$7). This estimate always exceeds Pollock's estimator $\widehat{M}_{ij}^{\mathrm{P:E}}$ (7c) for exponential persistence

$$\widehat{M}_{ij}^{\mathrm{H}} \ge \widehat{M}_{ij}^{\mathrm{P:E}} = \frac{c_{ij}I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}\left[1-e^{-I_{ij}/\hat{t}_{ij}}\right]}. \tag{10}$$

The two never differ by more than one percent, and coincide whenever $I_{ij} < 4.6\hat{t}_{ij}$, so $\widehat{M}_{ij}^{\mathrm{H}}$ may be viewed simply as a complicated way of expressing $\widehat{M}_{ij}^{\mathrm{P}}$ for exponential persistence times. Huso's estimator will be valid and nearly unbiased under the assumptions:

$\mathrm{A}_1^{\mathrm{H}}$: Each period begins with no discoverable carcasses.

$\mathrm{A}_2^{\mathrm{H}}$: Carcass persistence times have exponential distributions.

The estimation equations considered here –

$$
\begin{aligned}
\widehat{M}_{ij}^{\mathrm{EJ}} &= \frac{C_{ij} I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}} && (1)\\
\widehat{M}_{ij}^{\mathrm{S}} &= \frac{C_{ij} I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}}\left[\frac{e^{I_{ij}/\hat{t}_{ij}} - 1 + \hat{s}_{ij}}{e^{I_{ij}/\hat{t}_{ij}} - 1}\right] && (3)\\
\widehat{M}_{ij}^{\mathrm{P}} &= \frac{C_{ij}}{\hat{p}_{ij}\hat{s}_{ij}} && (6)\\
&= \frac{C_{ij} I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}}\left[1 - e^{-I_{ij}/\hat{t}_{ij}}\right]^{-1} \quad \text{for exponential persistence} && (7c)\\
&= \frac{C_{ij} I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}} P\left(\frac{1}{\alpha}, \left[\Gamma\left(1 + \frac{1}{\alpha}\right) I_{ij}/\hat{t}_{ij}\right]^{\alpha}\right)^{-1} \text{for Weibull persistence} && (8c)\\
\widehat{M}_{ij}^{\mathrm{H}} &= \frac{C_{ij} I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}\left[0.99\,\Lambda\left(1 - e^{-I_{ij}/\hat{t}_{ij}}\right)\right]} \approx \frac{C_{ij} I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}}\left[1 - e^{-I_{ij}/\hat{t}_{ij}}\right]^{-1} && (9)
\end{aligned}
$$

– are all intended to adjust for the gross underestimation of mortality M_{ij} by simple carcass counts C_{ij}. Each of them relies on the Common Assumptions A1–A4 (see p. 31) and each is a valid estimator of M_{ij} under some additional assumption ($\mathrm{A}_1^{\mathrm{EJ}}$, $\mathrm{A}_1^{\mathrm{S}} - \mathrm{A}_3^{\mathrm{S}}$, $\mathrm{A}_1^{\mathrm{P}}$ and $\mathrm{A}_1^{\mathrm{H}}$ & $\mathrm{A}_2^{\mathrm{H}}$, respectively).

Discussion

The Figures

Figures 16-19 illustrate the models for fatality and removal implicit in the estimators. Each figure shows simulated counts $G_{ij}(t)$ of carcasses in the area as solid black stair-step curves that increase by one with each new fatality, decrease by one with each scavenger removal, and decrease by C_{ij} at the end of the j^{th} interval upon the discovery and removal of C_{ij} carcasses by the search teams (each C_{ij} is indicated by a red downward arrow). In Figures 16–18, undiscovered carcasses remain present and may be discovered by later searches. To simplify comparison by focusing attention on what is different about the models (and not just random variation), the same fatality and removal times are used for each, so the functions $G(t)$ are identical in Figures 16-18. (In Figure 19, necessarily featuring different removal times, carcasses are removed following searches.)

The mean value functions $g_{ij}(t)$ implicit in the models are shown as solid blue curves, beginning each interval at an open circle and ending it at a filled circle (these overlap in Figure 16, where $g_{ij}(t)$ takes a constant value). Simulations and mean value calculations all use a daily fatality rate of $m_{ij} = 3\mathrm{d}^{-1}$, so $10\mathrm{d} \times 3\mathrm{d}^{-1} = 30$ fatalities would be expected in each interval, or 120 overall (113 appeared in the simulation). Rate of removal by scavengers was $r_{ij} = 0.25\mathrm{d}^{-1}$, so persistence times averaged $t_{ij} = 1/r_{ij} = 4\mathrm{d}$ and, at steady-state, $m_{ij}t_{ij} = 3\mathrm{d}^{-1} \times 4\mathrm{d} = 12$ carcasses would be present. The search teams, whose proficiency was $s_{ij} = 70\,percent$, discovered 35 carcasses in the four intervals of the simulation.

Comparing the Estimators

The estimators fall into two groups. Estimators $\widehat{M}_{ij}^{\mathrm{EJ}}$ and $\widehat{M}_{ij}^{\mathrm{S}}$ each assume that some or all carcasses remain across searches, and that undiscovered carcasses from earlier time periods are removed or discovered at the same rates as fresh carcasses. In contrast, estimators $\widehat{M}_{ij}^{\mathrm{P}}$ and $\widehat{M}_{ij}^{\mathrm{H}}$ assume that each search period begins with no discoverable carcasses. For a fixed searcher proficiency and carcass persistence rate under the same site-specific characteristics, the ordering of the estimators is consistently:

$$\widehat{M}_{ij}^{\mathrm{EJ}} < \widehat{M}_{ij}^{\mathrm{S}} < \widehat{M}_{ij}^{\mathrm{P}} \le \widehat{M}_{ij}^{\mathrm{H}} \tag{11}$$

for exponential persistence probability distributions. Note that then $\widehat{M}_{ij}^{\mathrm{H}} \equiv \widehat{M}_{ij}^{\mathrm{P}}$ unless $I_{ij} > 4.6\hat{t}_{ij}$, in which case they differ by at most 1.01 percent.

Choosing an Estimator

Which group of estimation equations is more appropriate for a particular species and experimental design— one of those ($\widehat{M}_{ij}^{\mathrm{EJ}}$, $\widehat{M}_{ij}^{\mathrm{S}}$) in which carcasses from earlier periods persist? Or one of those (like $\widehat{M}_{ij}^{\mathrm{P}}$) in which each period is assumed to begin with no carcasses present?

Imagine sending two search teams with the same proficiency (say, 50 percent) into the same area in which, say, 20 carcasses are present, one after the other. The first team should find about 50 percent × 20 = 10 carcasses, on average — but what would the *second* team find?

If they would be expected to find nothing, because all the discoverable carcasses would have been removed by the first team, then the Erickson & Johnson and Shoenfeld estimators ($\widehat{M}_{ij}^{\mathrm{EJ}}$, $\widehat{M}_{ij}^{\mathrm{S}}$) would not be appropriate. Both would underestimate M_{ij} by a factor of about $\left[1 - e^{-I_{ij}/\hat{t}_{ij}}\right]$, leading to a negative bias.

If they would find about 50 percent × 10 = 5 carcasses (half those not found by the first team), then Pollock's and Huso's estimators would be inappropriate. Both would overestimate M_{ij} by a factor of about $\left[1 - (1 - \hat{s}_{ij})e^{-I_{ij}/\hat{t}_{ij}}\right]^{-1}$, leading to a positive bias.

Bias from Inappropriate Equation

These biases are apparent in the figures. In Figure 16, the stair-step simulated curves $G_{ij}(t)$ typically lie well below the Erickson & Johnson mean function $g_{ij}(t) \equiv g_{ij}^{\infty}$, and their endpoints (the filled squares) lie below g_{ij}^{∞} on average, leading to underestimation (by −5.9 percent on average, for the parameters in this simulation). In Figure 18, the stair-step simulated curves typically lie above Pollock's mean function $g_{ij}(t)$ and the period endpoints, the filled squares, lie above $g_{ij}(t)$ on average, leading to overestimation (but only by +2.5 percent for the parameters used here). In Figure 17, the simulated curves $G_{ij}(t)$ coincide on average with Shoenfeld's mean function $g_{ij}(t)$, leading to accurate estimates. Figure 19 shows the degradation-based estimator $\widehat{M}_{ij}^{\mathrm{P}} = \widehat{M}_{ij}^{\mathrm{H}}$ with a simulation consistent with their assumptions (exponential persistence times and carcass removal following searches), so there is no bias.

The biases would be larger with more frequent searches, possibly considerably larger. Daily searches, for example, with the same residence time $t_{ij} = 4\mathrm{d}$ and searcher proficiency $s_{ij} =$

70 $percent$, would lead to −71.1 percent bias for estimator $\widehat{M}_{ij}^{\mathrm{EJ}}$ and +30.5 percent bias for $\widehat{M}_{ij}^{\mathrm{H}}$ or $\widehat{M}_{ij}^{\mathrm{P}}$, while $\widehat{M}_{ij}^{\mathrm{S}}$ would remain unbiased.

In the scenario of Figure 19, where undiscovered carcasses remain undiscoverable as if they were removed, Pollock's estimator (and Huso's which is identical) is unbiased while Shoenfeld's and Erickson/Johnson's underestimate M_{ij} by factors of $\left[1-(1-s_{ij})e^{-I_{ij}/t_{ij}}\right]^{-1}$ and $\left[1-e^{-I_{ij}/t_{ij}}\right]$, respectively, for biases of −2.46 percent and −8.21 percent, respectively, with the 10-day search periods and 4-day persistence assumed here. For daily searches these biases would grow to −23.6 percent and −77.9 percent, respectively.

Bias Affecting All Equations

Each of the estimation formulas is based on an expression of the expected carcass count $\mathrm{E}\left[C_{ij}\right]$ as a function of the fatality count M_{ij} and some other variables, such as the average persistence time t_{ij} and the search team's proficiency s_{ij}. An estimator is then constructed by solving this equation for M_{ij} as a function of $\mathrm{E}\left[C_{ij}\right]$.

Consider, for example, estimator $\widehat{M}_{ij}^{\mathrm{EJ}}$ of Eqn. (1), derived from Equation (2), *i.e.*, the relation

$$\mathrm{E}\left[C_{ij}\right]I_{ij} = M_{ij}s_{ij}t_{ij}.$$

If both s_{ij} and t_{ij} are uncertain or variable, perhaps because they depend on covariates (grass height, etc.) that themselves are variable or perhaps simply because they must be estimated from data, then there is still a linear relation for the expectations

$$\mathrm{E}\left[C_{ij}I_{ij}\right] = \mathrm{E}\left[M_{ij}\hat{s}_{ij}\hat{t}_{ij}\right]$$

for independent unbiased estimators $\hat{s}_{ij}$ of s_{ij} and $\hat{t}_{ij}$ of t_{ij}. Bias enters, however, when one makes the *non*-linear transformation of solving for M_{ij}:

$$M_{ij} \approx \widehat{M}_{ij} = \frac{C_{ij}I_{ij}}{\hat{s}_{ij}\hat{t}_{ij}}.$$

Because the function *x* ~~>1/*x* is convex (its graph curves upward), the expectation of $1/\hat{s}_{ij}$ will *always* exceed $1/\mathrm{E}\left[\hat{s}_{ij}\right]$, and that of $1/\hat{t}_{ij}$ will always exceed $1/\mathrm{E}\left[\hat{t}_{ij}\right]$, so uncertainty or variability in s_{ij} and t_{ij} will lead each of these estimators to *over*estimate fatality to some extent, with $\mathrm{E}[\widehat{M}_{ij}] > M_{ij}$. But how large is this positive bias?

If a positive random variable X has a log-normal distribution (commonly used to model uncertain positive quantities such as s_{ij} or t_{ij}) with mean $\mathrm{E}\,[X]=M$ and variance $\mathrm{V}[X]=V$, then $1/X$ also has a log-normal distribution, but the mean is *not* $1/M$. It is always larger:

$$\mathrm{E}\,\frac{1}{X} = \frac{1}{M}\left[1+\frac{V}{M^2}\right],$$

more than $1/M$ by a fraction V/M^2.

Thus if $\hat{s}_{ij}$ is an unbiased estimator of s with standard error ϵ, then $(1/\hat{s}_{ij})$ is a positively biased estimator of $(1/s_{ij})$ with bias given by:

$$\mathrm{E}\left[1/\hat{s}_{ij}\right] = (1/\hat{s}_{ij})\left[1 + \left(\epsilon/s_{ij}\right)^2\right]$$

with a similar formula for t_{ij}. If s_{ij} and t_{ij} are known to within a small proportional error, *i.e.*, if their standard errors are small fractions of their values, then little bias is introduced; if not, then more sophisticated statistical approaches may be warranted.

Variability

All the estimators considered here are of the form $\widehat{M}_{ij}$=κC_{ij}, proportional to the carcass count with a proportionality coefficient κ which will depend on I_{ij}, $\hat{s}_{ij}$, $\hat{t}_{ij}$, and perhaps other quantities. The value of κ is determined by solving for M_{ij} an equation for the expected number $\mathrm{E}[C_{ij}] \propto M_{ij}$ of carcasses counted. The resulting *variability* of the estimators $\widehat{M}_{ij}$ can be quite large.

Because C_{ij} has a Poisson distribution under the models justifying all four of the estimators under consideration, and Poisson random variables have variance equal to their means, the variance of each such estimator $\widehat{M}_{ij}$=κC_{ij} will be $\kappa^2 V[C_{ij}] = \kappa^2 \mathrm{E}[C_{ij}] = \kappa \mathrm{E}[\widehat{M}_{ij}]$. Even an unbiased estimator $\widehat{M}_{ij}$ with expected value $\mathrm{E}[\widehat{M}_{ij}] = M_{ij}$ will have variance κM_{ij} that may be quite large. For counts high enough to justify a central limit approximation, one should expect typical estimation errors to be on the order of $\sqrt{\kappa M_{ij}}$,

$$\left|\widehat{M}_{ij} - M_{ij}\right| \leq 1.645\sqrt{\kappa M_{ij}} \approx 1.645\sqrt{\kappa \widehat{M}_{ij}}$$

with probability about 90 percent (and similar formulas for other quantiles). For counts C_{ij} too small to justify the central limit theorem, the Anscombe transformation

$$Z := 2\sqrt{C_{ij} + 3/8} \sim No\left(2\sqrt{c_{ij} + 1/8}, 1\right)$$

for $c_{ij} := \mathrm{E}[C_{ij}]$ (Anscombe, 1948) leads to reliable interval estimates for M_{ij} for counts as low as $C_{ij} \geq 4$. Exact Poisson confidence intervals are available for all counts $C_{ij} \geq 0$.

For example, at the end of the second period of the simulation shown in Figure 17, $C_{i2} = 11$ carcasses were counted. With $s_{i2} = 0.7$ and $t_{i2} = 4$ estimated perfectly, Shoenfeld's estimator is $\widehat{M}^{s}_{i2} = \kappa C_{i2}$ with

$$\kappa = \frac{I_{i2}}{\hat{s}_{i2}\hat{t}_{i2}}\left[\frac{e^{I_{i2}/\hat{t}_{i2}} - 1 + \hat{s}_{i2}}{e^{I_{i2}/\hat{t}_{i2}} - 1}\right] = \frac{10}{0.7 \times 4}\left[\frac{e^{2.5} - 1 + 0.7}{e^{2.5} - 1}\right] = 3.795$$

so a 90 percent Central Limit interval estimate is $\widehat{M}^{s}_{i2} = 41.745 \pm 10.6 = [31.145, 52.345]$. The more accurate Anscombe approximation is [24.21, 66.31] and the exact Poisson interval is [23.41133, 69.09737]. In the simulation $M_{i2} = 30$ fatalities occurred, exactly the expected number $I_{i2} m_{i2} = 10 \times 0.3 = 30$, but the 90 percent interval for this estimator ranges from -21.9 percent below the true value to +130.3 percent above it.

What if the Common Assumptions Fail?

Common Assumption A_1, that all fatalities lead to carcasses within the study area, is usually false because some carcasses may fall outside the designated study area, and some birds may be crippled but able to make it outside the study region. If unaddressed, this "crippling bias" would lead to underestimation of fatality. It is usually addressed simply by estimating the probability π_{ij} that a fatality will lead to a carcass in the study area, then scaling any of the estimators ($\widehat{M}_{ij}^{\mathrm{EJ}}$, $\widehat{M}_{ij}^{\mathrm{S}}$, $\widehat{M}_{ij}^{\mathrm{P}}$, $\widehat{M}_{ij}^{\mathrm{H}}$) by a factor of $1/\hat{\pi}_{ij}$.

Common Assumption A_2 that all counted carcasses in the study region arise from encounters with the indicated turbine, is only approximately correct. Fatalities are usually assumed to be turbine related unless there is evidence to the contrary, but because the fatality rates from other causes are thought to be small enough this is not believed to lead to significant over-counting. A related problem is that some encounters with turbines may dismember a carcass into multiple pieces deposited in multiple discrete locations with the search area. Searchers attempt to prevent double-counting by matching parts, but this process is subject to error.

Search areas are generally established by rules of thumb, because of incomplete experimental data to suggest the true area of influence a turbine exerts, and may overlap. This could lead to misattribution, violating either A_1 or A_2.

Common Assumption A_3, that carcasses arrive uniformly over the time interval, will not be satisfied exactly. Actual fatality rates will vary over time with diurnal patterns, weather dependence, and other factors. If there are significant *trends* in fatality over the time period then this would affect each of the estimators, but haphazard variation on a rapid time-scale compared to search intervals will not. Some birds and bats have migratory behavior that may lead to widely differing rates from year to year or period to period, but if search intervals I_{ij} are short compared to migratory time scales then A_3 can still apply separately on each interval, but fatality and removal rates may vary for different time periods j.

Common Assumption A_4, that quantities are either constant or are sufficiently well represented by their averages, is also false. Both discovery by search teams and removal by scavengers are more difficult in areas or time periods within the study region where and when grass is taller, or light less available. Fortunately, these too are somewhat compensatory, but more elaborate modeling would be required to remove their effects entirely. Estimating s_{ij} and t_{ij} by imperfect estimators $\hat{s}_{ij}$ and $\hat{t}_{ij}$ does introduce some bias for all the estimators considered here, a rather technical issue.

Some estimators ($\widehat{M}_{ij}^{\mathrm{S}}$, $\widehat{M}_{ij}^{\mathrm{H}}$, and sometimes Pollock's $\widehat{M}_{ij}^{\mathrm{P}}$) also assume that carcass persistence times have exponential distributions. This distribution features a constant "hazard rate," so its use implies that carcasses remain equally attractive to scavengers over time. Evidence suggests that this is false. Over time carcasses do deteriorate, with two effects: they become less attractive to scavengers, reducing the removal rate r_{ij}; and they become more difficult for search teams to discover, reducing the proficiency s_{ij}. These two effects are somewhat compensatory, the first increasing and the second decreasing estimates of M_{ij}. If degradation is sudden and thorough enough it may be viewed simply as another form of removal by scavengers, maintaining validity for all the estimators, but if degradation is sufficient to deter scavengers but not enough to affect discovery that would lead to a positive bias.

Extensions

Each of the estimation approaches may be embellished to allow the rates of removal, fatality, or discovery to depend on meteorological, topographical, or other covariates, taken to be constant covariates for each turbine i and time interval j, at the cost of a considerable increase in computational complexity.

Coupled Degradation Models

In each of the models considered above the removal process and discovery are treated as "independent," even for those underlying estimators $\widehat{M}_{ij}^{\mathrm{P}}$ and $\widehat{M}_{ij}^{\mathrm{H}}$ that feature degradation. If in fact carcasses differ in their appeal to scavengers and the ease with which they are detected by search teams, and if the same carcasses that are easy for search teams to discover are those that are rapidly removed by scavengers, then each of these estimators will be biased. Each on average will underestimate M_{ij}, because the easily discovered carcasses will have been removed preferentially. Equation (12) shows an extension of Pollock's Weibull persistence equation (8c) for the most extreme case, where the removal and discovery processes are "coupled" in the sense that those carcasses with the longest persistence times are precisely those most difficult for search teams to discover:

$$\widehat{M}_{ij}^{\mathrm{x}} = \begin{cases} \dfrac{C\, I/\hat{t}_{ij}}{P\left(\frac{1}{\alpha}, \left[\Gamma\left(1+\frac{1}{\alpha}\right) I/\hat{t}_{ij}\right]^{\alpha}\right) - \left(1-\hat{s}_{ij}\right) I/\hat{t}_{ij}} & \hat{s}_{ij} > 1 - e^{(I/\hat{t}_{ij})^{\alpha}} \\ \dfrac{C\, I/\hat{t}_{ij}}{P\left(\frac{1}{\alpha}, \left(1-\hat{s}_{ij}\right)\right) - \alpha\left(1-\hat{s}_{ij}\right)\left[-\log\left(1-\hat{s}_{ij}\right)\right]^{1/\alpha}} & \hat{s}_{ij} \leq 1 - e^{(I/\hat{t}_{ij})^{\alpha}} \end{cases} \qquad (12)$$

Intermediate cases between independence (8c) and coupling (12) are possible too. More details are presented in Appendix B along with a more elaborate model in which:

- Scavenger removal rates r_{ij} and search team discovery rates s_{ij} are allowed to depend on extrinsic covariates (grass height, for example) and on carcass age (hence persistence times will not have exponential distributions and counts may not be Poisson);
- Mortality rates m_{ij} need not be constant (seasonal and diurnal patterns may be explored),
- Hierarchical structure exploits the similarities expected for data from different but comparable time periods or search regions.

Each of the models underlying the estimators considered above can be expressed as a special case of that new model. Parameter estimation for the new model is more computationally intensive than the estimation formulas given here, however, and will require more extensive data collection, such as that described in Appendix B, which may not be available at all sites of interest.

CHAPTER 4: Study Findings and Recommendations

CalWEA's study offers several lessons with implications for the experimental designs and field monitoring recommendations provided in the Guidelines. The key findings, elaborated below, can be summarized under the following general statements:

(1) Searcher proficiency is shown to be time-dependent.
(2) Searcher proficiency is site- and species-specific.
(3) Searcher proficiency is lower for bats than for birds.
(4) Carcass persistence is a time-dependent process.
(5) Small birds have a lower time-dependent persistence than bats.

In addition, CalWEA's analysis of the Guidelines' recommended fatality estimation equation (Pollock) and three other prominent estimators (Erickson & Johnson, Shoenfeld, and Huso) finds that:

(6) All four of the equations reviewed introduce some bias.
(7) The equations can be distinguished by their underlying assumption about whether undiscovered, unremoved carcasses remain "discoverable" in subsequent searches.
(8) For all four equations, length of search interval relative to mean persistence time is a key determinant of bias.

These findings have implications for pre- and post-construction monitoring activities, discussed below along with a recommendation for development of an improved estimating equation that takes into account findings 6-8, above.

Summary of Field Study Findings

Searcher Proficiency Shown to be Time-dependent

This study is the first to document quantitatively the long-term relationship between carcass age and the ability to detect the carcass. The implications for this issue are large, and will influence survey methods, the number of carcasses used during detection trials, and the approach to conducting pre-survey detection trials.

Searcher Proficiency is Site- and Species-specific

The magnitude of the searcher proficiency rate will be site specific, and will be a function of environmental and topological variables. In this study, searcher proficiency was significantly related to vegetation height. In addition to showing that searcher proficiency is a time-dependent process, Figures 14 and 15 clearly indicate that the shape of the searcher proficiency curves (with time and vegetation height) differ for birds and bats, and for small and large birds.

Searcher Proficiency is Lower for Bats than for Small Birds

A key contribution of this study is the findings associated with bats. Statistics derived from this study indicate that, on average, searcher proficiency of bats is roughly half that of small birds.

Large birds in this study were detected approximately 70 percent of the time. From a specific carcass perspective, approximately 30 percent of all small birds in the study were detected at least once, while only 19 percent of the bats were detected at least once.

The above rates for small birds are consistent with published literature values. For bats, however, the incorporation of time-based functions of searcher proficiency will have a significant impact on the resulting bat fatality estimation.

In this study, the searcher proficiency for small birds and bats was found to be similar after approximately 25 days, with the largest difference seen initially after carcass placement when the carcasses were fresh. An approximate 15 percent difference is seen between searcher proficiency in birds and bats with fresh carcasses. The searcher proficiency for birds and bats approached 2 percent after 30 days. This finding has implications for interval length in post-monitoring studies, where this study points to shorter intervals in order to maximize the chance of detecting a carcass on the ground.

Carcass Persistence is a Time-based Process

For small birds, an initial 10-15 percent loss in total numbers can be expected in the first few days after first appearance. For bats, the initial loss rate is smaller, ranging from zero to approximately 6 percent. Again, this finding for bats may not be expected based on the current literature. In this study, the persistence probability for small birds was 50 percent at approximately 10 days, and less than 20 percent after 40 days. For bats, however, the persistence probability was approximately 50 percent at 25 days, and did not drop below 20 percent over the course of the study.

Carcass persistence curves can be a function of seasonal effects. Persistence curves for both small birds and bats differ over the course of the study timeframe.

Small birds have lower time-dependent persistence than bats

Based on this study, bats persist longer on the field than birds. While the relative time-process of persistence will be site-specific (at other sites the predator population may prefer bats), the finding of an increased persistence of bats relative to birds has implications for the ability of estimating equations to work well without a well-defined and rigorously tested persistence curve for bats. Coupling the longer persistence with the lower detection rates of bats as compared to birds could lead to gross error in the expected fatality of bats if new bat-specific estimating equations are not fully developed and tested. Indeed, because bats persist for relatively long periods and are difficult to see on the ground, the interaction of searcher bias and detection proficiency plays a significant role in accurately estimating bats. In particular for bats, long-term field trials rigorously designed to generate time-based searcher detection proficiency and carcass persistence rates will be critical to accurate estimation of bat fatality.

Carcass persistence is best fit with a Weibull distribution

The assumption of an exponential decay function in many existing equations was not directly tested in this study. A two-parameter Weibull function, which provides greater flexibility than the simple exponential assumptions, is shown to work well within the study conditions. As noted in Chapter 3, the constant hazard assumption of the exponential function may not be realistic if older carcasses appear less attractive to scavengers, as shown in this study. The Weibull family of functions can be used to model carcass persistence without the assumption of constant hazard.

Summary of Estimating Equations Analysis

Existing fatality estimating equations assume that fatalities (and the corresponding occurrence of carcasses in a search plot) are randomly distributed over time. Because the experimental design of the CalWEA study did not allow for carcasses to be placed at random temporal intervals, direct calculation and comparison of the estimating equations against the known true number of birds and bats was not an appropriate test. Instead, equation properties and implicit assumptions were evaluated mathematically and the findings assessed in light of the findings from the field study.

The Existing Estimators All Introduce Some Bias

The CalWEA field study's finding that both searcher proficiency and carcass removal are time-dependent processes violates a common assumption of the four existing estimators that all carcasses are independent. This could easily be the case in this study where some carcasses specifically persisted and were not detected by the end of the study, indicating a lack of independence among the carcasses with respect to the two time-based processes.

If both searcher proficiency (s_{ij}) and mean persistence time (t_{ij}) are uncertain or variable, perhaps because they depend on covariates (grass height, etc.) that themselves are variable or perhaps simply because they must be estimated from data, then there is still a linear relation for the expectations for independent unbiased estimators $\hat{s}_{ij}$ of s_{ij} and $\hat{t}_{ij}$ of t_{ij}. Bias enters, however, when they are made the *non*-linear transformation of solving for M_{ij}.

Another common assumption, that quantities are either constant or are sufficiently well represented by their averages, is also false. Both discovery by search teams and removal by scavengers and weathering are more difficult in areas or time periods within the study region where and when grass is taller, or light less available. Fortunately, these too are somewhat compensatory, but more elaborate modeling would be required to remove their effects entirely. Estimating s_{ij} and t_{ij} by imperfect estimators $\hat{s}_{ij}$ and $\hat{t}_{ij}$ does introduce some bias for all the estimators considered here, a rather technical issue sketched in Chapter 3.

Key Assumptions Distinguish the Estimators

Each of the equations evaluated contains implicit assumptions pertaining to the nature of the rate of bird/bat fatality during the search interval, the distribution of carcass persistence times, and whether carcasses that persist from one search interval to the next are considered "discoverable" during a subsequent search. These distinguishing assumptions are summarized in Table 9.

Table 9: Key Assumptions Distinguishing Estimators Reviewed

Equation	Key Assumptions
Erickson & Johnson (1998)	A_1^{EJ}: The system is in equilibrium at each search. $I_{ij} \gg t_{ij}$,
Shoenfeld (2004)	A_1^{s}: Carcass persistence times have exponential distributions. A_2^{s}: All carcasses (both old and new) have the same probabilities of discovery s_{ij}. Undiscovered carcasses are no harder or easier to find than those that were discovered— *i.e.*, discovery failures are entirely random. A_3^{s}: The lengths I_{ij}, rates of mortality m_{ij} and removal r_{ij}, and the proficiencies s_{ij} are approximately constant over consecutive time intervals.
Pollock (2007)	A_1^{P}: Each period begins with no discoverable carcasses
Huso (2011)	A_1^{H}: Carcass persistence times have exponential distributions. A_2^{H}: Each period begins with no discoverable carcasses.

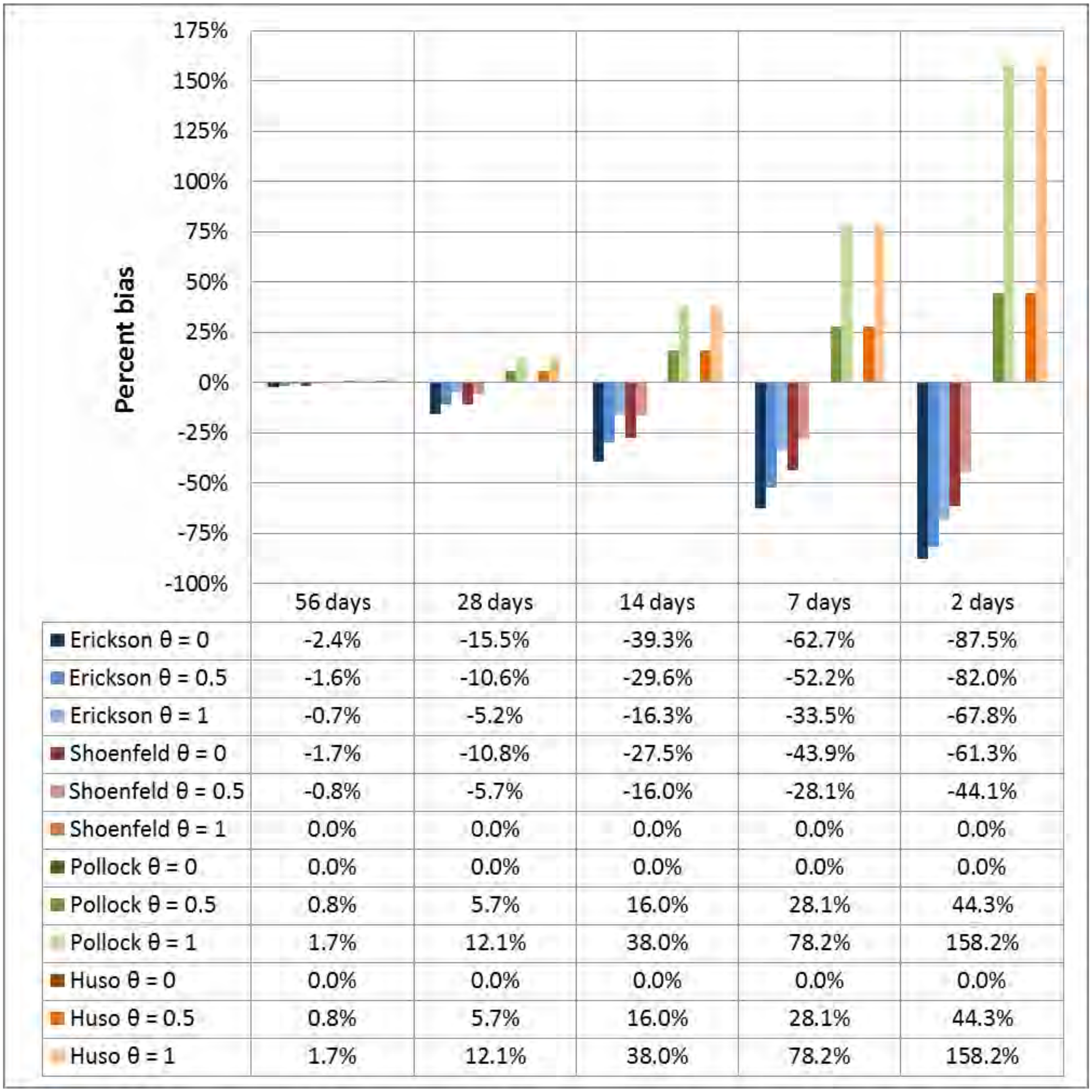
Source: Dr. Robert Wolpert

An important contribution of this analysis is the concept of "bleed-through" – the idea that every carcass not discovered and removed in a search, and does not persist due to scavenging, weathering, or other natural processes, remains for possible discovery in later searches. Both Erickson-Johnson and Shoenfeld's estimators assume 100 percent bleed-through. Huso's estimator assumes zero percent bleed-through – *none* of the carcasses not removed (by searchers or scavengers) are *ever* discovered in subsequent searches. Pollock's estimator uses an "average probability a carcass is unremoved until the search" (p_{ij}) rather than the more commonly used "mean persistence time" (t_{ij}). But as with Huso's estimator, Pollock's implicit assumption is that each period begins with no discoverable carcasses ("old" carcasses are never discovered).

Length of Search Interval Relative to Persistence Time is a Key Determinant of Bias

When search intervals are long with respect to persistence times, the influence of this "carcass at the beginning of the search interval" assumption is minimized and the estimators are nearly unbiased and provide very similar answers. However, for very short search intervals (a growing tendency in the wind industry), the bias in some equations can be large, and the equations can provide very different results. Figures 20-21 illustrate this point, showing the range of bias in fatality estimates obtained using the various estimators with different search intervals and bleed-through rates (theta = 0, 1 or 0.5), for given removal rates α = 1 and 0.5.

Figure 20: Comparison of Bias in Estimators at Various Search Intervals and "Bleed Through" (θ) Assumptions with Removal Rate α= 1

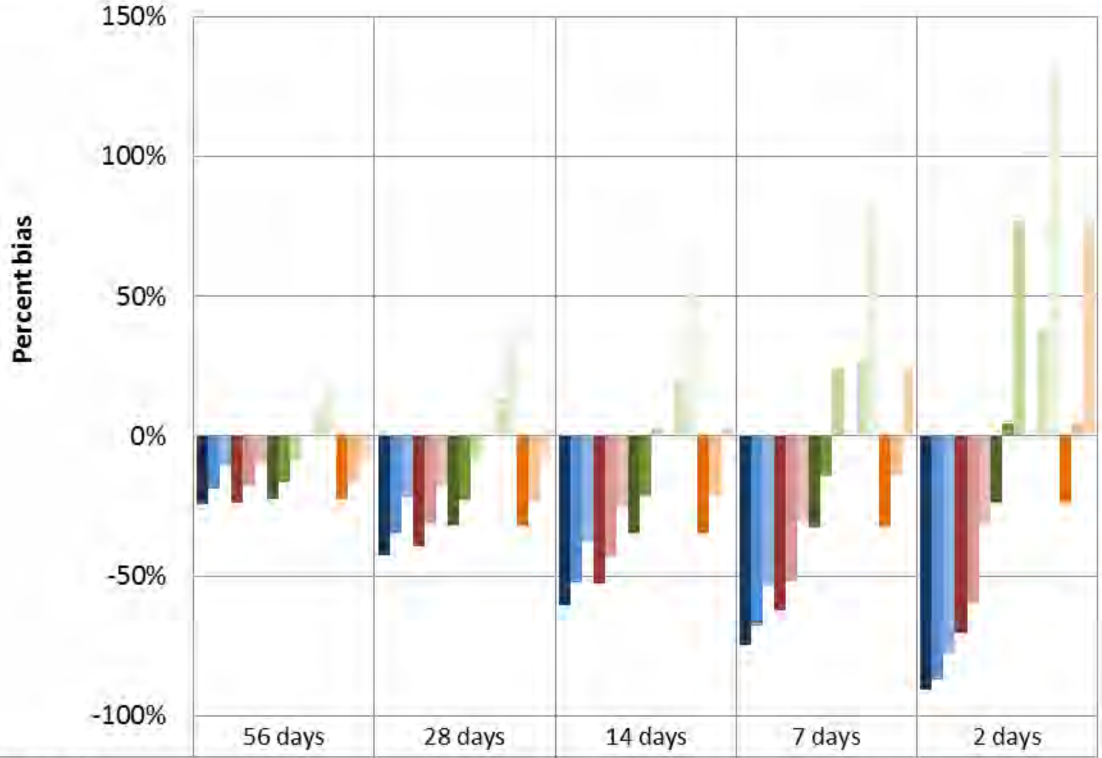


	56 days	28 days	14 days	7 days	2 days
Erickson θ = 0	-2.4%	-15.5%	-39.3%	-62.7%	-87.5%
Erickson θ = 0.5	-1.6%	-10.6%	-29.6%	-52.2%	-82.0%
Erickson θ = 1	-0.7%	-5.2%	-16.3%	-33.5%	-67.8%
Shoenfeld θ = 0	-1.7%	-10.8%	-27.5%	-43.9%	-61.3%
Shoenfeld θ = 0.5	-0.8%	-5.7%	-16.0%	-28.1%	-44.1%
Shoenfeld θ = 1	0.0%	0.0%	0.0%	0.0%	0.0%
Pollock θ = 0	0.0%	0.0%	0.0%	0.0%	0.0%
Pollock θ = 0.5	0.8%	5.7%	16.0%	28.1%	44.3%
Pollock θ = 1	1.7%	12.1%	38.0%	78.2%	158.2%
Huso θ = 0	0.0%	0.0%	0.0%	0.0%	0.0%
Huso θ = 0.5	0.8%	5.7%	16.0%	28.1%	44.3%
Huso θ = 1	1.7%	12.1%	38.0%	78.2%	158.2%

Where θ represents the percentage of carcasses neither discovered nor removed during one search interval that remain available to be discovered in later searches

Source: Dr. Robert Wolpert

Figure 21: Comparison of Bias in Estimators at Various Search Intervals and "Bleed Through" (θ) Assumptions with Removal Rate α= 0.5



	56 days	28 days	14 days	7 days	2 days
■ Erickson θ = 0	-24.3%	-42.5%	-60.4%	-74.8%	-90.5%
■ Erickson θ = 0.5	-18.6%	-34.7%	-52.3%	-68.0%	-86.9%
■ Erickson θ = 1	-10.7%	-22.2%	-37.4%	-53.6%	-77.9%
■ Shoenfeld θ = 0	-23.7%	-39.3%	-52.6%	-62.1%	-70.5%
■ Shoenfeld θ = 0.5	-18.0%	-31.1%	-43.1%	-51.9%	-59.4%
■ Shoenfeld θ = 1	-10.0%	-17.9%	-25.2%	-30.3%	-31.5%
■ Pollock Exp θ = 0	-22.4%	-31.9%	-34.7%	-32.5%	-23.7%
■ Pollock Exp θ = 0.5	-16.6%	-22.8%	-21.4%	-14.3%	4.8%
■ Pollock Exp θ = 1	-8.5%	-7.9%	3.2%	24.3%	76.9%
■ Pollock Weibull θ = 0	0.0%	0.0%	0.0%	0.0%	0.0%
■ Pollock Weibull θ = 0.5	7.5%	13.5%	20.2%	26.9%	37.5%
■ Pollock Weibull θ = 1	18.0%	35.3%	58.0%	84.1%	131.9%
■ Huso θ = 0	-22.4%	-31.9%	-34.7%	-32.5%	-23.7%
■ Huso θ = 0.5	-16.6%	-22.8%	-21.4%	-14.3%	4.8%
■ Huso θ = 1	-8.5%	-7.9%	3.2%	24.3%	76.9%

Where θ represents the percentage of carcasses neither discovered nor removed during one search interval and remain available to be discovered in later searches

Source: Dr. Robert Wolpert

The degree of bias among the equations is a function of many issues but, in all cases, it is a function of the inherent assumptions underlying the equation characteristics. Even when biased, if search intervals are *long* relative to mean persistence times, all four estimators give about the same answers. But if search intervals are *short* relative to mean persistence times, large differences among the equations are possible. In fact, it is very possible that, with short intervals, the results of the equations could differ by a factor of 3 or 4. For example, Shoenfeld's and Huso's estimators will differ by a factor of 3 or 4 or so if the search proficiency is 25 percent or 33 percent or so, because Huso assumes zero percent bleed-through and Shoenfeld assumes 100 percent bleed-through.

Conclusions and Recommendations

CalWEA's study provides new insights that could enhance the existing methods and procedures found in the Guidelines and other pre- and post-construction fatality monitoring guidelines used in the United States and internationally. Four major implications of this work and the corresponding recommendations are outlined here.

(1) Traditional fatality estimators do not account for time-dependence of carcass persistence and searcher proficiency, or for "bleed-through."

Recommendation: Use the proposed new Partial Periodic Estimator and integrated detection probability trial method (proposed in Appendices A and B, respectively).

(2) Traditional estimators can have high degrees of bias depending on the search interval, mean persistence, and bleed-through rate (theta) of the field data collected.

Recommendation: Do not use traditional estimators in conditions that produce levels of bias that are unacceptable for the intended purpose. Caution is particularly warranted where short search intervals have been used.

(3) Use of traditional estimators has resulted in an unknown degree of bias in the literature.

Recommendation: Carefully consider the value of metrics like "industry average" before applying them in policy or project-specific decisions.

(4) Previously generated fatality estimates used for project evaluation or broader purposes could be recalculated using the proposed new Partial Periodic Estimator, provided the key input variables (search interval, mean persistence, etc.) can be collected from the original studies and reasonable assumptions made about searcher proficiency probability distributions and theta values.

> *Recommendation:* Going forward, use a standardized approach to generate unbiased project-specific results that may be compared with each other, and to generate meaningful and unbiased industry averages and totals.

These implications and recommendations are briefly discussed here.

Current estimators do not account for time-dependent processes and "bleed-through."

Detection probability is now known to be sensitive to time-dependent processes of carcass persistence, searcher proficiency, and bleed-through (theta), and that the traditional fatality estimators do not account for these influences. Therefore a new Partial Periodic Estimator (Appendix A) and an integrated detection probability field-trial methodology (Appendix B) are proposed and recommended that incorporate:

- Trials for searcher proficiency & carcass removal rates conducted simultaneously (vs. independent trials)

Further, the Guidelines on these issues are recommended to be revisited.

Care must be taken to avoid unacceptable bias when using current fatality estimators.

The four traditional fatality estimators reviewed (Pollock, Erickson & Johnson, Shoenfeld and Huso) are now shown to have high degrees of bias depending on the search interval, mean persistence, and the proportion of bleed-through (theta) occurring in the field. Therefore these estimators are not recommended for use in conditions that produce unacceptable levels of bias (see Figures 20-21) unless biases can be corrected.

Note that "unacceptable" bias depends on circumstance and degree of accuracy needed.

- The inaccuracy of an estimate for a specific project may or may not be of consequence.
- The importance of accuracy or just precision depends on the sensitivity of the species, regulatory requirements, etc.

While individual project results are likely to be inaccurate, precise comparisons internal to a given project may still be useful provided the project studies are consistent with each other.

Use of previous study estimates

Previously generated study estimates can be used with some confidence in decision making where a persistence trial has produced a reliable mean value, providing that mean persistence time is shorter than the search interval (noting also that, in some cases, mean persistence will also have to be recalculated because of some common errors in methods of calculating this mean). If the persistence time is longer than the search interval, the estimate will be unreliable. If the mean is comparable to the search interval, the estimate will vary in the range of 30-40 percent.

Caution should be taken with metrics such as "Industry Average"

The findings in this project highlight the degree of difficulty that occurs when comparing mortality estimates among individual studies, particularly when the individual studies are not conducted with a standardized survey design. A number of factors make between-study results difficult, and also negate the ability to compare the results from a single study to an industry-wide average. For example, the following elements can negate the ability to compare mortality results on a national or state-wide basis: (1) differing approaches to treating the resulting survey data (*e.g.*, compiling data across individual turbines), (2) differing approaches to calculating inputs to the estimating equations (*e.g.*, estimation of mean persistence time), (3) the use of different equations, and (4) inconsistent survey design and field methods. Any industry average, therefore, will reflect a large variation among sites not due to variation in mortality, but due to the specific methods used to generate the mortality values. Therefore, a standardization of methods used to evaluate wind facility impacts is recommended, based in part on the findings of this report.

Considerable caution is in order when comparing individual project estimates to industry averages, given the possible level of bias in, and lack of comparability among, each of the source studies that are used to calculate the industry average. Similar cautions are in order when considering national total mortality figures.

Future Research

The results and findings of this study provide insight into needed changes in current monitoring practices and fatality estimation procedures at wind facilities. The existing estimating equations could be enhanced and improved with the addition of time-dependent processes for searcher proficiency and carcass persistence that are a function of environmental conditions. Appendix A presents a proposed new equation that incorporates these terms, and Appendix B outlines the key components for detection probability trial survey methods to support the proposed new estimator. Field testing the new estimating equation and protocols was beyond the scope of this study and report.

The Altamont study site provided a unique venue for studying fatality under changing conditions, and while all of the findings of this study will not directly translate to other sites, the general principles and findings should be applicable. The major findings of this study should hold generally for all wind facilities. However, the degree to which the vegetation height, time-based searcher efficiency, and other factors that were found influential in this study are transferable to other locations and conditions is explicitly unknown. Therefore, additional studies may provide insights on fatality estimation as a function of topographical, climatological, and environmental conditions.

CHAPTER 5: Bibliography

Abramowitz, M. and Stegun, I.A., eds. 1964. *Handbook of Mathematical Functions With Formulas, Graphs, and Mathematical Tables,* vol. 55 of *Applied Mathematics Series.* Washington, DC: National Bureau of Standards. Reprinted in paperback by Dover (1974). Available online at http://www.math.sfu.ca/~cbm/aands/.

Anscombe, F.J. 1948. The transformation of Poisson, binomial and negative-binomial data. *Biometrika* 35, 246-254. Doi:10.1093/biomet/35.3-4.246.

Arnett, E. B., M. M. P. Huso, J. P. Hayes, and M. Schirmacher. 2010. Effectiveness of changing wind turbine cut-in speed to reduce bat fatalities at wind facilities. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas.

Bevanger, K. 1999. Estimating Bird Mortality Caused By Collisions with Power Lines and Electrocution Methodology. In Ferrer, M. and G. Janss. Bird and Power Line Species Collisions, Electrocution and Breeding. Quercus, Madrid, Spain.

California Energy Commission and California Department of Fish and Game. 2007. *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development.* Technical Report CEC-700-2007-008-CMF. California Energy Commission, Renewables Committee, and Energy Facilities Siting Division; and California Department of Fish and Game, Resources Management and Policy Division. Sacramento, California.

Erickson, W.P., Strickland, M.D., Johnson, G.D. and Kern, J.W. 1998. Examples of statistical methods to assess risks of impacts to birds from wind plants. In *PNAWPPM-III: Proceedings of the Avian-Wind Power Planning Meeting III, San Diego, California.* Washington, DC: National Wind Coordinating Committee Meeting, May 1998. Prepared for the Avian Subcommittee of the National Wind Coordinating Committee by LGL, Ltd., King City, Ontario.

Erickson, W.P., J. Jeffrey, K. Kronner, and K. Bay. 2003a. Stateline wind project wildlife monitoring annual report: results for the period July 2001-December 2002. Prepared for FPL Energy, the Oregon Office of Energy, and the Stateline Technical Advisory Committee.

DeVault, T.L., Brisbin, I.L., and Rhodes, O.E. 2004. Factors influencing the acquisition of rodent carrion by vertebrate scavengers and decomposers.

DeVault, T.L., Rhodes, O.E., Jr., and Shivik, J.A. 2003. Scavenging by vertebrates: behavioral, ecological, and evolutionary perspectives on an important energy transfer pathway in terrestrial ecosystems. *Oikos* **102**: 225–234.

Environment Canada, Canadian Wildlife Service. 2006. Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds.

Galassi, M., Davies, J. Theiler, J., Gough, B., Jungman, G., Alken, P., Booth, M. and Rossi, F. 2009. *GNU Scientific Library Reference Manual.* Bristol, UK: Network Theory Ltd., 3rd edition.

Grodsky, S.M. and D. Drake. 2011. Bird and Bat Mortality at the Forward Energy Center in Southeastern Wisconsin. Final report prepared for Forward Energy LLC, Chicago, Illinois.

Howell, J.A. 1997. Avian mortality at rotor swept area equivalents, Altamont Pass and Montezuma Hills, California. *Trans. Western Sect. Wild/. Soc.* 33:24-29.

Howell, J.A. and J.E. DiDonato. 1991. Assessment of Avian Use and Mortality Related to Wind Turbine Operations, Altamont Pass, Alameda and Contra Costa Counties, California, September 1988 through August 1989. Final report submitted to U.S. Windpower, Inc.

California Department of Fish and Game. 2012. Natural Community Conservation Planning. NCCP Plan Summary – Altamont Pass Wind Resource Area (in planning phase). Available online at: http://www.dfg.ca.gov/habcon/nccp/status/Altamont/

Huso, M.M.P. 2011. An estimator of mortality from observed carcasses. *Environmetrics* 22: 318-329. DOI: 10.1002/env.1052.

Johnson, G.D., Erickson, W.P., Strickland, M.D., Shepherd, M.F., Shepherd, D.A. and Sarappo, S.A. 2003. Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota. *The American Midland Naturalist* 150: 332-342. DOI:10.1674/0003-0031 (2003) 150[0332:MOBAAL]2.0.CO;2.

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. A new method to determine bird and bat fatality at wind energy turbines from carcass searches. *Wildlife Biology* 17(4):350-363. 2011. Published By: Nordic Board for Wildlife Research. http://www.bioone.org/doi/full/10.2981/10-121

Kostecke, R.M., Linz, G.M. & Bleier, W.J. 2001. Survival of avian carcasses and photographic evidence of predators and scavengers. *Journal of Field Ornithology* 72: 439–447.

Orloff, S. and A. Flannery. 1996. A continued examination of avian mortality in the Altamont Pass Wind Resource Area. P700-96-004CN. Report from Ibis Environ. Servo and BioSystems Analysis Inc., Santa Cruz, California, for California Energy Commission, Sacramento, California.

Pollock, K. 2007. Personal communication in 2012 attributed equation used to adjust the number of bird or bat carcasses visually observed during an environmental monitoring survey of a wind facility in *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development. California Energy Commission.* Sacramento, California.

R Core Team. 2012. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing. Vienna, AT.

Shoenfeld, P.S. 2004. Suggestions Regarding Avian Mortality Extrapolation, unpublished report to West Virginia Highlands Conservancy, Davis, West Virginia. Available online at: http://www.wvhighlands.org/Birds/SuggestionsRegardingAvianMortality-Extrapolation.pdf.

Smallwood, K.S. and C.G. Thelander. 2004. Bird Mortality at the Altamont Pass Wind Resource Area: March 1998 - September 2001. Final report to the National Renewable Energy Laboratory (NREL), Golden, Colorado, BioResource Consultants, Ojai, California.

Smallwood, K.S. 2010. Baseline Avian and Bat Fatality Rates at the Tres Vaqueros Wind Project, Contra Costa County, California. Report to the East Bay Regional Park District.

Smallwood, K. S. 2007. Estimating wind turbine-caused bird mortality. *Journal of Wildlife Management* 71(8):2781-1701.

Tierney, Robyn. 2009. Buffalo Gap 2 Wind Farm Avian Mortality Study July 2007–December 2008 Final Survey Report. TRC Report No. 151143-B-01.

TRC Environmental Corporation. 2008. Post-Construction Avian and Bat Fatality Monitoring and Grassland Bird Displacement Studies at the Judith Gap Wind Energy Project, Wheatland County, Montana. Prepared by TRC Environmental Corp., Laramie, Wyoming, for Judith Gap, LLC, Chicago, Illinois.

APPENDIX A:
A New Equation for Estimating Avian Mortality Rates

A Partially Periodic Equation for Estimating Avian Mortality Rates

Robert L Wolpert

October 6, 2012

Abstract

A key issue in assessing the environmental impact of wind plants for electrical power generation is the rate of mortality of birds and bats caused by collisions with turbines. The direct approach of counting and removing carcasses near a turbine facility at designated time intervals must be corrected in some way for the effects of removal by scavengers, detection failure, and other systematic biases. A number of authors have proposed estimation formulas intended to adjust for these, based on somewhat different assumptions about the underlying processes.

One significant issue on which these authors differ is whether or not bird carcasses present but *not* discovered and removed in the search ending one time interval, might possibly be discovered and counted in the search ending a later interval. The "periodic" estimator proposed by Shoenfeld (2004), for example, is based on a model in which any undiscovered carcasses may be found in later searches, while the aperiodic estimators proposed by Pollock (CEC, 2007, Appendix F) and by Huso (2011) are both based on the assumption that each interval begins with no discoverable carcasses.

We present a unified "partially periodic" structure that encompasses all of these estimators, in which a specified fraction of undiscovered carcasses remain discoverable in future searches. It includes that of Shoenfeld and those of Pollock and of Huso as special cases in which that fraction is 100% or 0%, respectively. The proposed estimator also accommodates arbitrary removal time distributions, avoiding the unrealistic assumption of exponential removal distributions implicit in the estimation formulas of Shoenfeld and Huso.

1 Introduction

The data we consider will be repeated counts of bird or bat carcasses made in designated search areas near each of several wind turbines. Denote by C_{ij} the count of carcasses in the designated area near the jth wind turbine by a Search Team at the end of the ith time interval, of length I_{ij} days, and by s_{ij} the search proficiency (discovery probability for a carcass present at the time of the search) and by t_{ij} the average length of time (in days) before a new carcass is removed by scavengers.

For the special case of exponentially-distributed removal times, the proposed estimator (derived in Section (2.1) and generalized to arbitrary removal distributions in Section (2.2)) is:

$$\hat{M}_{ij}^{\star} = \frac{C_{ij} I_{ij}}{\hat{s}_{ij}\ \hat{t}_{ij}} \left\{ \frac{e^{I_{ij}/\hat{t}_{ij}} - \theta(1-\hat{s}_{ij})}{e^{I_{ij}/\hat{t}_{ij}} - 1} \right\}, \tag{1}$$

where $\theta \in [0,1]$ is the fraction of undiscovered carcasses that remain discoverable in future searches. This includes as special cases each four of the estimators compared in (Wolpert, 2012; Warren-Hicks *et al.*, 2012):

Shoenfeld: For $\theta = 1$, indicating that *all* unremoved carcasses are discoverable eventually, this is exactly Shoenfeld's (Shoenfeld, 2004) estimator

$$\hat{M}_{ij}^{\text{S}} = \frac{C_{ij} I_{ij}}{\hat{s}_{ij}\ \hat{t}_{ij}} \left\{ \frac{e^{I_{ij}/\hat{t}_{ij}} - 1 + \hat{s}_{ij}}{e^{I_{ij}/\hat{t}_{ij}} - 1} \right\}. \tag{2}$$

Thus Eqn (1) may be viewed as a generalization of Shoenfeld's estimator to *partial* periodicity, and that presented in Section (2.2) a further generalization to arbitrary removal distributions.

Pollock: Pollock's mortality estimator (CEC, 2007, Appendix F)

$$\hat{M}_{ij}^{\text{P}} = \frac{C_{ij}}{\hat{p}_{ij}\,\hat{s}_{ij}} \tag{3a}$$

depends explicitly on $\hat{p}_{ij}$, the estimated "average probability a carcass will remain until the next search". For exponentially-distributed removal times this is $\hat{p}_{ij} = [1 - e^{-I_{ij}/\hat{t}_{ij}}]\hat{t}_{ij}/I_{ij}$, so in this case $\hat{M}_{ij}^{\text{P}}$ may be expressed as

$$\hat{M}_{ij}^{\text{P:E}} = \frac{C_{ij} I_{ij}}{\hat{s}_{ij}\ \hat{t}_{ij}} \left[1 - e^{-I_{ij}/\hat{t_{ij}}}\right]^{-1} \qquad \text{(Exponential removal)}, \tag{3b}$$

the special case $\theta = 0$ of Eqn (1).

Huso: Huso's estimator (Huso, 2011) is identical to Pollock's for exponentially-distributed removal times (unless $I_{ij} > 4.6\,\hat{t}_{ij}$, in which case $\hat{M}_{ij}^{\text{H}}$ is about 1% larger), so it too is the special case of Eqn (1) with $\theta = 0$:

$$\hat{M}_{ij}^{\text{H}} = \frac{C_{ij} I_{ij}}{\hat{s}_{ij}\ \hat{t}_{ij}} \left[1 - e^{-I_{ij}/\hat{t}_{ij}}\right]^{-1}. \tag{4}$$

Erickson: Erickson & Johnson's estimator (Erickson *et al.*, 1998; Johnson *et al.*, 2003)

$$\hat{M}_{ij}^{\text{EJ}} = \frac{C_{ij} I_{ij}}{\hat{s}_{ij}\ \hat{t}_{ij}} \tag{5}$$

would be (1) in the special case of $\theta = (1 - \hat{s}_{ij})^{-1}$. Note $\theta > 1$ here, because this estimator's assumption that the system is in steady-state at each search is inconsistent with the usual practice of removing carcasses upon discovery by Search Teams.

Thus each of these estimators corresponds to some specific choices for removal distribution and for the parameter θ— but maybe not the choices one would prefer on further reflection.

Some have expressed the opinion that both 100% persistence of undiscovered carcasses (*i.e.*, $\theta = 1$, as in Shoenfeld's estimator) and 100% disappearance of them (*i.e.*, $\theta = 0$, as in Pollock's and Huso's) are unrealistic, and that the truth lies somewhere in between. Also, evidence (Bispo *et al.*, 2012; Warren-Hicks *et al.*, 2012, *p.* 21ff) suggests that other survival distributions fit removal times better than exponential distributions.

2 The Model Underlying the New Partially Periodic Estimator

Suppose (as usual) that carcasses arrive in a Poisson stream with average daily rate m_{ij} and, following Shoenfeld, that the process is "periodic" in the sense that consecutive interval lengths I_{ij} (in days), mean mortality rates m_{ij} (per day), and search proficiency probabilities s_{ij} vary slowly in time— and hence do not vary with index i (though they may still differ across turbines, indexed by j). In contrast to Shoenfeld, we now assume that while all unscavenged carcasses arriving during the current period are discoverable in the search ending that period, only a fraction $\theta_j \in [0, 1]$ of those unscavenged carcasses not discovered in that search will remain discoverable for future searches.

2.1 Exponential Removal Times

The average number of discoverable carcasses at the end of any period (call it $\mathfrak{g}_1$) will be the sum of those carcasses (if any) remaining unscavenged and undiscovered by earlier searches, plus those carcasses arriving at times uniformly distributed over the present interval and remaining unremoved until its end. For the case of exponentially-distributed persistence with rate $r_{ij} > 0$, this is

$$\mathfrak{g}_1 = e^{-r_{ij} I_{ij}}\, \mathfrak{g}_0 \qquad\qquad + m_{ij} \int_0^{I_{ij}} e^{-r_{ij}(I_{ij} - s)}\, ds$$

where $\mathfrak{g}_0$ denotes the average number of discoverable carcasses at the beginning of the period. By periodicity this is $\mathfrak{g}_0 = \mathfrak{g}_1 \theta_j (1 - s_{ij})$, so

$$\mathfrak{g}_1 = e^{-r_{ij} I_{ij}}\, \mathfrak{g}_1 \theta_j (1 - s_{ij}) + \frac{m_{ij}}{r_{ij}} \left[1 - e^{-r_{ij} I_{ij}}\right].$$

Collecting terms and solving, and using $r_{ij} = 1/t_{ij}$ and $\mathsf{E}M_{ij} = m_{ij}\, I_{ij}$,

$$\mathfrak{g}_1 = \frac{\mathsf{E}M_{ij} t_{ij}}{I_{ij}} \left\{ \frac{1 - e^{-I_{ij}/t_{ij}}}{1 - \theta_j (1 - s_{ij}) e^{-I_{ij}/t_{ij}}} \right\}.$$

For searchers with proficiency s_{ij} the expected carcass count is $\mathsf{E}[C] = s_{ij}\mathfrak{g}_1$, leading to the estimator

$$\hat{M}^{\star}_{ij} = \frac{C_{ij} I_{ij}}{\hat{s}_{ij}\ \hat{t}_{ij}} \left\{ \frac{1 - \theta_j (1 - \hat{s}_{ij}) e^{-\hat{z}_{ij}}}{1 - e^{-I_{ij}/t_{ij}}} \right\}. \tag{1}$$

2.2 The General Case

The exponential distribution, commonly used for modeling removal times, features constant *hazard*— the probability of removal by scavengers in a short time interval is approximately the same constant multiple $h\,\Delta$ of the interval's length Δ, irrespective of the age t of the carcass at the start of the interval. Evidence suggests that in fact the hazard rate $h(t)$ varies with carcass age, and that (at least for large t) it decreases. Warren-Hicks *et al.* (2012) found that Weibull distributions with shape parameter $\alpha < 1$ (whose hazard $h(t)$ decreases at rate $t^{-(1-\alpha)}$) fit the observed removal times far better than exponential distributions, while Bispo *et al.* (2012) found that log normal and log logistic distributions (whose hazards decrease at rate $1/t$ for large t) or Weibull distributions fit their data better than the exponential. In this section we develop a partially-periodic estimator for arbitrary removal distributions.

Denote by $\bar{F}_j(t) = \mathsf{P}[\tau > t]$ the complimentary CDF, or survival function, for removal times $\tau \geq 0$, and by

$$Q_j(t) \equiv \mathsf{E}[\tau \wedge t] = \int_0^t \bar{F}_j(x)\, dx \tag{6}$$

the *integrated survival function* or "ISF". Clearly $Q_j(t) \leq t$ (because $\bar{F}_j(x) \leq 1$), and $Q_j(t)$ increases as $t \to \infty$ to the mean removal time $t_{ij} \equiv \mathsf{E}[\tau] = \int_0^\infty \bar{F}_j(x)\, dx$ (which may be infinite for some distributions). As before denote by $\theta_j \in [0, 1]$ the average fraction of undiscovered carcasses that remain discoverable in later searches, by s_{ij} the probability a carcass present at the time of a search will be discovered, and by m_{ij} the average daily rate of mortality.

The discoverable carcasses on the ground at any given time include "new" carcasses that arrived since the last search along with those "old" ones that arrived in earlier periods and eluded discovery by search teams. Thus if $q_j \equiv \theta_j(1 - s_{ij})$ denotes the probability that a carcass is undetected in a search and remains discoverable for future searches, then t days after the most recent search the expected number $g_j(t)$ of discoverable carcasses is the sum

$$g_j(t) = \int_0^t m_{ij} \bar{F}_j(t - s) ds + \sum_{k \geq 1} q_j^k \int_{-kI_{ij}}^{-(k-1)I_{ij}} m_{ij} \bar{F}_j(t - s)\, ds$$

of those arriving in the current period and those arriving earlier who went undetected in some number $k \geq 1$ of searches. Changing variables to $x = t - s$,

$$\begin{aligned} &= m_{ij} \int_0^t \bar{F}_j(x) dx + m_{ij} \sum_{k \geq 1} q_j^k \int_{t+(k-1)I_{ij}}^{t+kI_{ij}} \bar{F}_j(x)\, dx, \\ &= m_{ij} Q_j(t) + m_{ij} \sum_{k \geq 1} q_j^k \big[Q_j(t + kI_{ij}) - Q_j(t + (k-1)I_{ij}) \big], \end{aligned}$$

(recall $Q_j(t) := \int_0^t \bar{F}_j(x)\, dx$), a telescoping series with sum

$$g_j(t) = m_{ij}(1 - q_j) \sum_{n \geq 0} q_j^n Q_j(t + nI_{ij}). \tag{7}$$

The expected number of carcasses counted $\mathsf{E}[C_{ij}]$ will be a fraction s_{ij} of $g_j(I_{ij})$, and the average daily mortality rate is $m_{ij} = \mathsf{E}[M_{ij}]/I_{ij}$, leading to the new Partially Periodic estimator

$$\hat{M}_{ij}^{\star} = \frac{C_{ij}\ I_{ij}}{R_{ij}\ \hat{s}_{ij}} \tag{8}$$

where $R_{ij} = g_j(I_{ij})/m_{ij}$ is given by

$$R_{ij} \equiv [1 - \theta_j(1 - s_{ij})] \sum_{k \geq 1} [\theta_j(1 - s_{ij})]^{k-1} Q_j(k\, I_{ij}). \tag{9a}$$

This sum always converges to a well-defined and finite quantity $R_{ij} \leq I_{ij}/[1 - \theta_j(1 - s_{ij})]$ for any removal distribution, even if $t_{ij} = \mathsf{E}[\tau]$ is infinite.

For $\theta_j = 0$ only the first term ($k = 1$) contributes to the sum in (9a). In that case $R_{ij} = Q_j(I_{ij}) = I_{ij} p_{ij}$ where $p_{ij} \equiv \int_0^{I_{ij}} \bar{F}_j(I_{ij} - t)\, dt / I_{ij}$ is the average probability a carcass is unremoved until the next search, and (8) reduces to Pollock's estimator $\hat{M}_{ij}^{\mathrm{P}} = C_{ij}/\hat{p}_{ij}\hat{s}_{ij}$ for any underlying removal distribution.

For $\theta_j > 0$, the kth term in the sum of (9a) accounts for carcasses that went undiscovered through $(k-1)$ searches and unremoved for about $k \times I_{ij}$ days. It's not surprising that only a few terms are necessary (usually just two or three) to evaluate R_{ij} with sufficient accuracy. Bounds are presented in Section (3) for finite approximations including simple truncation,

$$R_{ij} \approx R_{ij}^n \equiv [1 - \theta_j(1 - s_{ij})] \sum_{k=1}^{n} [\theta_j(1 - s_{ij})]^{k-1} Q_j(k\, I_{ij}). \tag{9b}$$

2.3 Parametric Examples

In this section we consider several parametric distributions commonly used for survival or lifetime analysis. To facilitate introducing a regression setting later to reflect dependence on covariates such as vegetation height, in each case we parametrize the distribution with a *rate* parameter $r_{ij} > 0$ and perhaps one or more shape parameters.

2.3.1 Exponential Persistence

For the exponential distribution, the survival function, mean, and ISF are

$$\bar{F}_j(t) \equiv \mathsf{P}[\tau > t] = e^{-r_{ij}\,t} \tag{10a}$$

$$t_{ij} \equiv \mathsf{E}[\tau] \quad = \int_0^\infty e^{-r_{ij}\,x}\,dx = 1/r_{ij} \tag{10b}$$

$$Q_j(t) \equiv \mathsf{E}[\tau \wedge t] \;= \int_0^t e^{-r_{ij}\,x}\,dx \;\; = t_{ij}[1 - e^{-t/t_{ij}}] \tag{10c}$$

for $t \geq 0$ so (7) and (9a) are geometric series with sums

$$g_j(t) = m_{ij} t_{ij} \left\{ 1 - \frac{1 - q_j}{1 - q_j\, e^{-I_{ij}/t_{ij}}} e^{-t/t_{ij}} \right\} \tag{10d}$$

$$R_{ij} = t_{ij} \frac{e^{I_{ij}/t_{ij}} - 1}{e^{I_{ij}/t_{ij}} - q_j} \tag{10e}$$

with $q_j \equiv \theta_j(1 - s_{ij})$. This leads to the exponential removal Partially Periodic estimator

$$\hat{M}^\star_{ij} \equiv \frac{C_{ij}\;I_{ij}}{\hat{R}_{ij}\;\hat{s}_{ij}} = \frac{C_{ij}\;I_{ij}}{\hat{s}_{ij}\;\hat{t}_{ij}} \left\{ \frac{e^{I_{ij}/\hat{t}_{ij}} - \theta_j(1 - s_{ij})}{e^{I_{ij}/\hat{t}_{ij}} - 1} \right\}$$

identical to (1). It reduces further to $\hat{M}^{\text{P:E}}_{ij}$ of Eqn (3b) or $\hat{M}^{\text{H}}_{ij}$ of Eqn (4) for $\theta_j = 0$ and to $\hat{M}^{\text{S}}_{ij}$ of Eqn (2) for $\theta_j = 1$.

2.3.2 Weibull Persistence

The survival function, mean, and ISF for the Weibull distribution with shape $\alpha > 0$ are

$$\bar{F}_j(t) \equiv \mathsf{P}[\tau > t] = e^{-(r_{ij}\,t)^\alpha} \tag{11a}$$

$$t_{ij} \equiv \mathsf{E}[\tau] \quad = \int_0^\infty e^{-(r_{ij}\,x)^\alpha}\,dx = \Gamma(1 + \tfrac{1}{\alpha})/r_{ij}, \tag{11b}$$

$$Q_j(t) \equiv \mathsf{E}[\tau \wedge t] \;= \int_0^t e^{-(r_{ij}\,x)^\alpha}\,dx \;\; = P\big(\tfrac{1}{\alpha}, (r_{ij}t)^\alpha\big)\, t_{ij} \tag{11c}$$

where $\Gamma(a)$ and $P(a, x)$ denote the gamma and incomplete gamma functions, respectively (Abramowitz and Stegun, 1964, §6.5), so $\hat{M}^\star_{ij} \equiv C_{ij} I_{ij}/\hat{R}_{ij}\hat{s}_{ij}$ with

$$g_j(t) = t_{ij}(1 - q_j)\, m_{ij} \sum_{k \geq 0} q_j^k P\big(\tfrac{1}{\alpha}, [r_{ij}(t + kI_{ij})]^\alpha\big) \tag{11d}$$

$$R_{ij} \equiv t_{ij}\,(1 - q_j) \sum_{k \geq 1} q_j^{k-1} P\big(\tfrac{1}{\alpha},\; (k\, r_{ij} I_{ij})^\alpha\big) \tag{11e}$$

again with $q_j \equiv \theta_j(1 - s_{ij})$ (see Section (3) for finite approximations). This is illustrated in Figure (1) and Section (2.5).

2.3.3 Log Normal Persistence

The survival function, mean, and ISF for the log normal distribution are

$$\bar{F}_j(t) \equiv \mathsf{P}[\tau > t] = \Phi\big(-\alpha \log_j(r_{ij}\, t)\big) \tag{12a}$$

$$t_{ij} \equiv \mathsf{E}[\tau] = \int_0^\infty \bar{F}_j(x)\, dx = e^{1/2\alpha^2}/r_{ij} \tag{12b}$$

$$Q_j(t) \equiv \mathsf{E}[\tau \wedge t] = \int_0^t \bar{F}_j(x)\, dx = \Phi\big(-\alpha \log_j(r_{ij}\, t)\big)\, t + \Phi\big(\alpha \log_j(r_{ij}\, t) - \tfrac{1}{\alpha}\big)\, t_{ij} \tag{12c}$$

where $\Phi(z)$ is the standard Normal CDF, and so $\hat{M}^\star_{ij} \equiv C_{ij} I_{ij}/\hat{R}_{ij}\hat{s}_{ij}$ with

$$g_j(t) = (1 - q_j)\, m_{ij} \sum_{k \ge 0} q_j^k Q_j(t + kI_{ij}) \tag{12d}$$

$$R_{ij} \equiv (1 - q_j) \sum_{k \ge 1} q_j^{k-1} Q_j(k\, I_{ij}). \tag{12e}$$

The log normal distribution is more commonly parametrized by the mean $\mu = -\log r_{ij}$ and variance $\sigma^2 = 1/\alpha^2$ of $\log \tau$.

2.3.4 Log Logistic Persistence

The survival function, mean, and ISF for the log logistic (or "Fisk") distribution are

$$\bar{F}_j(t) \equiv \mathsf{P}[\tau > t] = [1 + (r_{ij} t)^\alpha]^{-1} \tag{13a}$$

$$t_{ij} \equiv \mathsf{E}[\tau] = \int_0^\infty \frac{dx}{1 + (r_{ij} x)^\alpha} = \begin{cases} \frac{\pi/\alpha}{r_{ij} \sin(\pi/\alpha)} & \alpha > 1 \\ \infty & \alpha \le 1 \end{cases} \tag{13b}$$

$$\begin{aligned} Q_j(t) \equiv \mathsf{E}[\tau \wedge t] = \int_0^t \frac{dx}{1 + (r_{ij} x)^\alpha} &= t\; {}_2F_1\big(1, \tfrac{1}{\alpha}; 1 + \tfrac{1}{\alpha}; -(r_{ij} t)^\alpha\big) \\ &= \frac{t}{1 + (r_{ij} t)^\alpha}\; {}_2F_1\big(1, 1; 1 + \tfrac{1}{\alpha}; \frac{1}{1 + (r_{ij} t)^{-\alpha}}\big) \end{aligned} \tag{13c}$$

where ${}_2F_1(a, b; c; z)$ is Gauss' hypergeometric function (Abramowitz and Stegun, 1964, §15.1). Note $t_{ij} = \infty$ is possible for this distribution. Again $\hat{M}^\star_{ij} \equiv C_{ij} I_{ij}/\hat{R}_{ij}\hat{s}_{ij}$ with

$$g_j(t) = (1 - q_j)\, m_{ij} \sum_{k \ge 0} q_j^k Q_j(t + kI_{ij}) \tag{13d}$$

$$R_{ij} \equiv (1 - q_j) \sum_{k \ge 1} q_j^{k-1} Q_j(k\, I_{ij}) \tag{13e}$$

with finite approximations given in Eqn (19). The log logistic distribution is more commonly parametrized by the median $m = -\log r_{ij}$ and scale $s = 1/\alpha$ of $\log \tau$.

2.4 Estimating Parameters and Persistence

The parameters governing removal distributions are usually estimated with the help of *removal trials* in which some number C_0 of carcasses are placed at known locations at time $t_0 = 0$, then checked on each of some number n of succeeding days $0 < t_1 < t_2 < \cdots < t_n$ revealing counts $C_0 \geq C_1 \geq C_2 \geq \cdots \geq C_n$ of remaining carcasses (see, for example, Erickson *et al.*, 2008, §2.6). To simplify some formulas below, set $t_{n+1} \equiv \infty$ and $C_{n+1} \equiv 0$, with $\bar{F}_j(\infty) = 0$.

2.4.1 Estimating Parameters

If we were able to observe the exact lengths of time $\{\tau_k\}$ until each carcass's removal, the log likelihood function for the rate parameter r_{ij} and shape parameter α of any of the distributions considered in Sections 2.3.2–2.3.4 would be

$$\ell(\alpha, r_{ij}) = \sum_k \log f_j(\tau_k; \alpha, r_{ij})$$

where $f_j(t; \alpha, r_{ij}) \equiv -(\partial/\partial t)\bar{F}_j(t; \alpha, r_{ij})$ denotes the probability density function (pdf) for removal, with the parameter dependence made explicit. Our data are censored, however, to only the counts C_m of $\{\tau_k\}$ in the intervals (t_m, ∞) for $0 \leq m \leq n$, leading to the multinomial log likelihood

$$\ell(\alpha, r_{ij}) = \sum_{m=0}^{n} [C_m - C_{m+1}] \log\left(\bar{F}_j(t_m; \alpha, r_{ij}) - \bar{F}_j(t_{m+1}; \alpha, r_{ij})\right) \tag{14}$$

from which estimates $\hat{\alpha}$, $\hat{r}_{ij}$ can be found numerically. For equally-spaced search intervals $t_m = m\Delta$ and exponentially-distributed removal, a closed-form expression for the rate maximum likelihood estimators (MLEs) of r_{ij} and of the mean persistence time $t_{ij} = 1/r_{ij}$ are available:

$$\hat{r}_{ij} = \frac{1}{\Delta} \log\left\{1 + \frac{C_0 - C_n}{\sum_{1\leq m\leq n} C_m}\right\} = \frac{1}{\Delta} \log\left\{\frac{\sum_{0\leq m<n} C_m}{\sum_{0<m\leq n} C_m}\right\}, \qquad \hat{t}_{ij} = 1/\hat{r}_{ij} \tag{15}$$

Note this is quite different from the formula for estimating mean persistence suggested in (Erickson *et al.*, 2008, §3.3), which will systematically underestimate $\hat{t}_{ij}$. Searcher proficiency s_{ij} can also be estimated empirically from removal trial experimental data (see Section (2.4.3)).

2.4.2 Empirical Persistence

An alternative to the parametric models presented in Section (2.3) is to estimate R_{ij} directly from experimental data gathered in a removal trial. If θ_j and s_{ij} (and hence q_j) are known, then the maximum likelihood estimator (MLE) $\hat{R}_{ij}$ can be computed from the MLE $\hat{Q}_j(t)$ of the ISF $Q_j(t)$.

Unfortunately the MLE for the ISF is not uniquely determined— the likelihood takes the same maximum value at all non-decreasing functions $Q(t)$ satisfying $\hat{Q}_j^-(t) \le Q(t) \le \hat{Q}_j^+(t)$, with lower and upper limits given by:

$$\hat{Q}_j^-(t) = \sum_{k=1}^{n} \frac{C_{k-1} - C_k}{C_0}(t_{k-1} \wedge t) + \frac{C_n}{C_0} t_n \qquad \hat{Q}_j^+(t) = \sum_{k=1}^{n} \frac{C_{k-1} - C_k}{C_0}(t_k \wedge t) + \frac{C_n}{C_0} t \tag{16}$$

These lead in turn to lower and upper MLEs for R_{ij} of

$$\hat{R}_{ij}^{\pm} \equiv (1 - q_j) \sum_{k \ge 1} q_j^{k-1} \hat{Q}_j^{\pm}(k\, I_{ij})$$

and hence to Partially Periodic estimators

$$\hat{M}_{ij}^{\star\pm} \equiv \frac{C_{ij}\ I_{ij}}{\hat{R}_{ij}^{\mp}\ \hat{s}_{ij}}. \tag{17}$$

The estimator $\hat{M}_{ij}^{\star+}$ generated from the lower MLE $\hat{R}_{ij}^-$ is conservative, in that it will slightly overestimate M_{ij} on average, while on average that $\hat{M}_{ij}^{\star-}$ generated from $\hat{R}_{ij}^+$ will slightly underestimate M_{ij}. Note too that the sums for evaluating both R_{ij}^- and R_{ij}^+ entail at most $\lceil t_n / I_{ij} \rceil$ terms, since for $t > t_n$ the function $\hat{Q}_j^-(t)$ is constant and $\hat{Q}_j^+(t)$ is linear, leading to summable geometric series. The difference $[\hat{Q}_j^+(t) - \hat{Q}_j^-(t)]$ for $t \le t_n$ are weighted averages of the inter-search intervals $[t_k - t_{k-1}]$, hence smaller than the largest such interval.

2.4.3 Regression

Now suppose that in a trial we have a vector of $p \ge 1$ covariates for each carcass that might affect the rate of removal, such as vegetation height or slope. Model the rate parameter r_{ij} for the kth carcass as

$$r_{ij} = \exp(X_k \cdot \beta)$$

for a p-dimensional vector β of regression coefficients, and denote by t_k^- the last search time $\{t_m\}$ the carcass was still present, and by t_k^+ the first search time the carcass was absent (or ∞ if the trial ended before it was removed). The log likelihood function of (14) becomes

$$\ell(\alpha, \beta) = \sum_k \log \left[\bar{F}_j\big(t_k^-; \alpha, \exp(X_k \cdot \beta)\big) - \bar{F}_j\big(t_k^+; \alpha, \exp(X_k \cdot \beta)\big) \right] \tag{18}$$

which can be maximized numerically in the parameters α and β.

These covariates may also affect the probability of discovery s_{ij}, which could also be modeled in log-linear fashion as

$$s_{ij} = \exp(X_k \cdot \gamma)$$

for an uncertain p-dimensional vector γ of regression coefficients.

2.5 Illustration

Figure 1 shows a simulation of four $I_{ij} = 10\,\mathrm{d}$ periods with average daily mortality rate of $m_{ij} = 3\,\mathrm{d}^{-1}$. Persistence distributions are Weibull with shape $\alpha = 0.70$ and mean $t_{ij} = 15\,\mathrm{d}$; search proficiency is $s_{ij} = 30\%$, and $\theta_j = 50\%$ of carcasses remain discoverable in subsequent periods (a compromise between the Shoenfeld and Pollock values). Counts of discoverable carcasses are shown as stair-step curve beginning and ending at open and filled squares, that increases (resp. decreases) by one with each new fatality (resp. removal by scavengers), and decreases by the number C_{ij} of carcasses discovered and removed by searchers (shown as a red downward arrow) and by an additional number that become undiscoverable. Expected numbers of discoverable carcasses are shown as smooth curves beginning and ending at open and filled circles. For these values, Erickson & Johnson's estimator has a bias of -50% (*i.e.*, on average $\hat{M}_{ij}^{\mathrm{EJ}} \approx \frac{1}{2} M_{ij}$) and Shoenfeld's $\hat{M}_{ij}^{\mathrm{S}}$ has bias -34.2%, because each assumes that *all* carcasses remain discoverable while in fact only half do. Pollock's estimator $\hat{M}_{ij}^{\mathrm{P:W}}$ has positive bias $+22.8\%$, because it assumes that *no* carcasses remain discoverable while in fact half do. Pollock's $\hat{M}_{ij}^{\mathrm{P:E}}$ (and Huso's identical $\hat{M}_{ij}^{\mathrm{H}}$) comes closer, with just $+2.7\%$ bias, because the reduction from its incorrect assumption of exponential removal distributions and the inflation from its incorrect assumption that intervals begin without discoverable carcasses nearly cancel out (a coincidence arising from our choice of parameter values). The new Partially Periodic estimator $\hat{M}_{ij}^{\star}$ has zero bias.

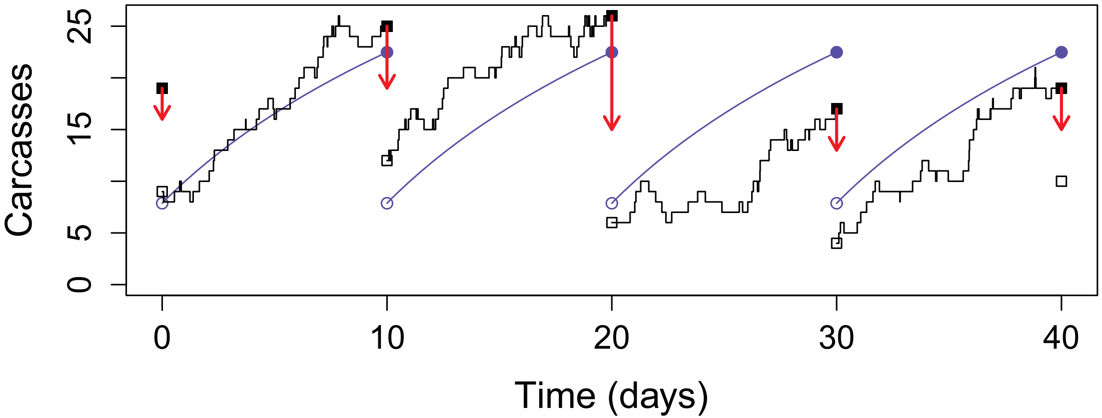


Figure 1: One draw (stair-step) from random distribution of all carcasses present at times t, for $0 \le t \le 40\,\mathrm{d}$. Expected value $g(t)$ is shown as solid line, beginning and ending search periods at open and filled circles, removal by search teams as downward arrows.

For exponential removal times ($\alpha = 1$), the new estimator will always lie between the estimators

$$\hat{M}_{ij}^{\mathrm{S}} < \hat{M}_{ij}^{\star} < \hat{M}_{ij}^{\mathrm{P}}$$

of Shoenfeld and Pollock (or, equivalently, Huso), with negligible differences among them whenever $I_{ij}/\hat{t}_{ij}$ is large. The differences are larger with more frequent searches, but never exceed a factor of s_{ij}: for any I_{ij} and $\hat{t}_{ij}$, always $s_{ij}\hat{M}_{ij}^{\mathrm{P}} \le \hat{M}_{ij}^{\mathrm{S}} \le \hat{M}_{ij}^{\mathrm{P}} \le \hat{M}_{ij}^{\mathrm{S}}/s_{ij}$.

3 Computation

3.1 Evaluating R_{ij}

Since $Q_j(t) \le t$ and $Q_j(t) \le \hat{t}_{ij}$, the truncation error incurred by approximating R_{ij} with just the first n terms as in Eqn (9b)

$$R_{ij}^n \equiv (1-q_j)\sum_{k=1}^{n} q_j^{k-1} Q_j(k\, I_{ij})$$

is bounded above by both of

$$\begin{aligned} R_{ij} - R_{ij}^n &\le (1-q_j)\sum_{k>n} q_j^{k-1} k\, I_{ij} &&= q_j^n\, I_{ij}\,[n + 1/(1-q_j)] \\ R_{ij} - R_{ij}^n &\le (1-q_j)\sum_{k>n} q_j^{k-1}\, \hat{t}_{ij} &&= q_j^n\, \hat{t}_{ij} \end{aligned}$$

and, by monotonicity, is bounded below by

$$R_{ij} - R_{ij}^n \ge (1-q_j)\sum_{k>n} q_j^{k-1}\, Q_j\big(n\, I_{ij}\big) = q_j^n\, Q_j(n\, I_{ij}),$$

leading to the two-sided bound

$$R_{ij}^{n-} \equiv R_{ij}^n + q_j^n\, Q_j(n\, I_{ij}) \quad\le\quad R_{ij} \quad\le\quad R_{ij}^{n+} \equiv R_{ij}^n + q_j^n \min\Big(\hat{t}_{ij},\ I_{ij}\big[n + 1/(1-q_j)\big]\Big). \quad (19)$$

For the parameter values used in the simulation of Section (2.5) presented in Figure 1 the error is bounded by $(0.5 * (1-0.3)e^{-2.5})^N = (0.0288)^N$, so just $N = 2$ terms suffice for 99.92% accuracy.

3.2 Special Functions

The partially-periodic estimator $\hat{M}_{ij}^{\star}$ of Eqn (1) is simple to evaluate in closed form under the assumption that removal times have exponential distributions, as is the estimator $\hat{M}_{ij}^{\star+}$ of Eqn (17) based on non-parametric empirical estimation of removal distributions. The version of $\hat{M}_{ij}^{\star}$ for log normal removal distributions presented in Section (2.3.3) requires only the cumulative normal distribution function $\Phi(z)$, available in virtually every computing environment, but the estimators for assumed log logistic or Weibull removal distributions require slightly less commonly used functions.

The complete and incomplete gamma functions $\Gamma(a)$ and $P(a,x)$ required for the Weibull estimator of Section (2.3.2) are included in `R` (R Core Team, 2012) as `gamma(a)` and `pgamma(x,a)`, respectively, and are also included in Matlab, Mathematica, the gnu scientific library (gsl: Galassi *et al.*, 2009), and other standard computational environments. In Microsoft Excel they are available as $\Gamma(a) =$ `EXP(GAMMALN.PRECISE(a))` and $P(a,x) =$ `GAMMA.DIST(x,a,1,TRUE)`, respectively (for versions of MS Excel prior to 10, use `GAMMALN` and `GAMMADIST` instead).

Gauss' hypergeometric function ${}_2F_1(a,b;c;z)$ needed for the log logistic removal models of Section 2.3.4) is available in MATLAB, in Mathematica, and `R` (using the `gsl` package). While it's not included in MS Excel, certain special cases are— for example, for $\alpha = 2$, $Q_j(t) = \arctan(r_{ij}t)/r_{ij}$ and (13e) becomes

$$\begin{aligned} R_{ij} &= (1-q_j)\sum_{k\ge 1} q_j^{k-1}\arctan(kr_{ij}I_{ij})/r_{ij} \\ \approx R_{ij}^{n-} &\equiv (1-q_j)\sum_{k=1}^{n} q_j^{k-1}\arctan(kr_{ij}I_{ij})/r_{ij} + q_j^n\arctan(nr_{ij}I_{ij})/r_{ij} \end{aligned}$$

for any small n, easily evaluated in Excel, with an error bounded by Eqn (19).

4 Non-constant Removal Rates and Proficiencies

One part of a 2011 study by the California Wind Energy Association (Warren-Hicks *et al.*, 2012) consisted of a removal trial in which a number of bird and bat carcasses were placed in known locations and followed for 45 days. At intervals, searches would be undertaken and each discovered carcass would be recorded. Periodically the trial coordinators would check each carcass to see if it had yet been removed by scavengers.

4.1 Estimating Proficiency Time Dependence

A key finding of this study is that the proficiency s_{ij} does *not* appear to be constant, unrelated to the age of the carcass— rather, that older carcasses have a lower probability of discovery than fresher carcasses. This is illustrated in Figure (2), which shows the data for small birds: 38 successful discoveries of carcasses aged 1–28 days, shown as small circles ∘ at height $y = 1$, and 185 undiscovered carcasses, aged 1–45 days, shown as small circles at height $y = 0$ (a small jitter is added to the locations of each circle to reveal multiplicity). The overall average proficiency is $\bar{s}_{ij} = 17\%$, but there is clear evidence that $\bar{s}_{ij}(t)$ diminishes with carcass age t. The figure also shows an empirical exponential moving-average estimate (with a 5-day window) as a dashed red line, and the best fit with a logistic regression model shown as a solid blue curve:

$$\hat{s}_{ij}(t) = \left(1 + e^{0.6441+0.0911t}\right)^{-1}, \tag{20a}$$

starting at $\hat{s}_{ij}(0) = 45.75\%$, falling to the overall average $\hat{s}_{ij}(10.3) = 17\%$ after about 10 days and continuing to fall down to a negligible $\hat{s}_{ij}(45) = 0.86\%$. The two curves are in substantial agreement throughout the range, suggesting that the logistic regression model is a good fit. The best fit for a model with simple exponentially-decreasing proficiency

$$\hat{s}_{ij}(t) = e^{-1.017-0.0777t} \tag{20b}$$

(in green) is virtually indistinguishable; we'll return to this one in Section (4.3).

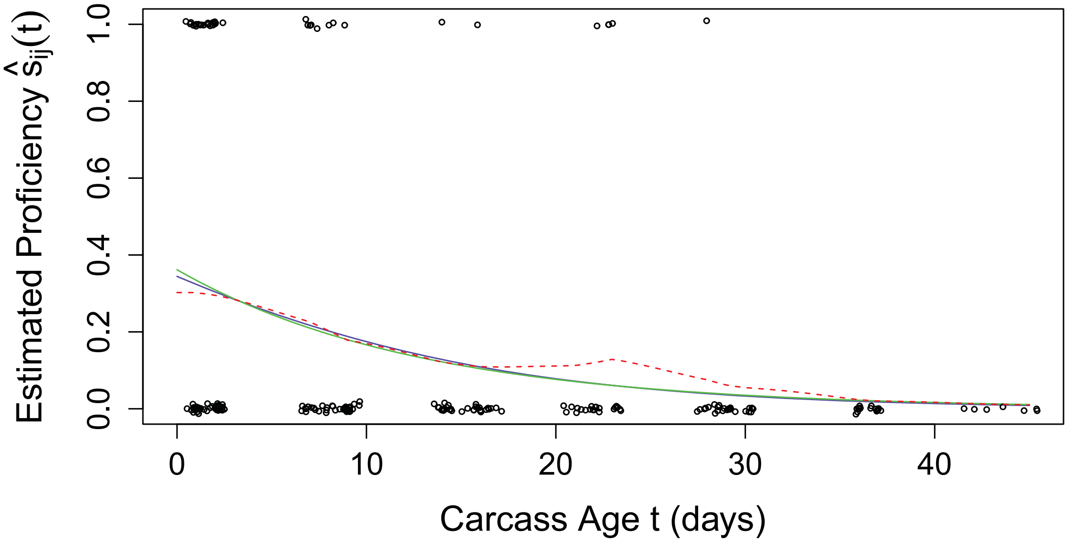


Figure 2: Time-dependence of search proficiency $\hat{s}_{ij}(t)$. Dashed red curve is nonparametric moving-average estimator (exponential window, width 5 days), solid blue and green curves are best logistic-regression and exponential fits (see Eqn (20)).

4.2 Estimating Removal Time Dependence

Other investigators (such as Bispo *et al.*, 2012) have reported earlier that exponential distributions offer a worse fit to empirical data on carcass removal by scavengers than several alternatives, and data from Warren-Hicks *et al.* (2012) reaffirm this finding. Figure (3) shows the upper and lower empirical survival curves (Kaplan and Meier, 1958) for these censored data, along with best fits for Exponential Distribution (dashed red curve) and Weibull (solid blue curve). Evidently the Weibull fits far better. Both log-logistic and log-normal fits are similar to Weibull, and far better than exponential, suggesting that hazard rate (daily probability of removal by scavengers), like search proficiency, diminishes over time. The best-fit Weibull had shape parameter $\hat{\alpha} = 0.4606$ with a Standard Error of $0.0532\,\mathrm{d}$, about 10.31 Standard Errors below the value $\alpha = 1$ corresponding to the exponential distribution, leading to emphatic rejection of exponentially-distributed removal. The estimated rate parameter is $\hat{r}_{ij} = 0.07944$, for a mean persistence time of

$$\hat{t}_{ij} = \Gamma(1 + 1/\hat{\alpha})/\hat{r}_{ij} = 29.64\,\mathrm{d},$$

substantially longer than the estimate $\hat{t}_{ij} = 16.68\,\mathrm{d}$ under the exponential model which (see Figure (3)) systematically underestimates early removal and overestimates late removal.

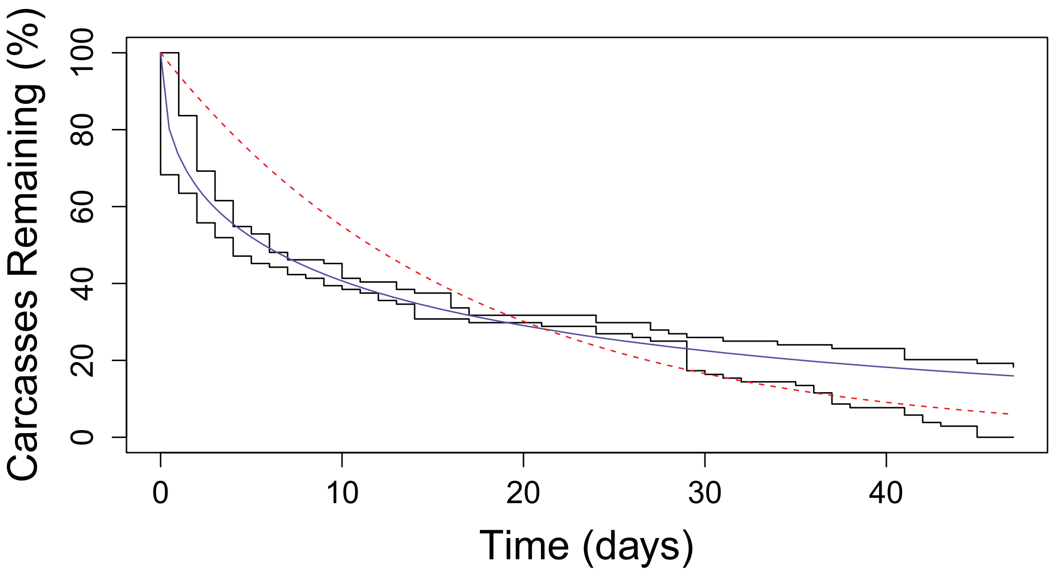


Figure 3: Upper and lower empirical (Kaplan-Meier) Removal curves (solid black stair-steps), with best Weibull fit (solid blue curve) and best Exponential fit (dashed red curve).

4.3 Adapting the Model and Mortality Estimators

Although the model and mortality estimator of Section (2.2) makes no assumptions on removal distributions, and the parametric examples presented in Section (2.3) include the Weibull, Lognormal, and Log Logistic, all of which fit our data well, each of of these (along with all other published mortality estimators we are aware of) are built on the assumption that search proficiency is constant, unrelated to carcass age; in Section (4.1) we showed that this assumption appears to be false. In this section we will adapt the model and estimators of Sections (2.2) and (2.3) to accommodate age-dependent proficiency.

By the same argument and changes-of-variables that led to Eqn (9a), the number of carcasses counted at each search will have a Poisson distribution with mean

$$c_{ij} = m_{ij} \sum_{k=0}^{\infty} \theta^k \int_{kI_{ij}}^{(k+1)I_{ij}} \bar{F}_j(x) s_{ij}(x) \prod_{1 \le n \le k} \left[1 - s_{ij}(x - nI_{ij})\right] dx \tag{21a}$$

or, for $\theta = 0$ as assumed by Pollock and Huso, just one term $k = 0$:

$$= m_{ij} \int_0^{I_{ij}} \bar{F}_j(x) s_{ij}(x)\, dx. \tag{21b}$$

Using $\mathsf{E}[M_{ij}] = I_{ij} m_{ij}$, this leads to a variation on (8),

$$\hat{M}^{\star}_{ij} = \frac{C_{ij}\ I_{ij}}{R^{\star}_{ij}} \tag{22a}$$

where now $R^\star_{ij}$ is given by

$$R^\star_{ij} \equiv \sum_{k=0}^{\infty} \theta^k \int_{kI_{ij}}^{(k+1)I_{ij}} \bar{F}_j(x) s_{ij}(x) \prod_{1 \le n \le k} \big[1 - s_{ij}(x - nI_{ij})\big]\, dx. \tag{22b}$$

This can be computed numerically for any specified proficiency function $s_{ij}(x)$ (like the logistic or exponential regressions of Eqn (20a) or Eqn (20b)) and any of the empirical or parametric removal distributions of Section (2.3) or Section (2.4.2).

4.3.1 An Efficient Computational Scheme

For exponentially diminishing proficiency $s_{ij}(t) = \exp(-a - bt)$ (which fits our data well, as shown in Figure (2)), $R^\star_{ij}$ is the sum

$$R^\star_{ij} = I_{ij} \sum_{k=0}^{\infty} T_k$$

of terms

$$\begin{aligned} T_k &= \theta^k I_{ij}^{-1} \int_{kI_{ij}}^{(k+1)I_{ij}} \bar{F}_j(t) e^{-a-bt} \prod_{1 \le n \le k} \big[1 - e^{-a-b(t-nI_{ij})}\big]\, dt \\ &= \theta^k \int_0^1 \bar{F}_j((k+x)I_{ij}) e^{-a-bI_{ij}(x+k)} \prod_{0 \le n < k} \big[1 - e^{-a-bI_{ij}(x+n)}\big]\, dx \end{aligned}$$

each expressible as the sum of 2^k terms of the form

$$Q^\star_{kmn} = \theta^k (-1)^{m+1} \int_0^1 \bar{F}_j\big((k+x)I_{ij}\big) e^{-m\,(a+bI_{ij}\,x) - n\,bI_{ij}}\, dx \tag{23}$$

for suitable nonnegative integers k, m, n that can be enumerated recursively. The first few terms are

$$\begin{aligned} T_0 &= Q^\star_{010} \\ T_1 &= Q^\star_{111} + Q^\star_{121} \\ T_2 &= Q^\star_{212} + Q^\star_{223} + Q^\star_{222} + Q^\star_{233} \\ T_3 &= Q^\star_{313} + Q^\star_{325} + Q^\star_{324} + Q^\star_{336} + Q^\star_{323} + Q^\star_{335} + Q^\star_{334} + Q^\star_{346} \end{aligned}$$

The integral in (23) is easily evaluated using Simpson's rule, or is available in closed form for Weibull removal with shape parameters $\alpha = 1$ (the exponential case) or $\alpha = \frac{1}{2}$ (very close to our estimated shape parameter $\hat{\alpha} = 0.4606$ for small birds). The truncation error from using only the first N terms $0 \le k < N$ in (22b) is bounded by

$$0 \le \text{Truncation Error} \le \frac{\theta^N \bar{F}_j(N\,I_{ij}) \exp(-a - N\,bI_{ij})}{\max\{bI_{ij}, (1 - \theta e^{-bI_{ij}})\}}$$

For the parameter estimates in our study[1], a 40% error would be made using only $N = 1$ term (*i.e.*, neglecting bleed-through), but the error falls to 8% with $N = 2$ terms and below 0.5% with $N = 4$, indicating that a significant fraction of old carcasses were present from the immediately preceding period, but essentially none from more than three periods earlier. The values of $R^\star_{ij}$ and corresponding estimators $\hat{M}^\star_{ij} = C_{ij} I_{ij}/R^\star_{ij}$ with $\theta = 50\%$ were:

I_{ij}	2 d	7 d	14 d	28 d
$R^\star_{ij}$	1.094	2.2224	2.9013	3.327
$\hat{M}^\star_{ij}$	$1.8\,C_{ij}$	$3.15\,C_{ij}$	$4.8\,C_{ij}$	$8.4\,C_{ij}$

5 Interval Estimates for M_{ij} and m_{ij}

Each of the estimators in Sections (2) and (4) is of the form "$\hat{M}_{ij} = \kappa C_{ij}$" for some $\kappa \geq 1$, proportional to the carcass count C_{ij}, because in each C_{ij} has either a binomial or a Poisson distribution with mean proportional to M_{ij} or to $m_{ij} = \mathsf{E} M_{ij}/I_{ij}$:

$$\mathsf{E}[M_{ij}] = m_{ij} I_{ij}, \qquad \mathsf{E}[C_{ij}] = m_{ij} I_{ij}/\kappa, \qquad \kappa \equiv \frac{I_{ij}}{s_{ij} R_{ij}} \text{ or } \frac{I_{ij}}{R^\star_{ij}} \tag{24a}$$

where R_{ij} is given by Eqn (9a) and $R^\star_{ij}$ by Eqn (22b). In this Section we present Confidence Interval estimators for M_{ij} and m_{ij}.

5.1 Estimating M_{ij} when $\theta = 0$

If $\theta = 0$ then all of the C_{ij} carcasses discovered will be from the M_{ij} of the current period I_{ij}, with conditional distribution

$$C_{ij} \mid M_{ij} \sim \mathsf{Bi}(M_{ij}, 1/\kappa).$$

If the constant κ is known precisely (if θ_j, I_{ij}, s_{ij}, and the removal distribution including its parameters are all known, for example), then an exact Confidence Interval for $M_{ij} \approx \hat{M}^\star_{ij} = \kappa C_{ij}$ can be constructed as follows. For any chosen confidence level γ (like 0.90, for example), an exact $100\gamma\%$ Confidence Interval is given by

$$\gamma \leq \mathsf{P}\big\{\texttt{lo}(C_{ij}) \leq M_{ij} \leq \texttt{hi}(C_{ij})\big\} \tag{24b}$$

where the functions `lo()` and `hi()` are given for integers $c \geq 0$ by

$$\texttt{lo}(c) = \sup\left\{m \geq c : \texttt{pbeta(1/kap; c+1, m-c)} \leq \frac{1-\gamma}{2}\right\}$$
$$\texttt{hi}(c) = \inf\left\{m \geq c : \texttt{pbeta(1/kap; c, m+1-c)} \geq \frac{1+\gamma}{2}\right\}$$

---

[1] Maximum likelihood estimates were $\hat{\alpha} \approx 0.4606$, $\hat{r}_{ij} \approx 0.07944$, $\hat{a} = 1.017$ and $\hat{b} = 0.0777$

For large C_{ij} and moderate κ these are approximately

$$\texttt{lo}(c), \texttt{hi}(c) \approx \kappa \left[c \pm \sqrt{c}\; z\sqrt{(\kappa-1)/\kappa}\right]$$

for $z := \Phi^{-1}\left(\frac{1+\gamma}{2}\right)$, so the CI widths are roughly proportional to $\sqrt{c}$ for large c. They fall to zero for $c = 0$.

5.2 Estimating $\mathsf{E}M_{ij}$ when $0 \le \theta \le 1$

If $\theta > 0$ some carcasses discovered in a search may have arisen from fatalities in earlier time period— so it is possible to have a positive count $C_{ij} > 0$ even if $M_{ij} = 0$, making it challenging to find interval estimates for M_{ij} based only on the count C_{ij} from the current period. Under the assumption of near periodicity, however, even though the actual fatality counts M_{ij} will vary from period to period by chance, the *mean* fatality counts $\mathsf{E}M_{ij} = m_{ij}I_{ij}$ should be approximately constant. An exact $100\gamma\%$ Confidence Interval is given by

$$\gamma \le \mathsf{P}\left\{\texttt{lo}(C_{ij}) \le \mathsf{E}M_{ij} \le \texttt{hi}(C_{ij})\right\} \tag{24c}$$

where the functions `lo()` and `hi()` are gamma distribution quantiles determined for integers $c \ge 0$ by the relations

$$(1-\gamma)/2 = P(c,\ \texttt{lo}(c)/\kappa) \qquad\qquad (1+\gamma)/2 = P(c+1,\ \texttt{hi}(c)/\kappa). \tag{24d}$$

In `R`, the solutions (with variables `c`, `gam` and `kap` for c, γ and κ respectively) are

$$\texttt{lo}(c) = \texttt{kap * qgamma((1-gam)/2, c);}$$
$$\texttt{hi}(c) = \texttt{kap * qgamma((1+gam)/2, c+1);}$$

with similar formulas in MS Excel (where `GAMMA.INV(q,a,1)` takes the place of `R`'s `qgamma(q, a)`) or other environments. For example, with the parameter values used in the simulation shown in Figure 1, $R_{ij} = 0.49956$, $I_{ij}/t_{ij} = 10/15 = 0.6667$ and $s_{ij} = 0.3$, so $\kappa = I_{ij}/(R_{ij}s_{ij}) \approx 4.4483$. The proposed estimator is $\hat{M}^{\star}_{ij} = \kappa C_{ij} \approx 4.45 \times C_{ij}$, and $\gamma = 90\%$ confidence interval estimates of M_{ij} (whose true value averaged $m_{ij}I_{ij} = 30$ in the simulation) for various count values of C_{ij} would be:

C_{ij}	lo	$\hat{M}^{\star}_{ij}$	hi
0	0.00	0.00	13.33
1	0.23	4.45	21.10
2	1.58	8.90	28.01
3	3.64	13.35	34.49
4	6.08	17.79	40.72
5	8.76	22.24	46.77
6	11.62	26.69	52.68
7	14.61	31.14	58.49
8	17.71	35.59	64.21
9	20.89	40.04	69.86
10	24.13	44.48	75.45
11	27.44	48.93	80.99
12	30.80	53.38	86.49
13	34.21	57.83	91.94
14	37.65	62.28	97.36
15	41.13	66.73	102.74

This illustrates how imprecisely M_{ij} is determined by the counts C_{ij} (especially for low counts) even if α, θ_j, I_{ij}, s_{ij}, and t_{ij} are all known precisely. If any of these must be estimated, then the uncertainty about M_{ij} is greater.

Bayesian estimates and Credible Intervals are also available for conjugate gamma prior distribution $M_{ij} \sim \mathsf{Ga}(a, b)$,

$$\mathsf{E}[M_{ij} \mid C_{ij}] = \frac{\kappa}{1+\kappa b}\,[C_{ij} + a] = \frac{\hat{M}^{\star}_{ij} + \kappa a}{1+\kappa b} \tag{25a}$$

$$\gamma = \mathsf{P}\Big\{\texttt{lo}(C_{ij}) \le M_{ij} \le \texttt{hi}(C_{ij})\Big\} \tag{25b}$$

$$\texttt{lo}(c) = \texttt{qgamma((1-gam)/2, c+a) * kap/(1+kap*b);} \tag{25c}$$

$$\texttt{hi}(c) = \texttt{qgamma((1+gam)/2, c+a) * kap/(1+kap*b);} \tag{25d}$$

The reference or "noninformative" choice would be $a = \frac{1}{2}$, $b = 0$; more generally, experience in similar settings may suggest an appropriate "prior sample size" b and "prior sample sum" a. Note the same Confidence Intervals and Credible Intervals also apply to any of the estimators $\hat{M}^{\text{EJ}}_{ij}$, $\hat{M}^{\text{H}}_{ij}$, $\hat{M}^{\text{S}}_{ij}$, $\hat{M}^{\text{H}}_{ij}$, since they are special cases of $\hat{M}^{\star}_{ij}$.

A Appendix: Notation Glossary

For convenience we collect here notation used in this document:

$\mathfrak{g}_0$ be the number of discoverable carcasses on the ground at the start of a period,
$\mathfrak{g}_1$ be the number of discoverable carcasses on the ground at the end of a period.

By periodicity we take to be the same for all periods, though they may vary with the turbine i (but to simplify the notation we ignore this). At turbine i and time period j, let:

C_{ij} (count) = number of carcasses counted,
I_{ij} (search interval) = number of days between searches,
M_{ij} (mortality) = true number of carcasses during interval,
m_{ij} (mortality rate) = daily average arrival rate of carcasses,
p_{ij} (persistence probability) = probability of remaining unremoved until next search,
r_{ij} (rate parameter) = common parameter for all removal distributions,
s_{ij} (search proficiency) = probability a carcass will be discovered,
t_{ij} (mean persistence) = average number of days a carcass remains unremoved,
α (shape parameter) = common parameter for all removal distributions,
θ_j (periodicity) = fraction of undiscovered carcasses that remain discoverable,
τ (persistence time) = number of days a carcass remains unremoved,
q_j $(\theta_j(1 - s_{ij}))$ = probability undiscovered but still discoverable,
$\bar{F}_j(t)$ (survival function) $= \mathsf{P}[\tau > t]$,
$Q_j(t)$ (ISF) $= \mathsf{E}[\tau \wedge t] = \int_0^t \bar{F}_j(x)\,dx$,

References

Abramowitz, M. and Stegun, I. A., eds. (1964) *Handbook of Mathematical Functions With Formulas, Graphs, and Mathematical Tables*, vol. 55 of *Applied Mathematics Series.* Washington, D.C.: National Bureau of Standards. Reprinted in paperback by Dover (1974); on-line at `http://www.math.sfu.ca/~cbm/aands/`.

Bispo, R., Bernardino, J., Marques, T. A. and Pestana, D. (2012) Modeling carcass removal time for avian mortality assessment in wind farms using survival analysis. *Environmental and Ecological Statistics.* doi:10.1007/s10651-012-0212-5. (in press).

California Energy Commission and California Department of Fish and Game (2007) California guidelines for reducing impacts to birds and bats from wind energy development. Tech. Rep. CEC-700-2007-008-CMF, California Energy Commission, Renewables Committee, and Energy Facilities Siting Division, and California Department of Fish and Game, Resources Management and Policy Division. Commission Final Report.

Erickson, W. P., Jeffrey, J. D. and Poulton, V. K. (2008) Puget sound energy wild horse wind facility post-construction avian and bat monitoring: First annual report january–december 2007. Tech. rep., Puget Sound Energy (Ellensburg, WA 98296) and Wild HOrse Wind Facility Technical Advisory Committee (Kittitas County, WA); prepared by Western EcoSystems Technology Inc, Cheyenne, WY.

Erickson, W. P., Strickland, M. D., Johnson, G. D. and Kern, J. W. (1998) Examples of statistical methods to assess risks of impacts to birds from wind plants. In *PNAWPPM-III: Proceedings of the Avian-Wind Power Planning Meeting III, San Diego, CA*. Washington, DC: National Wind Coordinating Committee Meeting, May 1998. Prepared for the Avian Subcommittee of the National Wind Coordinating Committee by LGL, Ltd., King City, Ont.

Galassi, M., Davies, J., Theiler, J., Gough, B., Jungman, G., Alken, P., Booth, M. and Rossi, F. (2009) *GNU Scientific Library Reference Manual.* Bristol, UK: Network Theory Ltd, 3rd edn.

Huso, M. M. P. (2011) An estimator of wildlife fatality from observed carcasses. *Environmetrics*, **22**, 318–329. doi:10.1002/env.1052.

Johnson, G. D., Erickson, W. P., Strickland, M. D., Shepherd, M. F., Shepherd, D. A. and Sarappo, S. A. (2003) Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota. *The American Midland Naturalist*, **150**, 332–342. doi: 10.1674/0003-0031(2003)150[0332:MOBAAL]2.0.CO;2.

Kaplan, E. L. and Meier, P. (1958) Nonparametric estimation from incomplete observations. *J. Am. Stat. Assoc.*, **53**, 457–481.

R Core Team (2012) *R: A Language and Environment for Statistical Computing.* R Foundation for Statistical Computing, Vienna, AT.

Shoenfeld, P. S. (2004) Suggestions regarding avian mortality extrapolation. Online at `http://www.wvhighlands.org/Birds/SuggestionsRegardingAvianMortality-Extrapolation.pdf`.

Warren-Hicks, W., Newman, J., Wolpert, R. L., Karas, B. and Tran, L. (2012) *Improving Methods for Estimating Fatality of Birds and Bats at Wind Energy Facilities.* (California Wind Energy Association). Publication number: CEC-XXX-2012-XXX.

Wolpert, R. L. (2012) Four equations for estimating avian mortality rates. Working Draft for Cal/WEA Review Purposes Only.

APPENDIX B:
A New Survey Method for Detection Probability Trials for Partial Periodic Estimator

Introduction

This study identified and explained major influences on detection probability for periodic searches of bird and bat fatalities. These discoveries led to the creation of a new Partial Periodic Estimator (Appendix A), which requires modifications to the traditional survey methodology. The following lays out the framework for wind energy fatality monitoring surveys and detection probability trials that support the new estimator and account for the major influences on detection probability.

1. Time dependent carcass persistence and searcher proficiency: It has been well documented that carcass persistence is dependent on carcass age, and this study shows that search proficiency is also dependent on carcass age.
2. Carcasses can persist through multiple search intervals, allowing for multiple detection events: Some of the previous fatality estimation equations (*e.g.,* Pollock and Huso) do not account for the common occurrence of carcasses being deposited in one search interval that persist into subsequent intervals and are detected at a later date. The Partial Periodic Estimator measures this “bleed-through” process with a new term, “theta,” which is the proportion of undiscovered carcasses that remain discoverable.
3. Other covariates such as vegetation height can also have strong influences on detection probability.

Preliminary Scavenger Removal Trial

Before a main study begins, a preliminary traditional 60-day scavenger removal trial is required to estimate the ballpark mean persistence of carcasses (bats, small birds, and large birds) and variation in removal times. The recommended main study search interval is equal to the shortest mean persistence of the three carcass types placed. The recommended main detection probability trial length is three times the mean persistence of the longest persisting carcass type. The number of carcasses used in the main detection probability trial for each size category should be based on the variation of removal times.

Main Study Detection Probability Trial

Carcass Placement

Carcass placement timing should occur to simulate the assumed steady random rate of deposit. Carcasses should be placed at random positions in a search area to account for covariates such as vegetation height and slope. Carcasses should be marked to distinguish them as trial carcasses and not true fatalities. Carcasses should be mapped with sub-meter accurate Global Positioning System (GPS) receivers, or their positions should be cryptically marked to help a project field manager certify their presence while keeping field technicians blind to their presence. Main study detection probability trials should occur at least once per season, and the trial length should be equal to three times the mean persistence of the longest persisting carcass type in the preliminary scavenger removal trial. All carcasses should be placed at monitored wind turbines.

Integrated Carcass Persistence and Proficiency Detection Events

For any given carcass and search, the probability of persistence and detection (searcher proficiency) are both time dependent and dependent on one another. This makes it highly effective and desirable to measure these outcomes together in an integrated trial, rather than in two independent trials.

After placing trial carcasses strategically at monitored wind turbines, carcass persistence and searcher proficiency needs to be measured.

To establish carcass persistence, a traditional scavenger removal trial schedule of carcass checks is recommended for all trial carcasses –the project field manager checks carcasses every day for the first week, every three days for the next two weeks, and then every seven days until all carcasses are removed or the end of the trial is reached. In addition to the traditional schedule of carcass checks, supplemental carcass checks should occur for trial carcasses on search days. Note that many of the supplemental carcass checks will overlap with the traditional schedule of carcass checks and will not require extra effort. Carcass checks of trial carcasses on the day of searches should be conducted after field technicians complete their searches to maintain the searchers' blindness.

To establish searcher proficiency, field technicians record all marked carcasses they detect while conducting their standard scheduled searches. They should be instructed not to disturb these marked carcasses; they are left in place for future project field manager persistence carcass checks. Because the project field manager conducts carcass checks of trial carcasses on search days, the true persistence status of those trial carcasses is known; therefore negative searcher detections can interpreted as either a searcher's miss of a persisting trial carcass or that the trial carcass was removed by scavengers.

Integrating the carcass persistence and searcher proficiency trials can simultaneously produce time dependent carcass persistence and searcher proficiency functions for the same set of trial carcasses.

Search Interval Bleed-through of Carcasses: Theta

The final term that needs to be measured for the Partial Periodic Estimator is theta, the fraction of undiscovered carcasses that remain discoverable over time through multiple search intervals. Because trial carcasses are placed to simulate a random steady state of deposit at monitored wind turbines and the persistence and detection of trial carcasses are tracked, the number of trial carcasses that are not detected and not removed in one interval that persist to be possibly detected in a subsequent interval can be measured.

Collateral Data and Advantages to the New Method

Because a preliminary persistence trial is conducted first, proper trial carcass sample size, trial length, and search interval can be established for the main monitoring program ahead of time. This will introduce an evidence-based approach rather than guessing or using a "rule-of-thumb" to establish these aspects of the program.

The data collected from the new method can be used to source estimates for all four traditional fatality estimation equations reviewed in this study. The traditional persistence carcass check schedule is conserved, and the traditional simple initial fresh carcass searcher proficiencies can be extracted from the initial detection outcome of this method. This can allow for easy comparisons of estimator results to compare to previous studies that used other estimators. In addition, a remarkably simple empirical estimator is also sourced by the data collected and can be used as an independent check on the Partial Periodic Estimator. The number of total searcher-detected trial carcasses divided by the number of placed trial carcasses should be equal to (or close to) the overall detection probability derived by the Partial Periodic Estimator. This is because the effects of the integrated time dependent probabilities of carcasses persistence and searcher proficiency as well as the bleed-through theta mechanism are implicit in the proportional detection outcomes of this new method.

Overall, this new method and estimator are much more sensitive to the major influences that affect detection probability, reducing bias and improving the predictive power of estimating the impacts of wind turbines on wildlife.

APPENDIX C:
Data Dictionary & Data Fields Used for Recording Carcasses

Table C-1: Data Dictionary

Variable	Description	Units
ID	Unique record identifier for all data rows	Number
Date	Date that a status check or search took place	Julian date format
String	Unique identifier for a collection of turbines where trial carcasses were placed and searches occurred	Unique number
Species	The species or unknown species determination (ex UNRA, unknown raptor)	AOU species code
Photo	Unique identifier per photo	Photo number
Sex	The sex determination of trial carcasses, if known	U=unknown; M=Male; F=Female
Age	The age class of the trial carcass, if known	A=adult; J=juvenile; U=unknown
Class	The group status of trial carcass, Bird or Bat	Bird or Bat
Grid_Cell	The dominant grid cell that the carcass occupies on specified date	Alpha-numeric map key
PositionID	ID at time of search, based on last known position	Carcass_ID + position modifier
AssignedID	ID after QA and analysis, may combine several unknown or found IDs	Carcass_ID
PID	An identifying number for the project field manager who conduct the status check. Searcher that conduct the search	See data file for codes
Person	Project field manager or field technician	Name
SearchDay	Does record represent a day when searchers were present	Yes / No
DetectionStatus	The detection outcome generated by a status check or search	P = placement of carcass; F = found carcass; NF = a not found carcass; NC = a not checked carcass position (only after many prior checks, and assurance that carcass has been removed)

Variable	Description	Units
DetectionType	The type of detection (if detected)* ** If a specific carcass was ever detected during the study, it was considered a detection.*	S: Found during standard status check without additional effort; F: Found during flushing search around last known location of carcass; I: Found incidentally at unknown position without systematic search; 0: Found but not enough evidence to be considered fatality; M: Found carcass due to Marker (FM) or Did Not Find the Marker (NFM)
PositionPresence	Indictor of carcass presence at time of search	1=present; 0=absent
AssignedPresence	Indicator of carcass presence after analysis and QA	1=present; 0=absent
Veg_HT	Vegetation height	Inches
ScavengerIndex	A subjective index of the carcass "attraction" to a scavenger on a day	Index 1: Fresh carcass and very attractive for removal/scavenging; Index 2: Partially scavenged or decayed carcass , moderately attractive for removal/scavenging; Index 3: Completely scavenged or decayed (no remaining edible or attractive tissue), low attraction for removal/scavenging
GPSMarkID	Garmin record ID; allows sync with latitude and longitude	Number
Latitude	Position where carcass found during search	GPS Lat
Longitude	Position where carcass found during search	GPS Long
Note	Any field notes made by searcher or project field manager	Text
BlockNum	Block ID: contains multiple strings searched in a consistent time period	Ranges from 1 – 4
DistanceSighted	Distance from searcher to found carcass	Meters

Variable	Description	Units
TrialCarcass	Indicator of a trial carcass placed at t=0	Yes / No
TemperatureHighF	Daily high temperature	Degrees F
TemperatureAvgF	Daily average temperature	Degrees F
TemperatureLowF	Daily low temperature	Degrees F
DewpointHighF	Daily high dewpoint	Degrees F
DewpointAvgF	Daily average dewpoint	Degrees F
DewpointLowF	Daily low dewpoint	Degrees F
HumidityHigh	Daily high humidity	Percent
HumidityAvg	Daily average humidity	Percent
HumidityLow	Daily low humidity	Percent
PressureMaxIn	Daily maximum pressure	mmBars
PressureMinIn	Daily minimum pressure	mmBars
WindSpeedMaxMPH	Daily maximum wind speed	Miles per hour
WindSpeedAvgMPH	Daily average wind speed	Miles per hour
GustSpeedMaxMPH	Daily maximum wind gust speed	Miles per hour
PrecipitationSumIn	Daily total precipitation	Inches
RELEV	Elevation (feet) of nearest grid cell at the ridge crest	Feet
VELEV	Elevation (feet) of nearest grid cell at the valley bottom	Feet
DELTAELV	Change in elevation (feet) between nearest ridge crest and nearest valley bottom. Measure of slope size	Feet
TOTDIST	Total horizontal distance (feet) between nearest valley bottom and nearest ridge crest. Measure of slope size.	Feet
RDIST	Horizontal distance (feet) between grid cell and nearest ridge crest	Feet
VDIST	Horizontal distance (feet) between grid cell and nearest valley bottom	Feet
DEMELV	Elevation (feet) of target grid cell centroid, according to digital elevation model	Feet
ASPECT	Degrees from true north toward which the grid cell faces	Degrees
SLOPE	Percentage slope of grid cell, determined by trend with nearest grid cell in the uphill direction and with the nearest grid cell in the downhill direction. Measures local slope.	Percent

Variable	Description	Units
SLPBIN	Slope values aggregated into bins	Percent
VPLYDIST	Horizontal distance (feet) between grid cell and nearest grid cell along boundary of the closest valley bottom polygon.	Feet
VPLYELV	Vertical distance (feet) between grid cell and nearest grid cell along boundary of the closest valley bottom polygon.	Feet
RPLYDIST	Horizontal distance (feet) between grid cell and nearest grid cell along boundary of the closest ridge top polygon.	Feet
RPLYELV	Vertical distance (feet) between grid cell and nearest grid cell along boundary of the closest ridge top polygon.	Feet
Within slope hazard zone?	Whether grid cell occurs within a ridge saddle, break in slope, or other slope feature determined to be more often used by flying raptors. This determination was judgment based, and not the product of modeling.	1=yes; 0=no
Gross slope	Average slope from nearest valley bottom to nearest ridge crest, measured as ratio of elevation difference and total slope distance.	Ratio (%)
Distance ratio	Ratio of horizontal distance (feet) between grid cell and nearest valley bottom and of distance between grid cell and nearest ridge crest. Values of #DIV/0! in this ratio occurred for grid cells at the ridge crest; repairs were left to the analyst.	Ratio (%)
Elevation ratio	Ratio of vertical distance (feet) between grid cell and nearest valley bottom and of vertical distance between grid cell and nearest ridge crest. Values of #DIV/0! in this ratio occurred for grid cells at the ridge crest; repairs were left to the analyst.	Ratio (%)

Source: EcoStat, Inc.

Table C-2: Master Data Fields Used in Recording Carcasses Found

Recorded Master Data Fields
Record ID: Unique record identifier for all data rows.
Date: Date that a status check or search took place.
String: Unique identifier for a collection of turbines that trial carcasses were placed and searches occurred.
Species: The species or unknown species determination (ex UNRA, unknown raptor).
Sex: The sex determination of trial carcasses, if known.
Age: The age class of the trial carcass, if known.
Class: The group status of trial carcass, Bird or Bat.
Grid Cell: The dominant grid cell that the carcass occupied on specified date.
Carcass ID: The unique identifier for marked placed trial carcasses, naturally detected carcasses, and unknown marked carcasses.
Assigned ID: The assigned carcass ID for unknown marked carcasses based on proximity to known carcass ID positions and presence status.
P_ID: Identifying number for project field manager who conducted status check, and searcher who conducted search.
Search Outcome: The search outcome, whether a carcass was detected on a day Yes/No.
Presence: The known presence of a carcass on a day Yes/No.
Vegetation height: The vegetation height measure at the position of the carcass.
Scavenger Index: A relative index of carcass condition.
Index 1: A fresh carcass.
Index 2: A partially scavenged or decayed carcass.
Index 3: A completely scavenged or decayed (no remaining edible tissue).
Recorded Master Data Fields
Topo: A topographical feature that the carcass position occupied.
Detection status: The detection outcome generated by a status check or search.
P: Placement of a trial carcass
F: Carcass found
NF: Carcass not found
NC: Carcass position not checked
Detection type: The type of detection (if detected).
S: Found during a standard status check without additional effort.
F: Found during a flushing search around the last known location of a carcass.
I: Found incidentally at an unknown position without a systematic search.
0: Found but not enough evidence to be considered a fatality.
M: Found carcass due to the Marker (FM) or Did Not Find the Marker (NFM).

Source: EcoStat, Inc.

Table C-3: Data Collected by Project Field Managers for Unknown Carcasses

Date	mm/dd/yyyy
Project Field Manager	Project field manager initials.
String	String number.
Start and End Time	24 hour time. Time when the field technician arrived at the string and left after completing the search.
Grid Cell	Alphanumeric cell address indicating the position of the fatality remains.
Species	Project field manager's best understanding of species identification.
Nearest Turbine	The closest complete turbine to the evidence of fatality.
Distance	Distance (in meters) from evidence of fatality to Nearest Turbine.
Bearing	Compass bearing from the Nearest Turbine to the evidence of fatality.
Latitude Longitude	GPS NAD 24 CONUS hddd.ddddd
Carcass sign	One or more code can be entered. Coded categories of carcass sign for evidence of fatality: F = 10 or more feathers W = partial or intact wing or wings T = partial or intact tail PB = body parts or partial body WB = complete whole body H = partial skull or complete head
Photo number	Camera letter and photo numbers.
Vegetation height	The vegetation height (in inches) at the position of the evidence of fatality.
Marked	Yes or No indicating whether the fatality legs and wings were taped or whether the flight feather (wing and tail) were clipped.
Carcass ID	If the legs were taped, the number indicated was recorded.
Scavenger Index	A relative rating of carcass condition: 1 – Fresh 2 – Partially scavenged or decayed 3 – Completely scavenged (feather spots or bones) or very decayed
Notes	

Source: EcoStat, Inc.

APPENDIX D: Figures Illustrating Biases for Equations in the Current Literature

Robert L. Wolpert

The four estimating equations considered here all represent quite similar attempts to estimate the actual number of avian fatalities in a specified area during each of a sequence of time intervals from counts of carcasses. For a variety of reasons some carcasses may not be counted: some may have been removed by scavengers, some may have fallen outside the search region, and searchers may fail to see some carcasses. The four equations differ in the assumptions they make in order to adjust for these missing carcasses.

Two of the estimation equations, those of Erickson, Johnson, *et al.* and of Shoenfeld, assume that search teams will find both "new" carcasses (those killed during the current time period) and "old" ones (those killed during earlier periods, but not removed by scavengers or search teams). Old and new carcasses are assumed to be equally likely to be removed by scavengers, and equally likely to be discovered in a subsequent searches. These estimators will *under*-estimate true mortality if these assumptions are wrong.

Conversely the other two estimation equations, those of Pollock and of Huso, begin with the assumption that *all* carcasses counted are new (*i.e.*, died during the current time interval). Both will *over*-estimate true mortality if this is wrong.

Shoenfeld's estimator always exceeds that of Erickson, Johnson, *et al.*, because the latter assume (incorrectly, in practice) that search teams do not remove carcasses. Huso's estimator is identical[1] to a special case of Pollock's: the case in which scavengers are assumed to remove fresh carcasses and old ones at the same rates (technically, that the "persistence time" before scavengers remove a carcass have "exponential" probability distributions). Pollock's estimator does not require that assumption. For exponential persistence times, the estimators of Erickson, Johnson, *et al.*, Shoenfeld, Pollock, and Huso are ordered consistently

$$\hat{M}_{ij}^{\text{EJ}} < \hat{M}_{ij}^{\text{S}} \quad < \quad \hat{M}_{ij}^{\text{P}} \le \hat{M}_{ij}^{\text{H}}$$

All four give similar estimates when the interval between searches is long compared to mean carcass persistence times, but differences among them are larger when searches are made more frequently to reduce the loss of carcasses to scavenging. With frequent searches, $\hat{M}_{ij}^{\text{P}}$ and $\hat{M}_{ij}^{\text{H}}$ can be as much as three or four times larger than $\hat{M}_{ij}^{\text{S}}$ for small birds. The key issue, then, to guide the choice of estimators, is:

> *What fraction of carcasses missed by a search team might*
> *still be discovered as "old" carcasses in a later search?*

If that fraction is 100% then Shoenfeld's estimator $\hat{M}_{ij}^{\text{S}}$ is most accurate on average if search teams remove the carcasses they discover, and Erickson & Johnson's $\hat{M}_{ij}^{\text{EJ}}$ if they don't.

If that fraction is 0% then Pollocks's estimator $\hat{M}_{ij}^{\text{P}}$ is most accurate on average, with the side benefit that it does not require the "exponential distribution" assumption.

If that fraction is somewhere between 0% and 100%, then some sort of compromise between $\hat{M}_{ij}^{\text{S}}$ and $\hat{M}_{ij}^{\text{P}}$ is called for. Such a compromise is proposed and described in Appendix A, *A New Equation for Estimating Avian Mortality Rates.*

---

[1] Except that Huso's estimator is inflated by about 1% in the rare case when intervals between consecutive searches are more than 4.6 times the average length of time before scavengers remove a carcass.

Figures Illustrating Equation Biases

Figures 1–6 below show eight-week simulations of carcass arrivals and removals by scavengers as stair-step curves increasing at each arrival and decreasing at each removal, with searches at specified intervals from two to 56 days. Carcasses discovered and removed are indicated by downwards pointing red arrows; expected numbers of carcasses are indicated by smooth blue curves.

Figures 1–3 assume exponential distributions for persistence times (so scavengers remove fresh and older carcasses at the same rates), while Figures 4–6 assume Weibull removal distributions with parameter values suggested by our data.

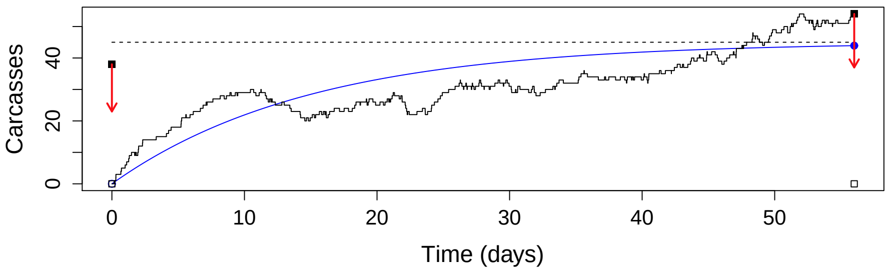
Figures 1, 4 assume that only "new" carcasses can be discovered, so each curve begins each search period with zero carcasses. This assumption underlies Pollock's and Huso's estimators, so their bias is zero in the exponential persistence case, Figure 1 (and, for Pollock, also for Weibull persistence, Figure 4).

Figures 3, 6 assume that 100% of old carcasses remain discoverable, so each curve begins at the point of the red arrow (indicating that carcasses disappear only because of their discovery by search teams). This assumption underlies Erickson, Johnson, *et al.*'s and Shoenfeld's estimators, so Shoenfeld has no bias in Figure 3. Erickson, Johnson, *et al.* still underestimate M_{ij} there because of their assumption that search teams don't remove carcasses.

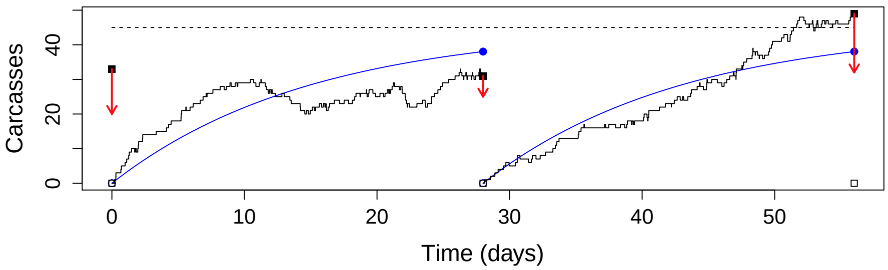
Finally, figures 2, 5 take the compromise position that (on average) 50% of undiscovered carcasses will remain discoverable; typically here Erickson, Johnson, *et al.*'s and Shoenfeld's estimators will underestimate, while Pollock's and Huso's will overestimate.

Below each of these thirty plots is a table giving the bias (as a percentage of the truth) for each of the four estimators (or five, for Weibull distributions, where results for both exponential and Weibull versions of Pollock's estimator are reported).

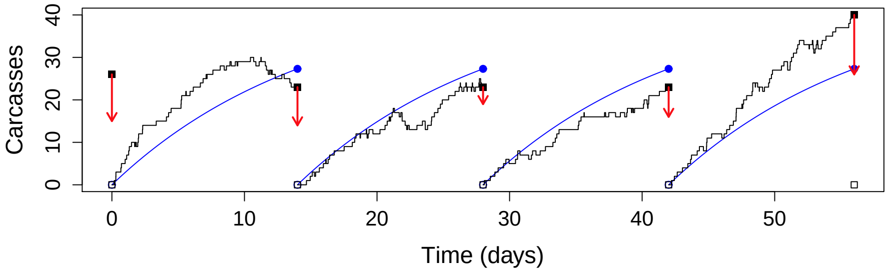
All the biases are smaller for long search intervals (at the top of each figure) and greater for shorter ones (at the bottom of each figure). Huso's estimator is identical to the exponential version of Pollock's, and so has the same bias in every case. The new estimator described in Appendix A, *A New Equation for Estimating Avian Mortality Rates*, has zero bias in all of these cases.



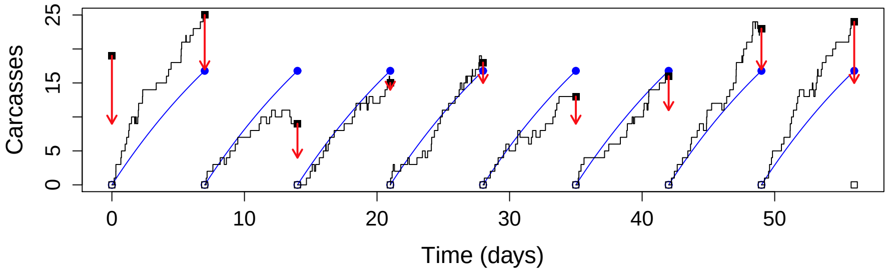
Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -2.4\%$ $\hat{M}_{ij}^{\mathrm{S}} : -1.7\%$ $\hat{M}_{ij}^{\mathrm{P}} : 0\%$ $\hat{M}_{ij}^{\mathrm{H}} : 0\%$



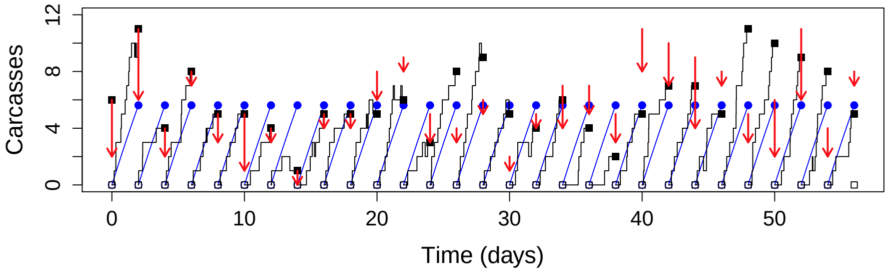
Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -15.5\%$ $\hat{M}_{ij}^{\mathrm{S}} : -10.8\%$ $\hat{M}_{ij}^{\mathrm{P}} : 0\%$ $\hat{M}_{ij}^{\mathrm{H}} : 0\%$



Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -39.3\%$ $\hat{M}_{ij}^{\mathrm{S}} : -27.5\%$ $\hat{M}_{ij}^{\mathrm{P}} : 0\%$ $\hat{M}_{ij}^{\mathrm{H}} : 0\%$

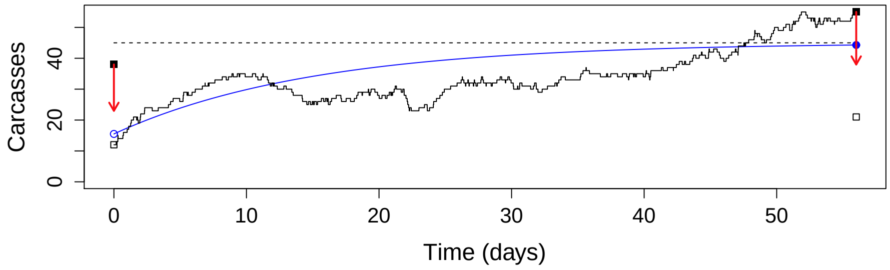


Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -62.7\%$ $\hat{M}_{ij}^{\mathrm{S}} : -43.9\%$ $\hat{M}_{ij}^{\mathrm{P}} : 0\%$ $\hat{M}_{ij}^{\mathrm{H}} : 0\%$

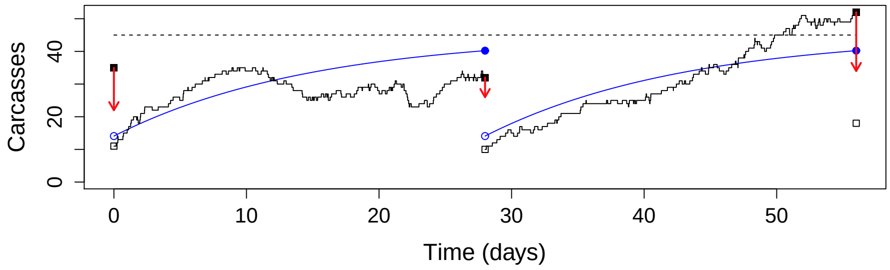


Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -87.5\%$ $\hat{M}_{ij}^{\mathrm{S}} : -61.3\%$ $\hat{M}_{ij}^{\mathrm{P}} : 0\%$ $\hat{M}_{ij}^{\mathrm{H}} : 0\%$

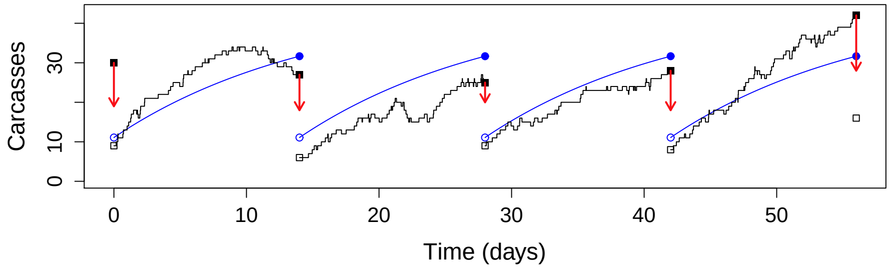
Figure 1: Exponential Persistence, Full Degradation: $\alpha = 1$, $\theta = 0$



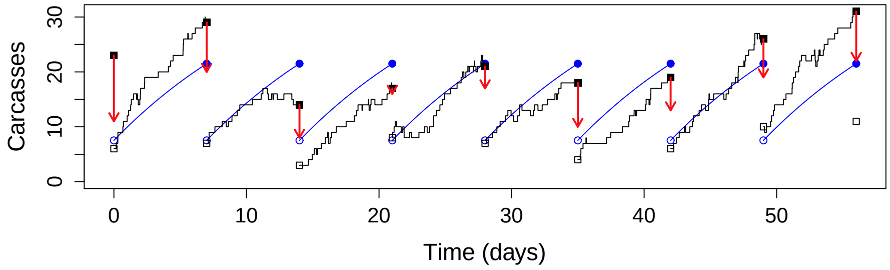
Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -1.6\%$ $\hat{M}_{ij}^{\mathrm{S}} : -0.8\%$ $\hat{M}_{ij}^{\mathrm{P}} : 0.8\%$ $\hat{M}_{ij}^{\mathrm{H}} : 0.8\%$



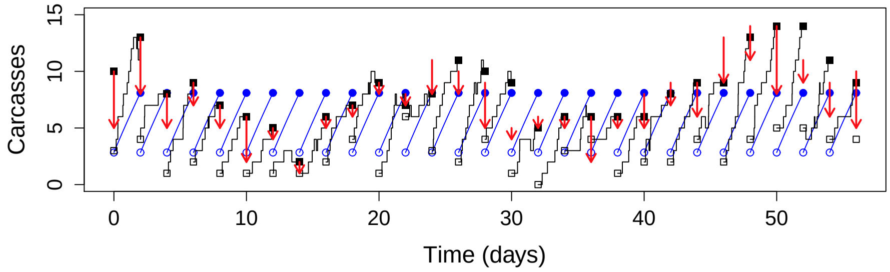
Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -10.6\%$ $\hat{M}_{ij}^{\mathrm{S}} : -5.7\%$ $\hat{M}_{ij}^{\mathrm{P}} : 5.7\%$ $\hat{M}_{ij}^{\mathrm{H}} : 5.7\%$



Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -29.6\%$ $\hat{M}_{ij}^{\mathrm{S}} : -16\%$ $\hat{M}_{ij}^{\mathrm{P}} : 16\%$ $\hat{M}_{ij}^{\mathrm{H}} : 16\%$

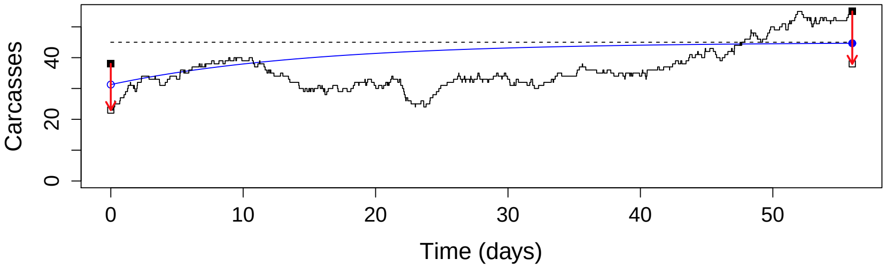


Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -52.2\%$ $\hat{M}_{ij}^{\mathrm{S}} : -28.1\%$ $\hat{M}_{ij}^{\mathrm{P}} : 28.1\%$ $\hat{M}_{ij}^{\mathrm{H}} : 28.1\%$

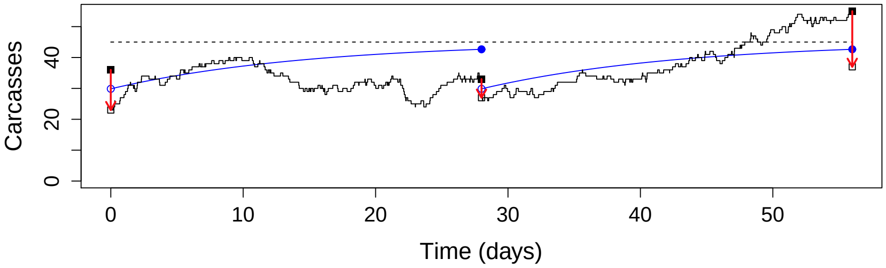


Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -82\%$ $\hat{M}_{ij}^{\mathrm{S}} : -44.1\%$ $\hat{M}_{ij}^{\mathrm{P}} : 44.3\%$ $\hat{M}_{ij}^{\mathrm{H}} : 44.3\%$

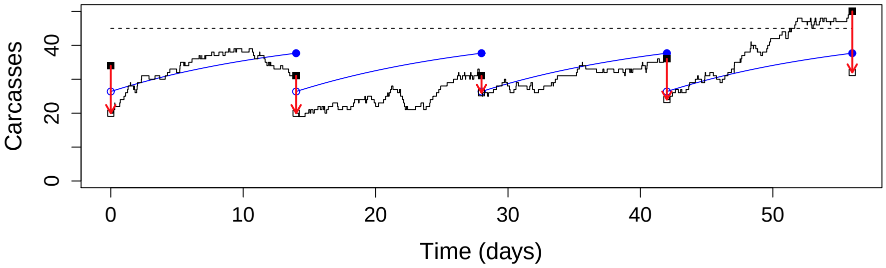
Figure 2: Exponential Persistence, Half Degradation: $\alpha = 1$, $\theta = 0.5$



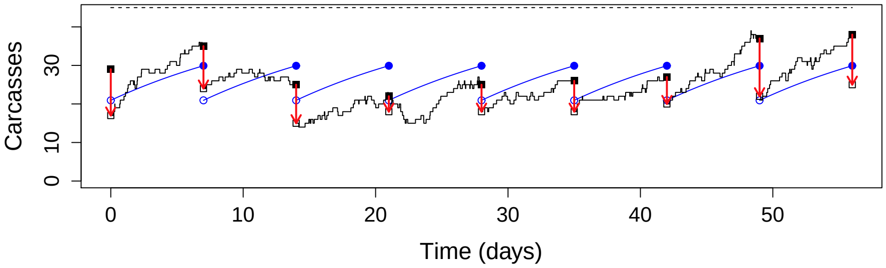
Bias: $\hat{M}_{ij}^{\text{EJ}}: -0.7\%$ $\hat{M}_{ij}^{\text{S}}: 0\%$ $\hat{M}_{ij}^{\text{P}}: 1.7\%$ $\hat{M}_{ij}^{\text{H}}: 1.7\%$



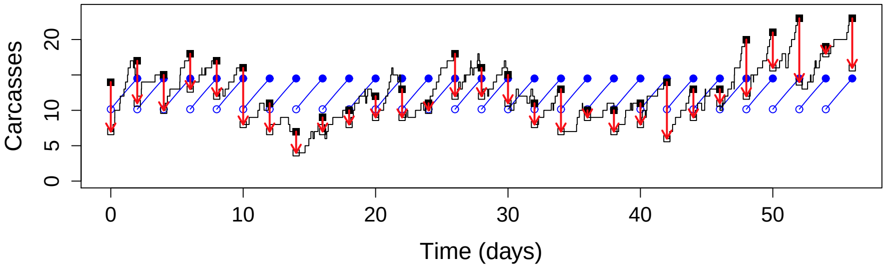
Bias: $\hat{M}_{ij}^{\text{EJ}}: -5.2\%$ $\hat{M}_{ij}^{\text{S}}: 0\%$ $\hat{M}_{ij}^{\text{P}}: 12.1\%$ $\hat{M}_{ij}^{\text{H}}: 12.1\%$



Bias: $\hat{M}_{ij}^{\text{EJ}}: -16.3\%$ $\hat{M}_{ij}^{\text{S}}: 0\%$ $\hat{M}_{ij}^{\text{P}}: 38\%$ $\hat{M}_{ij}^{\text{H}}: 38\%$

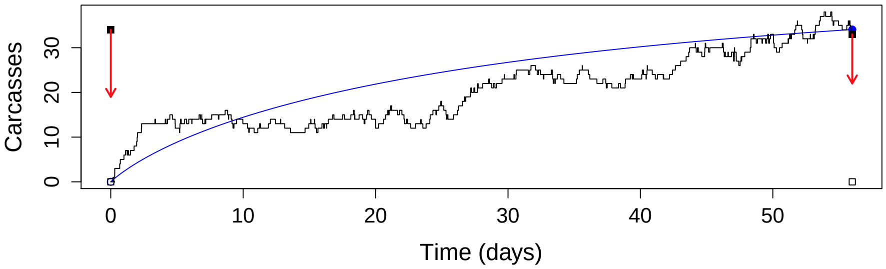


Bias: $\hat{M}_{ij}^{\text{EJ}}: -33.5\%$ $\hat{M}_{ij}^{\text{S}}: 0\%$ $\hat{M}_{ij}^{\text{P}}: 78.2\%$ $\hat{M}_{ij}^{\text{H}}: 78.2\%$

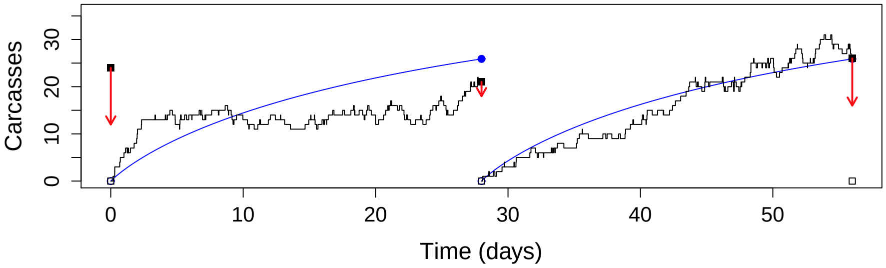


Bias: $\hat{M}_{ij}^{\text{EJ}}: -67.8\%$ $\hat{M}_{ij}^{\text{S}}: 0\%$ $\hat{M}_{ij}^{\text{P}}: 158.2\%$ $\hat{M}_{ij}^{\text{H}}: 158.2\%$

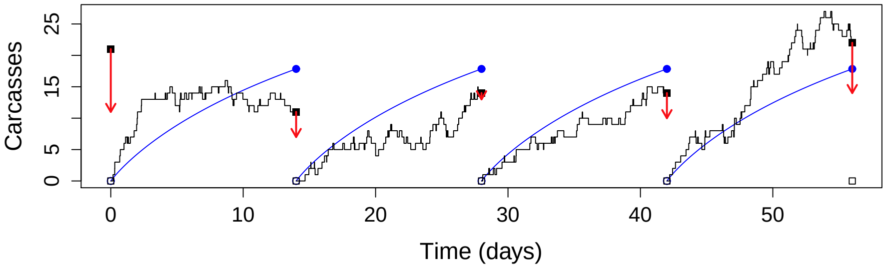
Figure 3: Exponential Persistence, No Degradation: $\alpha = 1$, $\theta = 1$



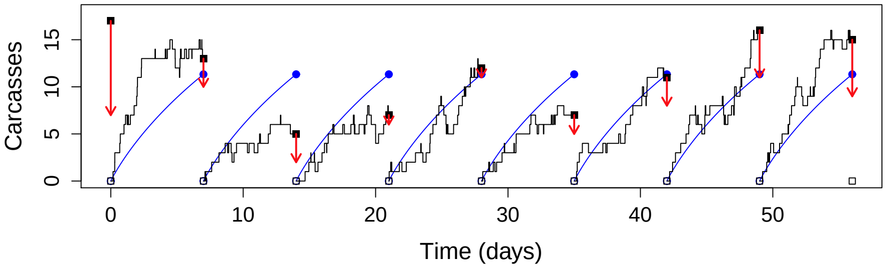
Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -24.3\%$ $\hat{M}_{ij}^{\mathrm{S}} : -23.7\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : -22.4\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 0\%$ $\hat{M}_{ij}^{\mathrm{H}} : -22.4\%$



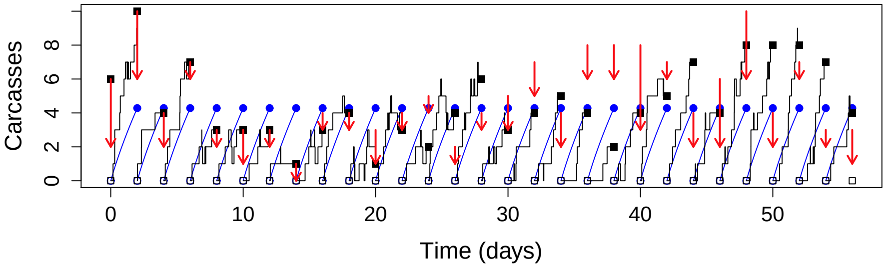
Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -42.5\%$ $\hat{M}_{ij}^{\mathrm{S}} : -39.3\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : -31.9\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 0\%$ $\hat{M}_{ij}^{\mathrm{H}} : -31.9\%$



Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -60.4\%$ $\hat{M}_{ij}^{\mathrm{S}} : -52.6\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : -34.7\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 0\%$ $\hat{M}_{ij}^{\mathrm{H}} : -34.7\%$

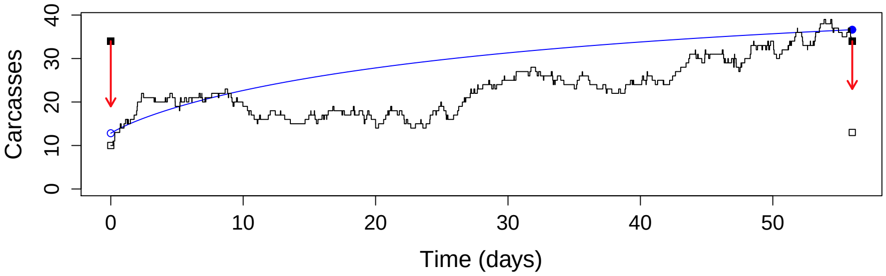


Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -74.8\%$ $\hat{M}_{ij}^{\mathrm{S}} : -62.1\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : -32.5\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 0\%$ $\hat{M}_{ij}^{\mathrm{H}} : -32.5\%$

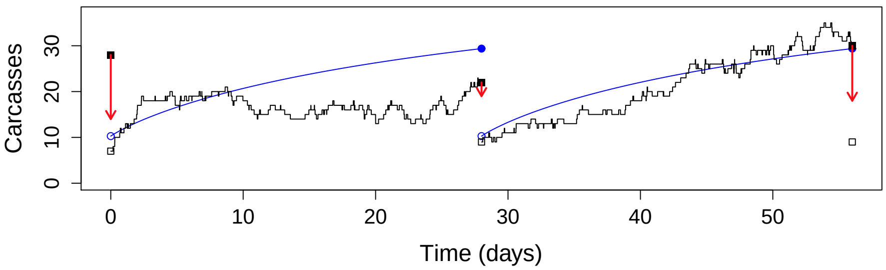


Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -90.5\%$ $\hat{M}_{ij}^{\mathrm{S}} : -70.5\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : -23.7\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 0\%$ $\hat{M}_{ij}^{\mathrm{H}} : -23.7\%$

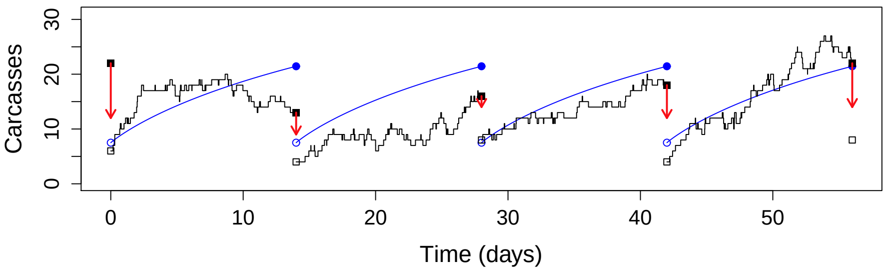
Figure 4: Weibull Persistence, Full Degradation: $\alpha = 0.5$, $\theta = 0$



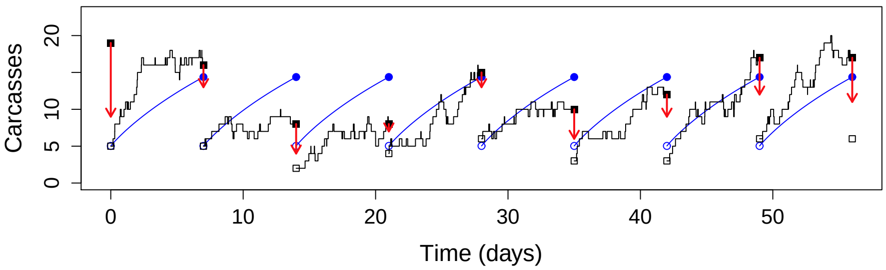
Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -18.6\%$ $\hat{M}_{ij}^{\mathrm{S}} : -18\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : -16.6\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 7.5\%$ $\hat{M}_{ij}^{\mathrm{H}} : -16.6\%$



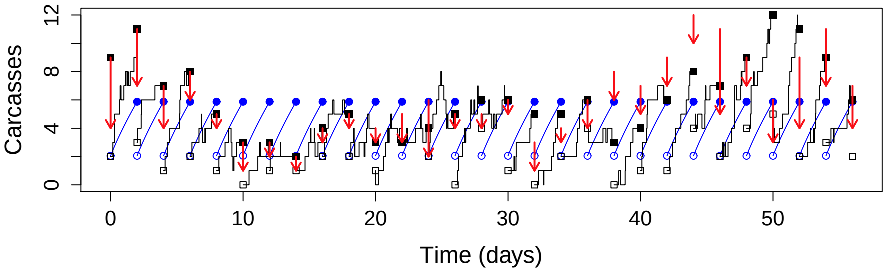
Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -34.7\%$ $\hat{M}_{ij}^{\mathrm{S}} : -31.1\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : -22.8\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 13.5\%$ $\hat{M}_{ij}^{\mathrm{H}} : -22.8\%$



Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -52.3\%$ $\hat{M}_{ij}^{\mathrm{S}} : -43.1\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : -21.4\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 20.2\%$ $\hat{M}_{ij}^{\mathrm{H}} : -21.4\%$

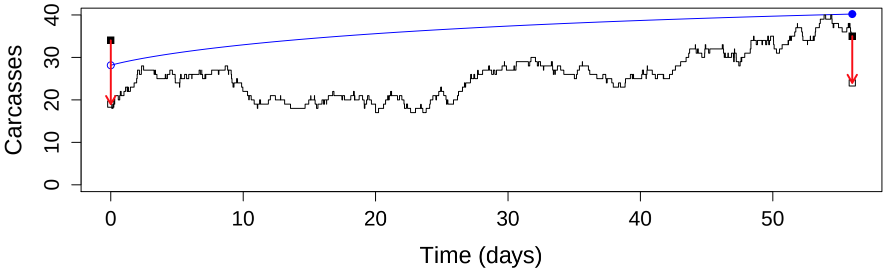


Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -68\%$ $\hat{M}_{ij}^{\mathrm{S}} : -51.9\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : -14.3\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 26.9\%$ $\hat{M}_{ij}^{\mathrm{H}} : -14.3\%$

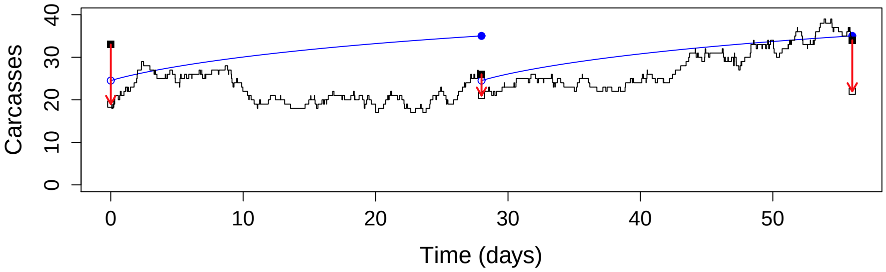


Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -86.9\%$ $\hat{M}_{ij}^{\mathrm{S}} : -59.4\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : 4.8\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 37.5\%$ $\hat{M}_{ij}^{\mathrm{H}} : 4.8\%$

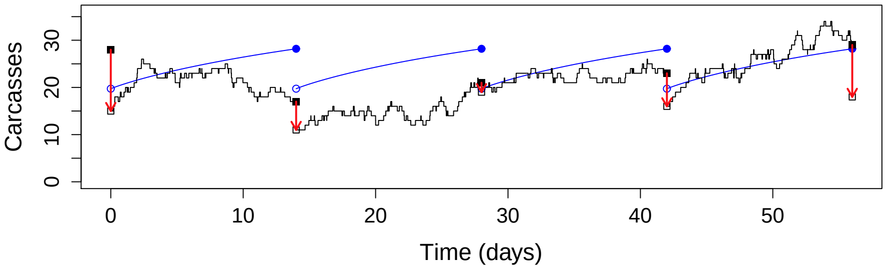
Figure 5: Weibull Persistence, Half Degradation: $\alpha = 0.5$, $\theta = 0.5$



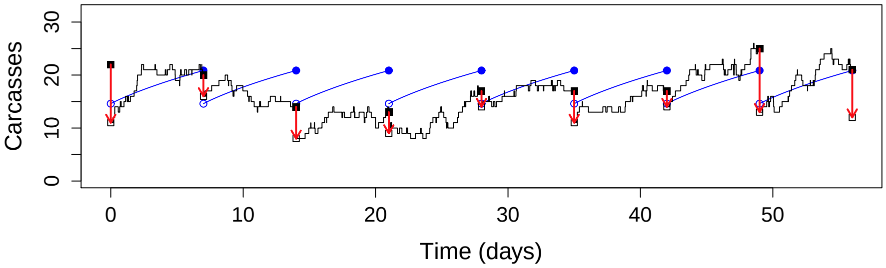
Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -10.7\%$ $\hat{M}_{ij}^{\mathrm{S}} : -10\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : -8.5\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 18\%$ $\hat{M}_{ij}^{\mathrm{H}} : -8.5\%$



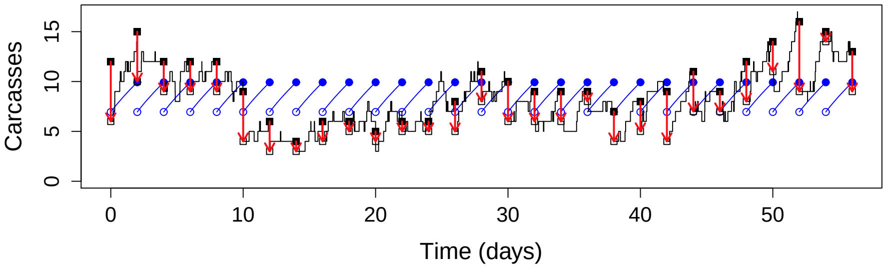
Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -22.2\%$ $\hat{M}_{ij}^{\mathrm{S}} : -17.9\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : -7.9\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 35.3\%$ $\hat{M}_{ij}^{\mathrm{H}} : -7.9\%$



Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -37.4\%$ $\hat{M}_{ij}^{\mathrm{S}} : -25.2\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : 3.2\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 58\%$ $\hat{M}_{ij}^{\mathrm{H}} : 3.2\%$



Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -53.6\%$ $\hat{M}_{ij}^{\mathrm{S}} : -30.3\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : 24.3\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 84.1\%$ $\hat{M}_{ij}^{\mathrm{H}} : 24.3\%$



Bias: $\hat{M}_{ij}^{\mathrm{EJ}} : -77.9\%$ $\hat{M}_{ij}^{\mathrm{S}} : -31.5\%$ $\hat{M}_{ij}^{\mathrm{P:E}} : 76.9\%$ $\hat{M}_{ij}^{\mathrm{P:W}} : 131.9\%$ $\hat{M}_{ij}^{\mathrm{H}} : 76.9\%$

Figure 6: Weibull Persistence, No Degradation: $\alpha = 0.5$, $\theta = 1$

Figure Walk-through

Robert L Wolpert

October 26, 2012

1 Introduction

Figure (1) shows two views of the same simulated two-week period, in which fatality occurs at a rate of about one per day and in which weekly searches were made with proficiency $s_{ij} = 30\%$. Carcass persistence is exponentially distributed with mean $t_{ij} = 15\,\mathrm{d}$, and $\theta = 50\%$ of undiscovered carcasses remain across search intervals (those that do *not* remain might be thought to have decayed). Table 1 shows the arrival time and fate of each carcass.

Upper Figure

Each fatality is shown in the upper "Time line" figure as an "×" mark, followed by a horizontal line that indicates the fate of this particular carcass.

Carcasses eventually removed by scavengers are shown in red, with a red dashed red line extending from a red cross "× – –" marking the fatality to an open circle "– – ○" marking the removal. Vertical position in this plot is another indicator of persistence— points are sorted so the carcasses removed most quickly are at the top, those removed most slowly at the bottom (for more on this see *p.* 3 below).

Carcasses eventually discovered in searches are shown as solid black lines, beginning at a black "×—" marking the fatality and ending at one of the weekly search times on days zero, seven or fourteen. Discoveries are marked by black filled circles "—●" for "new" carcasses, *i.e.*, those from the search week, while "old" carcass discoveries are marked with crossed squares "—⊠".

Finally, undiscovered carcasses that become undiscoverable are marked by faint dotted blue lines, beginning at a blue cross "× · · ·" marking the fatality and ending unceremoniously at a search time. We'll discuss the curved lines in the top figure below on *p.* 3.

Lower Figure

The ground "Carcass Count" is shown in the lower figure as a stair-step curve $G(t)$ that indicates the number of discoverable carcasses on the ground at each time t. Between searches, this increases by one with each new fatality and decreases by one with each removal by scavengers. After each search time, $G(t)$ drops by the number of carcasses discovered and removed by the Search Team, which is indicated by a downward red "↓". In addition, some carcasses may "disappear" as they become undiscoverable (or perhaps decay); if so, $G(t)$ will drop further to begin the next period at a value below the red arrow point, indicated by an open square "□". The number possibly discoverable at each search is shown by the filled square "■".

In the bottom figure, the smooth blue curve shows the expected number of discoverable carcasses for the model assumed by the Pollock and Huso estimators— beginning each period with zero carcasses at a blue "○—", then rising smoothly over the period to a peak marked with a blue "—●", then dropping to zero to begin the next period due to those estimators' assumption of "zero carcasses beginning each period", or "no old carcasses". Those curves generally lie below $G(t)$, because their "no old carcass" assumption is false in this simulation, leading estimators $\hat{M}^{\text{P}}_{ij}$ and $\hat{M}^{\text{H}}_{ij}$ of Pollock and Huso to overestimate M_{ij} on average.

A Walk Through This Simulation

This simulation begins at time $t = 0$ with $G(0+) = 2$ discoverable carcasses present, the remnants of the arrivals, removals, and weekly searches from 50 earlier simulated days (not shown) generated to ensure that this two-week period would be typical. Sixteen additional simulated fatalities occurred between days 0 and 14, about what one would expect for an average daily mortality of $m_{ij} = 1/\,\text{d}$.

The first new fatality occurs 0.838 days (20 hours, 7.5 minutes) into the simulation, indicated by a red × at the top left in the upper figure and by the unit increase of $G(t)$ by one (from 2 to 3) in the lower one. The top figure shows that this carcass is eventually removed by scavengers at time $t = 2.015$; this event is indicated in the lower curve by a drop of $G(t)$ from 5 to 4.

$G(t)$ had risen to 5 by time $t = 2.015$ due to the second and third fatalities, which arrived just 41 minutes apart at times $t = 1.27$ and $t = 1.30$, increasing $G(t)$ by one at each event. The earlier of these two is eventually removed by scavengers at time $t = 4.92$, but the latter lasts long enough to be discovered by the Search Team on day seven.

The Day 7 Search

The lower figure shows that $G(7) = 8$ discoverable carcasses were present for the day-7 search, and that three were discovered then (because the red arrow "↓" extends from 8 down to 5). Two of the three discovered carcasses were "new" ones, that arrived at times $t = 1.30$ and $t = 2.41$; the other one was an "old" carcass, that arrived at time $t = -0.17$, four hours and five minutes before the start of our two week-long simulation. Of the five carcasses that were present but not discovered in the day-7 search, two became undiscoverable (on average we would expect $(1 - \theta) = 50\%$ of them to do so), leaving $G(7+) = 3$ discoverable carcasses just after the search to begin the second week.

In the top figure, the two carcasses that become undiscoverable are indicated by blue "× ···" marks beginning at times $t = 3.58$ and $t = 5.90$, and ending with the search at

$t = 7$. That figure also reveals the eventual fate of the other $G(7+) = 3$ carcasses that were present but not discovered in the day-7 search— one of them (the one that arrived at $t = 2.42$) is eventually removed by scavengers at time $t = 13.78$, just before the day-14 search, while the other two eventually became undiscoverable (decayed, perhaps), one on day 14 and one later (on day 21, as it happens).

The Day 14 Search

The search on Day 14 discovered three carcasses, all "new" (having arrived at times $t = 10.50$, 11.77, and 13.23, all in the range $(7, 14]$). Four carcasses were missed in this search: two that arrived just minutes apart at $t \approx 1.43$, which were also both missed in the search on day 7 and both of which are eventually lost to decay, one arriving at $t = 13.23$, also lost to decay; and one (the red $\times --$) arriving at $t = 12.58$, that will eventually be removed by scavengers at time $t = 27.13$ after eluding discovery in both the day-24 and day-21 searches.

The Curves in the Top Figure

Height in the top figure is in fact the "quantile" of the persistence times— so half the arrivals (all marked by $\times$'s) are in the upper half of the figure, 10% in the top (or bottom) tenth, and so on. In fact, the sixteen arrival marks "$\times$" are distributed perfectly evenly (or "uniformly") in the two-dimensional rectangle with height $0 < y < 1$ and width $0 < t < 14$.

The smooth black curves in the upper figure mark the earliest time a carcass can arrive and still be unremoved by scavengers at the next search time. SO, *every* $\times$ outside all the triangular regions marks the arrival of a carcass that will be removed by scavengers before the next search (and so is red), while *every* "$\times$" inside the triangular regions will still be on the ground at the time of at least one search. If it is undiscovered in that search then it still might be removed by scavengers or to decay (and hence some of those marks are red $\times$ or blue $\times$). More frequent searches (smaller values of I_{ij}, here 7) reduce loss to scavenging precisely because they reduce the area outside these triangular regions, but evidently there is a rapidly diminishing return on investment when I_{ij} is reduced far below t_{ij} (here 15 d), because there is little remaining area outside the union of triangles; see Figure 2.

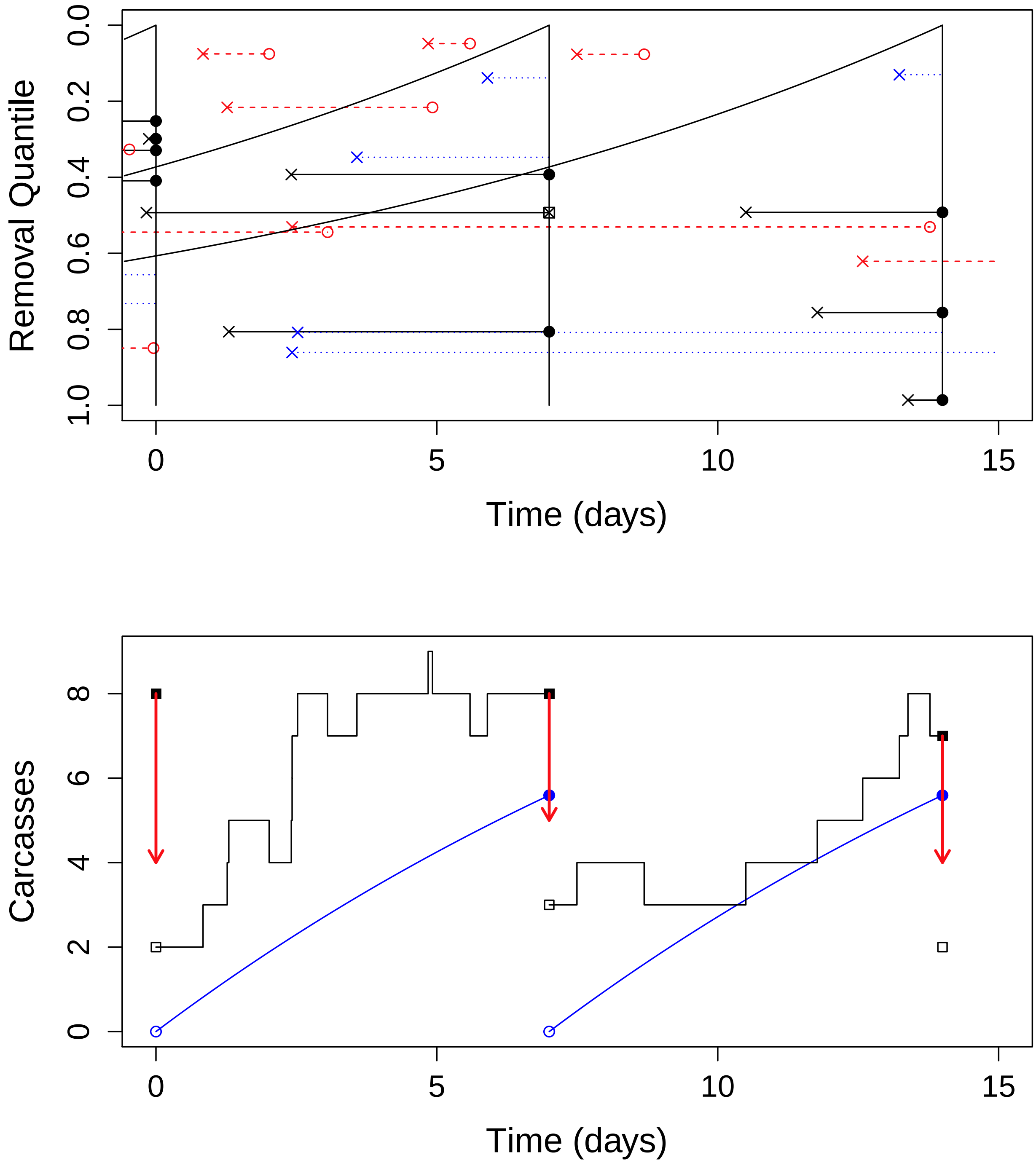


Figure 1: Two graphical views of consecutive one-week searches: Individual time-lines (top), Ground carcass count (bottom). Search proficiency is $s_{ij} = 30\%$; persistence is exponential with mean $t_{ij} = 15\,\mathrm{d}$; $\theta = 50\%$ of undiscovered carcasses remain discoverable for future searches.

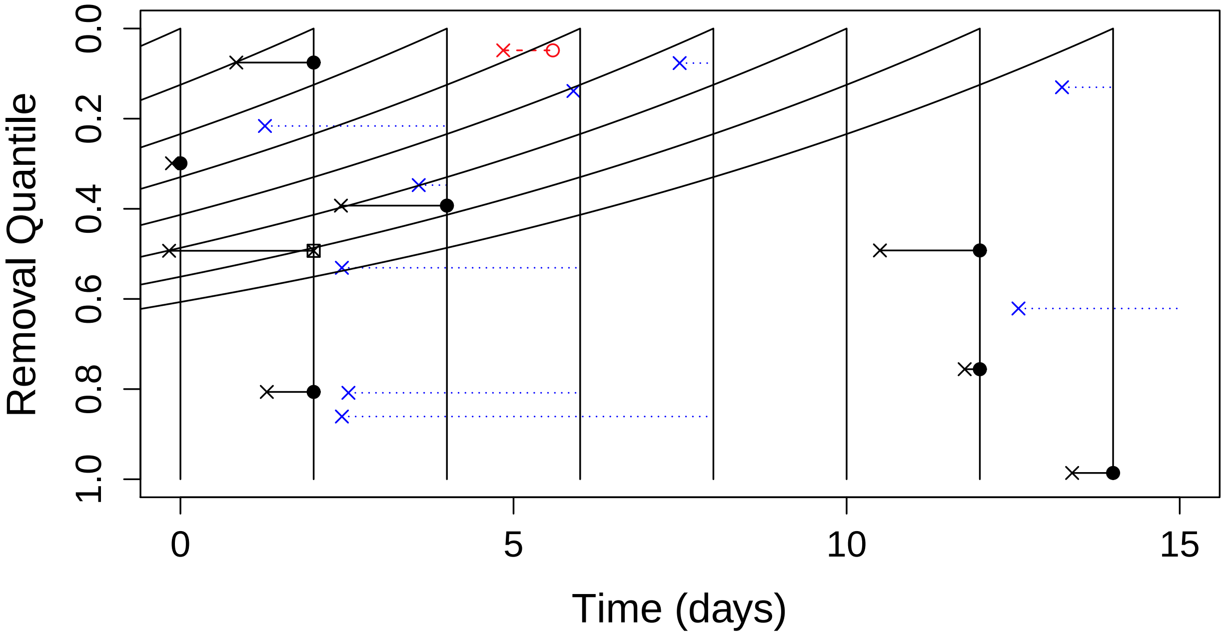


Figure 2: The same simulation, but with $I_{ij} = 2$-day search intervals. Note fewer carcasses lost to scavenging, but only one more discovery (7 in the seven searches on days 2,4,...,14).

Serial	Arrival	Departure	Fate
	−0.1703770	7	Disc
	−0.1270495	5.201678	Rem
1	0.8383745	2.015476	Rem
2	1.2684557	4.922724	Rem
3	1.2967885	7	Disc
4	2.4092051	7	Disc
5	2.4233033	13.776822	Rem
6	2.4236632	21	
7	2.5218538	14	
8	3.5768155	7	
9	4.8454552	5.590141	Rem
10	5.8996038	7	
11	7.4934336	8.690271	Rem
12	10.5000953	14	Disc
13	11.7721292	14	Disc
14	12.5795863	27.139489	Rem
15	13.2330163	14	
16	13.3854000	14	Disc

Table 1: Arrival and depature times for the sixteen carcasses appearing during period $(0, 14]$ and the two earlier carcasses still present past time $t = 0$.

APPENDIX E:

Public Webinar Presentation

Improving Methods for Estimating Fatality of Birds and Bats at Wind Energy Facilities

California Wind Energy Association Public Webinar

September 26, 2012

Primary Authors:
William Warren-Hicks, Ph.D., Cardno Entrix
Jim Newman, Ph.D., Normandeau Associates
Robert Wolpert, Ph.D., Duke University
Brian Karas, EcoStat
Loan Tran, EcoStat

California Energy Commission Grant # PIR-08-028
U.S. Fish and Wildlife Service Grant #13410BG006

CalWEA

CalWEA

Project Structure

California Energy Commission Project Managers: Joe O'Hagan, John Matthias
U.S. Fish and Wildlife Service Project Managers: Mark Miller, Jim Michaels

CalWEA Executive Director: Nancy Rader
CalWEA Project Manager: Heather Rhoads-Weaver
Editor: Susan Savitt Schwartz

Primary Authors:
William Warren-Hicks, Ph.D., Cardno Entrix (formerly with EcoStat)
Jim Newman, Ph.D., Normandeau Associates
Robert Wolpert, Ph.D., Duke University
Brian Karas, EcoStat
Loan Tran, EcoStat

Project Advisory Committee Members:
Eric Smith, Ph.D., Virginia Tech
John Hayes, Ph.D., University of Florida
Dick Anderson, Consultant (formerly with California Energy Commission)
Bronwyn Hogan, U.S. FWS (formerly with CDFG)
Kevin Martin, Terra-Gen Power (formerly with Acciona)
Renee Culver, NextEra Energy Resources

Peer Reviewers: Amanda Hale, Ph.D., TCU, Lyman McDonald, Ph.D., WEST

CalWEA

Background

- 2007 CEC/CDFG Guidelines
  - *Guidelines for Reducing Bird & Bat Impacts from Wind Energy Development*
- 2008 CEC Research "Roadmap" on Impact Assessment Methods
- 2008 CEC PIER RFP
- 2009 CEC PIER Award to CalWEA
  - Address Guidelines' Appendix F
- 2011 Supplemental FWS Grant to CalWEA

CalWEA

Project Goals

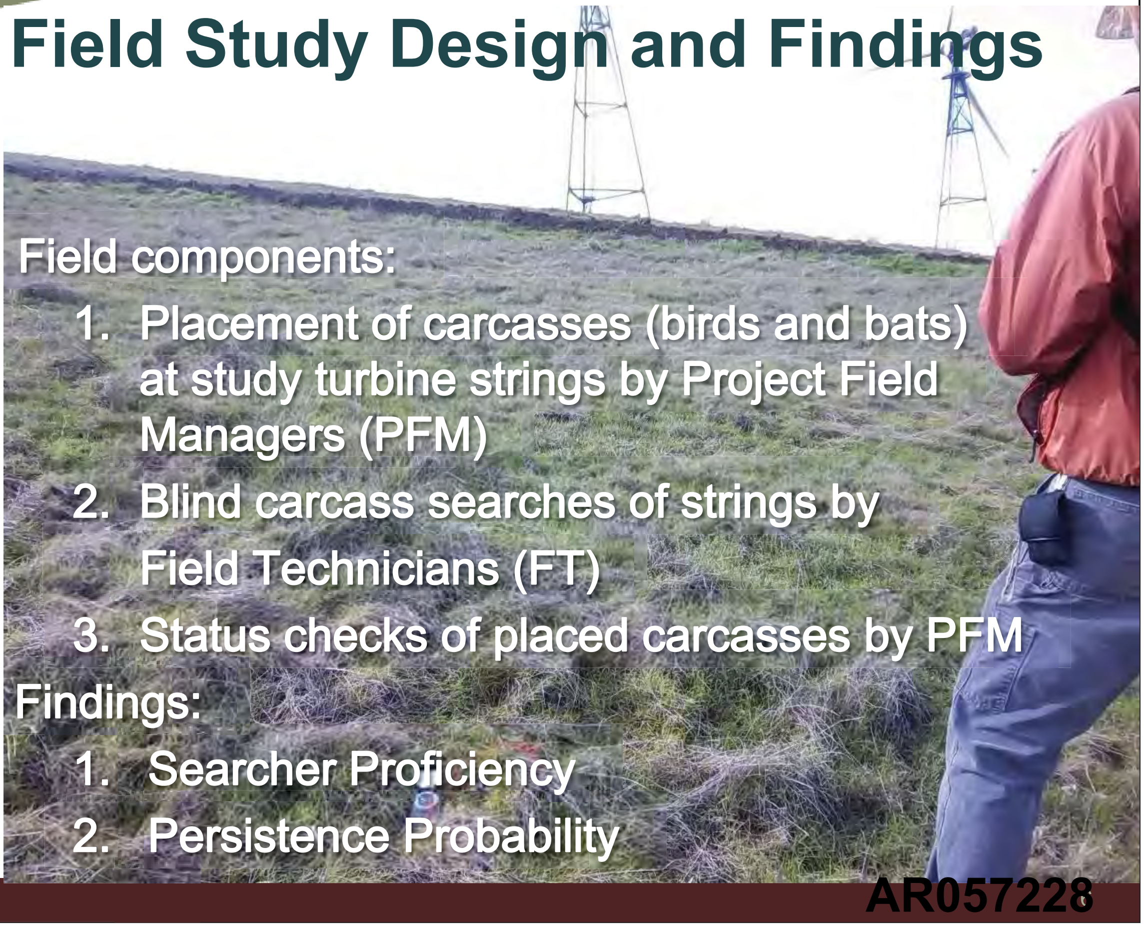
- Improve the accuracy of methods for estimating the number of bird and bat fatalities associated with wind energy facilities
- Provide guidance leading to improved procedures for mortality monitoring at wind energy facilities

Preview of Conclusions

- Fatality estimators in use often produce biased results
- This calls into question the appropriate use of traditional estimators where the error would be of consequence, whether for project-specific results, industry averages, or industry totals
- Standardized methods are needed to generate fatality detection probabilities and fatality estimates
- Our proposed new estimator produces unbiased results, and requires new field protocols

---

Field Study Design and Findings



Field components:

1. Placement of carcasses (birds and bats) at study turbine strings by Project Field Managers (PFM)
2. Blind carcass searches of strings by Field Technicians (FT)
3. Status checks of placed carcasses by PFM

Findings:

1. Searcher Proficiency
2. Persistence Probability

CalWEA

Field Study Design Details

- In all cases, prior to searches the true number and location of carcasses is known to PFMs, but not to FTs
- Each string is searched for up to 60 days, or until all carcasses are removed
- Strings selected to represent various environmental conditions, including grass height, slope, vegetation type
- Carcasses are tagged and followed consistently throughout study period by PFMs

CalWEA

Survey Design Characteristics

- January 7, 2011 – April 1, 2011
- Weekly searches by FTs
- PFMs sampled and noted carcasses approx. every 3 days
- Blocks of strings sampled simultaneously, surrogate for time changes in ecology

Small bird carcasses placed during study	Bat carcasses placed during study	Incidentally found carcasses added to study	Study length (days)
90	78	21	113

FT conducting a search

Field Technician

Searching in tall grass

PFM Status Check

CalWEA

Searching in short grass

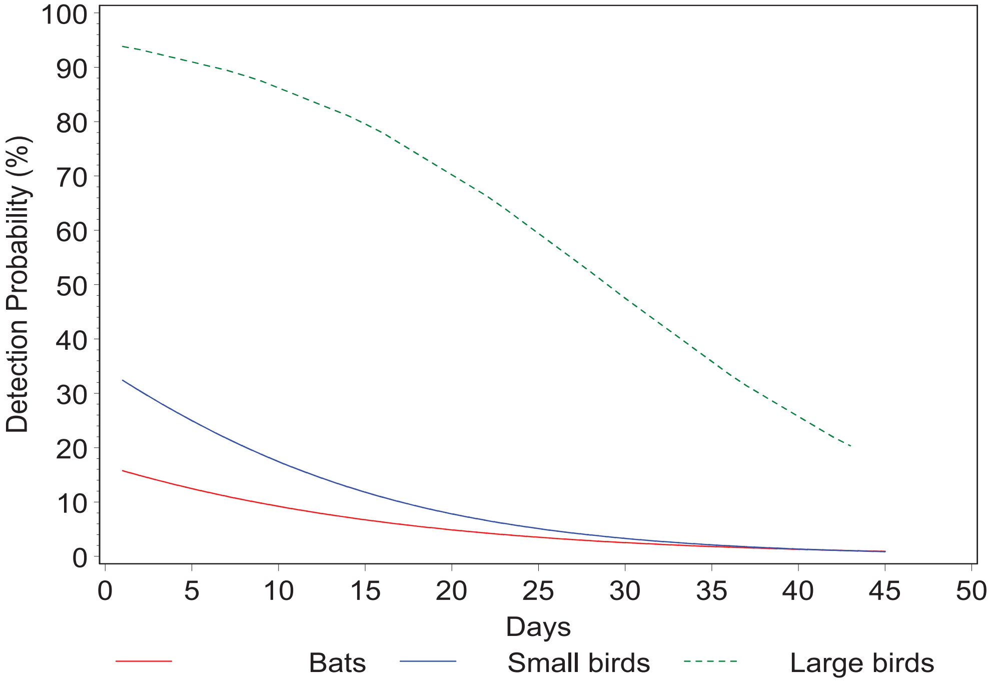
PFM Status Check

CalWEA

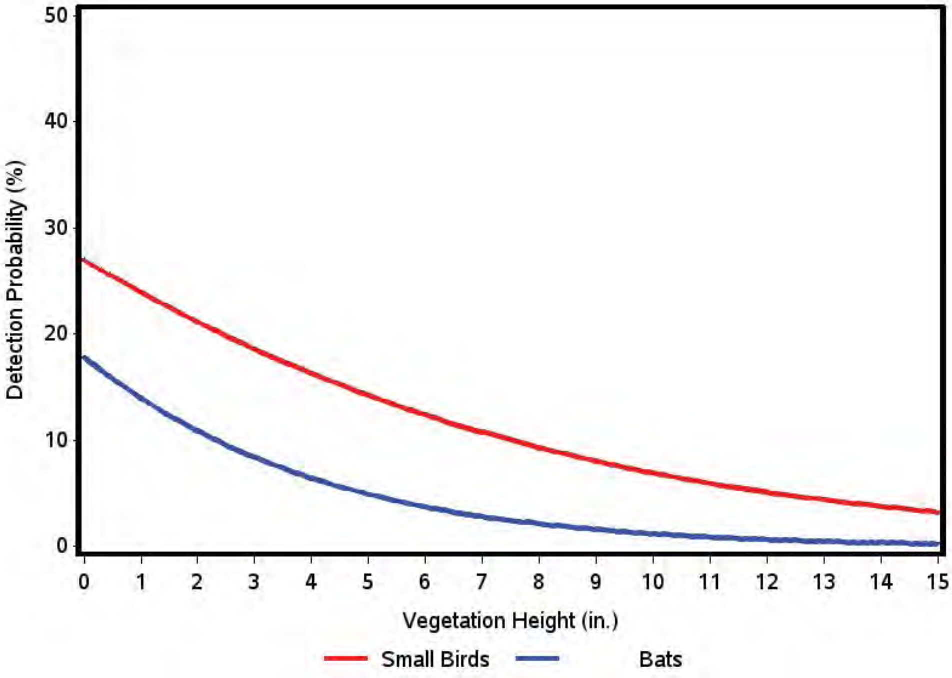
Percent of Birds and Bats Observed

Species	Detected 1st observation	Average detected over all trials for all observers	Unique carcasses detected during study
Bats	14.1%	8.1%	19.2%
Small Birds	22.2%	17.0%	30.8%
Large Birds	83.3%	67.7%	100%

Searcher Proficiency: A Time Dependent Process

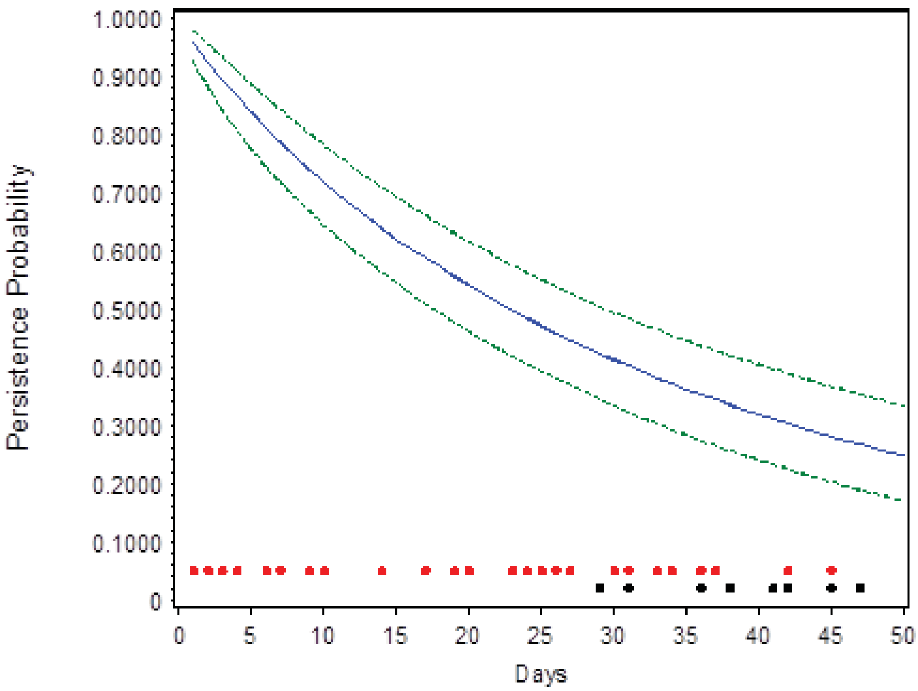


Searcher Proficiency: Dependency on Grass Height



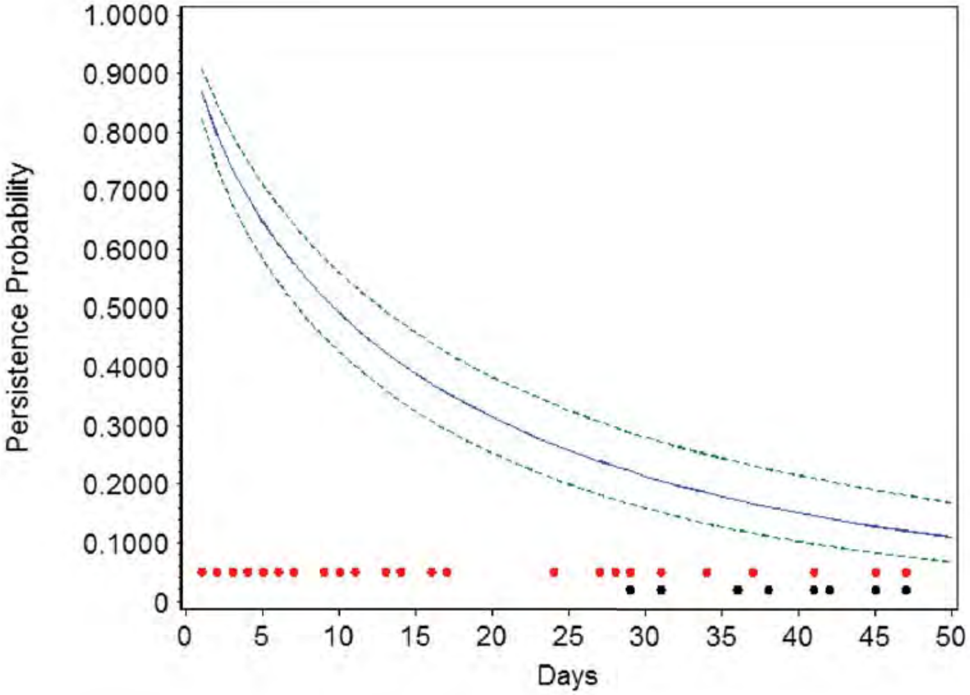
Persistence Probability:

Bats (Weibull Distribution, Mean = 43 days)



Persistence Probability:

Small Birds (Weibull Distribution, Mean = 30 days)



Implications: Field Study

- Carcass persistence is a time-dependent process, fits best with a Weibull distribution
- Searcher proficiency is a function of time
- Ecological conditions impact searcher proficiency (e.g., vegetation height)
- Searcher proficiency for bats is considerably less than for small birds
- Small birds have lower time-dependent persistence than bats
- Above have implications for selection of estimation equation and equation inputs

---

Partially-Periodic Estimation of Avian Mortality

Robert L Wolpert

Department of Statistical Science *and*
Nicholas School of the Environment
Duke University

CalWEA-CEC Webinar: 2012-09-26

Carcass Counts and Avian Mortality

Let's start with Repeated carcass counts by Field Technicians at regular intervals in specified regions near specific turbines, with:

I_{ij} (interval) = days between successive searches,
M_{ij} (mortality) = number of carcasses during interval,
C_{ij} (count) = number of carcasses counted by FTs,

Naïve estimate "$\hat{M}_{ij} = C_{ij}$" would be okay if:

- A_1: No carcasses at start of interval;
- A_2: Every fatality leads to a carcass;
- A_3: No other carcass sources;
- A_4: Carcasses remain throughout period;
- A_5: Field Technicians find every one.

More realistically...

Several authors have proposed improved estimators to accommodate removal by scavengers and discovery failure, based on one or more of:

p_{ij} (persistence) = probability a carcass is unremoved,
r_{ij} (removal rate) = probability per day of scavenging,
s_{ij} (search proficiency) = discovery probability by FTs,
t_{ij} (persistence time) = mean days carcass unremoved.

Each estimator embodies some assumptions.

Erickson & Johnson

Erickson, Strickland, Johnson, Kern (1998):

$$\hat{M}_{ij}^{\mathrm{EJ}} = \frac{C_{ij}\, I_{ij}}{\hat{s}_{ij}\, \hat{t}_{ij}}$$

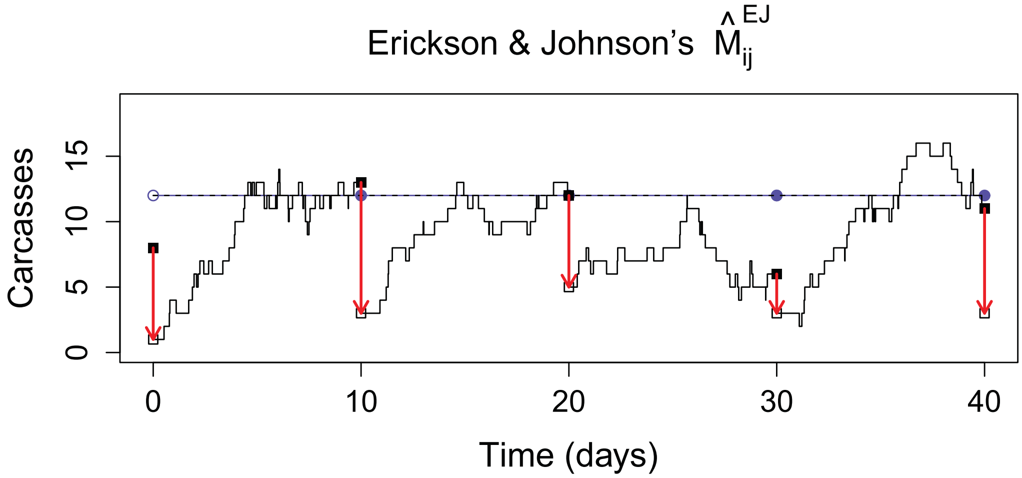
Based on:

$$\mathrm{E}[C_{ij}] = M_{ij}\ (t_{ij}/I_{ij})\ (s_{ij})$$

Assumes:

A_1^{EJ}: The system is in equilibrium at each search.

Erickson & Johnson in Pictures



Shoenfeld's Periodic Equation

Shoenfeld (2004):

$$\hat{M}^{S}_{ij} = \frac{C_{ij}\; I_{ij}}{\hat{s}_{ij}\; \hat{t}_{ij}} \left[\frac{e^{I_{ij}/\hat{t}_{ij}} - 1 + \hat{s}_{ij}}{e^{I_{ij}/\hat{t}_{ij}} - 1} \right]$$

Based on:

$$\mathrm{E}[C_{ij}] = \underbrace{M_{ij}\; (t_{ij}/I_{ij})(1 - e^{-I_{ij}/t_{ij}})\; s_{ij}}_{\text{New}} + \underbrace{\mathrm{E}[C_{ij}]\; (1 - s_{ij})\; e^{-I_{ij}/t_{ij}}}_{\text{Old}}$$

Assumes:

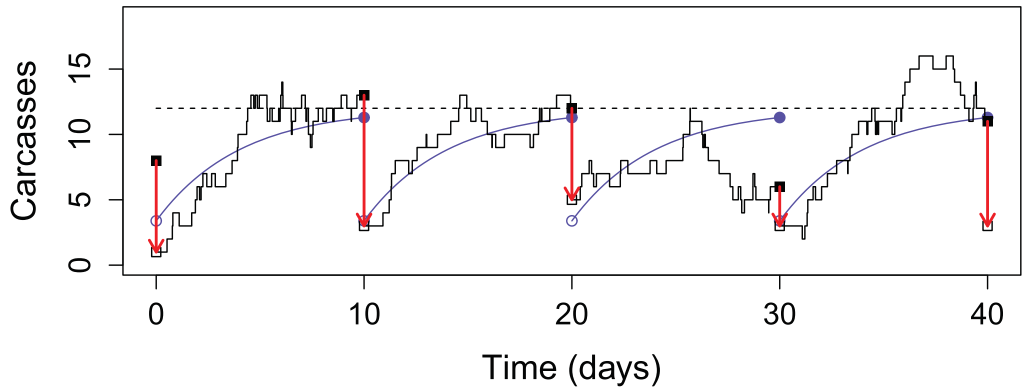
A^S_1: Carcass persistence times have exponential distributions.

A^S_2: New & Old carcasses have same discovery probability s_{ij}

A^S_3: Intervals I_{ij}, mortality and removal rates m_{ij}, r_{ij}, and persistence s_{ij} are similar in consecutive intervals.

Shoenfeld in Pictures

Shoenfeld's $\hat{M}^S_{ij}$



Reflection...

- Both $\hat{M}_{ij}^{\mathrm{EJ}}$ and $\hat{M}_{ij}^{\mathrm{S}}$ assume “100% bleed-through”— Every carcass that is not removed by scavengers, and is not discovered and removed in a search, remains for possible discovery in later searches.
- Shoenfeld also assumes exponential distributions for removal.
- Erickson & Johnson also assume equilibrium, even though FTs remove carcasses discovered in searches.
- Always $\hat{M}_{ij}^{\mathrm{EJ}} < \hat{M}_{ij}^{\mathrm{S}}$, with small differences if $I_{ij} \gg t_{ij}$:

$$\hat{M}_{ij}^{\mathrm{EJ}} < \hat{M}_{ij}^{\mathrm{S}} = \hat{M}_{ij}^{\mathrm{EJ}}\left[1 + \frac{s_{ij}}{e^{I_{ij}/t_{ij}} - 1}\right]$$

Estimators without bleed-through

Perhaps *none* of the “Old” carcasses that were

- Not removed by scavengers, and
- Not discovered & removed by FTs

are ever discovered in subsequent searches.

If so, we can remove the bleed-through part from Shoenfeld’s equation to get a new estimator:

Huso's Equation

Huso (2011) proposed:

$$\hat{M}^{\mathrm{H}}_{ij} = \begin{cases} \dfrac{C_{ij}\, I_{ij}}{\hat{s}_{ij}\, \hat{t}_{ij}\left(1-e^{-I_{ij}/\hat{t}_{ij}}\right)} & I_{ij} < \hat{I}_{ij} \\ \dfrac{C_{ij}\, I_{ij}}{\hat{s}_{ij}\, \hat{t}_{ij}\left(1-e^{-\hat{I}_{ij}/\hat{t}_{ij}}\right)} & I_{ij} > \hat{I}_{ij} \end{cases}$$

Based on:

$$\mathrm{E}[C_{ij}] = M_{ij}\ (t_{ij}/I_{ij})(1-e^{-I_{ij}/t_{ij}})\ s_{ij}$$

Assumes:

$\mathrm{A}^{\mathrm{H}}_{1}$: Each period begins with no discoverable carcasses.

$\mathrm{A}^{\mathrm{H}}_{2}$: Persistence times have exponential distributions.

Huso's Equation

Huso (2011) proposed:

$$\hat{M}^{\mathrm{H}}_{ij} = \frac{C_{ij}\, I_{ij}}{\hat{s}_{ij}\, \hat{t}_{ij}\left[0.99 \wedge (1-e^{-I_{ij}/\hat{t}_{ij}})\right]}.$$

Based on:

$$\mathrm{E}[C_{ij}] = M_{ij}\ (t_{ij}/I_{ij})(1-e^{-I_{ij}/t_{ij}})\ s_{ij}$$

Assumes:

$\mathrm{A}^{\mathrm{H}}_{1}$: Each period begins with no discoverable carcasses.

$\mathrm{A}^{\mathrm{H}}_{2}$: Persistence times have exponential distributions.

Huso's Equation

Huso (2011) proposed a slight variation on:

$$\hat{M}^{\mathrm{H}}_{ij} \approx \frac{C_{ij}\, I_{ij}}{\hat{s}_{ij}\, \hat{t}_{ij}\, (1 - e^{-I_{ij}/\hat{t}_{ij}})}.$$

Based on:

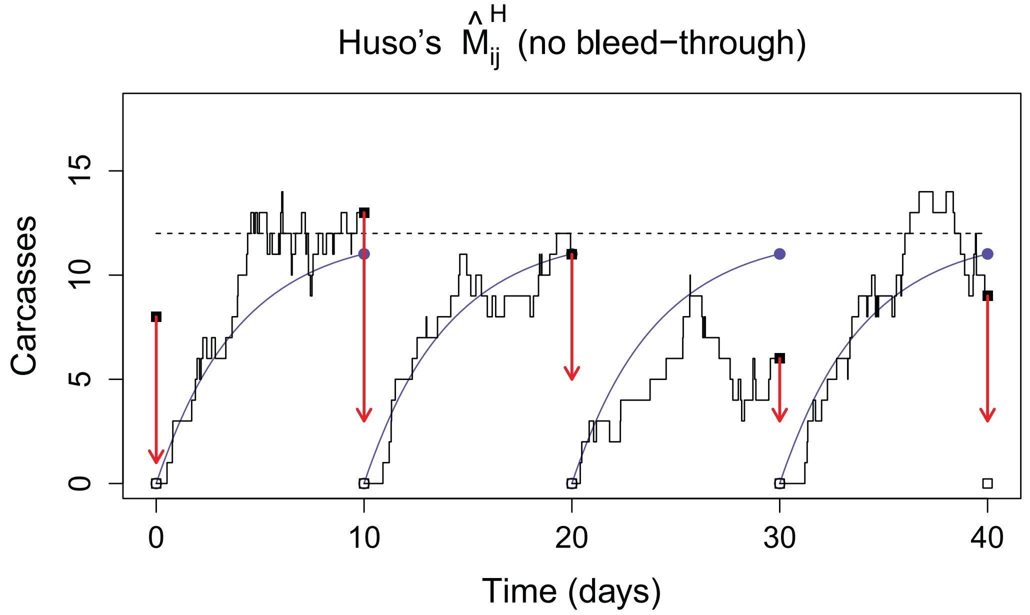
$$\mathrm{E}[C_{ij}] = M_{ij}\ (t_{ij}/I_{ij})(1 - e^{-I_{ij}/t_{ij}})\ s_{ij}$$

Assumes:

$\mathrm{A}^{\mathrm{H}}_1$: Each period begins with no discoverable carcasses.

$\mathrm{A}^{\mathrm{H}}_2$: Persistence times have exponential distributions.

Huso in Pictures



Pollock's Estimator

Pollock (2007) based an estimator on "average probability a carcass is unremoved until the search" p_{ij}, instead of more commonly used mean persistence time t_{ij}:

$$\begin{aligned}\hat{M}^{\mathrm{P}}_{ij} &= \frac{C_{ij}}{\hat{s}_{ij}\,\hat{p}_{ij}} && \text{(any dist'n)}\\ &= \frac{C_{ij}\,I_{ij}}{\hat{s}_{ij}\,\hat{t}_{ij}}[1-e^{-I_{ij}/\hat{t}_{ij}}]^{-1} && \text{(w/Expon.)}\\ &= \frac{C_{ij}\,I_{ij}}{\hat{s}_{ij}\,\hat{t}_{ij}}\,P\big(\tfrac{1}{\alpha},\ [\Gamma(1+\tfrac{1}{\alpha})I_{ij}/\hat{t}_{ij}]^{\alpha}\big)^{-1} && \text{(w/Weibull)}\end{aligned}$$

Based on:

$$\mathrm{E}[C_{ij}] = M_{ij} \ \times\ p_{ij}\ \times\ s_{ij}$$

Assumes:

$\mathrm{A}^{\mathrm{P}}_{1}$: Each period begins with no discoverable carcasses.

More reflection...

- Both $\hat{M}^{\mathrm{H}}_{ij}$ and $\hat{M}^{\mathrm{P}}_{ij}$ assume "0% bleed-through"— "Old" carcasses are never discovered.
- Huso also assumes exponential distributions for removal.
- Pollock's equation can be instantiated for any specific removal distribution, or used in "raw" form with direct empirical estimates of $\hat{p}_{ij}$.
- For exponential removal,

$$\hat{M}^{\mathrm{EJ}}_{ij} < \hat{M}^{\mathrm{S}}_{ij} \quad < \quad \hat{M}^{\mathrm{P}}_{ij} = \hat{M}^{\mathrm{H}}_{ij}$$

(unless $I_{ij} > 4.6t_{ij}$, when $\hat{M}^{\mathrm{H}}_{ij}$ is 1% bigger than $\hat{M}^{\mathrm{P}}_{ij}$)

Do the differences matter?

- If $I_{ij} \gg t_{ij}$ (That is, if search intervals are long compared to mean persistence times), Then NO, all four estimators give about the same answers.
- BUT, they differ substantially under more frequent sampling.
- For typical search proficiencies of $25\% < s_{ij} < 60\%$,

If $I_{ij} \approx 2t_{ij}$, $\hat{M}_{ij}^{\mathrm{EJ}}$ is 4– 9% lower than $\hat{M}_{ij}^{\mathrm{S}}$

$\hat{M}_{ij}^{\mathrm{H}} = \hat{M}_{ij}^{\mathrm{P}}$ is 6–11% higher;

If $I_{ij} \approx t_{ij}$, $\hat{M}_{ij}^{\mathrm{EJ}}$ is 13–26% lower than $\hat{M}_{ij}^{\mathrm{S}}$

$\hat{M}_{ij}^{\mathrm{H}} = \hat{M}_{ij}^{\mathrm{P}}$ is 17–38% higher;

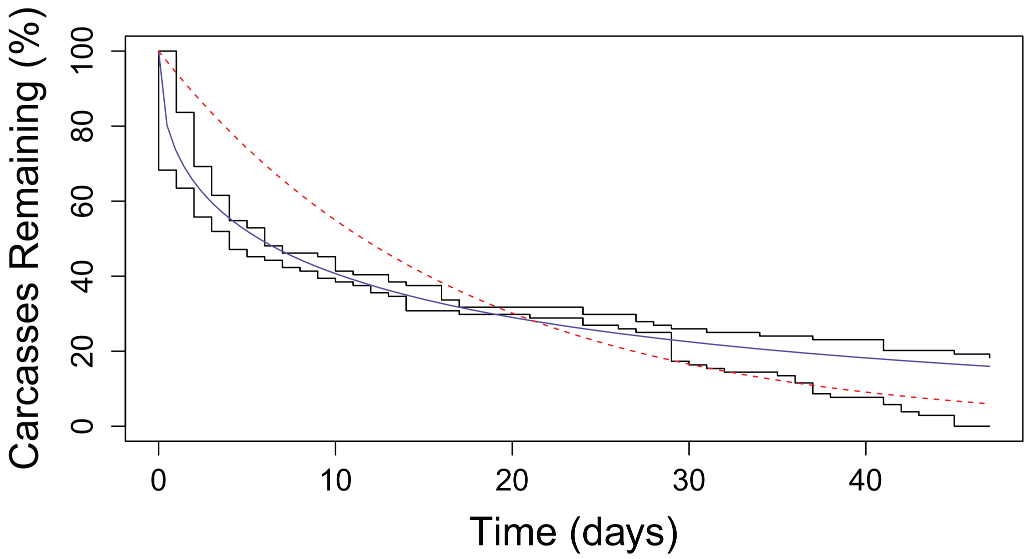
If $I_{ij} \approx \frac{1}{2}t_{ij}$, $\hat{M}_{ij}^{\mathrm{EJ}}$ is 28–48% lower than $\hat{M}_{ij}^{\mathrm{S}}$

$\hat{M}_{ij}^{\mathrm{H}} = \hat{M}_{ij}^{\mathrm{P}}$ is 32–83% higher

- No matter how short I_{ij} is, $\hat{M}_{ij}^{\mathrm{S}}$ is never more than s_{ij} times smaller than $\hat{M}_{ij}^{\mathrm{H}} = \hat{M}_{ij}^{\mathrm{P}}$ (at most a factor of 3 or 4).

Are the Assumptions True?

Exponential persistence?



Are the Assumptions True?

Exponential persistence?

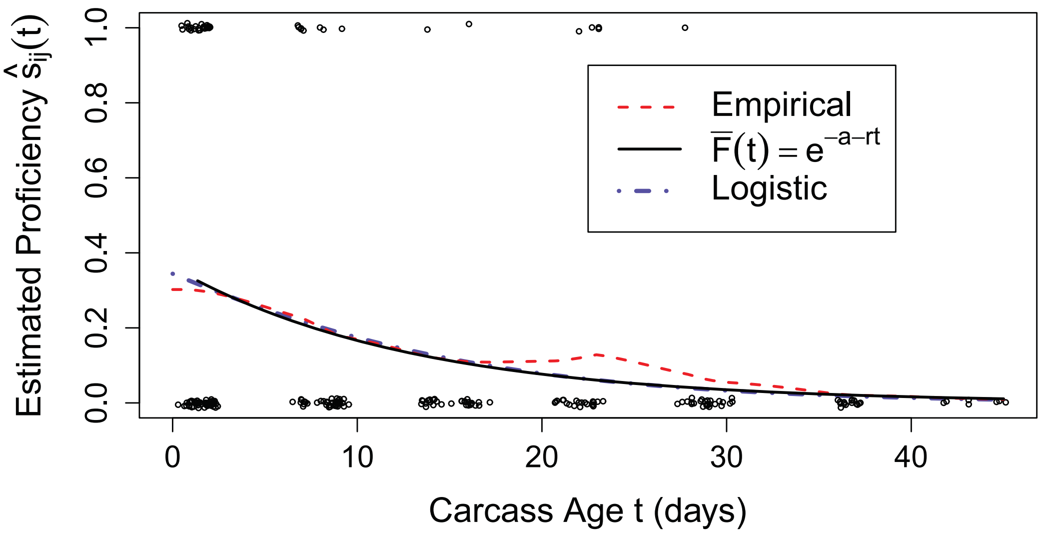
- Weibull, Lognormal, Fisk (Log-logistic) distributions *all* fit data far better than Exponential.
- Ex(λ) is the special case "$\alpha = 1$" of We(α, λ)
- Maximum Likelihood Estimate of α for small birds was

$$\hat{\alpha} = 0.4606, \text{ Standard Error} = 0.0532$$

- MLE is 10.14 SEs away from Exponential Dist'n ($\alpha = 1$)... *P*-value is 1.8×10^{-24}, far below 0.05.
- Higgs Boson discovery claim was based on 5 SE difference.

Are the Assumptions True?

Constant Proficiency s_{ij}?



Zero bleed-through? 100% bleed-through?

- For long search intervals, bleed-through doesn't matter.
- For short search intervals, probably some old carcasses are discovered.
- Falling search proficiency with carcass age ameliorates this—old carcasses are less likely to be found.
- None of the existing estimators reflects falling s_{ij}.

A note about "Mean Persistence Time" t_{ij}

- Most estimators depend on estimates of average time t_{ij} until removal by scavengers.
- This is a hard thing to estimate, because of censored observations and heavy tails.
- If persistence really had exponential distributions it wouldn't matter... but evidence shows that's wrong.
- Methods recommended in the literature systematically underestimate t_{ij}.
- The relation between daily removal rates and t_{ij} is highly model-dependent.

Something New: A Unified Partially-Periodic Estimator

$$\hat{M}^{\star}_{ij} = \frac{C_{ij}\, l_{ij}}{\hat{s}_{ij}\ \hat{t}_{ij}} \left\{ \frac{e^{l_{ij}/\hat{t}_{ij}} - \theta(1-\hat{s}_{ij})}{e^{l_{ij}/\hat{t}_{ij}} - 1} \right\},$$

with “bleed-through” parameter $0 \le \theta \le 1$. Special cases:

- $\theta = \mathbf{0}$: Identical to estimator of Huso and Pollock
- $\theta = \mathbf{1}$: Identical to estimator of Shoenfeld
- $\theta = \frac{\mathbf{1}}{\mathbf{1-s_{ij}}}$: Identical to estimator of Erickson & Johnson

For values $0 < \theta < 1$, this interpolates among them.

Based on:

$$\mathsf{E}[C_{ij}] = M_{ij}\ (t_{ij}/l_{ij})(1 - e^{-l_{ij}/t_{ij}})\ s_{ij} + \quad \theta \quad \mathsf{E}[C_{ij}]\ (1 - s_{ij})\ e^{-l_{ij}/t_{ij}}$$

But...

- This form of the Partially Periodic Estimator allows one to overcome the bleed-through problem, but
- It still assumes exponential distributions (as do Shoenfeld’s and Huso’s estimators)
- It still assumes constant search proficiency (as do all four previous estimators)

- Something better is needed.

Something Better

A new estimator based on the assumptions:

- Declining removal rate achieved through Weibull We(α, r) persistence distribution

$$\mathrm{P}[\tau > t] = e^{-(r\,t)^{\alpha}}$$

  for some parameters $0 < \alpha \leq 1$, $r > 0$;
- Diminishing proficiency

$$s_{ij}\,(t_k) = e^{-a-b\,t_k}$$

  where t_k denotes the "age" of kth carcass
- Partial periodicity, with a fraction $0 \leq \theta \leq 1$ of remaining carcasses still discoverable
- Parameters (α, r), (a, b), θ are estimated in Detection Probability Trials designed to accommodate censoring.

The New Estimator:

$$\hat{M}^{\star}_{ij} = \frac{C_{ij}\,I_{ij}}{R^{\star}_{ij}}$$

where C_{ij} is the Carcass Count, I_{ij} is Interval Length and, for $\theta = 0$ (no bleed-through, as in Huso and Pollock), and $R^{\star}_{ij}$ is the *adjusted* (for diminished search proficiency) *remainder factor*:

$$R^{\star}_{ij} = \int_0^{I_{ij}} \exp\Big(-(r_{ij}\;x)^{\alpha} - a - bx\Big)\,dx$$

Easily calculated on a computer— or, for $\alpha \approx 1/2$ as in our small bird data, available explicitly as

$$\begin{aligned} R^{\star}_{ij} &= Q^{\star}(0; a, b, r_{ij}) - Q^{\star}(I_{ij}; a, b, r_{ij}), \quad \text{where} \\ Q^{\star}(x; a, b, r) &= \exp\big(-a - bx - \sqrt{rx}\big)/b \\ &\quad - e^{-a+r/4b}\,\Phi\Big(-\sqrt{2bx} - \sqrt{r/2b}\Big)\sqrt{\pi r/b^3}. \end{aligned}$$

Summary

New estimator:

- Includes as special cases those of Erickson & Johnson, Shoenfeld, Huso, and Pollock,
- Extends to **Partially Periodic** case of $\theta > 0$,
- Allows exponential or more realistic **Weibull** persistence times with **declining removal rate**,
- Allows constant or more realistic **dimishing proficiency**,
- Is not much harder to use than existing ones, after an **integrated detection trial** to estimate the five parameters
  (α, r) (for persistence distribution),
  (a, b) (for proficiency), and
  θ (for bleed-through).

Suggestions:

- For short intervals $I_{ij} \ll t_{ij}$, bleed-through θ is important—getting it wrong will distort estimates (up *or* down).
- For long intervals $I_{ij} \gg t_{ij}$, diminishing proficiency $s_{ij}(t)$ is important. So is declining removal rate: use Weibull or Log Normal or Log Logistic removal distributions, *not* exponential.
- For moderate intervals $I_{ij} \approx t_{ij}$ and search proficiencies s_{ij}, ratios among estimators are no worse than about 3:2.
- All these issues (bleed-through, diminishing proficiency, declining removal rate) can be addressed with a modest increase in complexity with a **partially periodic estimator** and a suitable **integrated detection probability trial**.

CalWEA

Summary: Model Comparison

Model Characteristics

- Contrasting with lessons from the field work:
  - All models assume constant searcher proficiency
  - Some models assume an exponential distribution (fresh and older carcasses equally attractive to scavengers)
- Some models assume bleed-through (Shoenfeld), some don’t (Huso, Pollock), and E&J assume equilibrium

---

CalWEA

Summary: Model Comparison

- For exponential removal:

  Erickson & Johnson < Shoenfeld < Pollock < Huso

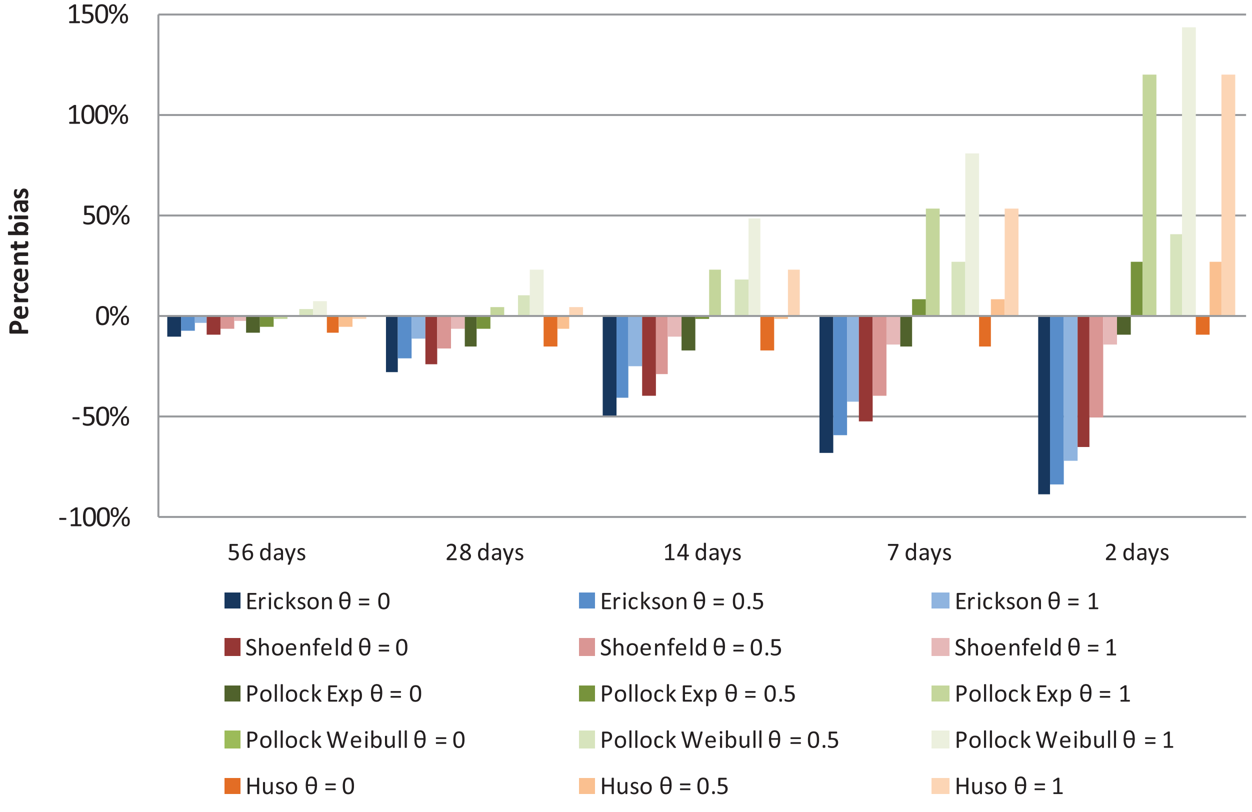
- Even though biased, if search interval is long compared to mean persistence time:
  - **All 4 estimators give about the same results**
- But, if search interval is short relative to persistence:
  - **Differences among equations increase**

Are Short Search Intervals Useful?

- Short search intervals increase chance of bias
  - Short intervals do not allow system to reach equilibrium, inconsistent with E&J assumption
  - Huso and Pollock assume 0% bleed-through, therefore bias will occur if bleed-through is more
  - Shoenfeld assumes 100% bleed-through, therefore bias will occur if bleed-through is less
- New partially-periodic equation allows for any bleed-through, therefore works very well with short or long intervals

---

Comparison of Bias in Estimators at Various Search Intervals and "Bleed-Through" θ Assumptions with Removal Distribution α = 0.7



Recommendations

Given the shortcomings of traditional estimators …

Traditional fatality estimators do not sufficiently account for

- Time-dependent processes of carcass persistence and searcher proficiency, and
- “Bleed-through” (the portion of carcasses persisting through a search interval that can be detected in subsequent search interval)

… CalWEA’s Research Team developed and recommends:

- New fatality estimator (“partially-periodic” presented above), and
- Integrated detection probability trial methodology

Why Traditional Detection Trials Won’t Work

- Traditional Searcher Proficiency Trials
  - Only fresh carcass detection events
  - One day trials
- Traditional Carcass Persistence Trials
  - No way of measuring bleed-through

Requirements for a New Integrated Detection Probability Trial

1. A preliminary traditional carcass persistence trial
2. Strategic placement of trial carcasses
3. Traditional schedule of carcass checks, with additional checks on the same day as scheduled searches
4. Searchers record detected trial carcasses over multiple search intervals
5. Measure the proportion of carcasses that persist (bleed-through) from one search interval to the next to derive the term theta

Analytical Products Gained From New Integrated Detection Trial

1. Time dependent probabilities for carcass persistence and searcher proficiency
2. A measurement of theta (bleed-through)
3. Traditional fatality estimator parameters are conserved

CalWEA

Conclusions

Policy Decision Implications

- Potentially faulty fatality estimates are being used in decision-making
- Are the errors of consequence?
  - Accuracy vs. precision
- Caution is required …

CalWEA

Conclusions

Policy Decision Implications

- Caution needed in determining:
  - National avian and bat mortality
  - Industry averages
  - Regulatory standards for monitoring
  - Numerical “thresholds” for post-construction monitoring and adaptive management requirements
- Caution needed when comparing:
  - Specific project results to national industry averages
  - Intra-project results where study approaches have differed
  - Results among wind facilities
- What degree of accuracy and precision is needed?

Conclusions

Study Design Implications

- To generate accurate and comparable fatality detection probabilities and fatality estimates
  - Uniform, standardized methods are needed
  - Partially periodic equation produces unbiased results
  - New equation requires new field study protocols

Final Thoughts & Questions

This webinar will be posted (early October)
and the final report by (November)

www.calwea.org

CENTINELA SOLAR PROJECT
BIRD AND BAT CONSERVATION STRATEGY
POST-CONSTRUCTION MONITORING:
ANNUAL REPORT FOR THE PERIOD OF
OCTOBER 2014 – DECEMBER 2015

Prepared for:

SAN DIEGO GAS & ELECTRIC COMPANY
8330 Century Park Court
San Diego, California 92123

Prepared by:

CHAMBERS GROUP, INC.
9909 Huennekens Street, Suite 206
San Diego, California 92121

JANUARY 2016

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SECTION 1.0 – INTRODUCTION

The Centinela Solar Energy Project (CSE Project) includes the construction, operation, and maintenance of a solar electric power generating facility and associated electrical line on private and federal lands in southern Imperial County, California. The Post-Construction Bird and Bat Conservation Strategy (BBCS) addresses the implementation of a post-construction avian mortality monitoring program to evaluate whether anticipated baseline impacts on avian species are consistent with actual outcomes on a San Diego Gas & Electric (SDG&E) managed portion of the CSE Project (CSE BBCS Project). The purpose of the CSE BBCS is to implement a program to identify and avoid risks to avian and bat species that could result from post-construction activities and maintenance of the CSE Project. The goal of this CSE BBCS Project is to implement a series of best management practices in order to operate the CSE Project to avoid or reduce risk to birds, bats, and their habitats. The CSE BBCS Project includes post-construction monitoring intended to facilitate documentation of avian mortalities that might occur and to identify factors associated with avian mortalities. The BBCS requires implementation of the proposed monitoring program and will assist the United States Fish and Wildlife Service (USFWS) and U.S. Department of the Interior Bureau of Land Management (BLM) to evaluate the effectiveness of the avoidance, protection, and minimization measures. This report is intended to provide an annual report of post-construction monitoring for avian mortalities along the portion of the generation-interconnection (gen-tie) electric line currently owned and operated by SDG&E.

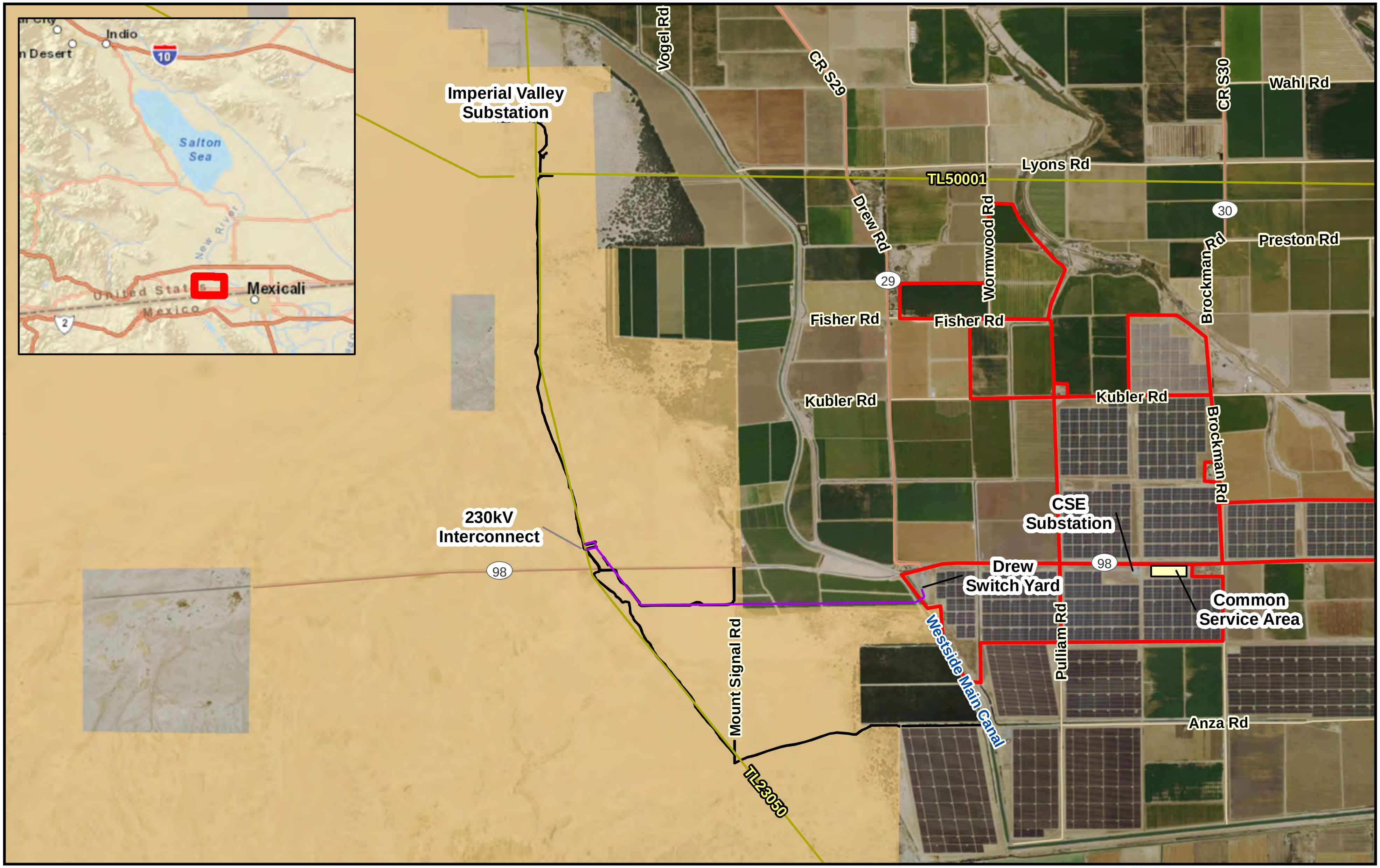
1.1 PROJECT DESCRIPTION

The BLM El Centro Office approved Alternative 3 of the CSE Project EIR/EA on December 15, 2011 (BLM 2011). The general location of the CSE Project is the Mount Signal area of Imperial County, approximately eight miles southwest of the city of El Centro, Imperial County, California (Figure 1). The CSE Project consists of an approximately 2,067-acre solar electric power generating facility (CSE Facility) and double-circuit, 230 kilovolt (kV), overhead electrical line (gen-tie line) that will connect to the Imperial Valley Substation (IV Substation) on federal land managed by the BLM (Figure 1). The CSE Facility and gen-tie line are collectively referred to as the CSE Project.

The CSE Facility site is comprised of approximately 2,067 acres of private land. The Applicant controls the CSE Facility site through a combination of options to purchase and lease agreements and fee ownership by an affiliate. Major features of the CSE Facility site includes a photovoltaic (PV) array field, substation, switchyard, earthen storm water retention and detention basins, access roads, perimeter fencing and a common service area that includes support buildings and maintenance facilities. The gen-tie line originates at the CSE Facility substation, located immediately south of Highway 98 and approximately 0.5 mile east of Pulliam Road, and extends approximately 1.5 miles generally west through the CSE Facility site. From the western boundary of the CSE Facility site, the gen-tie line continues west across the Westside Main Canal and through private agricultural lands south of Highway 98. The BLM right-of-way (ROW) for the gen-tie line encompasses the segment from Mount Signal Road south of Highway 98 and traverses approximately 1.25 miles of native desert west and then north to a location just north of Highway 98, where the gen-tie line crosses under the existing 230kV lines and interconnects with a radial line owned by SDG&E, providing an electrical connection to the IV Substation (230-kV interconnect). The gen-tie line includes the constructed Drew Switchyard on the CSE Facility site east of the Westside Main Canal, and both sides of the double-circuit structures between the Drew Switchyard and the connection to the SDG&E radial line that was utilized by CSE to construct the “loop-in.” The gen-tie line design consists of double-circuit, tubular steel monopole structures, with tubular steel H-frame and three-pole dead-end structures at the undercrossing location. Typical tower structure heights range from 100 to 130 feet. Each side of the double-circuit structures will support three two-bundle conductors and one shield wire. Typical overall structure widths are approximately 20 feet for the double-circuit structures.

The portion of the CSE Project that SDG&E is responsible for monitoring as part of the CSE BBCS Project consists of the approximately 2.5-mile portion of the gen-tie line from Drew Switchyard to the 230kV interconnect. Upon the conclusion of construction of the CSE Project, operation and maintenance associated with the 2.5-mile gen-tie line became the responsibility of SDG&E. Ownership of the gen-tie line from the Drew Switchyard to the 230kV interconnect was transferred to SDG&E following construction in September 2013. Upon transfer of these assets, SDG&E assumed responsibility for monitoring the approximately 2.5-mile gen-tie line to comply with the terms of the CSE BBCS, Section 6, Post-construction Monitoring.

Additional Documentation Attachment to Comment 2-F1
Attachment I-3



Legend

Project Features

- CSE 230kV Gen-Tie Line & BBCS Project Area
- Access Road
- Existing Transmission Line
- 🟥 CSE Facility
- BLM Land

N

0 800 1,600
Meters

Centinela Solar Energy Project (CSE)
Bird & Bat Conservation Strategy (BBCS)
Project Location & Vicinity Map
Figure 1

Name: 20642 BBCS Year2 Fig1 Location & Vicinity.Mxd
Print Date: 2/11/2016, Author: [illegible]

CHAMBERS GROUP

1.2 POST-CONSTRUCTION MONITORING

Section 6 of the CSE BBCS necessitates the implementation of a post-construction avian mortality survey program. Post-construction monitoring is designed to evaluate whether anticipated baseline impacts on avian species are consistent with actual outcomes.

During the year one survey (October 2013 – September 2014), post-construction mortality monitoring occurred over the first seven days of each month. Monitoring occurred by transect, with portions of the line that were sampled accounting for at least 20 percent coverage of the gen-tie line managed by SDG&E. Information was collected for all mortalities observed including: Universal Transverse Mercator (UTM) location, species, sex, age, distance from nearest CSE BBCS Project component, bearing from nearest CSE BBCS Project component, observable injuries, surrounding habitat, and photos.

Following discussion with BLM and USFWS in February 2015, the year two post-construction mortality monitoring study design was modified beginning March 2015, to include surveys twice weekly with no more than three days occurring between surveys. To capture additional data, the year two survey period was extended to 15 months (October 2014 – December 2015). Similar to the year one survey, monitoring occurred along the 1.25 miles of the creosote scrub habitat portion of the line from Mount Signal Road north to the 230kV interconnect, located on BLM land (Survey Area). The modified design increased the Survey Area to include 50 percent coverage of the gen-tie line managed by SDG&E, representing an increase of 100 percent from year one of the study. Information collected for all mortalities observed followed that of year one of the study. Per guidelines outlined in Section 6 of the CSE BBCS, data collected during the post-construction avian mortality surveys will be used for two primary analyses using the statistical software programs DISTANCE and MARK: (1) estimate the most effective transect survey width to search for carcasses and (2) estimate total avian mortality on the gen-tie line during the 15-month period beginning October 2014 and ending December 2015.

1.3 STUDY BACKGROUND

Avian collisions with man-made structures are estimated to be one of the leading causes of non-natural death of birds worldwide. Estimates of avian collisions and mortalities with electrical power lines are lacking and very challenging to determine due to the variety of biases. Detection and reporting of avian line strikes vary due to observer detection bias, scavenger removal, habitat type, crippling bias, and seasonal abundance (Rioux et. al 2013). The CSE BBCS Project will provide valuable data on the impacts of this 230kV gen-tie within this arid desert region of southeastern California.

Collision events are rarely directly observed in the field, thus the best method for measuring collision rates is for trained observers to search for carcasses (Rioux et. al. 2013). Detection biases have been carefully considered during the design modification of the CSE BBCS. Observer detection bias can vary depending on weather, habitat conditions, and carcass size. The selected study area is comprised of creosote scrub habitat characterized by low vegetation ground coverage and low height. Additionally, the Survey Area is within the Yuma desert which experiences favorable weather conditions for detecting avian line strikes. Due to favorable observation conditions, it was not anticipated that observer bias would have significant impact on detection of avian line strikes. Observer bias studies were conducted during year one only. The observed bias studies resulted in 93 percent detection of placed objects. The observer bias studies are addressed further in Section 2 and Section 3.

Scavenger removal of carcasses is a potentially serious bias in desert conditions. High visibility of carcasses to both mammal and avian scavengers in the desert environment means scavenger removal rates may be high at the selected Survey Area. Additionally, anticipated increases in scavenger abundance (e.g., nesting by scavengers such as common ravens, loggerhead shrikes, and raptors during the spring months) is expected to coincide with seasonal changes in avian abundance (spring migration), further confounding the bias. It is anticipated that scavenger removal rate will have a significant impact on detection of avian line strikes and is addressed further in Section 2 and Section 3.

SECTION 2.0 – METHODS

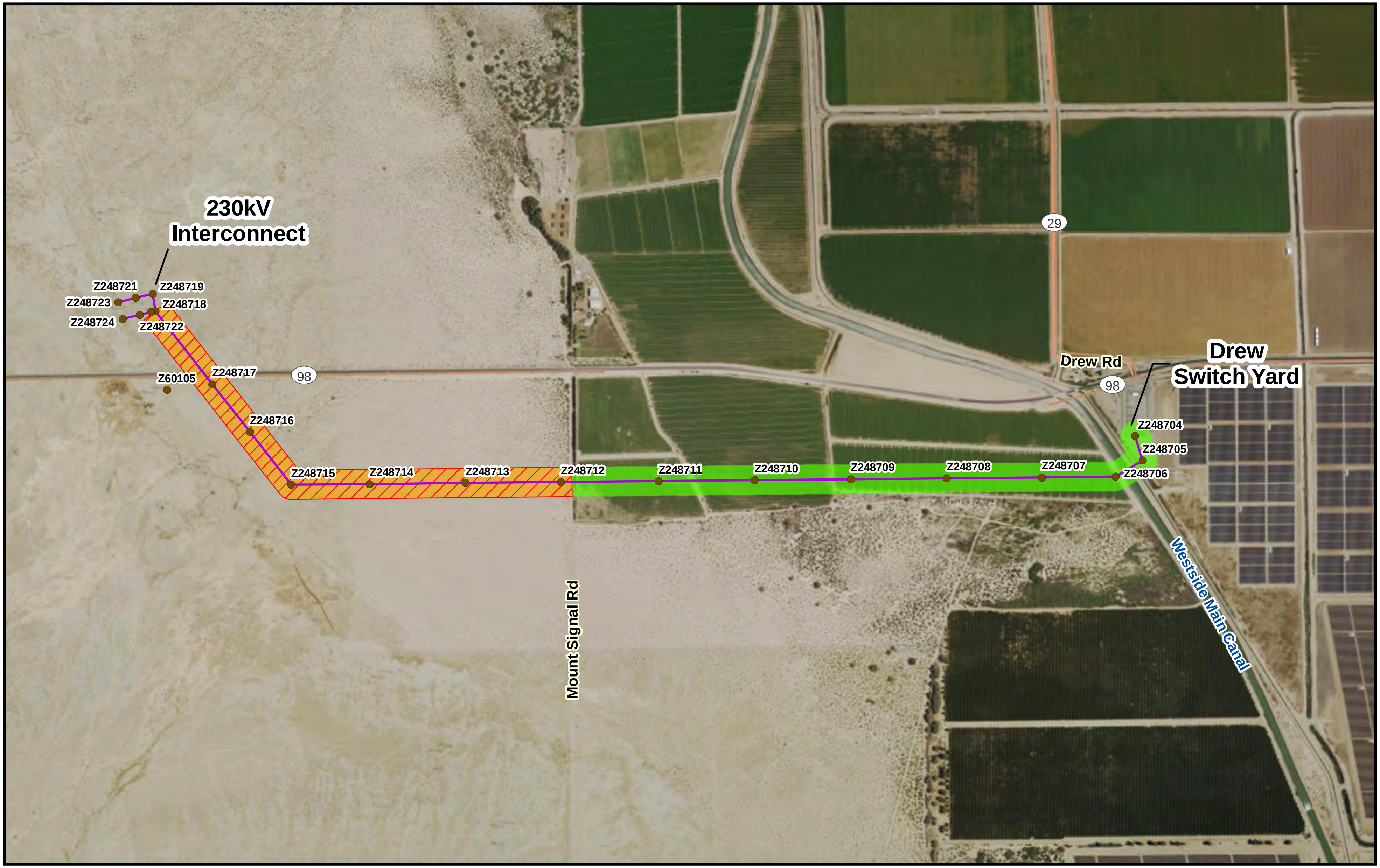
2.1 SELECTION OF STUDY AREA FOR INCREASED DETECTIONS

The portion of the CSE Project that SDG&E is responsible for monitoring as part of the CSE BBCS Project consists of the approximately 2.5-mile portion of the gen-tie line from the constructed switchyard (Drew Switchyard) to the 230-kV interconnect (Figure 2). From the Drew Switchyard, the gen-tie line extends east through 1.25 miles of agricultural lands followed by 1.25 miles of creosote scrub habitat, terminating at the boundary of the existing SDG&E north-south, 230-kV ROW. However, executing the CSE BBCS within the area described above, specifically the private agricultural land located on the eastern half of the gen-tie line, posed several complications with regard to data collection, survey replication, land access, confounding variables, and surveyor safety. As such, during year one of the study, 20 percent of the 2.5-mile gen-tie was selected for study within the 1.25 miles of creosote scrub habitat located on BLM land on the western half of the CSE BBCS Project area. During review of survey efforts from October 2013 to February 2015, it was determined by USFWS and BLM to redesign the survey protocol to increase probability of avian line strike detections to fulfill the requirements of CSE BBCS. The survey area was redefined beginning March 2015 to include the full 1.25 miles of creosote scrub habitat located west of Mount Signal Road, beginning at the Drew Switchyard and extending west and north to the 230-kV interconnect (Figures 2 and 3), to account for 50 percent coverage of the entire gen-tie line. The modified Survey Area extends 2,012 meters along the centerline and buffers out 20 meters on either side of the centerline. In addition, the timing of the surveys were modified from occurring during the first seven days straight of each month, to occurring weekly on Tuesdays and Fridays throughout each month. The modifications in the Project survey design are intended to result in a higher detection of mortalities along the gen-tie.

Within the Survey Area, four transects were assigned and labeled with letters “A” through “D.” Transects were spaced 10 meters apart, with transects B and C occurring 5 meters on either side of centerline. Transects A and D were placed 10 meters from transects B and C, respectively, situating them15 meters on either side of center line in order to provide full visual ground coverage of the survey area (Figure 3).

2.2 TRANSECT SAMPLING

During transect sampling, two biologist walked transects, scanning the ground for evidence of avian mortalities such as carcasses, feather spots, scavenged carcasses, or individual feathers (sign). When sign was observed, the biologists marked their location from which the observation occurred on the transect with a pin flag, and collected and entered data on the Avian Mortality Reporting Form (Appendix A). Once all data was collected and entered, the biologists returned to their marked location and resumed transect sampling.



Legend

Project Features

● Transmission Structure

CSE 230kV Gen-Tie Line & BBCS Project Area

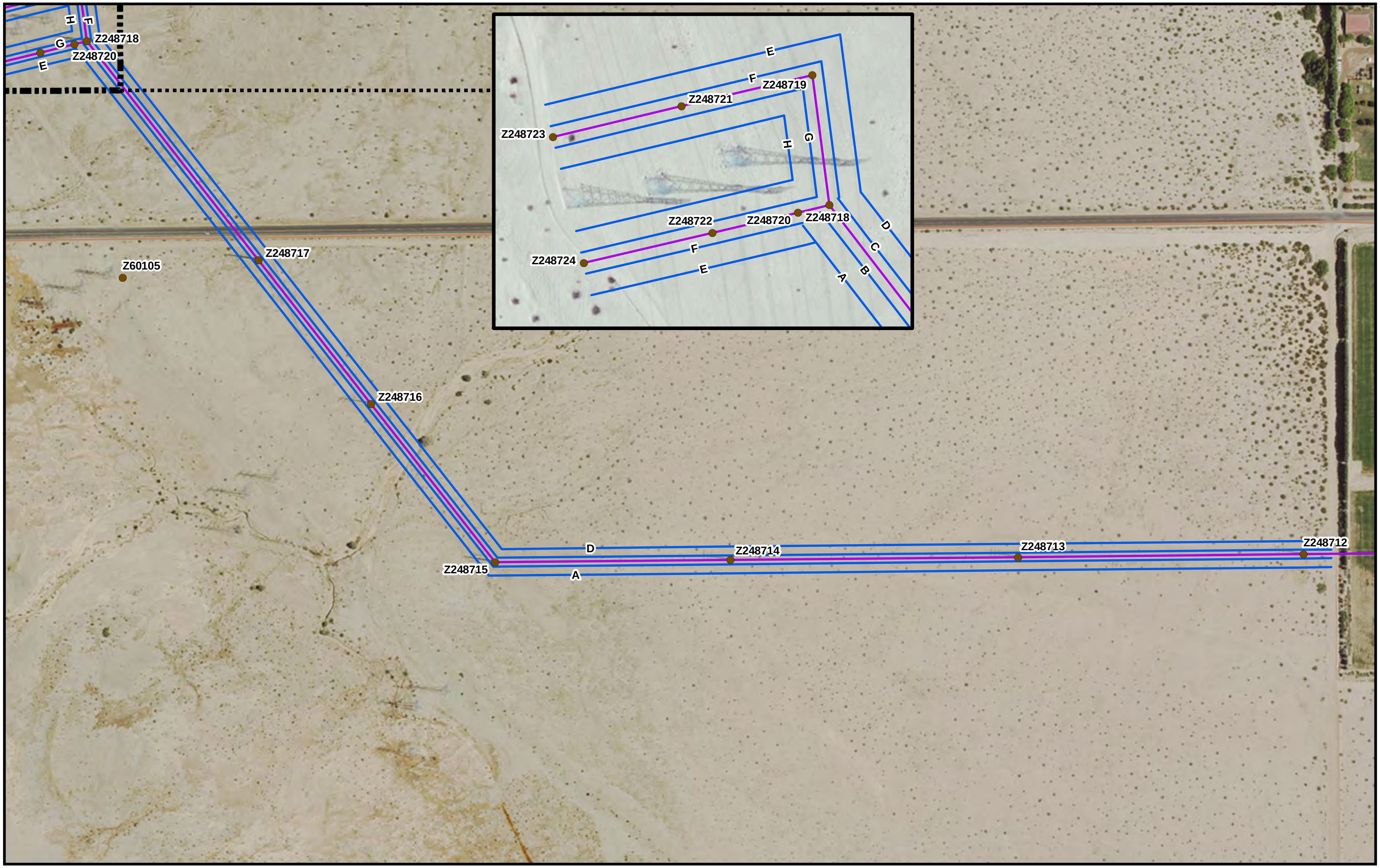
▨ BBCS Study Area

🟧 Creosote scrub

🟩 Agriculture

Centinela Solar Energy Project (CSE)
Bird & Bat Conservation Strategy (BBCS)
BBCS Study Area Map
Figure 2

Name: 20642 BBCS Year2 Fig2 Study Area_rev.Mxd
Print Date: 2/11/2016, Author: [illegible]



Legend

Project Features

- ● Transmission Structure
- CSE 230kV Gen-Tie Line & BBCS Project Area
- BBCS Survey Transect

N

0 100 200
Meters

Centinela Solar Energy Project (CSE)
Bird & Bat Conservation Strategy (BBCS)
BBCS Survey Area Map
Figure 3

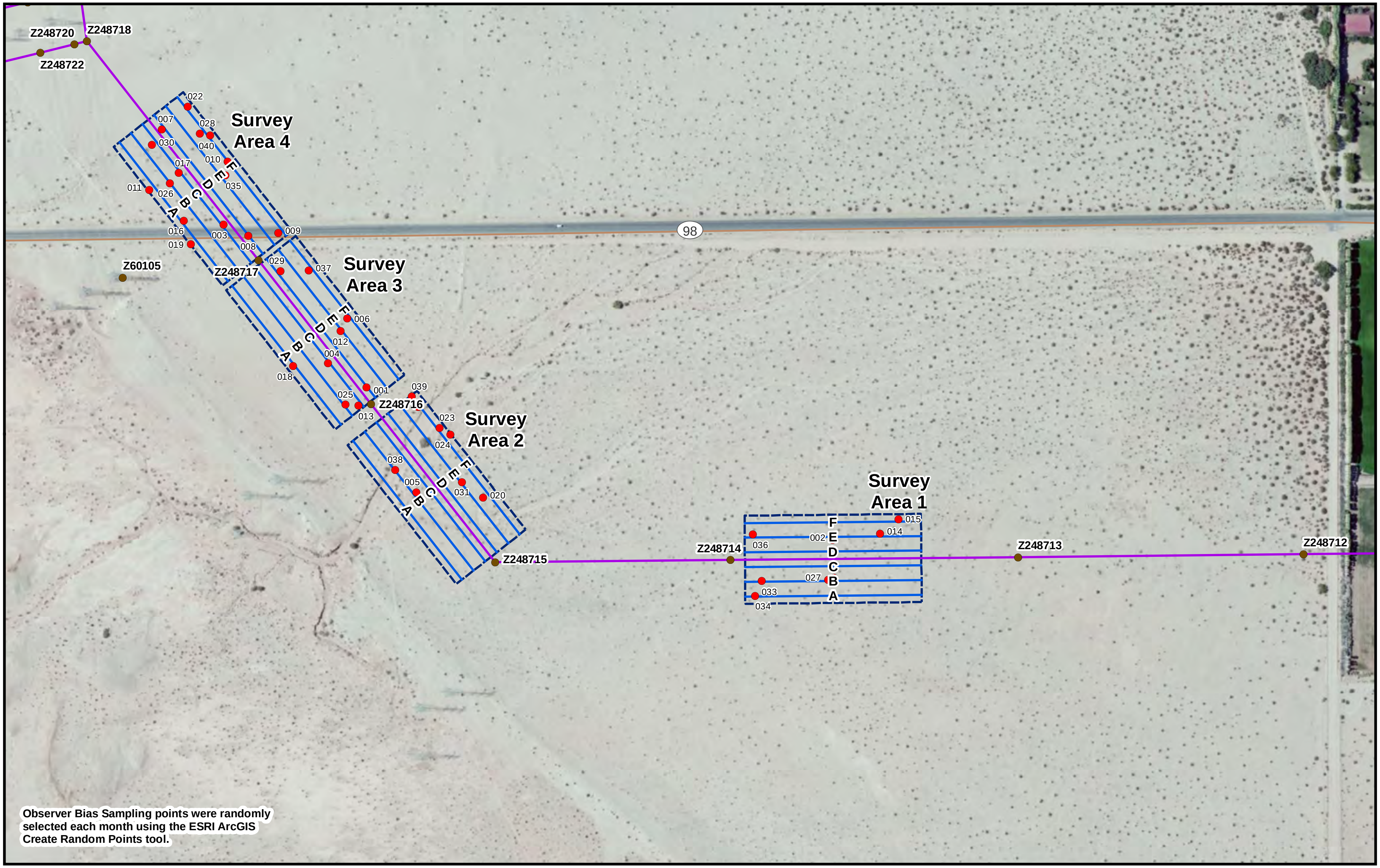
Name: 20642 BBCS Year2 Fig3 Survey Area.Mxd
Print Date: 1/31/2016, Author: [illegible]

2.3 OBSERVER BIAS STUDY

The observer bias study was conducted during year one only along the original Project Survey Area design. As such, the study area included only 20 percent of the gen-tie line. The observer bias study was conducted concurrently with transect surveys during year one to eliminate any differences in variables between the surveys. Up to 40 trial birds (observer bias objects) with unique numbers were placed at random within the survey transect areas. Random placement locations within survey transect areas were selected using the “Create Random Points” tool in ArcGIS. Artificial birds with realistic feathers and coloration were used as observer bias objects. Study objects ranged from 3.5 to 5 inches in length. Coloration of study objects were brown, gray, other drab colors, and yellow, to mimic species naturally occurring within the survey area, such as migrating warblers and sparrows (Photograph 1). Locations for placement of observer bias objects were documented using Arc GIS software. A sample of randomly generated observer bias object locations is included in Figure 4. To remove bias, the biologist placing trial birds did not conduct avian line-strike surveys for the given survey period. Random selection of placement for observer bias study objects was repeated for each round of surveys.

Photograph 1.
Representative examples of observer bias objects used for study

When avian mortality surveyors located an observer bias object, information including UTM location and assigned object number was recorded to verify data collection accuracy. The object was then collected and removed from the survey area. Observer bias study data was collected during each trial period to account for varying avian abundance, seasonal variables, and environmental variables that may change over the course of the year. Additionally, conducting the observer bias study concurrently with the mortality surveying efforts ensures that the observer’s effort is consistent across studies.



Observer Bias Sampling points were randomly selected each month using the ESRI ArcGIS Create Random Points tool.

Legend

Project Features

●	Transmission Structure
—	CSE 230kV Gen-Tie Line & BBCS Project Area
—	BBCS Survey Transect
▭	BBCS Survey Area
●	Observer Bias Object

N

0 100 200
Meters

Centinela Solar Energy Project (CSE)
Bird & Bat Conservation Strategy (BBCS)
BBCS Observer Bias Sampling Map
Figure 4

Name: 20642 BBCS Year Fig4 Observer Bias Sample.Mxd
Print Date: 10/24/2014, Author: [illegible]

2.4 SCAVENGING BIAS STUDY

During transect sampling, all sign of avian mortality was recorded and given a unique identifier. Unique identifiers were assigned by year, month, day, and the number of avian mortalities observed during the day. For example, the second (02) potential avian mortality observed on April 14, 2015 would be labeled 20150414_02. This unique identifier was used to conduct follow-up monitoring observations for each intact carcass located during the following survey period. Following initial observation, biologists checked the status of each carcass during all subsequent surveys for use in the scavenger bias study. Observers returned to each mortality to monitor for scavenger activity until the carcass was naturally removed. Once a carcass was no longer present, biologists recorded the last day the carcass was observed. The initial and last observation dates the carcass was observed were used to determine the average number of days carcasses persisted within the survey area prior to being naturally removed.

2.5 CARCASS REMOVAL TRIAL

Two rounds of carcass removal trials were conducted over the course of five consecutive days. Carcass removal trials were conducted concurrently with BBCS mortality surveys where feasible. Carcass removal trials consisted of 10 avian carcasses (brown-headed cowbirds) randomly placed within the BBCS Survey Area at sunrise, when mortality surveying typically occurs (Figure 5). Care was taken to survey for potential scavengers during the placement of carcasses so as not to attract scavengers to the area. Following placement of the trial carcasses, biologists returned to monitor scavenging and removal of carcasses daily at sunrise. During the five day monitoring period, two of the trial carcass checks occurred during scheduled BBCS mortality surveys, for a total of three additional days for each trial period. During carcass checks, presence/absence, condition, and sign of all trial carcasses was documented. Information collected was used to determine the rate of carcass removal between BBCS mortality surveys (two day and three day intervals). This data was used to extrapolate the number of mortalities likely occurring during days when BBCS mortality surveys did not occur based on the observed number of mortalities and known observer bias/detection rates. A total of two trials were conducted; one in late spring (May) and one in summer (June). No trials were conducted during fall and winter due to expected low numbers of observed mortalities and relative decline of potential scavengers during the avian non-breeding season.

Legend

Project Features

● Transmission Structure

🟩 BBCS Carcass Removal Trial (2015)

— CSE 230kV Gen-Tie Line & BBCS Project Area

— BBCS Survey Transect

N

0 100 200

Meters

Centinela Solar Energy Project (CSE)
Bird & Bat Conservation Strategy (BBCS)
Carcass Locations for Carcass Removal Trials
Figure 5

Name: 20642 BBCS Year2 Fig5 Carcass Removal Trial.Mxd
Print Date: 2/11/2016, Author: [illegible]

SECTION 3.0 – RESULTS

3.1 TRANSECT SAMPLING RESULTS

Sixteen intact avian carcasses were observed during transect sampling within the Survey Areas during the survey year (October 2014 – December 2015). In addition to documenting intact carcasses, data was collected when scavenged, dismembered carcasses, or injured birds were observed during transect sampling. Table 1 shows the number of carcass observations by carcass condition observed during each survey period. Table 2 summarizes the total number of mortalities observed by carcass condition for survey year two. The location of all observed carcasses is shown in Figure 6.

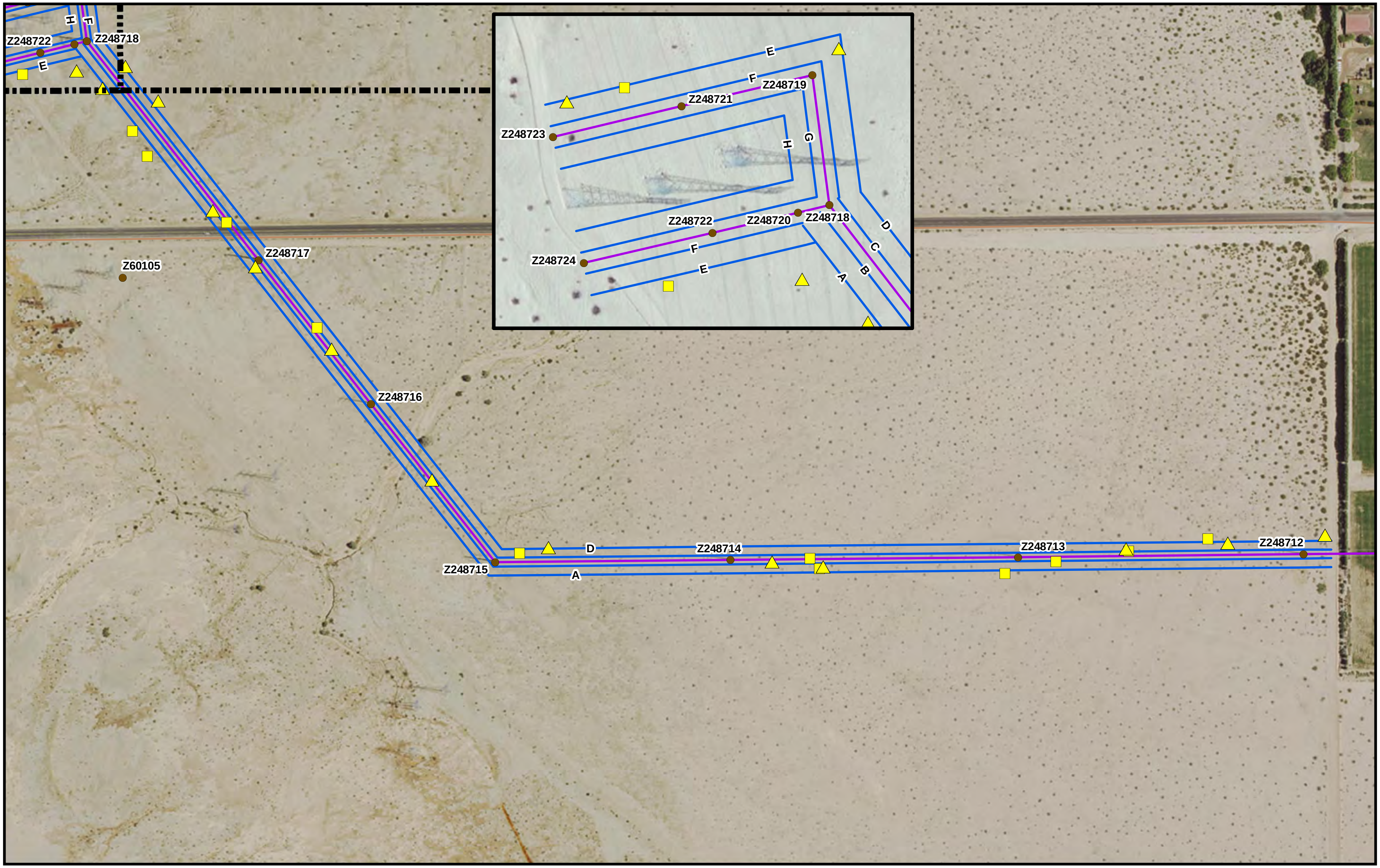
Table 1: Number of Carcass Observations Per Month

Carcass Condition	October 2014	November 2014	December 2014	January 2015	February 2015	March 2015	April 2015	May 2015	June 2015	July 2015	August 2015	September 2015	October 2015	November 2015	December 2015
Intact	0	0	0	0	0	3	3	5	1	0	1	2	1	0	0
Scavenged	0	0	0	0	0	0	1	2	0	0	0	1	0	0	0
Dismembered	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0
Injured	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotals	0	0	0	0	0	3	4	9	2	1	1	4	1	0	1

Table 2: Summary of Carcass Observations for Year Two

Carcass Condition	Cumulative Observations
Intact	16
Scavenged	4
Dismembered	4
Injured	0
Cumulative Total	24

Intact carcasses of one Eurasian collared-dove, one common yellowthroat, one Brewer's sparrow, one MacGillivray's warbler, one orange-crowned warbler, five Wilson's warblers, one western tanager, one white-winged dove, one vesper sparrow, one unknown Epidonax species (possibly willow flycatcher), one Bewick's wren, and one house wren were observed during the October 2014 – December 2015 survey year. Details including species, condition, and location of all intact avian carcasses are included in Table 3. On average, intact avian carcasses were observed 12.60 meters from the gen-tie line centerline.



Legend

Project Features

● Transmission Structure

CSE 230kV Gen-Tie Line & BBCS Project Area

BBCS Survey Transect

12-Month Survey Results

△ Intact (16)

□ Scavenged (13)

N

0 100 200
Meters

Centinela Solar Energy Project (CSE)
Bird & Bat Conservation Strategy (BBCS)
BBCS Survey Results Map
Figure 6

Name: 20642 BBCS Year2 Fig6 Survey Results.Mxd
Print Date: 2/11/2016, Author: stondre

CHAMBERS GROUP

Table 3: Location of Intact Avian Carcasses Observed

Date	Species	Condition	UTME	UTMN	Point ID	Distance From Centerline (meters)
3/17/2015	Eurasian collared-dove	Intact	621285	3616674	03_17_01	17.41
3/24/2015	Brewer's sparrow	Intact	622076	3616106	03_24_01	8.43
3/27/2015	common yellowthroat	Intact	621229	3616668	03_27_01	30.61
4/17/015	orange-crowned warbler	Intact	621431	3616446	20150417_01	6.75
4/21/2015	MacGillivray's warbler	Intact	621764	3616128	20150421_01	14.90
4/28/2015	Wilson's warbler	Intact	621245	3616773	20150428_01	16.59
5/5/2015	Wilson's warbler	Intact	622534	3616132	20150505_01	12.40
5/8/2015	Wilson's warbler	Intact	621121	3616748	20150508_01	13.30
5/8/2015	Wilson's warbler	Intact	621259	3616648	20150508_02	18.00
5/15/2015	Wilson's warbler	Intact	621518	3616352	20150515_01	3.25
5/19/2015	western tanager	Intact	622419	3616126	20150519_01	7.18
6/2/2015	Empidonax sp.	Intact	621321	3616634	20150602_01	21.90
8/18/2015	white-winged dove	Intact	621632	3616204	20150818_01	1.57
9/18/2015	Bewick's wren	Intact	621383	3616510	20150918_01	5.54
9/22/2015	vesper sparrow	Intact	622017	3616111	20150922_03	2.75
10/13/2015	house wren	Intact	622644	3616142	20151013_01	21.10

3.2 OBSERVER BIAS STUDY RESULTS

The observer bias study was conducted during year one only (October 2013 – September 2014). The year one observer bias study resulted in an average rate of detection for observer bias objects of 92.77 percent for objects present for one day within the Survey Area. The average observation bias rate represents the likelihood of a mortality being detected on the initial survey day following its occurrence within the Survey Area. Table 4 shows the number of observer bias objects placed within all the survey areas for a given survey period and the subsequent number of objects detected on the first survey day following the objects being present. In order to prevent conditioning of surveying biologists expecting observer bias objects to be placed within the first day of a survey period, placement of objects within the Survey Area occurred at different times within each survey month. The number of objects placed was also varied randomly. Finally, during two survey periods (March and September), no observer bias objects were placed. These measures were taken intentionally to avoid bias within the observer bias trial. Results from April are not included in determining average detection rate due to an extreme wind event that resulted in observer bias objects being blown outside of the survey area; therefore, these objects would not have been expected to be detected given the study's methods.

Table 4: Year One Observer Bias Study Results

Month	Number of Objects Placed	Number of Objects Detected	Percent Detection
QTR 1			
October	37	35	94.59
November	40	38	95
December	20	19	95
QTR 2			
January	15	10	66.67
February	11	11	100
March	n/a	n/a	n/a
QTR 3			
April	*15*	*4*	*26.67*
May	12	12	0
June	12	12	100
QTR 4			
July	14	14	100
August	19	16	84
September	n/a	n/a	n/a
Total*	**180**	**167**	**92.77**

*Represents average rate of detection between survey months not including results from April due to environmental variables.

3.3 SCAVENGING BIAS STUDY RESULTS

In total, 16 intact carcasses and 8 scavenged and dismembered carcasses were detected during the October 2014 – December 2015 survey year. Of intact carcasses detected, all carcasses were surveyed during following surveys for use for the scavenger bias study. Scavenged and dismembered carcasses detected were not used in the scavenging bias study. Carcasses were removed an average of 2.63 days after initial observation, resulting in 88 percent of all carcasses being scavenged within three days of mortality.

Table 5: Scavenger Bias Study Results

Carcass ID	Species	Initial Date Obs.	Initial Date Absent	# Days Present
20150317_01	Eurasian collard dove	3/17/2015	3/20/2015	2
20150324_01	Brewer's sparrow	3/24/2015	3/27/2015	2
20150327_01	common yellowthroat	3/27/2015	3/29/2015	2
20150417_01	orange-crowned warbler	4/17/015	4/21/2015	4
20150421_01	MacGillivray's warbler	4/21/2015	4/24/2015	2
20150428_01	Wilson's warbler	4/28/2015	5/5/2015	6
20150505_01	Wilson's warbler	5/5/2015	5/8/2015	2
20150508_01	Wilson's warbler	5/8/2015	5/12/2015	3
20150508_02	Wilson's warbler	5/8/2015	5/12/2015	3
20150515_01	Wilson's warbler	5/15/2015	5/19/2015	3
20150519_01	western tanager	5/19/2015	5/22/2015	2
20150602_01	Empidonax sp.	6/2/2015	6/5/2015	2
20150818_01	white-winged dove	8/18/2015	8/21/2015	2
20150918_01	Bewick's wren	9/18/2015	9/22/2015	3
20150922_03	vesper sparrow	9/22/2015	9/25/2015	2
20151013_01	house wren	10/13/2015	10/16/2015	2
Average				**2.63**

3.4 CARCASS REMOVAL TRIAL

A total of two carcass removal trials were conducted during year two, one in late spring (May) and one in summer (June). During the spring trial, five of the ten carcasses were scavenged within one day of placement, three additional carcasses were scavenged within two days of placement, and the remaining two carcasses remained through the end of the survey period. During the summer trial, three out of ten carcasses were scavenged within one day of placement, one was scavenged within two days, three were scavenged within three days, one was scavenged within four days, and two of the carcasses remained through the end of the survey period.

Table 6: Carcass Removal Trial Results

Trial	# of Carcasses Scavenged within One Day	# of Carcasses Scavenged within Two Days	# of Carcasses Scavenged within Three Days	# of Carcasses Scavenged within Four Days	# of Carcasses Scavenged within Five Days
Spring	5	3	0	0	0
Summer	3	1	3	1	0

SECTION 4.0 – ANALYSIS

4.1 OBSERVER BIAS ANALYSIS

The literature review results of observation bias rates are misleading because of differing environmental variables across studies (e.g., ground cover, elevation changes, bird size). A literature review of observation rates varied from 30 to 86 percent due to those variables (Morrison 2002). Although this makes comparing observer bias rates difficult, the results of the observer bias study conducted during year one showed an average observer detection rate of 92.77 percent. Our result is higher than any other reported observation rate from the literature review; however, no studies reviewed took place in such open creosote scrub habitat.

4.2 OPTIMAL TRANSECT WIDTH ANALYSIS

In total, 16 observations of intact avian carcasses were made during the survey year, October 2014 - December 2015. The sample size is too small to generate a statistically significant result for optimal transect width as required by the CSE BBCS using DISTANCE, the statistical software program identified in Section 6 Post-Construction Monitoring. Ideally, if the study were able to gather sufficient data points, the data would have been used to analyze detection probabilities given varying distances from the centerline using DISTANCE. This would have provided a range of transect width options from the centerline that produce detection probabilities of up to 100 percent. Only intact line strike detections would be used for analysis because the original location or probable cause of death for scavenged avian detections cannot be determined[1].

4.3 SCAVENGING BIAS ANALYSIS

During the October 2014 - December 2015 survey year, all 16 intact avian mortalities were selected for the scavenger bias study. Although all were subsequently scavenged, with an average of 2.63 days from detection to scavenging event, this is not a sufficient sample to statistically analyze scavenger rate.

4.4 CARCASS REMOVAL TRIAL

During the spring 2015 trial, 50 percent of carcasses were scavenged within one day and 80 percent of the carcasses had been scavenged within two days. During the summer 2015 trial, 30 percent of the carcasses were scavenged within one day and 70 percent had been scavenged within three days of placement. The removal trials show that on average 75 percent of carcasses are scavenged within three days of placement. As such, it is expected that survey results for the October 2014 - December 2015 survey period spaced an average of 2.5 days apart (48 to 72 hours) likely resulted in an approximate detection rate of 25 percent of the total avian mortalities occurring within the Survey Area due to scavenger removal.

---

[1] Because scavenged carcasses have been disturbed, moved, or otherwise altered from their origin, carcasses initially observed in the scavenged condition were not included in the project data set for these studies due to their potential of presenting a confounding variable at this stage of the study. Although data was collected for scavenged, dismembered, and injured birds, Avian Mortality Reporting Forms were not submitted because these observations are not necessarily indicative of line strikes within the Study Area.

SECTION 5.0 – DISCUSSION

5.1 STUDY AREA SELECTION

Conducting post-construction avian mortality surveys, observer bias studies, scavenger bias studies, and carcass removal trials within both the creosote scrub habitat located along the western portion of the gen-tie line and within the private agricultural land located along the eastern portion of the gen-tie line presented the following potential complications with survey design and data analysis.

5.1.1 Vegetation Substrate

Vegetation height within an agricultural area can be highly variable within a year, season, or month. As a result, detection probability by observers would also be expected to vary between each month of surveys depending on crop maturity, density, and species. If crop height and/or density is high, then detection probability would be expected to decrease, resulting in a smaller sample size of data. Additionally, crop height and/or density may also result in a higher scavenging bias being perceived. For example, surveyors may find only easily located carcasses, which would also be easily located by scavengers; therefore, when carcasses are marked for capture/recapture analysis, an inaccurate scavenging bias could be determined. Lastly, variable vegetation within a year would require that observer bias be accounted for each crop stage or type and then applied separately to each survey period, rather than a uniform observer bias determined over the course of a year being applied to the CSE BBCS Project as a whole.

5.1.2 Survey Replication

Replication of each survey transect for the duration of the survey period is a critical component in applying the software program DISTANCE. By placing survey transects within the private agricultural section of the gen-tie line, the study would have run the risk of not being able to replicate transects each month. One potential complication is denial of land access during a survey day or entire survey period. Land access may be denied due to crop harvesting, damage being done to crops during the study, unsafe conditions such as flooding, or by owner preference. Similarly, if equipment is operating within a survey transect, conditions may not be safe for access by the surveyor within the appropriate survey window. The potential inability to replicate surveys throughout the study duration would be a significant project design flaw.

5.1.3 Human Disturbance

Agricultural areas are subject to various types of disturbance throughout the year. Should harvesting, tilling, or other land alteration occur within transects, carcasses may be disrupted, buried, destroyed, or removed. If any of the aforementioned activities did occur, potential would exist that a significant percentage of mortalities could become detectable (that previously may have gone undetected) or go undetected, skewing the data. If any of these activities were to occur following the initial day of surveys within a survey period, removal of carcasses by anthropogenic means could artificially inflate scavenging bias due to marked birds no longer being present or detectable. These potential disturbances could also result in surveys not being accurately replicated, as described above.

5.1.4 Variations in Avian Abundance Between Habitats

By surveying two different habitats, the study may observe variations in avian abundance within the Study Area. If the agricultural areas have seed storage or harvesting or provide additional sources of food/water, avian numbers may be higher in these areas. Conversely, human activity and lighting may deter birds from the area. Although statistical models are capable of extrapolating mortalities for the CSE BBCS Project area within multiple habitat types, reliability of estimates increases when surveys include areas with monotypic habitat, an expected high detection probability, and consistent abundance of birds throughout the survey area.

5.1.5 Modification to Avoid Design Flaws

Many of the design flaws described above were avoided by having the Study Area include only creosote scrub habitat along the western portion of the CSE BBCS Project. Survey transects accounted for 50 percent of the entire 2.5-mile gen-tie line; however, by not surveying the portion of the gen-tie line on agricultural land, extrapolating avian mortalities over the Project timeline did not account for any potential differences in the abundance/frequency of potential line strikes occurring between the creosote scrub habitat and the agricultural areas. Analysis was intended to be performed using Program DISTANCE to extrapolate the total number of mortalities recorded only within the native creosote scrub habitat. This number would then be applied to the remainder of the line (the agricultural area) as a function of the linear distance. For example, the creosote scrub habitat to be surveyed would account for 50 percent of the entire gen-tie. Thus the agricultural area of the line would represent 2 times the linear distance of the gen-tie as that represented by the creosote scrub area. Avian mortalities extrapolated within the creosote scrub habitat using DISTANCE would be multiplied by 2. This method did not account for any differences in the number of potential line strikes occurring between different habitat types. Therefore, the assumption can be made that if the mortalities are higher within creosote scrub than agricultural land, the total extrapolated number of mortalities for the entire gen-tie line will be overestimated. Conversely, if mortalities are higher within agricultural areas than creosote scrub, the total extrapolated number of mortalities for the entire gen-tie line will be underestimated.

While over or underestimating numbers of mortalities are potential problems, from the perspective of feasibility, surveying only within creosote scrub habitat remained the preferred CSE BBCS Project design. The reduced Study Area did not account for habitat variations along the gen-tie line, but it did allow for a usable set of data to be collected for the study and greatly reduce the possibility of being unable to collect statistically sound and accurate data, replicate surveys, or having to mitigate for unknown variables.

5.2 SCAVENGING BIAS

Although only 16 intact avian carcasses were observed and included in the scavenging bias trial, there is reason to suspect that common ravens and coyotes are primarily responsible for scavenging mortalities. Photograph 2 provides evidence of this from a shot captured by a Cuddeback camera that was placed during the year one survey facing an avian mortality (ID 5_4_03, a Wilson's warbler). This avian mortality was a probable line strike that likely occurred the morning it was found. The condition of the warbler's body at the time of initial observation suggested that the carcass was found within a few hours of its death. The camera was placed at approximately 0835 on May 4, 2014. The camera was triggered by the raven and took Photograph 2 at 0954 on May 4, 2014, suggesting that common ravens can potentially scavenge avian mortalities within a few hours of their death. In addition, during surveys and the carcass removal trials conducted during year two, ravens were directly observed picking up carcasses several times, and coyote tracks and large clumps of feathers were observed leading to areas where two carcasses had been placed. Coyote tracks were regularly observed throughout surveys during year one and two, as shown in Photograph 3.

Although coyotes primarily scavenge and hunt at night, biologists reported seeing coyotes in transects as late as 0900 during surveys. It is probable that coyotes are capable of scavenging avian mortalities the same day as death.

Photograph 2.

Common raven photographed immediately prior to scavenging avian mortality ID 5_4_03

Photograph 3.

Coyote tracks found adjacent to a scavenged carcass

5.2.1 Observations of Scavenged Mortalities

During the year two reporting period, a total of four mortalities were observed in the scavenged condition. Scavenged carcasses present a unique dataset for this study in that they represent a mortality disturbed from its original location and condition. Although data was collected on Avian Mortality Report forms for all scavenged carcasses, these observations pose several potential complications during analysis. Scavenged carcasses may represent natural predation events, and mortalities may not be attributed to collisions. Thus, inclusion of these observations may result in over estimation of total avian mortalities within the study. Furthermore, during the scavenging event, carcasses may be transported or moved within a survey area, resulting in modification of the carcasses distance from the centerline and therefore should not be used to evaluate optimal transect width. Only if sufficient data is available regarding the consistency of scavenged carcasses with intact carcasses in relationship to distance from centerline, species represented, detection probability, and potential translocation during scavenging, should these points be reliably included in the dataset.

5.3 SEASONAL VARIATION

As discussed by Bevanger & Brøseth (2004) and Smallwood (2007), avian line-strike rates with electrical power lines vary by season due to fluctuations of seasonal abundance. Given that the CSE BBCS Project area is located within a critical area of the Pacific Flyway, bird abundance was anticipated to be greatest during spring and fall migrations. As expected, it appeared that spring migration saw an increase in avian mortality detections as well as an increase scavenger activity, particularly during the May surveys. However, there was not a spike in mortality or bird activity during the fall migration as previously anticipated. Common ravens were present and actively scavenging during the spring and early summer months of the spring migration, but by late June common ravens were less frequently observed within the Study Area. However, sample sizes for this Project are small, and do not provide statistically significant findings to support nor refute the correlation of seasonal migrations by passerines with numbers of line strikes.

5.4 CSE BBCS PROJECT DESIGN MODIFICATION

A total of nine mortalities were observed during the year one survey period. In order to increase the number of mortalities detected, the Project survey design was modified and extended to include three additional months during year two. The modified survey design during year two resulted in the detection of 24 mortalities. Although more mortalities were observed during year two, the number of observed mortalities did not provide a sufficient amount of data to run statistically sound analyses of an optimal transect width for the CSE BBCS Project, to extrapolate total avian mortality on the CSE BBCS Project by survey year, or to estimate scavenger and observation bias rates using the program DISTANCE.

5.5 ESTIMATED TOTAL AVIAN MORTALITY

The survey design implemented during year two of the Project did not provide a sample size large enough to run statistical analysis to obtain an estimate of total avian mortality. However, with the information gathered from the observer bias study and the scavenger studies, a general estimate of avian mortalities can be obtained. It should be noted that this estimated number represents a maximum expected number of mortalities and does not account for seasonal variation, changes in scavenger abundance, variations in survey spacing (two days versus three days) or other confounding factors. The following assumptions are made for the entire line:

1. Avian mortality rates are consistent throughout the entire gen-tie
2. Scavenger bias rates for carcass removal are estimated at the maximum rate of 82 percent within a three day period and are consistent throughout the survey period (i.e. 18 percent of mortalities would be detected for surveys spaced 3 days apart)
3. The carcass detection rate for the entire gen-tie is 93 percent of all mortalities occurring

The assumptions above were applied to a total of 24 avian mortalities observed within the Survey Area (including all intact, scavenged, and dismembered). Based on the Survey Area including 50 percent of the total gen-tie, a total of 48 mortalities were estimated for detection of the entire 2.5 mile gen-tie. When taking into account the results of the observer bias studies and the percent of carcasses scavenged within three days, it can be estimated that on average 286 (48 divided by 0.18 (number of mortalities detected every three days) divided by 0.93 (rate of detection)) avian mortalities occur yearly along the CSE BBCS Project, with the majority of these mortalities occurring during the spring migration.

SECTION 6.0 – REFERENCES

Avery, Michael L.
1979 Review of Avian Mortality Due To Collisions With Manmade Structures. U.S. Fish and Wildlife Service. Accessed January 3, 2014. http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1001&context=icwdmbirdcontrol.

Bevanger, K. and H. Brøseth
2004 Impact of power lines on bird mortality in subalpine area. Animal Biodiversity and Conservation 27.2. Accessed January 3, 2014. http://www.iberica2000.org/documents/EOLICA/BIRD_MORTALITY/POWER_LINES/Ptarmig an_collision_w_power_lines.pdf.

Jalkotzy, M.G., P.I. Ross, and M.D. Nasserden
1997 *The effects of Linear Development on Wildlife: A Review of Selected Scientific Literature*. Report: 1-354. Calgary, Prep for Canadian Association of Petroleum Producers. Arc Wildlife Services Ltd.

Janss, Guyonne F.E.
2000 Avian mortality from power lines: a morphological approach of a species-specific mortality. Department of Applied Biology, Estacion Biologica de Donana. Seville, Spain.

Morrison, M.
2002 *Searcher Bias and Scavenging Rates in Bird/Wind Energy Studies*. National Renewable Energy Laboratory. Golden, Colorado. Accessed December 27, 2013. http://www.batsandwind.org/pdf/Searcher%20bias%20and%20scavenging%20in%20bird%20wind%20energy%20studies.pdf.

Smallwood, S.
2007 Estimating Wind Turbine-Caused Bird Mortality, *Journal of Wildlife Management 71(8):2781-2791.*

APPENDIX A – AVIAN MORTALITY REPORTING FORM

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 03/17/2015 **TIME: 7:47 AM** **OBSERVER: showard**

PROXIMAL TO PROJECT COMPONENT: Z248718

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621285 North: 3616674

BEARING (degrees) to PROJECT COMPONENT: 147

DISTANCE (meters) to PROJECT COMPONENT: 52

CARCASS DESCRIPTION

SPECIES: ECDO Tag/Band Number: None

AGE: Adult SEX: Female CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 day

CAUSE OF DEATH: Presumed Collision

OBSERVABLE INJURIES: Head Trauma

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: Brood patch, early in development likely not yet incubating. Carcass initially observed on 3/17 and naturally observed to be removed by scavengers on 3/20 (next survey pass). Scattered feather spot observed within 20ft of location.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 68-76 CLOUD COVER: none

PRECIPITATION (last 24 hours): partly cloudy WIND DIRECTION: North WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** Eurasian collared dove 20150317_01
	**Photograph 2.** Eurasian collared-dove 20150317_01
	**Photograph 3.** Habitat surrounding Eurasian collared-dove 20150317_01
	**Photograph 4.** Nearest project feature to Eurasian collared-dove 20150317_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE:03/24/2015 **TIME: 8:15 AM** **OBSERVER: showard**

PROXIMAL TO PROJECT COMPONENT: Z248714

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 622076 North: 3616106

BEARING (degrees) to PROJECT COMPONENT: 176

DISTANCE (meters) to PROJECT COMPONENT: 105

CARCASS DESCRIPTION

SPECIES: BRSP Tag/Band Number: None

AGE: Adult SEX: Female CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 day

CAUSE OF DEATH: Presumed Collision

OBSERVABLE INJURIES: Head Trauma

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: Intact carcass appears to have broken neck. No other observables injuries.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 61- 77 CLOUD COVER: none

PRECIPITATION (last 24 hours): partly cloudy WIND DIRECTION: South WIND SPEED: 0-10

PHOTOGRAPHS:

Photograph 1. Brewer's sparrow 20150324_01

Photograph 2. Brewer's sparrow 20150324_01

Photograph 3. Habitat surrounding Brewer's sparrow 20150324_01

Photograph 4. Habitat surrounding and nearest project feature surrounding Brewer's sparrow 20150324_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 03/27/2015 **TIME: 8:29 AM** **OBSERVER: showard**

PROXIMAL TO PROJECT COMPONENT: Z248720

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621229 North: 3616668

BEARING (degrees) to PROJECT COMPONENT: 94 DISTANCE (meters) to PROJECT COMPONENT: 30

CARCASS DESCRIPTION

SPECIES: COYE ID: 03_27_01 Tag/Band Number: None

AGE: Adult SEX: Male CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 day

CAUSE OF DEATH: Unknown

OBSERVABLE INJURIES: None

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: Probable line strike mortality.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 61-86 CLOUD COVER: none

PRECIPITATION (last 24 hours): clear WIND DIRECTION: Northeast WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** Common yellowthroat 20150327_01
	**Photograph 2.** Common yellowthroat 20150327_01
	**Photograph 3.** Habitat surrounding common yellowthroat 20150327_01
	**Photograph 4.** Habitat surrounding and nearest project feature surrounding common yellowthroat 20150327_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 04/13/2015 **TIME: 6:47 AM** **OBSERVER: showard**

PROXIMAL TO PROJECT COMPONENT: Z248714

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 622061 North: 3616115

BEARING (degrees) to PROJECT COMPONENT: -179

DISTANCE (meters) to PROJECT COMPONENT: 90

CARCASS DESCRIPTION

SPECIES: Warbler Tag/Band Number: none

AGE: Unknown SEX: Unknown CONDITION: Scavenged

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): 2 days

CAUSE OF DEATH: Unknown

OBSERVABLE INJURIES: Other

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: Partial left wing of unknown warbler species with connective tissue present. Kit fox prints in immediate area surrounding.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 63-65 CLOUD COVER: none

PRECIPITATION (last 24 hours): clear WIND DIRECTION: Northeast WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** Unknown warbler 20150413_01
	**Photograph 2.** Unknown warbler 20150413_01
	**Photograph 3.** Habitat surrounding unknown warbler 20150413_01
	**Photograph 4.** Nearest project feature to unknown warbler 20150413_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 04/17/2015 **TIME: 7:05 AM** **OBSERVER: showard**

PROXIMAL TO PROJECT COMPONENT: Z248717

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621432 North: 3616446

BEARING (degrees) to PROJECT COMPONENT: 63

DISTANCE (meters) to PROJECT COMPONENT: 8

CARCASS DESCRIPTION

SPECIES: OCWA ID: 20150417_01 Tag/Band Number: None

AGE: Adult SEX: Female

CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 day

CAUSE OF DEATH: Presumed Collision

OBSERVABLE INJURIES: Head Trauma

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place NOTES: Female OCWA directly under conductor, left side of face sheered off and exposed from presumed collision. 4/21/15 Carcass observed through binoculars to be present in same location. CORA picked up carcass after monitors resumed survey –kquint.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit):60-80 CLOUD COVER: none

PRECIPITATION (last 24 hours): clear WIND DIRECTION: South WIND SPEED: 0-10

PHOTOGRAPHS :

	**Photograph 1.** Orange-crowned warbler 20150417_01
	**Photograph 2.** Orange-crowned warbler 20150417_01
	**Photograph 3.** Habitat surrounding orange-crowned warbler 20150417_01
	**Photograph 4.** Nearest project feature to orange-crowned warbler 20150417_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 04/21/2015 **TIME: 6:39 AM** **OBSERVER: kquint**

PROXIMAL TO PROJECT COMPONENT: Z248715

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621765 North: 3616128

BEARING (degrees) to PROJECT COMPONENT: -164

DISTANCE (meters) to PROJECT COMPONENT: 63

CARCASS DESCRIPTION

SPECIES: MGWA ID: 20150421_01 Tag/Band Number: None

AGE: Adult SEX: Male CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 day

CAUSE OF DEATH: Presumed Collision

OBSERVABLE INJURIES: Head Trauma

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: 4/24/15 Carcass absent. Likely CORA tracks present where carcass initially observed.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 64-73 CLOUD COVER: none

PRECIPITATION (last 24 hours): mostly clear WIND DIRECTION: Northwest WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** MacGillivray's warbler 20150421_01
	**Photograph 2.** MacGillivray's warbler 20150421_01
	**Photograph 3.** Habitat surrounding MacGillivray's warbler 20150421_01
	**Photograph 4.** Nearest project feature to MacGillivray's warbler 20150421_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 04/28/2015 **TIME: 11:34 AM** **OBSERVER: rhutcheson**

PROXIMAL TO PROJECT COMPONENT: Z248719

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621245 North:3616773

BEARING (degrees) to PROJECT COMPONENT: -134

DISTANCE (meters) to PROJECT COMPONENT: 17

CARCASS DESCRIPTION

SPECIES: WIWA ID: 201504281_01 Tag/Band Number: None

AGE: Adult SEX: Male CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): 2 days

CAUSE OF DEATH: Presumed Collision

OBSERVABLE INJURIES: Head Trauma

SUBSTRATE/GROUND COVER *(at carcass location):* Below Ankle

DISPOSITION OF CARCASS[1]: left in place

NOTES: Carcass estimated to be present for greater than one day based on desiccated eyes and ants present on carcass.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 67-72 CLOUD COVER: none

PRECIPITATION (last 24 hours): clear WIND DIRECTION: West WIND SPEED: 0-10 .

PHOTOGRAPHS:

	**Photograph 1.** Wilson's warbler 20150428_01
	**Photograph 2.** Wilson's warbler 20150428_01
	**Photograph 3.** Habitat surrounding Wilson's warbler 20150428_01
	**Photograph 4.** Nearest project feature to Wilson's warbler 20150428_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 05/05/2015 **TIME: 5:22 AM** **OBSERVER: kquint**

PROXIMAL TO PROJECT COMPONENT: Z248712

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 622535 North: 3616133

BEARING (degrees) to PROJECT COMPONENT: -8

DISTANCE (meters) to PROJECT COMPONENT: 86

CARCASS DESCRIPTION

SPECIES: WIWA ID: 20150505_01 Tag/Band Number: None

AGE: Adult SEX: Male CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 day

CAUSE OF DEATH: Unknown

OBSERVABLE INJURIES: None

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: Carcass appears stiff with rigormortis set in. Unable to determine COD, potential neck trauma.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 67-80 CLOUD COVER: none

PRECIPITATION (last 24 hours): clear WIND DIRECTION: Northeast WIND SPEED: 0-10

PHOTOGRAPHS:

Due to technical difficulties, no photographs are available

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 05/08/2015 **TIME: 7:07 AM** **OBSERVER: rhutcheson**

PROXIMAL TO PROJECT COMPONENT: Z248723

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621122 North 3616748

BEARING (degrees) to PROJECT COMPONENT: -111

DISTANCE (meters) to PROJECT COMPONENT: 17

CARCASS DESCRIPTION

SPECIES: WIWA ID: 20150508_01 Tag/Band Number: None

AGE: Adult SEX: Female CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): 2 days

CAUSE OF DEATH: Unknown

OBSERVABLE INJURIES: None

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: Carcass appears stiff with rigamortis. Estimated time since death approximately 2 days. Likely result of recent storm event.

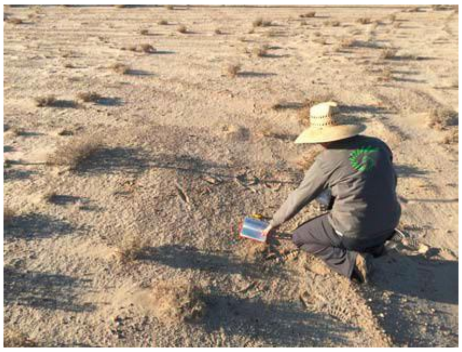
Carcass found adjacent to 230kv line and may not be associated with Project.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 57-62 CLOUD COVER: none

PRECIPITATION (last 24 hours): mostly clear WIND DIRECTION: Northwest WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** Wilson's warbler 20150508_01
	**Photograph 2.** Wilson's warbler 20150508_01
	**Photograph 3.** Habitat surrounding Wilson's warbler 20150508_01
	**Photograph 4.** Nearest project feature to Wilson's warbler 20150508_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 05/08/2015 **TIME: 7:25 AM** **OBSERVER: rhutcheson**

PROXIMAL TO PROJECT COMPONENT: Z248718

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621259 North: 3616649

BEARING (degrees) to PROJECT COMPONENT: 109

DISTANCE (meters) to PROJECT COMPONENT: 56

CARCASS DESCRIPTION

SPECIES: WIWA ID: 20150508_02 Tag/Band Number: None

AGE: Adult SEX: Female CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 day

CAUSE OF DEATH: Unknown

OBSERVABLE INJURIES: Other

SUBSTRATE/GROUND COVER *(at carcass location):* Below Ankle

DISPOSITION OF CARCASS[1]: left in place

NOTES: Carcass intact and likely result of recent storm event.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 57-62 CLOUD COVER: none

PRECIPITATION (last 24 hours): mostly clear WIND DIRECTION: Northwest WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** Wilson's warbler 20150508_02
	**Photograph 2.** Wilson's warbler 20150508_02
	**Photograph 3.** Habitat surrounding Wilson's warbler 20150508_02
	**Photograph 4.** Nearest project feature to Wilson's warbler 20150508_02

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 05/12/2015 **TIME: 6:52 AM** **OBSERVER: kquint**

PROXIMAL TO PROJECT COMPONENT: Z248715

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621763 North: 3616140

BEARING (degrees) to PROJECT COMPONENT: -154

DISTANCE (meters) to PROJECT COMPONENT: 65

CARCASS DESCRIPTION

SPECIES: Unknown warbler ID: 20150512_01 Tag/Band Number: None

AGE: Unknown SEX: Unknown CONDITION: Dismembered

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): 2 days

CAUSE OF DEATH: Unknown

OBSERVABLE INJURIES: Other

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: Single left wing actively being scavenged by ants. Likely that remainder of carcass was removed from survey area. Wing is warbler or similar size and drab gray with nearby flight feather displaying white patch.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 70-90 CLOUD COVER: none

PRECIPITATION (last 24 hours): mostly cloudy WIND DIRECTION: North WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** Unknown warbler 20150512_01
	**Photograph 2.** Unknown warbler 20150512_01
	**Photograph 3.** Habitat surrounding unknown warbler 20150512_01
	**Photograph 4.** Nearest project feature to Unknown warbler 20150512_01

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 05/15/2015 **TIME: 7:05 AM** **OBSERVER: hfranklin**

PROXIMAL TO PROJECT COMPONENT: Z248716

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621518 North: 3616353

BEARING (degrees) to PROJECT COMPONENT: -54

DISTANCE (meters) to PROJECT COMPONENT: 77

CARCASS DESCRIPTION

SPECIES: WIWA ID: 20150515_01 Tag/Band Number: None

AGE: Adult SEX: Female CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 day

CAUSE OF DEATH: Presumed Collision

OBSERVABLE INJURIES: None

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: Carcass intact and no observable trauma. Likely the result of the storm overnight. 5/19/15: one small clump of feathers left. Bird carcass gone.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 64-65 CLOUD COVER: cloudy

PRECIPITATION (last 24 hours): rain WIND DIRECTION: Southeast WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** Wilson’s warbler 20150515_01
Photo Missing	**Photograph 2.** Photo missing
	**Photograph 3.** Habitat surrounding Wilson’s warbler 20150515_01
	**Photograph 4.** Nearest project feature to Wilson’s warbler 20150515_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 05/19/2015 **TIME: 6:48 AM** **OBSERVER: hfranklin**

PROXIMAL TO PROJECT COMPONENT: Z248713

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 622419 North: 3616127

BEARING (degrees) to PROJECT COMPONENT: -176

DISTANCE (meters) to PROJECT COMPONENT: 123

CARCASS DESCRIPTION

SPECIES: WETA ID: 20150519_01 Tag/Band Number: None

AGE: Adult SEX: Female CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): 2 days

CAUSE OF DEATH: Presumed Collision

OBSERVABLE INJURIES: Head Trauma

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: Appears stiff with rigamortus, presumed deceased for at least 2 days.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 71-75 CLOUD COVER: clear

PRECIPITATION (last 24 hours): none WIND DIRECTION: East WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** Western tanager 20150519_01
	**Photograph 2.** Western tanager 20150519_01
	**Photograph 3.** Habitat surrounding western tanager 20150519_01
	**Photograph 4.** Nearest project feature to western tanager 20150519_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 05/22/2015 **TIME: 6:43 AM** **OBSERVER: ccongedo**

PROXIMAL TO PROJECT COMPONENT: Z248721

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621148 North: 3616755

BEARING (degrees) to PROJECT COMPONENT: -17

DISTANCE (meters) to PROJECT COMPONENT: 27

CARCASS DESCRIPTION

SPECIES: YEWA ID: 20150522_01 Tag/Band Number: None

AGE: Adult SEX: Male CONDITION: Scavenged

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 day

CAUSE OF DEATH: Presumed Collision

OBSERVABLE INJURIES: Head Trauma

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: breeding plumage present

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 63-68 none CLOUD COVER: mostly clear

PRECIPITATION (last 24 hours): none WIND DIRECTION: West WIND SPEED: 10-20

PHOTOGRAPHS:

Due to technical difficulties, no photographs are available

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 05/22/2015 **TIME: 7:04 AM** **OBSERVER: ccongedo**

PROXIMAL TO PROJECT COMPONENT: Z248718

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621293 North:3616600

BEARING (degrees) to PROJECT COMPONENT: 117

DISTANCE (meters) to PROJECT COMPONENT: 114

CARCASS DESCRIPTION

SPECIES: YEWA ID: 20150522_02 Tag/Band Number: None

AGE: Adult SEX: Male CONDITION: Scavenged

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 day

CAUSE OF DEATH: Presumed Collision

OBSERVABLE INJURIES: Head Trauma

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: Presumed present for less than one day due to lack of rigamortis. Beginning of breeding plumage present.

5/29 Carcass not present.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 63-68 CLOUD COVER: mostly clear

PRECIPITATION (last 24 hours): none WIND DIRECTION: West WIND SPEED: 10-20

PHOTOGRAPHS:

Due to technical difficulties, no photographs are available

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 06/02/2015 TIME: 6:33 AM OBSERVER: RHutcheson

PROXIMAL TO PROJECT COMPONENT: Z248718

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621322 North: 3616634

BEARING (degrees) to PROJECT COMPONENT: 140

DISTANCE (meters) to PROJECT COMPONENT: 105

CARCASS DESCRIPTION

SPECIES: Empidonax sp. ID: 20150602_01 Tag/Band Number: None

AGE: Adult SEX: Male CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 day

CAUSE OF DEATH: Presumed Collision

OBSERVABLE INJURIES: Head Trauma

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: Left in place

NOTES: Unknown empidonax sp. no eye ring visible due to ant scavenging. Faint wing bars. Potential WIFL.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 69-84 CLOUD COVER: clear

PRECIPITATION (last 24 hours): none WIND DIRECTION: Northwest WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** Empidonax sp 20150602_01
	**Photograph 2.** Empidonax sp 20150602_01
	**Photograph 3.** Habitat surrounding Empidonax sp 20150602_01
	**Photograph 4.** Nearest project feature to Empidonax sp 20150602_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 06/23/2015 **TIME: 6:43 AM** **OBSERVER: RHutcheson**

PROXIMAL TO PROJECT COMPONENT: Z248722

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621180 North: 3616663

BEARING (degrees) to PROJECT COMPONENT: 72

DISTANCE (meters) to PROJECT COMPONENT: 27

CARCASS DESCRIPTION

SPECIES: Unknown ID: 20150623_01 Tag/Band Number: None

AGE: Adult SEX: Unknown CONDITION: Dismembered

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): 3 days

CAUSE OF DEATH: Unknown

OBSERVABLE INJURIES: Other

SUBSTRATE/GROUND COVER *(at carcass location):* Below Ankle

DISPOSITION OF CARCASS left in place

NOTES: Seven flight feathers connected by bone and tissue. Tissue is dry and appears to be days old.

WEATHER CONDITIONS

NA

PHOTOGRAPHS:

	**Photograph 1.** Unknown species 20150623_01
	**Photograph 2.** Unknown species 20150623_01
	**Photograph 3.** Habitat surrounding unknown species 20150623_01
	**Photograph 4.** Nearest project feature to unknown species 20150623_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 07/21/2015 **TIME: 5:58 AM** **OBSERVER: kquint**

PROXIMAL TO PROJECT COMPONENT: Z248712

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 622555 North: 3616122

BEARING (degrees) to PROJECT COMPONENT: -2

DISTANCE (meters) to PROJECT COMPONENT: 65

CARCASS DESCRIPTION

SPECIES: WWDO ID: 20150721_01 Tag/Band Number: None

AGE: Unknown SEX: Unknown CONDITION: Dismembered

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): 2 days

CAUSE OF DEATH: Unknown

OBSERVABLE INJURIES: None

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: Both wings intact and scattered feathers surrounding them. Red ants scavenging connective tissue. 8/4 both wing pieces were still present. A few flight feather left in tact.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 79-82 CLOUD COVER: clear

PRECIPITATION (last 24 hours): none WIND DIRECTION: East WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** White-winged dove 20150721_01
	**Photograph 2.** White-winged dove 20150721_01
	**Photograph 3.** Habitat surrounding white-winged dove 20150721_01
	**Photograph 4.** Nearest project feature to white-winged dove 20150721_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 08/18/2015 **TIME: 6:14 AM** **OBSERVER: RHutcheson**

PROXIMAL TO PROJECT COMPONENT: Z248716

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621632 North: 3616205

BEARING (degrees) to PROJECT COMPONENT: 129

DISTANCE (meters) to PROJECT COMPONENT: 110

CARCASS DESCRIPTION

SPECIES: WWDO ID: 20150818_01 Tag/Band Number: None

AGE: Adult SEX: Unknown CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): 2 days

CAUSE OF DEATH: Presumed Collision

OBSERVABLE INJURIES: Other

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: Carcass was absent on 20150821. No evidence of scavenging was present. No feathers were observed.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 82-86 CLOUD COVER: clear

PRECIPITATION (last 24 hours): none WIND DIRECTION: West WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** White-winged dove 20150818_01
	**Photograph 2.** White-winged dove 20150818_01
	**Photograph 3.** Habitat surrounding white-winged dove 20150818_01
	**Photograph 4.** Nearest project feature to white-winged dove 20150818_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 09/04/2015 **TIME: 7:33 AM** **OBSERVER: rHutcheson**

PROXIMAL TO PROJECT COMPONENT: Z248713

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 622340 North: 3616112

BEARING (degrees) to PROJECT COMPONENT: 173

DISTANCE (meters) to PROJECT COMPONENT: 43

CARCASS DESCRIPTION

SPECIES: WWDO ID: 20150904_02 Tag/Band Number: None

AGE: Unknown SEX: Unknown CONDITION: Scavenged

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): 2 days

CAUSE OF DEATH: Unknown

OBSERVABLE INJURIES: None

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place NOTES: WWDO feathers scattered in a one foot diameter. Approximately 25 feathers appeared to be plucked from WWDO.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 77-84 CLOUD COVER: clear

PRECIPITATION (last 24 hours): none WIND DIRECTION: South WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** White-winged dove 20150904_02
	**Photograph 2.** White-winged dove 201500904_02
	**Photograph 3.** Habitat surrounding white-winged dove 20150904_02
	**Photograph 4.** Nearest project feature to white-winged dove 20150904_02

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 09/18/2015 **TIME: 8:01 AM** **OBSERVER: hfranklin**

PROXIMAL TO PROJECT COMPONENT: Z248717

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621384 North: 3616510

BEARING (degrees) to PROJECT COMPONENT: -47

DISTANCE (meters) to PROJECT COMPONENT: 76

CARCASS DESCRIPTION

SPECIES: Bewick’s wren ID: 20150918_01 Tag/Band Number: None

AGE: Adult SEX: Male CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 day

CAUSE OF DEATH: Unknown

OBSERVABLE INJURIES: None

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place NOTES: 9/22/15 clump of dark down feathers stuck in TIQPLI

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 68-81 CLOUD COVER: clear

PRECIPITATION (last 24 hours): none WIND DIRECTION: N/A WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** Bewick's wren 20150918_01
Photo Missing	**Photograph 2.** Photo missing
	**Photograph 3.** Habitat surrounding Bewick's wren 20150918_01
	**Photograph 4.** Nearest project feature to Bewick's wren 20150918_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 09/22/2015 **TIME: 6:59 AM** **OBSERVER: kquint**

PROXIMAL TO PROJECT COMPONENT: Z60105

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621338 North: 3616571

BEARING (degrees) to PROJECT COMPONENT: -112

DISTANCE (meters) to PROJECT COMPONENT: 148

CARCASS DESCRIPTION

SPECIES: VESP ID: 20150922_01 Tag/Band Number: None

AGE: Adult SEX: Unknown CONDITION: Dismembered

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): 2 days

CAUSE OF DEATH: Unknown

OBSERVABLE INJURIES: None

SUBSTRATE/GROUND COVER *(at carcass location):* Below Ankle

DISPOSITION OF CARCASS[1]: left in place NOTES: Wings and skull are present. Ants have scavenged most of the connective tissue.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit):79 CLOUD COVER: cloudy

PRECIPITATION (last 24 hours): none WIND DIRECTION: South WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** Vesper sparrow 20150922_01
	**Photograph 2.** Vesper sparrow 20150922_01
	**Photograph 3.** Habitat surrounding vesper sparrow 20150922_01
	**Photograph 4.** Nearest project feature to vesper sparrow 20150922_01

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 09/22/2015 **TIME: 7:55 AM** **OBSERVER: kquint**

PROXIMAL TO PROJECT COMPONENT: Z248714

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 622018 North: 3616112

BEARING (degrees) to PROJECT COMPONENT: 178

DISTANCE (meters) to PROJECT COMPONENT: 47

CARCASS DESCRIPTION

SPECIES: VESP ID: 20150922_03 Tag/Band Number: None

AGE: Adult SEX: Unknown CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 day

CAUSE OF DEATH: Presumed Collision

OBSERVABLE INJURIES: Head Trauma

SUBSTRATE/GROUND COVER *(at carcass location):* Bare Ground

DISPOSITION OF CARCASS[1]: left in place

NOTES: Bird has a broken neck and rigor mortis has not yet set in.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 79 CLOUD COVER: cloudy

PRECIPITATION (last 24 hours): none WIND DIRECTION: South WIND SPEED: 0-10

PHOTOGRAPHS:

Due to technical difficulties, no photographs are available

CENTINELA SOLAR ENERGY PROJECT MORTALITY REPORTING FORM

DATE: 10/13/2015 **TIME: 6:33 AM** **OBSERVER: kquint**

PROXIMAL TO PROJECT COMPONENT: Z248712

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 622645 North: 3616142

BEARING (degrees) to PROJECT COMPONENT: -139

DISTANCE (meters) to PROJECT COMPONENT: 33

CARCASS DESCRIPTION

SPECIES: house wren ID: 20151013_01 Tag/Band Number: None

AGE: Unknown SEX: Unknown CONDITION: Intact

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 day

CAUSE OF DEATH: Unknown

OBSERVABLE INJURIES: Broken Wing(s)

SUBSTRATE/GROUND COVER *(at carcass location):* Below Ankle

DISPOSITION OF CARCASS[1]: left in place

NOTES: Ants actively scavenging otherwise intact carcass.

WEATHER CONDITIONS

AIR TEMPERATURE (degrees fahrenheit): 76-84 CLOUD COVER: clear

PRECIPITATION (last 24 hours): none WIND DIRECTION: East WIND SPEED: 0-10

PHOTOGRAPHS:

	**Photograph 1.** House wren 20151013_01
	**Photograph 2.** House wren 20151013_01
	**Photograph 3.** Habitat surrounding house wren 20151013_01
	**Photograph 4.** Nearest project feature to house wren 20151013_01

DEPARTMENT OF FISH AND GAME
LAW ENFORCEMENT DIVISION

EVIDENCE/ PROPERTY TRACKING FORM

SUSPECT'S NAME: LAST FIRST MI Solar Partners I,II,VII LLC		CDL N/A	D.O.B. N/A
DATE OF VIOLATION: N/A	CITATION #: N/A	SEIZED BY: CYRUS MOPTADERI	
COURT: San Bernardino	CASE/ DOCKET #: N/A	STORAGE LOCATION:	

WAS FIREARMS DATA FORWARDED TO DISPATCH FOR CLETS ENTRY? YES ☐ NO ☐ N/A ☒

ITEM DESCRIPTION

(FOR ADDITIONAL ITEMS USE ENF-50A)

SERIAL #	DESCRIPTION (Include Make and Model)	EVENT #
1	Bank Swallow	

LOG IN DATA

DATE LOGGED IN:	LOGGED IN BY:	RECEIVED BY:

LOG OUT DATA

HAS EVIDENCE BEEN FORFIETED? YES ☐ NO ☐

ARE ALL FORFEITURE DOCUMENTS COMPLETE? YES ☐ NO ☐

HAS EVIDENCE BEEN TRANSFERRED TO APPROPRIATE LOCATION FOR FINAL DISPOSITION? YES ☐ NO ☐

RELEASED BY:	RECEIVED BY:	DATE:

CHAIN OF CUSTODY

ITEM #	DATE	FROM	TO	LOCATION	DISPOSITION
1	3 SEP	IIS 640358 3933539	OFFICE FREEZER	ISEGS SITE	DEAD
	" "	OFFICE FREEZER	WILDLIFE LAB VIA FEDEX.		" "
1	9/8/15	Fed Ex	K.Rogers, WIL	Freezer Ranch. Cordova, CA	frozen carcass

DISPOSITION INFORMATION

(CHECK APPROPRIATE ANSWERS)

ARE FORFEITURE DOCUMENTS FILED WITH THE COURT: YES ☐ NO ☐

IS A COURT RECIEPT SUFFICIENT FOR RELEASE? YES ☐ NO ☐ HAS ONE BEEN ISSUED? YES ☐ NO ☐

IS A FORMAL ORDER REQUIRED FOR RELEASE? YES ☐ NO ☐ HAS ONE BEEN ISSUED? YES ☐ NO ☐

****FAX TO APPROPRIATE PROPERTY OFFICER AND SUPERVISOR****

ENF-50 (1/09)

N15-609
rec'd 9/8/15

3 September 2015

Enclosed is the requested carcass, Bank Swallow (*Riparia riparia)*. This bird is incident 2015_422_ISEGS, according to naming convention used for all on-site fatalities. UTMs and details are provided on the enclosed card (with the carcass). The bird has been processed, documented, and archived as required by our SPUT guidelines on site (ISEGS).

As Field Lead for the WEST-Inc Avian/Bat Team, I collected, processed, and shipped this bird personally. Detailed documentation (including age/sex, carcass notes, discovery notes) are documented on site, and available if required.

Please contact Doug Davis, site representative, or myself for further information.

Copies of our SPUT and SCP permits are attached.

Cyrus Moqtaderi

WEST-INC Field Lead

Phone: 307-630-1335

Coordinates provided:
DD WGS84
35.5355545, -115.451764
Unit 1 Street 302

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Topaz Solar Farm
10400 Helios Way
Santa Margarita, California 93453

Delivered via Electronic Mail

2014 Second Quarterly Report

COA 62 Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan Quarterly Report

July 10, 2014

Discussion

The enclosed report has been prepared to address the reporting requirements for Condition of Approval (COA) 62 Bird Monitoring and Avoidance Plan (BMAP). This plan is merged with the Avian and Bat Protection Plan (ABPP), comprising a comprehensive avian management plan for the Topaz project.

In response to COA 62, the Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP/BMAP) has been prepared, which further describes the approach to implementing the condition requirements.

COA 62 requires quarterly and annual reports. Quarterly reports are required during construction and for three years following the beginning of plant operation.

Following the completion of the fourth quarter of monitoring the biologist shall prepare an annual report that summarizes the year's data, analyzes any project-related bird fatalities or injuries detected, and provides recommendations (in consultation with the County) for future monitoring and any adaptive management actions needed.

Quarterly Reportable Items

COA 62 BMAP requires quarterly reports describing the dates, durations, and results of monitoring and data collection. The quarterly reports shall provide a detailed description of any project-related bird or wildlife deaths or injuries detected during the monitoring study or at any other time.

Report Data

Attached is the quarterly report prepared by Althouse & Meade (COA 62 and ABPP Quarterly Monitoring Report by Althouse & Meade April 01- June 30, 2014.

If there are questions regarding this report, please contact:

Jason Dart
Topaz Site Compliance Manager
Topaz Solar Farm
10400 Helios Way
Santa Margarita, CA

Topaz Solar Farms

COA 62 Year 3 Second Quarter Report

April 1 – June 30, 2014

for

Avian and Bat Protection Plan

and

Bird Monitoring and Avoidance Plan

House finch nestlings (left), horned lark (center), horned lark nest (right), Topaz Solar Farms 2014. Photographs by P. Gaede.

Prepared for

Topaz Solar Farms LLC
10400 Helios Way
Santa Margarita, CA 93453

By

ALTHOUSE AND MEADE, INC.
BIOLOGICAL AND ENVIRONMENTAL SERVICES
1602 Spring Street
Paso Robles, CA 93446
(805) 237-9626

July 2014

654.48

Table of Contents

Tables

Figures

Exhibits

1.0 Introduction

This Year 3 Second Quarter report provides bird and bat information as specified in the Topaz Solar Farms Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP and BMAP; Althouse and Meade, Inc. June 2011). Section 5.5 of the ABPP and BMAP describes information to be included in reports and requires quarterly reports to be submitted to the County of San Luis Obispo (County), U.S. Fish and Wildlife Service (USFW) and the California Department of Fish and Wildlife (CDFW). The Avian and Bat Protection Plan (ABPP; Section 2.0) and Bird Monitoring and Avoidance Plan (BMAP; Section 3.0) are requirements of County of San Luis Obispo Conditions of Approval (COA) 61 and 62, and were prepared in consultation with USFWS and CDFW.

1.1 Construction Status

Construction of Blocks 1-9 was completed in 2013, and Blocks 10-17 were completed in 2014 by the end of June (Table 1). All completed blocks were transferred to and are now managed by Operations and Maintenance (O&M). Exhibit 1 illustrates construction status of Blocks through June 2014.

TABLE 1. CONSTRUCTION STATUS BY BLOCK. Date of transfer to O&M is provided for Blocks 1-17. Bold indicates transfer during 2nd quarter.

Block(s)	Month and Year Transferred to O&M	Block(s)	Month and Year Transferred to O&M
1	March 2013	**12**	**May 2014**
2	March 2013	**13**	**May 2014**
3	March 2013	14	January 2014
4	April 2013	15	February 2014
5	April 2013	**16**	**May 2014**
6	March 2013	**17**	**June 2014**
7	May 2013	18	-
8	June 2013	19	-
9	July 2013	20	-
10	March 2014	21	-
11	**May 2014**	22	-

2.0 Avian and Bat Protection Plan

The ABPP monitoring program compiles general information on bird and bat presence, interactions with facility components, injuries, and mortality at the Topaz Solar Farms (TSF). During construction phases of the project this task is completed by the project biologists, as part of routine daily biological monitoring. In blocks under Operations and Maintenance (O&M) control, data is collected from a variety of sources, including pre-activity surveys, O&M technician reports, and during field work conducted for BMAP studies. Information regarding the detailed bird use and mortality risk assessment study is reported in Section 3.0.

For the ABPP, this quarterly report provides information collected during active construction in Blocks 11-13 and 16-22, spanning the period from April 1 through June 30, 2014

2.1 General Bird Surveys

2.1.1 Methods

General bird surveys are conducted on and around active construction areas of TSF project site on a daily basis seven days a week throughout the year by project biologists. Lists of bird species observed by each biological monitor are recorded on daily construction monitoring forms, which are then scanned, archived, and reviewed by project ornithologists Peter Gaede and Jason Dart.

2.1.2 Results

Monitors recorded a total of 82 species of birds in April, May, and June 2014 and an additional five birds not identified to species. Of those 82 species, 8 were waterbirds and 8 were raptors. Some of the 8 waterbird species were observed in lands surrounding Topaz including a private pond less than a thousand feet from TSF, and others were observed flying over TSF without using project features as habitat. Demolition of the TSF dust control pond (DCP) occurred during this reporting period; the DCP was where most onsite waterbird detections were recorded. Table 1 lists all bird species observed in this quarter with information on observation frequency.

TABLE 2. APRIL – JUNE 2014 GENERAL BIRD SURVEY RESULTS. All bird species recorded this quarter are listed. Top twenty species most frequently observed, waterbirds, and raptors are indicated.

Species	Most Frequent	Waterbird	Raptor
American Kestrel			✓
American Pipet			
Anna's Hummingbird			
Ash-Throated Flycatcher			
Bald Eagle		✓	✓
Barn Swallow			
Black Phoebe			
Black-Chinned Hummingbird			
Black-Headed Grosbeak			
Black-Throated Gray Warbler			
Blue Grosbeak			
Brewer’s Blackbird	✓		
Brown-Headed Cowbird			
Bullock's Oriole	✓		
Burrowing Owl	✓		✓
California Thrasher			
California Towhee			
Calliope Hummingbird			
Cassin's Kingbird	✓		
Chipping Sparrow			
Cliff Swallow	✓		
Common Raven	✓		
Common Yellowthroat			
Dusky Flycatcher			
Eurasian Collared Dove	✓		
European Starling	✓		
Ferruginous Hawk			✓
Golden-Crowned Sparrow			
Golden Eagle			✓
Gray Flycatcher			
Greater Roadrunner			
Greater Yellowlegs		✓	
Great-Tailed Grackle			
Green Heron		✓	
Hammond's Flycatcher			
Horned Lark	✓		
House Finch	✓		
House Sparrow	✓		
Killdeer		✓	
Lark Sparrow			
Lawrence's Goldfinch			
Lesser Goldfinch			
Lincoln's Sparrow			
Loggerhead Shrike			
Long-Billed Curlew		✓	
Mourning Dove	✓		
Nashville Warbler			
Northern Rough-Winged Swallow			
Orange-Crowned Warbler			
Pacific-Slope Flycatcher			
Prairie Falcon	✓		✓
Red-Tailed Hawk	✓		✓

Species	Most Frequent	Waterbird	Raptor
Red-Winged Blackbird			
Rock Pigeon	✓		
Ruby-Crowned Kinglet			
Rufous Hummingbird			
Savannah Sparrow	✓		
Say's Phoebe	✓		
Summer Tanager			
Swainson's Hawk			✓
Swainson's Thrush			
Tree Swallow			
Tri-Colored Blackbird			
Turkey Vulture	✓		
Unidentified Hummingbird sp.			
Unidentified Sandpiper sp.		✓	
Unidentified Swallow sp.			
Unidentified Swift sp.			
Unidentified Yellowlegs sp.		✓	
Vaux's Swift			
Vermilion Flycatcher			
Vesper Sparrow			
Violet-Green Swallow			
Warbling Vireo			
Western Kingbird	✓		
Western Meadowlark	✓		
Western Scrub-Jay			
Western Tanager			
Western Wood- Pewee			
White-Crowned Sparrow			
White-Faced Ibis		✓	
White-Throated Swift			
Willow Flycatcher			
Wilson's Warbler			
Yellow Warbler			
Yellow-Headed Blackbird			
Yellow-Rumped Warbler			

2.2 Nesting Activity

2.2.1 Methods

Focused nest surveys were conducted daily on and around the TSF project components under construction by biological monitors starting February 1, 2014. All nest surveys were conducted on foot by trained biologists. Strategically selected array areas near active construction were identified at the beginning of each week where surveyors walked all array rows searching for nests on the ground or on structures. Additionally, an area 300 feet around all perimeter fences of active construction areas was surveyed twice per week, per the approved Nesting Bird Management Plan (Althouse and Meade, Inc. 2013). Laydowns and move-on areas were surveyed as often as possible to prevent birds establishing nests in equipment and materials. Nests were also found by construction personnel in their work areas or incidentally found by biologists while monitoring construction activities. Nest starts were removed when the presence of a complete nest would conflict with construction activities or would present a danger to the birds. All nests and nest starts were documented. Nests identified from April to June 2014 in active construction areas are included in this report.

2.2.2 Results

The results of surveys from April through June 2014 are provided in Table 3. Other species identified nesting offsite (e.g. mitigation lands, future project lands, or areas managed by Operations and Maintenance) are not included in this table. Six horned lark nest starts were removed from construction areas during this quarter, as well as seven western kingbird and eleven house finch nest starts from equipment and materials. Many of these nest starts were multiple attempts by the same pair of birds, particularly the kingbirds. All nest starts were removed prior to being deemed complete by the Project Ornithologist. A nest was deemed complete when it was lined and ready to accept eggs. Common ravens and one pair of red-tailed hawks built nests on the PG&E transmission line power poles near the project, and ravens nested on several of the onsite medium voltage collector line poles.

A total of 71 horned lark nests were active in and near the construction areas of TSF during the second quarter of 2014 (Table 3 and Exhibit 2). Sixteen (23%) of the 71 nests fledged or were presumed to fledge successfully. Fifty-one (72%) of the nests failed. Three categories are distinguished for causes of nest failure: known/probable predation (39 nests, 55%), unknown (7 nests, 10%), and abandoned (5 nests, 7 %). Status of nest fledging could not be confidently determined for four (6%) of the 71 horned lark nests.

Eleven house finch nests were documented during the reporting period, eight (67%) of which fledged successfully. The remaining four (33%) nests failed due to several factors, as out lined in Table 3.

Of the five common raven nests, four (80%) fledged successfully and one (20%) failed due to unknown causes.

Only one mourning dove nest was located during the reporting period; it failed likely due to predation.

A red-tailed hawk nest on PGE transmission towers north of Block 11 was monitored during this reporting period; nestlings successfully fledged.

Exhibit 2 in Section 5.0 is a map of bird nests in and near areas of active construction April through June 2014.

TABLE 3. APRIL – JUNE 2014 BIRD NESTS. Active bird nests detected at Topaz Solar Farms from April to June 2014 in active construction areas.

Species	**Final Status**	**Number of Nests**	**Percent of Total**
Horned Lark	Fledged- Known/Probable	16	23
	Failed- Known/Probable Predation	39	55
	Failed- Unknown	7	10
	Failed- Abandoned	5	7
	Unknown	4	6
	Total	**71**	**-**
House Finch	Fledged- Known/Probable	8	67
	Failed- Abandoned	1	8
	Failed- Project Related[1]	1	8
	Failed- Known/Probable Predation	1	8
	Failed- Unknown	1	8
	Total	**12**	**-**
Common Raven	Fledged- Known/Probable[2]	4	80
	Failed- Unknown	1	20
	Total	**5**	**-**
Mourning Dove	Failed- Known/Probable Predation	1	100
	Total	**1**	**-**
Red-Tailed Hawk	Fledged- Known/Probable	1	100
	Total	**1**	**-**
	Grand Total	**90**	**100**
	Total Fledged	**29**	**32**
	Total Failed	**57**	**63**
	Total Unknown	**4**	**4**

---

[1] One house finch nest was abandoned due to the nest being transported on material approximately a mile across the site. The nest was returned to the location where it was found but the parents did not return. The five nestlings perished despite being taken to Pacific Wildlife Care the next day.

[2] One common raven nest was considered a success, although when the single nestling attempted to fledge, its foot became entangled in nesting material and it perished.

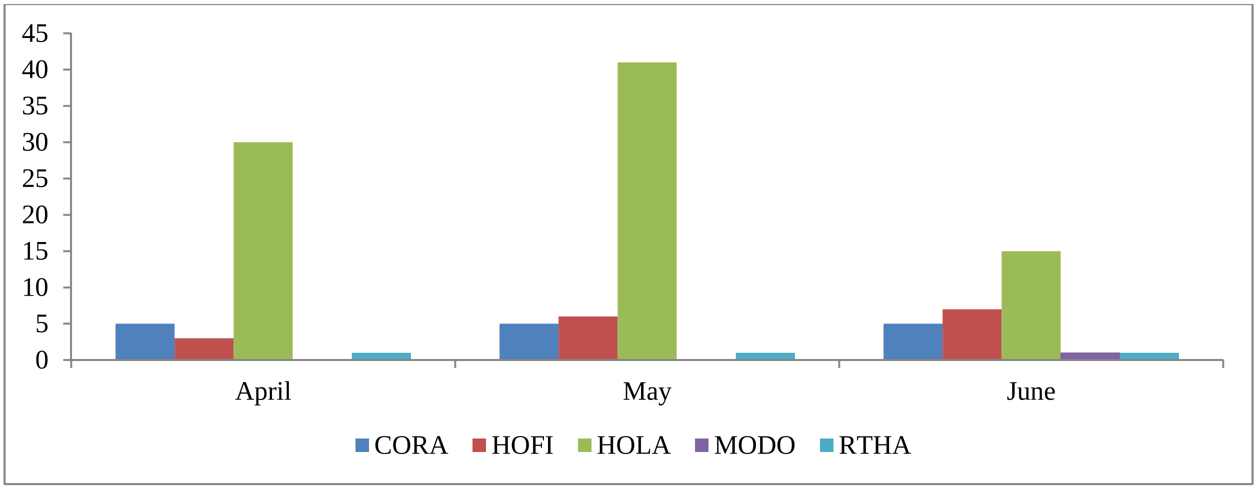


FIGURE 1. COUNT OF ACTIVE BIRD NESTS BY SPECIES AND MONTH. Bird nests detected at Topaz Solar Farms from April to June 2014 by species and month. Species abbreviations are as follows: CORA Common Raven, HOFI House Finch, HOLA Horned Lark, MODO Mourning Dove, RTHA Red-Tailed Hawk. Some nests, such as the ravens and hawks, were active during multiple months.

2.3 Avian and Other Wildlife Mortality

General biological monitoring of the Topaz work area documented bird, bat, and other wildlife mortality. All mortality identified on site during this reporting period is provided in Table 4. Cause of death is reported when known. Several of the avian fatalities identified were feather spots so predation as a cause of death could not be confirmed. Additionally, none of the collisions documented were with solar panels; the horned larks chased each other while exhibiting breeding behavior and collided with posts or windows. Snakes crossing roads or sunning themselves would often be run over by traffic throughout active construction areas. This table includes all fatalities found in active construction areas as well as areas managed by Commissioning or Operations and Maintenance.

TABLE 4. APRIL – JUNE 2014 AVIAN AND OTHER WILDLIFE MORTALITY. Bird and other wildlife mortality detected at the Topaz Solar Farms from April to June 2014. Asterisk indicates it was found during formal fatality surveys.

Month	Species	Location	Cause of Death
April	California Ground Squirrel	Helios Way	Vehicle Strike
	Common Raven*	Block 13 Powerline	Probable Collision
	Deer Mouse	Block 17	Equipment Crush
	Deer Mouse	Block 21	Unknown
	Gopher Snake	Block 19	Vehicle Strike
	Gopher Snake	First Solar Laydown	Vehicle Strike
	Gopher Snake	Block 18 Road	Vehicle Strike
	Horned Lark	Block 18	Probable Collision
	Horned Lark	Block 19	Collision
	Horned Lark Nestling	Block 19	Abandonment
	House Finch	Helios Way	Vehicle Strike

Month	Species	Location	Cause of Death
	Mourning Dove*	Block 12	Probable Predation
	Mourning Dove	Block 16	Probable Predation
	Western Kingbird*	Block 12	Probable Predation
	Western Meadowlark	Block 3	Probable Predation
May	California Towhee	Block 17 Move-On	Vehicle Strike
	Common Raven	Block 11 Powerline	Unknown
	Deer Mouse	Block 21	Drowned
	Gopher Snake	Block 18	Vehicle Strike
	Horned Lark	O&M Building	Window Collision
	Horned Lark	Block 19	Predation
	Northern Pacific Rattlesnake	Energy Place	Vehicle Strike
June	Common Raven	Block 1	Predation
	Common Raven	Block 15	Probable Predation
	Common Raven	Block 15	Probable Predation
	Common Raven	Block 8	Electrocution
	Common Raven	Block 7 Powerline	Entangled in Nesting Material
	Deer Mouse (4)	Block 20	Starvation
	Domestic Chicken*	Block 13	Probable Predation
	Domestic Chicken	Block 12	Probable Predation
	Domestic Chicken	Block 17	Predation
	Domestic Chicken	Cupertino Laydown	Predation
	Gopher Snake	Block 22	Vehicle Strike
	Gopher Snake	Block 22	Vehicle Strike
	Gopher Snake	Block 19	Unknown
	Horned Lark Fledgling	Block 17 Move-On	Vehicle Strike
	House Finch Nestlings (5)	Block 18	Construction Translocation
	Northern Pacific Rattlesnake	Block 20	Vehicle Strike

2.4 Adaptive Management

No adaptive management practices were implemented during the period from April through June 2014.

2.5 Bat Surveys

2.5.1 Methods

Acoustic monitoring surveys for bats on the project site were conducted at least one night per month using a Pettersson D240x (Pettersson Elektronik, Sweden) bat detector and Sonobat® (v.3.1 US west; DNDesign, Arcata, CA) acoustic analysis software. Sound frequencies between 10 and 120 kHz, the range utilized by bats, were detected and synthesized into time-expanded sound files and analyzed by Sonobat® software. Surveys were initiated near dusk, when bats commonly begin nightly foraging activities. Monitoring periods for each survey were limited to the battery-life of the Pettersson detector and typically ranged from three to six hours depending on the number of sound files detected. On April 23, 2014, the detector was placed on an extendable pole on a t-post between the Topaz Solar Farms substation and the PG&E switching station. On May 30, the detector was placed on a perimeter fencepost in the southwest corner of Block 19. On June 13, the detector was placed on a barb-wire fence post on the western edge of the Stewardship land west of Block 22, bordering the neighboring olive orchard. On June 20, the detector was placed in the northwestern corner of the Phase 6 Block 20 laydown yard. All detected bat calls were identified using the analysis software.

2.5.2 Results

On June 13, 2014 canyon bats (*Parastrellus hesperus*) were detected in the vicinity of Topaz Solar Farms; two detections consisting of 6 and 8 calls each were recorded. On June 20, 2014 two canyon bat detections of 7 and 8 calls and six Mexican free-tailed bat detections of 3 or 4 calls each were recorded within the work area of Topaz Solar Farms.

Canyon bats, formerly called western pipistrelles, are one of the smallest bats in California. They are typically considered a desert species and primarily roost in canyon and cliff sides, but may also roost in caves, mines, or buildings. Canyon bats tend to roost singly or in very small groups. They are among the most diurnal of bats and often begin foraging before sunset and continue until well after dusk. Canyon bats are considered common throughout their range. In the Carrizo Plain area, they likely roost in rocky outcroppings, cliff faces, as well as old structures.

Mexican free-tailed bats primarily roost in caves, but are frequently found in cavities under bridges and in buildings, where they roost gregariously. They may also roost singly or in small groups in large tree cavities. This species is common throughout the County. Maternity colonies form in spring and pups are born in the summer. Mexican free-tailed bats are one of the most widely distributed mammalian species in the Western Hemisphere and may fly more than 50 km a night to reach foraging areas. In the Carrizo Plain area, old barns and outbuildings likely provide abundant roosting sites for Mexican free-tailed bats.

The results of the April and May surveys showed no bat detections; however, sound files from the survey suggest the presence of acoustic interference with the detector. Table 5 provides a list of the number of detections of each bat species detected from April through June 2014. Each detection was assigned to species with a discrimination probability of 0.95 or higher.

No bat roosts are known to be present within or near the Topaz project site.

TABLE 5. TOPAZ SOLAR FARMS APRIL TO JUNE 2014 BAT SURVEYS. Bat acoustic monitoring survey dates, bat species detected at the Topaz Solar Farms project, and number of detections. Special status designations from CDFW and Western Bat Working Group (WBWG) are provided.

Survey Date	**Location**	**Total Detections**	**Common Name**	**Scientific Name**	**CDFW Status**	**WBWG Status**
4/23/2014	Substation	0	--	--	--	--
5/30/2014	Block 19	0	--	--	--	--
6/13/2014	Mitigation Section 31	2	Canyon bat	*Parastrellus hesperus*	None	None
6/20/2014	Conti Laydown	2	Canyon bat	*Parastrellus hesperus*	None	None
6/20/2014	Conti Laydown	6	Mexican [=Brazilian] free-tailed bat	*Tadarida brasiliensis*	None	Low

3.0 Bird Monitoring and Avoidance Plan

The BMAP study analyzes avian use surveys and avian fatality surveys to produce a risk index for various project components deemed to be potentially dangerous to birds, including array areas, overhead power lines and the Substation. Offsite grassland reference sites are used to gauge background mortality levels. Results are reported in this second quarterly report for Avian Use Surveys (Section 3.1), Avian Fatality Surveys (Section 3.2), and for bias trials (Section 3.3). Risk index calculations will be provided in the annual report.

3.1 Avian Use Surveys

3.1.1 Methods

Avian Use Surveys were conducted monthly from November 2011 through June 2014, and will continue throughout the construction period and for three years after construction is complete. Each month, 63 randomly selected survey points are completed, including 31 inside existing array areas, 18 along existing overhead power lines, 10 in grassland reference sites and 4 at energized equipment (substation). At each point, a 10 minute bird use count is conducted within a 50 meter radius of the surveyor. Avian Use Survey points are randomly selected each month across all six phases of the project and in offsite grassland reference areas (Exhibit 3).

3.1.2 Results

The four Survey Area Categories used as treatment types in this study comprise different habitat elements that influence species composition, abundance, and richness.

The Array Area category includes point counts conducted within solar array areas during active construction and in completed form. The habitat consists of rows of passive (non-moving) photovoltaic solar panels mounted to steel racking ranging from approximately 2 to 5 feet off the ground. The ground is seeded with a native seed mix to revegetate array areas to naturalized grassland habitat; vegetation density varied from 0 to 60 percent cover. Array Area survey point areas may also include perimeter fences, photovoltaic combining switchgear houses, as well as array roads.

The Energized Equipment category includes point counts conducted around the perimeter of the substation. The survey area includes the substation perimeter fence, transformers, power lines, and other electrical components. Within the substation fence the ground is gravel with no vegetation. Outside the perimeter fence, the ground is bare dirt with some patches of grass.

Overhead Powerline surveys represent areas underneath medium-voltage collector lines within the project. Vegetation varies depending on location; most powerlines are along array or perimeter access roads, however some locations are outside the fenced project areas in annual grassland habitat.

Reference Sites are composed of annual grassland habitat. They included point counts conducted on annual grassland in mitigation lands owned by California Department of Fish and Wildlife or Stewardship Land not developed by TSF.

In April, May, and June 2014, 189 avian point counts were conducted in the four survey area categories totaling 366.8 acres of survey area. During these surveys, 21 different bird species were observed (Table 6). The 10 most abundantly detected species, listed in decreasing order of abundance, were: horned lark (568 detections), common raven (46), house finch (36), western kingbird (18), mourning dove (12), European starling (10), turkey vulture (7), brewer's blackbird (6), tricolored blackbird (6), and red-tailed hawk (5). The most frequently encountered species, the horned lark, was detected more than twelve times as often as that of that of the second most frequently encountered species, the common raven. Horned larks are abundant year-around residents that nested within and around the TSF project site in high numbers in spring 2014. Both the horned lark and common raven were detected in high numbers in all project component categories and up to 51 percent less frequently in the Reference Site category.

TABLE 6. SPECIES COMPOSITION AND ABUNDANCE. All bird species detected during Avian Use Surveys in April, May and June 2014, with the average number of bird use detections per observation point calculated for each of the four survey area categories. Total detections for each species and each survey area type are provided in far right column and bottom row. Species are listed in decreasing order of abundance according to the total detections column.

Species	**Array Area** Ave. Detections per Obs. Pt.	**Energized Equipment** Ave. Detections per Obs. Pt.	**Overhead Powerline** Ave. Detections per Obs. Pt.	**Grassland/ Reference** Ave. Detections per Obs. Pt.	**Total Species Detections**
Horned Lark	4.63	1.42	1.06	2.10	568
Common Raven	0.25	0.17	0.31	0.13	46
House Finch	0.26	1.00	0.00	0.00	36
Western Kingbird	0.01	0.42	0.17	0.10	18
Mourning Dove	0.12	0.08	0.00	0.00	12
European Starling	0.05	0.08	0.06	0.03	10
Turkey Vulture	0.00	0.00	0.11	0.03	7
Brewer's Blackbird	0.02	0.00	0.07	0.00	6
Tricolored Blackbird	0.06	0.00	0.00	0.00	6
Red-tailed Hawk	0.02	0.00	0.06	0.00	5
Western Meadowlark	0.03	0.00	0.00	0.03	4
House Sparrow	0.00	0.08	0.04	0.00	3
Savannah Sparrow	0.02	0.00	0.02	0.00	3
Bullock's Oriole	0.02	0.00	0.00	0.00	2
Hummingbird sp.	0.01	0.00	0.02	0.00	2
Barn Swallow	0.01	0.00	0.00	0.00	1
Cliff Swallow	0.00	0.00	0.00	0.03	1
Eurasian Collared-Dove	0.00	0.08	0.00	0.00	1
Prairie Falcon	0.01	0.00	0.00	0.00	1
Say's Phoebe	0.00	0.00	0.00	0.03	1
Vesper Sparrow	0.01	0.00	0.00	0.00	1
Total Avian Detections	**516**	**40**	**103**	**75**	**734**

Species richness was calculated as the average number of species detected at each Observation Point. Among the treatment types, Energized Equipment had the highest species richness with an overall average of 1.67 species detected per Observation Point. Array Area had the next highest with an average of 1.30 species. Reference Site and Overhead Powerline categories were similar, with 0.80 and 0.93 species detected per Observation Point (Table 7 and Figure 2). The Energized Equipment species richness is about twice that of the undeveloped grassland sites.

Bird Utilization Rate (BUR) is calculated as the average number of birds observed per Observation Point count. Bird Utilization Rate is calculated for the four Survey Area Categories for April – June 2014 (Table 7 and Figure 2). Array Areas had the highest BUR at 5.55 birds per Observation Point. With 3.33 and 2.50 birds per Observation Point, Energized Equipment and Reference Site categories had the second and third highest BUR, and Overhead Powerline had the lowest BUR at 1.91 birds per Observation Point.

TABLE 7. AVIAN USE SURVEY POINT COUNTS AND DETECTIONS. Avian use survey point count data is provided for number of observation point counts, total area surveyed, total number of species detected, species richness and bird utilization rate. All results are from data collected in April, May and June 2014.

Type	**Number of Obs. Pt. Counts**	**Total Area Surveyed (Acres)**	**Total No. Species**	**Ave. No. Species per Obs. Pt (Species Richness)**	**Ave. No. Birds per Obs. Pt (BUR)**
Array Area	93	180.49	16	1.30	5.55
Energized Equipment	12	23.29	8	1.67	3.33
Overhead Powerline	54	104.80	10	0.93	1.91
Reference Site	30	58.22	8	0.80	2.50
Total	**189**	**366.80**	**21**	**1.14**	**3.88**

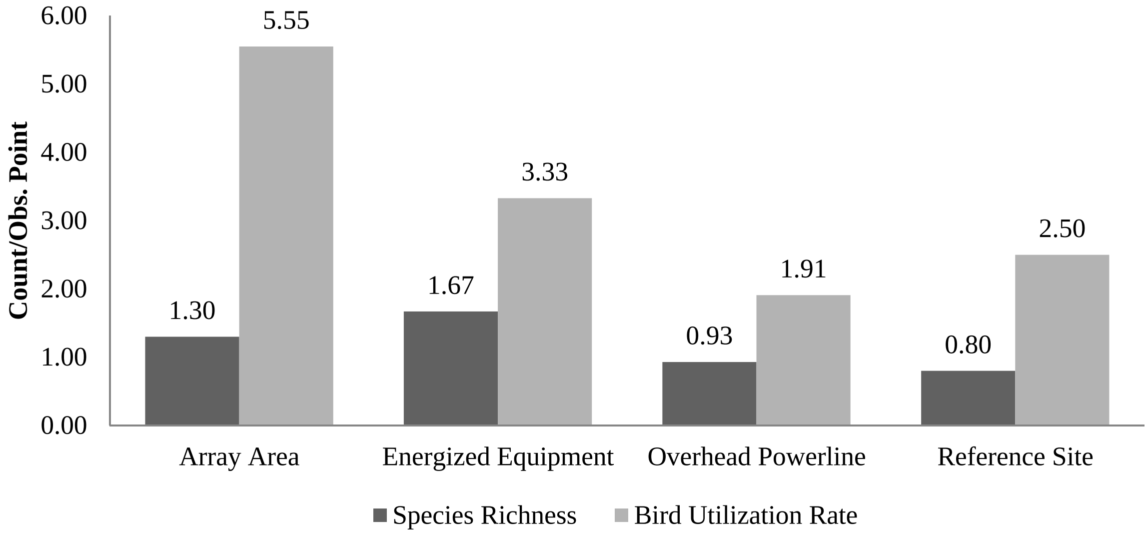


FIGURE 2. SPECIES RICHNESS AND BIRD UTILIZATION RATE. Species richness and bird utilization rate are provided for each of the four survey area categories.

.

3.2 Avian Fatality Surveys

3.2.1 Methods

Avian Fatality Surveys commenced upon completion of the first project components. Avian Fatality Surveys are conducted at randomly selected locations within four different survey area categories: Array Area, Overhead Powerline, Energized Equipment (Substation) and Reference Site. Search plots for Array Area, Reference Site, and Overhead Powerline were defined as a transect 14 feet wide and 480 feet long, or the area of a typical aisle in a PV array. The area searched in the Array Area and Reference Site each month are equivalent to approximately three PV arrays. The search plot for Energized Equipment is the entire area of the substation, which is 4.48 acres. All survey areas except Energized Equipment are randomly selected using an ArcGIS random point generator having defined areas as the constraining polygon. Avian Fatality Surveys are conducted within the same search plots each day for seven consecutive days every month. Repetitive surveys increase the chance of finding fatalities in a given area before predators remove the carcass, and also facilitate per day calculations.

3.2.2 Results

Each month, April through June 2014, we completed walking Avian Fatality Surveys for all transects within each of the Survey Area Categories for seven consecutive days each. Reference Site search plots were completed for seven consecutive days each, totaling 72.5 linear miles (123.1 acres) each month. Array Area search plots were completed for seven consecutive days each, totaling 72.5 linear miles (123.1 acres) each month. Overhead Powerline search plots were completed for seven consecutive days each, totaling 7.6 linear miles (13.0 acres) for April and May. In June, the powerline survey effort was increased to a total of 15.3 linear miles (25.9 acres). Energized Equipment was also surveyed for seven consecutive days, totaling 31.4 acres. See Exhibit 4 in Section 5.0 for a map of Avian Fatality Survey areas for April to June 2014.

Three months of surveys yielded a total distance of 465.7 linear miles and coverage of 884.6 acres. These surveys resulted in discovery of five fatalities, one each in Reference Site and Overhead Powerline, and three in Array Area. Fatality rates were calculated per search plot and mile walked (Table 8). Although only one fatality was found along the Powerline, it had the fewest search plots and therefore the highest fatality rate of 0.0030 fatalities/search plot. Array Areas had 3 fatalities and the second highest fatality rate of 0.0013 fatalities/search plot. In contrast, the same total acreage surveyed in Reference Site yielded only one fatality and therefore had a lower fatality rate of 0.0004 fatalities/search plot.

TABLE 8. BIRD FATALITY RATE. The survey results and efforts are indicated for each of the four survey area categories for the second quarter of 2014.

Survey Area Category	**Linear Miles**	**Acres**	**Search Plots**	**Total Fatalities**	**Fatality/ Search Plot**	**Fatality/ Mile**
Array Area	217.6	369.3	2394	3	0.0013	0.0138
Overhead Powerline	30.5	51.9	336	1	0.0030	0.0328
Reference Site	217.6	369.3	2394	1	0.0004	0.0046
Energized Equipment	-	94.1	21	0	0.0000	-
Total	**465.7**	**884.6**		**5**		

Cause of death was recorded for all fatalities, when known. The five fatalities documented during Avian Fatality Surveys in April, May, and June 2014 were classified as predation, collision, or unknown. The collision on the powerline was not confirmed, but was given a greater than 50 percent confidence level. Since it is difficult to determine cause of death with certainty, recent guidance from the U.S. Fish and Wildlife Service suggests attributing cause of death to a specific factor and including a confidence percent to indicate how confident the determination was (Table 9; A. Beck and T. Dietsch 2013). Predation as a cause of death is likely higher than reported, as often times a feather pile could not be confidently linked to a predation event as opposed to a scavenging event.

TABLE 9. CAUSE OF DEATH FOR AVIAN FATALITY SURVEY RESULTS. Cause of death tallied for avian fatalities detected within each of the four survey area categories, April – June, during formal avian fatality surveys. Percentages indicate confidence level.

Survey Area Category	Unknown	Predation Probable (>50%)	Collision Probable (>50%)
Array Area	0	3	0
Overhead Powerline	0	0	1
Reference Site	1	0	0
Energized Equipment	0	0	0
Total	**1**	**3**	**1**

3.3 Scavenger/Carcass Removal Trials and Searcher Efficiency Trials

3.3.1 Scavenger/Carcass Removal Trial

Scavenger/carcass removal trials were conducted in May and June 2014. Japanese quail carcasses were randomly placed by the trial administrator in Array Areas. Scavenger trials for Reference Site will be completed during the next quarter. The carcasses were numbered and labeled with a small band of green tape around one leg. Remote wildlife cameras were placed on half of the quail to document the scavenging animal.

Carcass monitoring procedures outlined in the ABPP/BMAP require carcasses to be checked the first three consecutive days after placement, twice a week for the next two weeks, and then once a week for the remainder of the 60 day trial. Monitoring stopped when 100 percent of the carcasses were scavenged. Upon routine monitoring of the carcasses, notes are recorded of the status and condition of the carcass. In these trials, with the exception of a few feathers, the carcass was simply present or not present.

As suspected, carcasses did not last long after they were placed in the Array Areas by the trial administrator. Eighty-five percent of the carcasses were scavenged within the first three days. All carcasses were scavenged within 2 weeks of being placed in the field (Figure 3). Of the ten cameras monitoring quail carcasses, seven captured photos of the predators, with the most common being ravens (Figure 4). Other scavengers include a bobcat, turkey vulture, coyote, and San Joaquin kit fox.

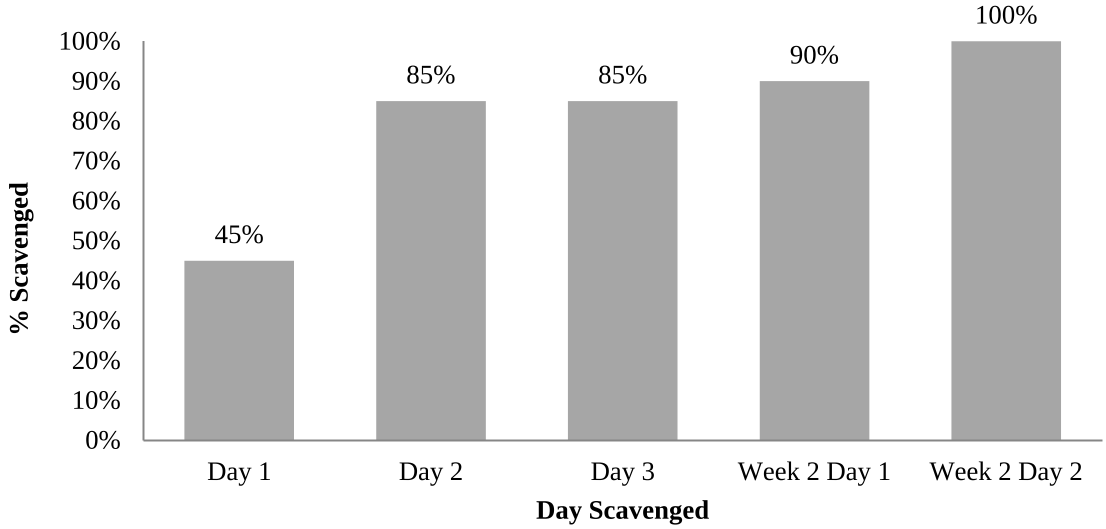


FIGURE 3. PERCENT SCAVENGED BY DAY (CUMULATIVE)-ARRAY AREA. Cumulative percent of carcasses scavenged in Array Areas by day in the June 2014 onsite trial. Percent scavenged is out of 20 quail placed.

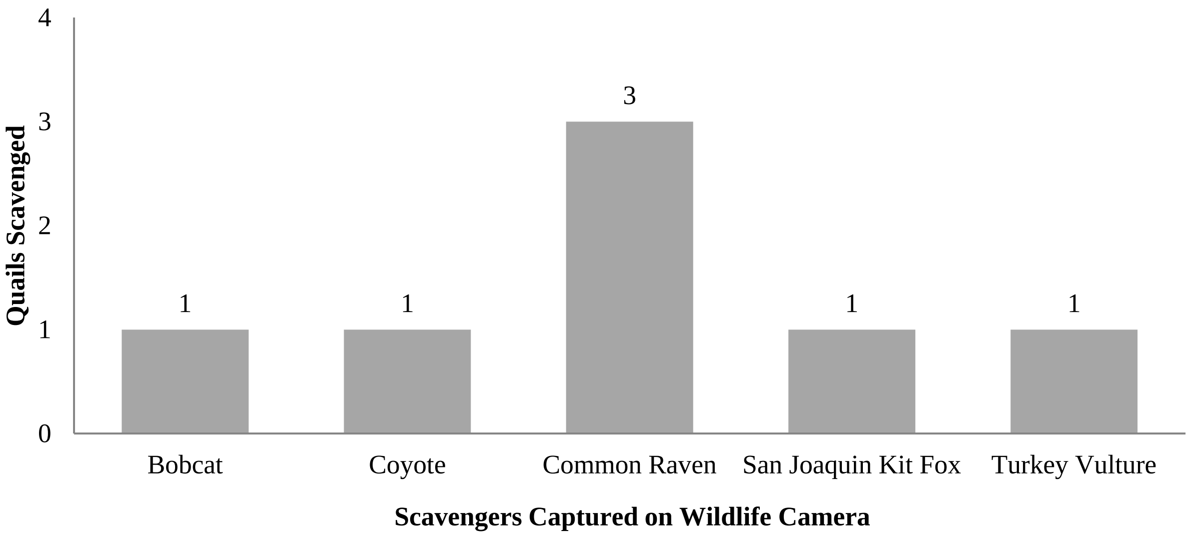


FIGURE 4. SCAVENGERS IDENTIFIED VIA REMOTE CAMERA. Number of quail carcasses scavenged by each predator out of seven photo captures.

3.3.2 Searcher Efficiency Trial

Searcher efficiency trials were conducted in June 2014. Prior to the commencement of the day's Avian Fatality Surveys, Japanese quail carcasses were randomly placed by the trial administrator in the search plots of the scheduled Avian Fatality Surveys, in Array Areas and Reference Site search plots. The trial was conducted blind, meaning carcasses were placed without the knowledge of the surveyors.

After the survey crew completed the day's surveys, the trial administrator performed a follow-up on all the carcasses placed prior to the trial. This was to determine how many of the original carcasses were in place, therefore available for detection, and how many carcasses had been scavenged by wildlife. The carcasses determined to have been scavenged by the time of the follow-up were removed from the detection rate calculation, since it could not be confirmed that the carcass was present when the surveyors were in that area.

Figure 5 provides detection rates for each Array Areas and Reference Site carcass placement in the trial. The detection rate is calculated by dividing the number of carcasses found by the number of carcasses placed minus any that were predated. Array Area detection rate was 60 percent, while Reference Site detection rate averaged 35 percent (Figure 5). Detection rate was higher in the Array Area search plots than in the Reference Site plots most likely because of less vegetation cover that provided greater visibility of the ground surface.

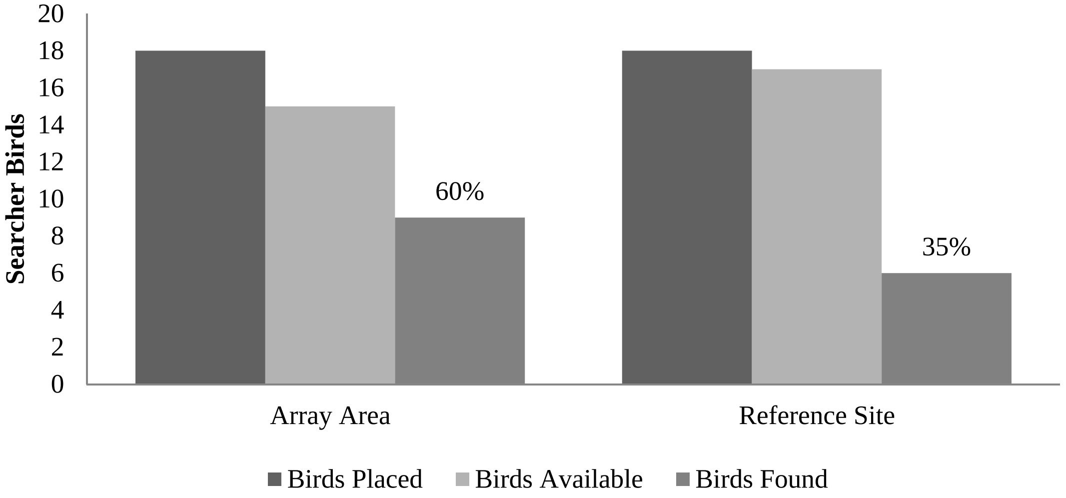


Figure 5. SEARCHER EFFICIENCY TRIAL. Detection rates are provided for Array Area and Reference Site searcher efficiency trials.

3.4 Discussion

The 2014 nesting season resulted in detection of a high number of nests in and near active construction areas, most notably for the horned lark. Horned lark nest success in 2014 was 23 percent, which is comparable to that of 2013 (21.5 percent), even though there were significantly more nests present in 2014 (71 nest) than in 2013 (14 nests). As with last year, predation was the primary cause of nest failure.

During this 2nd quarter reporting period, April, May, and June 2014, unadjusted Fatality Rate in Array Areas was three times higher than that recorded at the grassland Reference Site (0.0013 and 0.0004, respectively). Bird Utilization Rate was more than twice as high in the Array Areas (5.55 birds per Observation Point) than Reference Site (2.50 birds per Observation Point). The Fatality Rate calculated for this quarterly report was not adjusted for searcher and scavenger bias. Searcher efficiency in Array Areas found 1.7 times as many carcasses as in Reference Sites. This highlights the importance of obtaining accurate bias data and making final calculations incorporating the bias data, and the variation that can occur season to season and year to year. The annual report will provide bias adjusted Fatality Rates for all project components over the year. Searcher efficiency and scavenger trials will continue through 2014 to better refine bias data.

One raven was found dead beneath the power lines, with cause of death suspected to be collision (confidence of that determination was listed as probable, >50%). Ravens frequent the power lines, roosting on the poles and lines and nesting on several poles. It was not determined what the raven likely collided with, power pole or power line. A second raven was found dead at the base of a power pole, with cause of death confidently linked to electrocution based on physical examination of the carcass (singed feathers, entry and exit wounds). O&M technicians inspected the pole components and found the wildlife protector cap to be properly situated and no other evidence to suggest the cause of the electrocution. Continued monitoring and increased power line survey effort are being implemented to determine if these are isolated events or if a specific cause can be determined.

4.0 References

Althouse and Meade, Inc. 2011. Topaz Solar Farms Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. June 2011.

Althouse and Meade, Inc. 2013. Topaz Construction Phase Programmatic Nesting Bird Management Plan. Revised August 19, 2013.

Althouse and Meade, Inc. 2014. Topaz Solar Farms 2013 Fourth Quarter/Second Annual Report for Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. March 2014.

Althouse and Meade, Inc. 2014. Topaz Solar Farms COA 62 Year 3 First Quarter Report, January 1 – March 31, 2014 for Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. April 2014.

American Ornithologists Union. 1983. Check-list of North American Birds, 6th ed. Allen Press, Lawrence, KS. 877 pp.

Aspen Environmental Consultants. 2011. Final Environmental Impact Report for the Topaz Solar Farm. March.

Avian Power Line Interaction Committee (APLIC). 2006. *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006*. Edison Electric Institute, APLIC, and the California Energy Commission. Washington D.C. and Sacramento, CA.

Avian Power Line Interaction Committee (APLIC). 2012. *Reducing Avian Collisions with Power Lines: The State of the Art in 2012*. Edison Electric Institute and APLIC. Washington, D.C.

Beck, A. (First Solar) and T. Dietsch (USFWS) 2013. Personal communication regarding U.S. Fish and Wildlife Special Purpose Utility permit for avian fatality reporting.

5.0 Exhibits

- Exhibit 1. Construction Status as of June 30, 2014.
- Exhibit 2. Active Nests April - June 2014.
- Exhibit 3. Avian Use Survey Points April – June 2014.
- Exhibit 4. Avian Fatality Survey Areas April – June 2014.

Exhibit 1. Construction Status

As of June 30, 2014

First Solar.

Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

Map Updated: July 10, 2014 08:00 AM

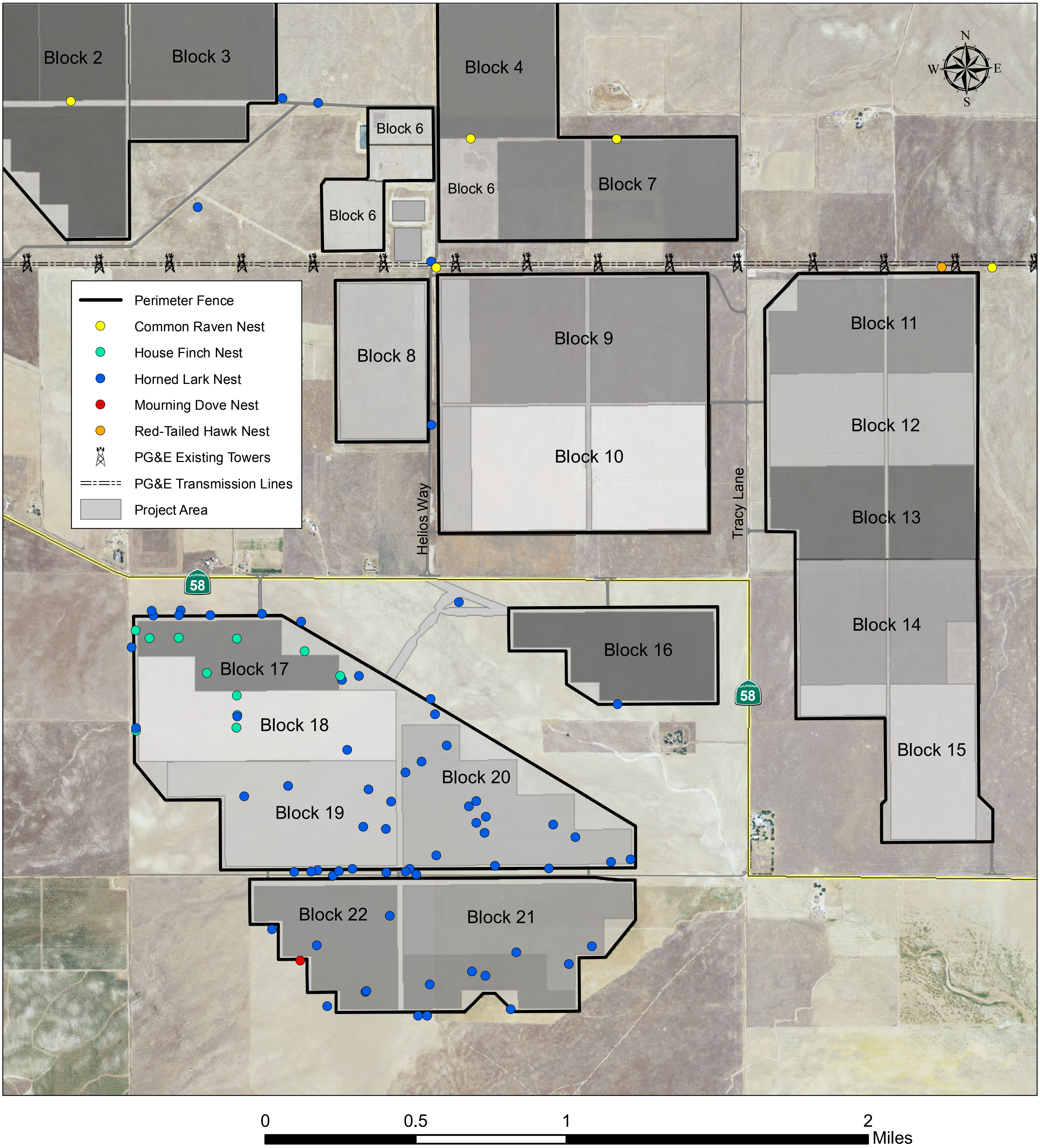
Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Additional Documentation Attachment to Comment 2-F1

Attachment I-3

Exhibit 2. Active Nests

April 2014 to June 2014



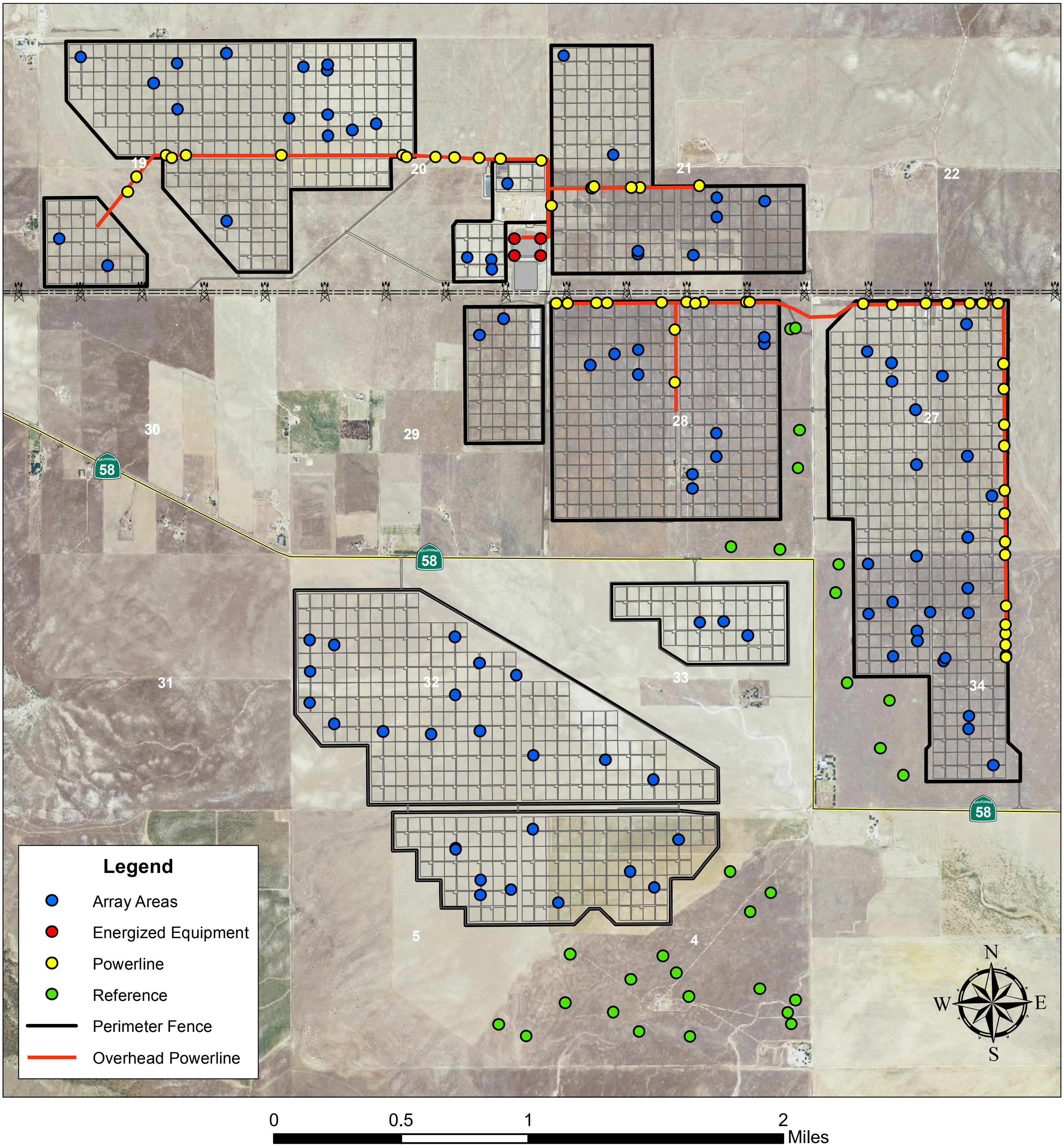
Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: July 25, 2014 08:16 AM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Exhibit 3. Avian Use Survey Points

April 2014 to June 2014



Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

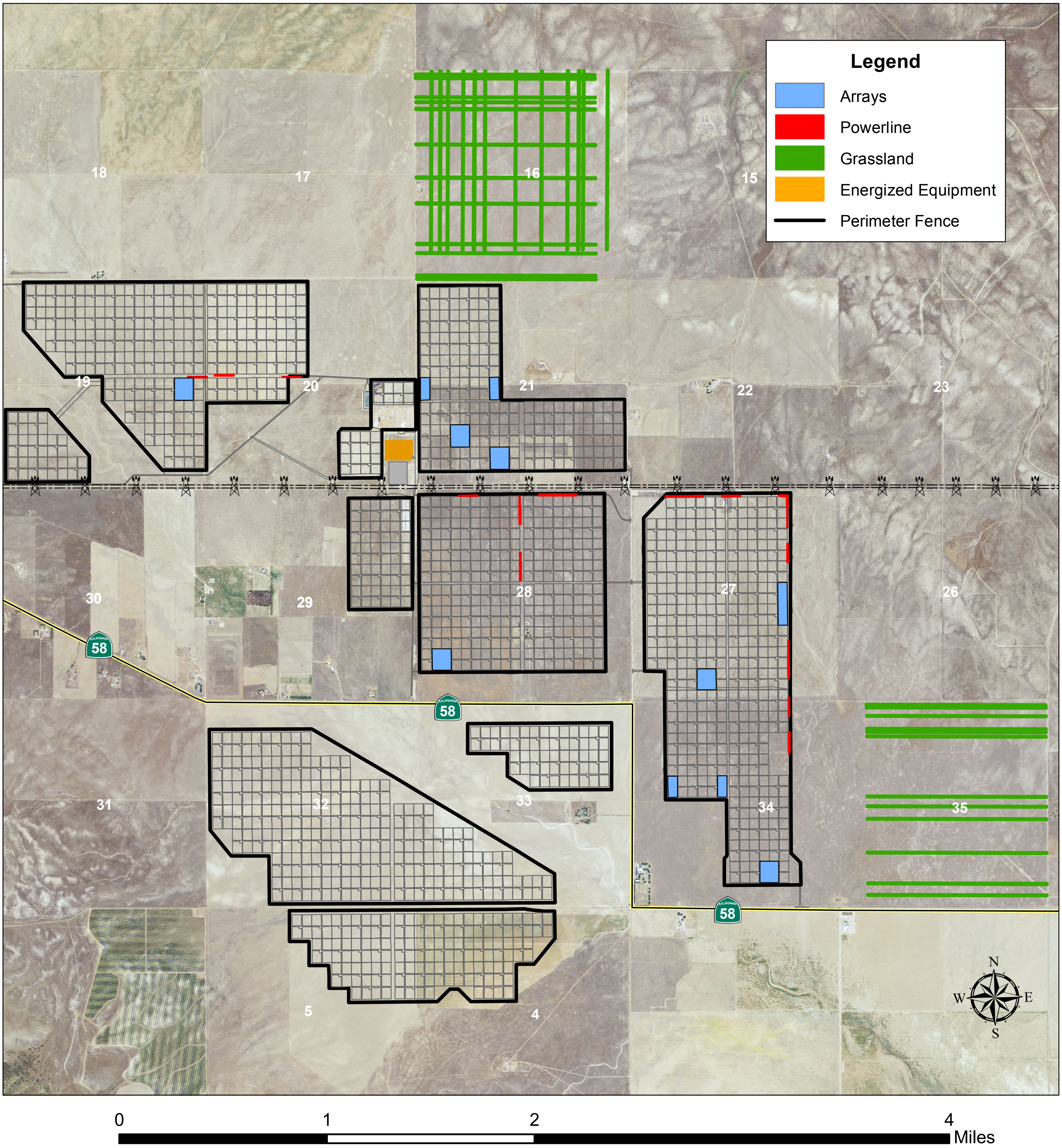
First Solar.

2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: July 10, 2014, 08:03 AM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Exhibit 4. Avian Fatality Survey Areas

April 2014 to June 2014



Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: July 08, 2014, 11:47 AM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Topaz Solar Farm

CA Department of Fish and Wildlife Transmittal

2nd Quarter 2014

Topaz Solar Farm

U.S. Department of Fish and Wildlife Services Transmittal

2nd Quarter 2014

Topaz Solar Farm
10400 Helios Way
Santa Margarita, California 93453

Delivered via Electronic Mail

2014 Third Quarterly Report

COA 62 Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan Quarterly Report

October 1, 2014

Discussion

The enclosed report has been prepared to address the reporting requirements for Condition of Approval (COA) 62 Bird Monitoring and Avoidance Plan (BMAP). This plan is merged with the Avian and Bat Protection Plan (ABPP), comprising a comprehensive avian management plan for the Topaz project.

In response to COA 62, the Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP/BMAP) has been prepared, which further describes the approach to implementing the condition requirements.

COA 62 requires quarterly and annual reports. Quarterly reports are required during construction and for three years following the beginning of plant operation.

Following the completion of the fourth quarter of monitoring the biologist shall prepare an annual report that summarizes the year’s data, analyzes any project-related bird fatalities or injuries detected, and provides recommendations (in consultation with the County) for future monitoring and any adaptive management actions needed.

Quarterly Reportable Items

COA 62 BMAP requires quarterly reports describing the dates, durations, and results of monitoring and data collection. The quarterly reports shall provide a detailed description of any project-related bird or wildlife deaths or injuries detected during the monitoring study or at any other time.

Report Data

Attached is the quarterly report prepared by Althouse & Meade (COA 62 Year 3 Third Quarter July 01-September 30, 2014 for ABPP and BMAP).

If there are questions regarding this report, please contact:

Jason Dart
Topaz Site Compliance Manager
Topaz Solar Farm
10400 Helios Way
Santa Margarita, CA

Topaz Solar Farms

COA 62 Year 3 Third Quarter Report

July 1 – September 30, 2014

for

Avian and Bat Protection Plan

and

Bird Monitoring and Avoidance Plan

House finch (left), loggerhead shrike (center), western meadowlark (right), Topaz Solar Farms 2014. Photographs by K. Weichert.

Prepared for

Topaz Solar Farms LLC
10400 Helios Way
Santa Margarita, CA 93453

by

ALTHOUSE AND MEADE, INC.
BIOLOGICAL AND ENVIRONMENTAL SERVICES
1602 Spring Street
Paso Robles, CA 93446
(805) 237-9626

October 2014

654.48

Table of Contents

Tables

Figures

Exhibits

1.0 Introduction

This Year 3 Third Quarter report provides bird and bat information as specified in the Topaz Solar Farms Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP and BMAP; Althouse and Meade, Inc. June 2011). Section 5.5 of the ABPP and BMAP describes information to be included in reports and requires quarterly reports to be submitted to the County of San Luis Obispo (County), U.S. Fish and Wildlife Service (USFW) and the California Department of Fish and Wildlife (CDFW). The Avian and Bat Protection Plan (ABPP; Section 2.0) and Bird Monitoring and Avoidance Plan (BMAP; Section 3.0) are requirements of County of San Luis Obispo Conditions of Approval (COA) 61 and 62, and were prepared in consultation with USFWS and CDFW.

1.1 Construction Status

Construction of Blocks 1-9 was completed in 2013, and Blocks 10-19 were completed in 2014 by the end of September (Table 1). All completed blocks were transferred to and are now managed by Operations and Maintenance (O&M). Exhibit 1 illustrates construction status through September 2014.

TABLE 1. CONSTRUCTION STATUS BY BLOCK. Date of transfer to O&M is provided for Blocks 1-17. Bold indicates transfer during 2^{nd} quarter.

Block(s)	Month and Year Transferred to O&M	Block(s)	Month and Year Transferred to O&M
1	March 2013	12	May 2014
2	March 2013	13	May 2014
3	March 2013	14	January 2014
4	April 2013	15	February 2014
5	April 2013	16	May 2014
6	March 2013	17	June 2014
7	May 2013	18	**August 2014**
8	June 2013	19	**August 2014**
9	July 2013	20	-
10	March 2014	21	-
11	May 2014	22	-

2.0 Avian and Bat Protection Plan

The ABPP monitoring program compiles general information on bird and bat presence, interactions with facility components, injuries, and mortality at the Topaz Solar Farms (TSF) project. During construction phases of the project this task is completed by the project biologists, as part of routine daily biological monitoring. In blocks under Operations and Maintenance (O&M) control, data is collected from a variety of sources, including pre-activity surveys, O&M technician reports, and during field work conducted for BMAP studies. Information regarding the detailed bird use and mortality risk assessment study is reported in Section 3.0.

For the ABPP, this quarterly report provides information collected during active construction in Blocks 18-22, spanning the period from June 1 through September 30, 2014

2.1 General Bird Surveys

2.1.1 Methods

General bird surveys are conducted on and around active construction areas of TSF project site on a daily basis seven days a week throughout the year by project biologists. Lists of bird species observed by each biological monitor are recorded on daily construction monitoring forms, which are then scanned, archived, and reviewed by project ornithologists Peter Gaede and Jason Dart.

2.1.2 Results

Monitors recorded a total of 48 species of birds in July, August and September 2014; an additional 3 birds were not identified to species level, but general bird type category was known and is included in the following tallies. Of the 48 identified species, 6 were waterbirds and 12 were raptors. Some of the 6 waterbird species were observed in lands surrounding Topaz including a private pond less than a thousand feet from TSF, and others were observed flying over TSF without using project features as habitat. Demolition of the TSF dust control pond (DCP) occurred during the last reporting period; the DCP was where most onsite waterbird detections were recorded. Table 1 lists all bird species observed in this quarter with information on observation frequency.

TABLE 2. JULY – SEPTEMBER 2014 GENERAL BIRD SURVEY RESULTS. All bird species recorded this quarter are listed. Top twenty species most frequently observed, waterbirds, and raptors are indicated.

Species	**Most Frequent**	**Waterbird**	**Raptor**
American Crow			
American Kestrel	✓		✓
American Pipit			
Anna's Hummingbird			
Ash-throated Flycatcher			
Brewer’s Blackbird	✓		
Burrowing Owl	✓		✓
California Quail			
Cassin's Kingbird			
Cliff Swallow			
Common Raven	✓		
Cooper's Hawk			✓
Double-crested Cormorant		✓	
Eurasian Collared Dove	✓		
European Starling	✓		
Golden Eagle	✓		✓
Great Blue Heron		✓	
Greater Roadrunner			
Great-tailed Grackle			
Horned Lark	✓		
House Finch	✓		
House Sparrow	✓		
Killdeer		✓	
Lark Sparrow	✓		
Lesser Goldfinch			
Loggerhead Shrike	✓		
Long-eared Owl			✓
Long-Billed Curlew		✓	
Mourning Dove	✓		
Northern Harrier			✓
Northern Mockingbird			
Orange-crowned Warbler			
Osprey		✓	✓
Peregrine Falcon			✓
Prairie Falcon	✓		✓
Red-Shouldered Hawk			✓
Red-tailed Hawk	✓		✓
Rock Pigeon	✓		
Savannah Sparrow			
Say's Phoebe	✓		
Tree Swallow			
Turkey Vulture	✓		
Unidentified Cormorant		✓	
Unidentified Shorebird		✓	
Unidentified Swift			
Vaux's Swift			
Western Bluebird			
Western Kingbird	✓		
Western Meadowlark	✓		
Western Sandpiper		✓	
Western Scrub-jay			
White-crowned Sparrow			
White-tailed Kite			✓
Yellow Warbler			
Yellow-rumped Warbler			

2.2 Nesting Activity

2.2.1 Methods

Focused nest surveys were conducted daily on and around the TSF project components under construction by biological monitors starting February 1, for the 2014 monitoring year. All nest surveys were conducted on foot by trained biologists. Strategically selected array areas near active construction were identified at the beginning of each week where surveyors walked all array rows searching for nests on the ground or on structures. Additionally, an area 300 feet around all perimeter fences of active construction areas was surveyed twice per week, per the approved Nesting Bird Management Plan (Althouse and Meade, Inc. 2013). Laydowns and move-on areas were surveyed as often as possible to prevent birds establishing nests in equipment and materials. Nests were also found by construction personnel in their work areas or incidentally found by biologists while monitoring construction activities. Nest starts were removed when the presence of a complete nest would conflict with construction activities or would present a danger to the birds. All nests and nest starts were documented. Nests identified from July to September 2014 in active construction areas are included in this report.

2.2.2 Results

The results of surveys from July through September 2014 are provided in Table 3. Other species identified nesting offsite (e.g. Mitigation Lands, future project lands, or areas managed by Operations and Maintenance) are not included in this table. No nest starts were removed during this reporting period.

Two house finch nests were documented in active construction areas during the reporting period, both of which fledged successfully (Table 3).

Exhibit 2 in Section 5.0 is a map of bird nests in and near areas of active construction July through September 2014.

TABLE 3. JULY – SEPTEMBER 2014 BIRD NESTS. Active bird nests detected at Topaz Solar Farms from July to September 2014 in active construction areas.

Species	Final Status	Number of Nests	Percent of Total
House Finch	Fledged	2	100

2.3 Avian and Other Wildlife Mortality

General biological monitoring of the Topaz work area documented bird, bat, and other wildlife mortality, as required by COA 62. All mortality identified on site during this reporting period is provided in Table 4. Cause of death is reported when known. Several of the avian fatalities identified were feather spots, so cause of death could not be confirmed. This table includes all fatalities found in active construction areas as well as areas managed by Commissioning or Operations and Maintenance.

TABLE 4. JULY – SEPTEMBER 2014 AVIAN AND OTHER WILDLIFE MORTALITY. Bird and other wildlife mortality detected at the Topaz Solar Farms from April to June 2014. Asterisk indicates found during formal fatality surveys.

Month	Species	Location	Cause of Death
July	Gopher Snake	Phase 6 Laydown	Vehicle Strike
	Common Raven*	Block 2	Predation
	Gopher Snake	Block 22	Probable Vehicle Strike
	Unknown Mouse (5)	Phase 6 Laydown	Abandonment
	McKittrick Pocket Mouse	Energy Place	Unknown
	Domestic Chicken	Block 17	Predation
August	Deer Mouse (4)	Phase 6 Laydown	Material Crush
	Horned Lark*	Block 7	Unknown
	Horned Lark*	Block 8	Unknown
	Horned Lark*	Block 8	Unknown
	Common Raven	Block 7	Possible Predation
	Rock Pigeon	Block 21	Probable Exhaustion
	Heermann’s Kangaroo Rat	Block 17	Drowning
	Unknown Mouse (5)	Secure Laydown	Exposure
September	Gopher Snake	Block 22	Vehicle Strike
	Killdeer*	Block 19	Unknown
	Common Raven*	Block 11	Unknown
	Domestic Cat	Secure Laydown	Unknown
	Desert Cottontail	Block 22	Predation

2.4 Adaptive Management

No adaptive management practices were implemented during the period from July through September 2014.

2.5 Bat Surveys

2.5.1 Methods

Acoustic monitoring surveys for bats on the project site were conducted at least one night per month using a Pettersson D240x (Pettersson Elektronik, Sweden) bat detector and Sonobat® (v.3.1 US west; DNDesign, Arcata, CA) acoustic analysis software. Sound frequencies in the range utilized by bats (10 to 120 kHz) were detected and synthesized into time-expanded sound files and analyzed by Sonobat® software. Surveys were initiated near dusk, when bats commonly begin foraging. Monitoring periods for each survey were limited to the battery life of the Pettersson detector and typically ranged from three to six hours depending on the number of sound files detected. On July 30 and August 15 the detector was placed on the perimeter fence just east of production well 7 (PW7). On September 2, 3, and 18 the detector was deployed in conjunction with night work for the medium voltage overhead collection line. On September 2 and 3 the detector was placed in the Phase 5 Move On area near the lights associated with the night work, and on September 18 it was deployed in Block 8. On September 29, the detector was placed on the perimeter fence in the northeast corner of Block 21. All detected bat calls were identified to species with a discrimination probability of 0.95 or higher using Sonobat® software.

2.5.2 Results

From July through September, six species of bat were detected at Topaz Solar Farms (Table 5). The majority of detections were Mexican free-tailed bats (*Tadarida brasiliensis*), which were detected on nearly every survey night. In addition, canyon bats (*Parastrellus hesperus*) were detected in both July and August and have been previously detected at Topaz Solar Farms during acoustic survey events. Silver-haired bat (*Lasionycteris noctivagans*), a CDFW Special Animal, and big brown bat (*Eptesicus fuscus*) were only detected during one night, in September. Western small-footed myotis (*Myotis ciliolabrum*), a CDFW Special Animal, was detected in July and September. Pallid bat (*Antrozous pallidus*), a CDFW Species of Special Concern, was detected in July and August with only a single detection on each survey night. No bat roosts are known to be present within the Topaz project site.

TABLE 5. ACOUSTIC BAT SURVEYS AT TOPAZ SOLAR FARMS FROM JULY TO SEPTEMBER 2014. Survey dates, bat species detected, number of detections, and special status designations from CDFW and Western Bat Working Group (WBWG) are provided.

Survey Date	**Location**	**Total Detections**	**Common Name**	**Scientific Name**	**CDFW Status**	**WBWG Status**
7/30/2014	PW7 near Block 20	1	Pallid bat	*Antrozous pallidus*	SSC	High
7/30/2014	PW7 near Block 20	3	Western small-footed myotis	*Myotis ciliolabrum*	SA	Medium
7/30/2014	PW7 near Block 20	2	Canyon bat	*Parastrellus hesperus*	None	Low
7/30/2014	PW7 near Block 20	3	Mexican free-tailed bat	*Tadarida brasiliensis*	None	Low
8/15/2014	PW7 near Block 20	1	Pallid bat	*Antrozous pallidus*	SSC	High
8/15/2014	PW7 near Block 20	4	Canyon bat	*Parastrellus hesperus*	None	Low
8/15/2014	PW7 near Block 20	4	Mexican free-tailed bat	*Tadarida brasiliensis*	None	Low
9/2/2014	Phase 5 Move-on	81	Mexican free-tailed bat	*Tadarida brasiliensis*	None	Low
9/3/2014	Phase 5 Move-on	3	Big brown bat	*Eptesicus fuscus*	None	Low
9/3/2014	Phase 5 Move-on	2	Silver-haired bat	*Lasionycteris noctivagans*	SA	Medium
9/3/2014	Phase 5 Move-on	201	Mexican free-tailed bat	*Tadarida brasiliensis*	None	Low
9/18/2014	Blocks 8-10	2	Western small-footed myotis	*Myotis ciliolabrum*	SA	Medium

Survey Date	**Location**	**Total Detections**	**Common Name**	**Scientific Name**	**CDFW Status**	**WBWG Status**
9/29/2014	Northeast corner of Block 21	3	Canyon bat	*Parastrellus hesperus*	None	Low
9/29/2014	Northeast corner of Block 21	1	Pallid bat	*Antrozous pallidus*	SSC	High

2.5.1 Species descriptions

Pallid bats are large, long-eared bats occurring throughout the state from deserts to moist forests. They primarily roost in crevices where they can retreat from view, frequently occurring in oak woodlands where they roost in tree cavities. These roosts are generally day or night roosts for one or a few bats. Attics may be used as roosts and during hot days they may emerge from crevices and roost on open rafters. Communal wintering or maternity colonies are more common in rock crevices and caves. In the Carrizo Plain area, nearby trees, old structures, cliff faces, and rocky outcropping may provide roosting sites for pallid bats.

Big brown bats are medium to large sized bats and have a wide distribution extending from Canada to northern South America. They are considered common within their range and tend to roost in man-made structures such as bridges, barns and attics. Females roost communally with males at hibernation sites and roost separately from males in spring and summer. Big brown bats would most likely roost in old structures in the Carrizo Plain area.

Silver-haired bats are medium-sized bats with black or dark brown hairs that are silver-tipped. It is a forest-dwelling species generally thought to be concentrated in the northern half of the state and considered relatively uncommon throughout much of its range. However, there are reports of this species in San Luis Obispo, Santa Barbara, and Ventura counties. This species typically roosts in trees, but has also been observed using structures such as attics and sheds. In the Carrizo Plain area, silver-haired bats most likely roost in the woodlands along the western periphery of the plain.

Western small-footed myotis is a small bat that occurs over most of California and the western United States. It roosts singly or in small groups in rocky cliffs, caves, mines, and man-made structures. Small-footed myotis commonly forages over water; both natural and man-made. In the Carrizo Plain area, they may roost in rocky cliffs or old structures.

Canyon bats, formerly called western pipistrelles, are one of the smallest bats in California. They are typically considered a desert species and primarily roost in canyon and cliff sides, but may also roost in caves, mines or buildings. Canyon bats tend to roost singly or in very small groups. They are among the most diurnal of bats and often begin foraging before sunset and continue until well after dusk. Canyon bats are considered common throughout their range. In the Carrizo Plain area, they likely roost in rocky outcroppings, cliff faces, and old structures.

Mexican free-tailed bats primarily roost in caves, but are frequently found in cavities under bridges and in buildings, where they roost gregariously. They may also roost singly or in small groups in large tree cavities. This species is common throughout San Luis Obispo County. Maternity colonies form in spring and pups are born in the summer. Mexican free-tailed bats are one of the most widely distributed mammalian species in the Western Hemisphere and may fly more than 50 km a night to reach foraging areas. In the Carrizo Plain area, old barns and outbuildings likely provide roosting sites for Mexican free-tailed bats.

3.0 Bird Monitoring and Avoidance Plan

The BMAP study analyzes avian use surveys and avian fatality surveys to produce a risk index for various project components deemed to be potentially dangerous to birds, including array areas, overhead power lines and the substation. Offsite grassland reference sites are used to gauge background mortality levels. Results are reported in this third quarter report for Avian Use Surveys (Section 3.1), Avian Fatality Surveys (Section 3.2), and for bias trials (Section 3.3). Risk index calculations will be provided in the annual report.

3.1 Avian Use Surveys

3.1.1 Methods

Avian Use Surveys were conducted monthly from November 2011 through September 2014, and will continue throughout the construction period and for three years after construction is complete. Each month, 63 randomly selected survey points are completed, including 31 inside existing array areas, 18 along existing overhead power lines, 10 in grassland reference sites and 4 at energized equipment (substation). At each point, a 10 minute bird use count is conducted within a 50 meter radius of the surveyor. Avian Use Survey points are randomly selected each month across all six phases of the project and in offsite grassland reference areas (Exhibit 3).

3.1.2 Results

The four Survey Area Categories used as treatment types in this study comprise different habitat elements that influence species composition, abundance and richness.

The Array Area category includes surveys conducted within solar array areas during active construction and in completed form. The habitat consists of rows of passive (non-moving) photovoltaic solar panels mounted to steel racking ranging from approximately 2 to 5 feet off the ground. The ground is seeded with a native seed mix to revegetate array areas to naturalized grassland habitat; vegetation density varied from 0 to 60 percent cover. Array Area survey point areas may also include perimeter fences, photovoltaic combining switchgear houses, as well as array roads.

The Energized Equipment category includes point counts conducted around the perimeter of the substation. The survey area includes the substation perimeter fence, transformers, power lines, and other electrical components. Within the substation fence the ground is gravel with no vegetation. Outside the perimeter fence, the ground is bare dirt with some patches of grass and forbs.

Overhead Powerline surveys represent areas underneath medium-voltage collector lines within the project. Vegetation varies depending on location. Most powerlines are along array or perimeter access roads, however some locations are outside the fenced project areas in annual grassland habitat.

Reference Sites are composed of annual grassland habitat. They included point counts conducted on annual grassland in mitigation lands owned and managed by California Department of Fish and Wildlife or Stewardship Land not developed by TSF.

In July, August, and September 2014, 189 avian point counts were conducted in the four Survey Area Categories totaling 366.8 acres of survey area. During these surveys, species composition consisted of 18 different bird species and one additional bird not identified to species. Bird abundance is examined as total number of detections per species as well as average number of detections per Observation Point (Table 6). The 10 most abundantly detected species, listed in decreasing order of total species detections, were: horned lark (527 detections), common raven (23), house finch (13), mourning dove (13), western sandpiper (13), turkey vulture (11), brewer's blackbird (10), house sparrow (9), loggerhead shrike (6), and Vaux's swift (4) and western meadowlark (4).

The most frequently encountered species, the horned lark, was detected more than 22 times as often as that of that of the second most frequently encountered species, the common raven. It was detected 3.4 times more frequently in Array Areas than in Reference Site grassland areas. The Energized Equipment category had the lowest average detections per Observation Point, which is consistent with lack of suitable foraging habitat in the substation. Common raven was detected at the Energized Equipment and Overhead Powerline categories most frequently. This is likely due to the availability of preferred perching locations on power poles.

TABLE 6. SPECIES COMPOSITION AND ABUNDANCE. All bird species detected during Avian Use Surveys in July, August, and September 2014 are listed, with the average number of bird use detections per observation point calculated for each of the four survey area categories. Total detections for each species and each survey area type are provided in far right column and bottom row. Species are listed in decreasing order of abundance according to the total detections column.

Species	**Array Area** Ave. Detections per Obs. Pt.	**Energized Equipment** Ave. Detections per Obs. Pt.	**Overhead Powerline** Ave. Detections per Obs. Pt.	**Grassland/ Reference** Ave. Detections per Obs. Pt.	**Total Species Detections**
Horned Lark	4.76	0.17	0.74	1.40	**527**
Common Raven	0.11	0.17	0.17	0.07	**23**
House Finch	0.14	0.00	0.00	0.00	**13**
Mourning Dove	0.11	0.00	0.00	0.10	**13**
Western Sandpiper	0.14	0.00	0.00	0.00	**13**
Turkey Vulture	0.06	0.00	0.04	0.10	**11**
Brewer's Blackbird	0.11	0.00	0.00	0.00	**10**
House Sparrow	0.00	0.33	0.09	0.00	**9**
Loggerhead Shrike	0.00	0.00	0.11	0.00	**6**
Vaux's Swift	0.04	0.00	0.00	0.00	**4**
Western Meadowlark	0.03	0.00	0.02	0.00	**4**
Unidentified Swift	0.00	0.00	0.06	0.00	**3**
Eurasian Collared-Dove	0.02	0.00	0.00	0.00	**2**
Western Kingbird	0.00	0.00	0.00	0.07	**2**
Burrowing Owl	0.00	0.00	0.00	0.03	**1**
Lesser Goldfinch	0.01	0.00	0.00	0.00	**1**
Rock Pigeon	0.01	0.00	0.00	0.00	**1**
Red-Tailed Hawk	0.01	0.00	0.00	0.00	**1**
Tree Swallow	0.01	0.00	0.00	0.00	**1**
Total Avian Detections	**518**	**8**	**53**	**66**	**645**

Species Richness was calculated as the average number of species detected at each Observation Point. Among the treatment types, Array Area had the highest species richness with an overall average of 0.96 species detected per Observation Point. Reference Site had the next highest with an average of 0.57 species, which was similar to Overhead Powerline at 0.54 species. Energized Equipment has the lowest with 0.42 species per observation point (Table 7 and Figure 1). The Array Area species richness is more than twice that of the Energized Equipment.

Bird Utilization Rate (BUR) is calculated as the average number of birds observed per Observation Point count. Bird Utilization Rate is calculated for the four Survey Area Categories for July – September 2014 (Table 7 and Figure 1). Array Areas had the highest BUR at 5.57 birds per Observation Point. With 1.77 and 1.22 birds per Observation Point, Reference Site and Overhead Powerline categories had the second and third highest BUR, and Energized Equipment had the lowest BUR at 0.67 birds per Observation Point.

TABLE 7. AVIAN USE SURVEY POINT COUNTS AND DETECTIONS. Avian use survey point count data is provided for number of observation point counts, total area surveyed, total number of species detected, species richness and bird utilization rate. All results are from data collected in July, August, and September 2014.

Type	**Number of Obs. Pt. Counts**	**Total Area Surveyed (Acres)**	**Total No. Species**	**Ave. No. Species per Obs. Pt (Species Richness)**	**Ave. No. Birds per Obs. Pt (BUR)**
Array Area	93	180.49	14	0.96	5.57
Energized Equipment	12	23.29	3	0.42	0.67
Overhead Powerline	54	104.80	6	0.54	1.22
Reference Site	30	58.22	7	0.57	1.77
Total Combined	**189**	**366.80**	**19**	**0.74**	**3.41**

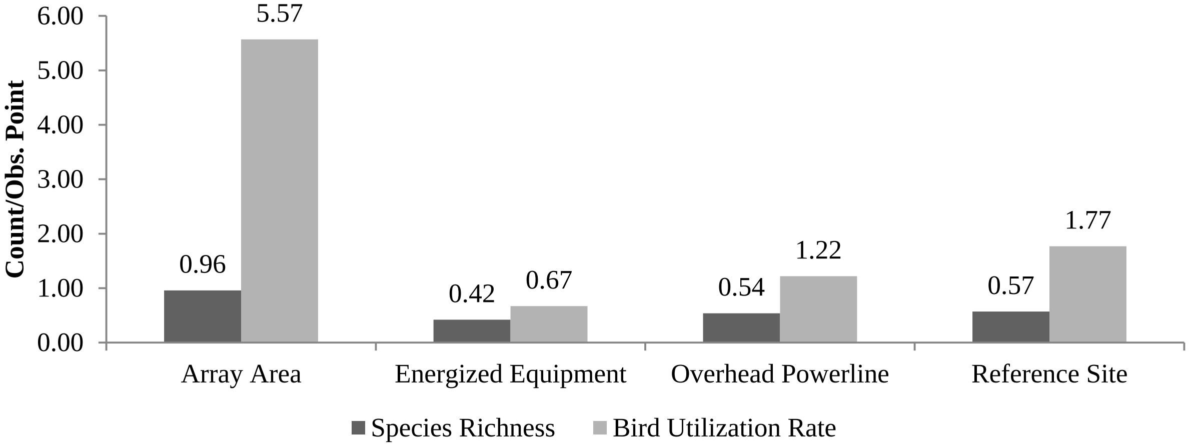


FIGURE 1. SPECIES RICHNESS AND BIRD UTILIZATION RATE. Species richness and bird utilization rate are provided for each of the four survey area categories.

.

3.2 Avian Fatality Surveys

3.2.1 Methods

Avian Fatality Surveys commenced upon completion of the first project components. Avian Fatality Surveys are conducted at randomly selected locations within four different survey area categories: Array Area, Overhead Powerline, Energized Equipment (Substation) and Reference Site. Search plots for Array Area, Reference Site and Overhead Powerline were defined as a transect 14 feet wide and 480 feet long, or the area of a typical aisle in a PV array. The area searched in the Array Area and Reference Site each month is equivalent to approximately three PV arrays. The search plot for Energized Equipment is the entire area of the substation, which is 4.48 acres. All survey areas except Energized Equipment are randomly selected using an ArcGIS random point generator having defined areas as the constraining polygon. Avian Fatality Surveys are conducted within the same search plots each day for seven consecutive days every month.[1] Repetitive surveys increase the chance of finding fatalities in a given area before predators remove the carcass, and also facilitate per day calculations.

3.2.2 Results

Each month, July through September 2014, we completed walking Avian Fatality Surveys for all transects within each of the Survey Area Categories for seven consecutive days each. Reference Site search plots were completed for seven consecutive days each, totaling 10.4 linear miles (17.6 acres) each day of surveys. Array Area search plots were completed for seven consecutive days each, totaling 10.4 linear miles (17.6 acres) each day. Overhead Powerline search plots were completed for seven consecutive days each, totaling 2.2 linear miles (3.7 acres) each day. Energized Equipment was also surveyed for seven consecutive days, totaling 4.5 acres each day. See Exhibit 4 in Section 5.0 for a map of Avian Fatality Survey areas for July to September 2014. In addition to these regular surveys, the Overhead Powerline in its entirety was surveyed on July 22, 2014; no fatalities were found. All acreage and mileage calculations reported exclude this one day survey.

Three months of surveys yielded a total distance of 504.0 linear miles and coverage of 953.8 acres. These surveys resulted in discovery of eight fatalities, two each in Reference Site and Overhead Powerline, and four in Array Area. Fatality rates were calculated per search plot and mile walked (Table 8). Although only two fatalities were found along the Powerline, it had the fewest search plots and therefore the highest fatality rate of 0.0038 fatalities/search plot. Array Areas had four fatalities and the second highest fatality rate of 0.0016 fatalities/search plot. In contrast, the same total acreage surveyed in Reference Site yielded two fatalities and therefore had a lower fatality rate of 0.0008 fatalities/search plot.

---

[1] The last day of September surveys was missed and was therefore searched for an additional two consecutive days the later in the month. No fatalities were found during these days.

TABLE 8. BIRD FATALITY RATE. The survey results and efforts are indicated for each of the four survey area categories for the third quarter of 2014.

Survey Area Category	**Linear Miles**	**Acres**	**Search Plots**	**Total Fatalities**	**Fatality/ Search Plot**	**Fatality/ Mile**
Array Area	228.0	386.9	2508	4	0.0016	0.0175
Overhead Powerline	48.0	81.5	528	2	0.0038	0.0417
Reference Site	228.0	386.9	2508	2	0.0008	0.0088
Energized Equipment	-	98.6	22	0	0.0000	-
Total Combined	**504.0**	**953.8**		**8**		

Cause of death was recorded for all fatalities, when known. The eight fatalities documented during Avian Fatality Surveys in July, August, and September 2014 were classified as predation or unknown. Since it is difficult to determine cause of death with certainty, recent guidance from the U.S. Fish and Wildlife Service suggests attributing cause of death to a specific factor and including a confidence percent to indicate how confident the determination was (Table 9; A. Beck and T. Dietsch 2013). Predation as a cause of death is likely higher than reported, as often times a feather pile could not be confidently linked to a predation event as opposed to a scavenging event.

TABLE 9. CAUSE OF DEATH FOR AVIAN FATALITY SURVEY RESULTS. Cause of death tallied for avian fatalities detected within each of the four survey area categories, July – September, during formal avian fatality surveys. Percentages indicate confidence level.

Survey Area Category	**Unknown**	**Predation Valid (>90%)**	**Predation Possible (1-50%)**	**Total**
Array Area	3	1	0	**4**
Overhead Powerline	2	0	0	**2**
Reference Site	1	0	1	**2**
Energized Equipment	0	0	0	**0**
Total Combined	**6**	**1**	**1**	**8**

3.3 Scavenger/Carcass Removal Trials and Searcher Efficiency Trials

3.3.1 Scavenger/Carcass Removal Trial

Scavenger/carcass removal trials were conducted in July and August 2014. Japanese quail carcasses were randomly placed by the trial administrator in Reference Site areas. Scavenger trials for Array Areas were completed during the last quarter. The carcasses were numbered and labeled with a small band of green tape around one leg. Remote wildlife cameras were placed on half of the quail to document the scavenging animal.

Carcass monitoring procedures outlined in the ABPP/BMAP require carcasses to be checked the first three consecutive days after placement, twice a week for the next two weeks, and then once a week for the remainder of the 60 day trial. Monitoring stopped when 100 percent of the carcasses were scavenged. Upon routine monitoring of the carcasses, notes are recorded of the status and condition of the carcass. In these trials, with the exception of a few feathers, the carcass was simply present or not present.

As expected, carcasses did not last long after they were placed in the Reference Site by the trial administrator. Eighty-five percent of the carcasses were scavenged within the first three days. All carcasses were scavenged within 2 weeks of being placed in the field (Figure 2). Of the ten cameras monitoring quail carcasses, eight captured photos of the suspected scavengers, with the most common being San Joaquin kit fox (Figure 3). Other scavengers include American badger, coyote, and common raven.

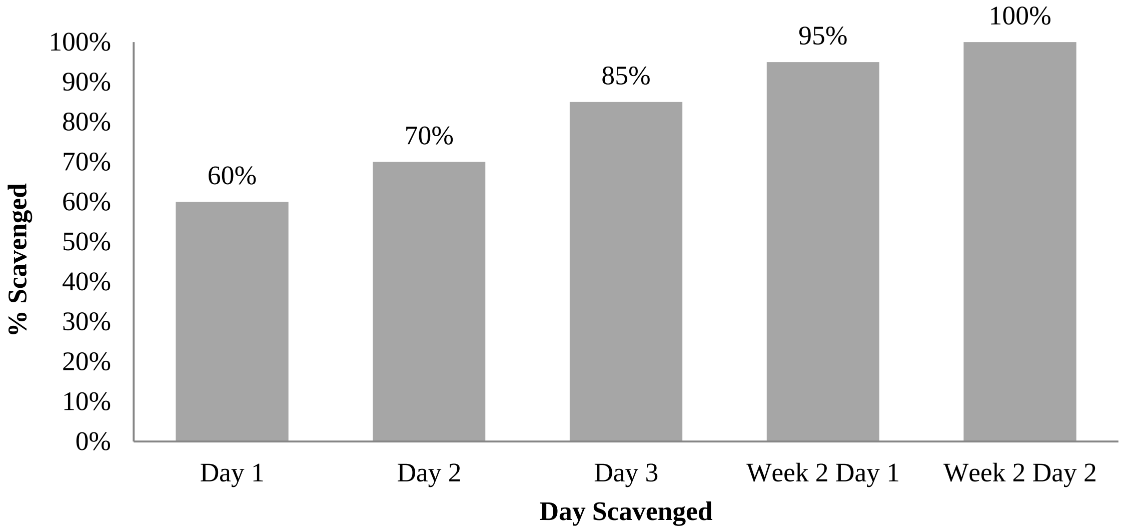


FIGURE 2. PERCENT SCAVENGED BY DAY (CUMULATIVE)-ARRAY AREA. Cumulative percent of carcasses scavenged in Array Areas by day in the July and August 2014 offsite trial. Percent scavenged is out of 20 quail placed.

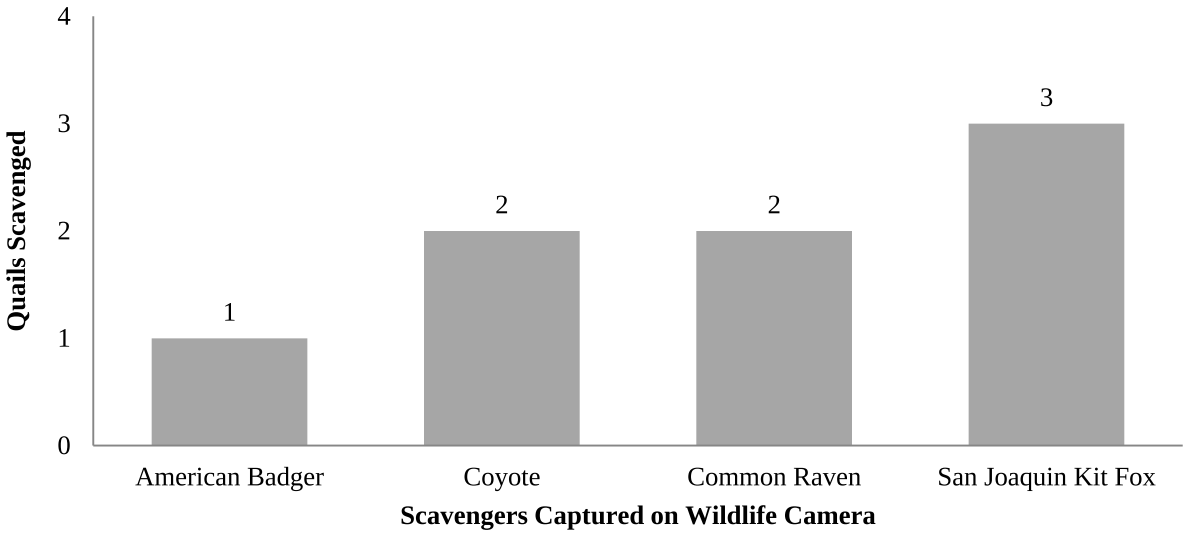


FIGURE 3. SCAVENGERS IDENTIFIED VIA REMOTE CAMERA. Number of quail carcasses scavenged by each suspected predator out of eight photo captures.

3.3.2 Searcher Efficiency Trial

Searcher efficiency trials were not conducted during this reporting period.

3.4 Discussion

The only bird nests that remained active past June were house finch nests. House finch nests were particularly common in staged equipment and material stacks.

During this 3rd quarter reporting period, July, June, and August 2014, unadjusted Fatality Rate in Array Areas was twice as high as that recorded at the grassland Reference Site (0.0016 and 0.0008, respectively). Bird Utilization Rate was more than three times as high in the Array Areas (5.57 birds per Observation Point) than Reference Site (1.77 birds per Observation Point). The data indicates more birds were present and more birds died within the Array Areas than in the Reference Site areas. The Overhead Powerline surveys yielded the highest unadjusted Fatality Rate, although collisions or electrocution were not suspected as the cause of death. Additionally, a comprehensive search conducted in one day along the entire power line did not detect any fatalities. The Fatality Rates calculated for this quarterly report were not adjusted for searcher and scavenger bias. The annual report will provide bias adjusted Fatality Rates for all project components over the year. Searcher efficiency and scavenger trials will continue through 2014 to better refine bias data.

The third quarter general bird surveys listed nearly half as many species as were listed in the second quarter. The Bird Utilization Rates and Species Richness values were also much less in all categories this quarter except for Array Areas. We suspect this is due to the record drought in California, and seasonal differences between spring and summer seasons with respect to bird presence. There was less available vegetation, water, and food this year for the birds and even less during this reporting period which was the hottest and driest part of the year.

4.0 References

Althouse and Meade, Inc. 2011. Topaz Solar Farms Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. June 2011.

Althouse and Meade, Inc. 2013. Topaz Construction Phase Programmatic Nesting Bird Management Plan. Revised August 19, 2013.

Althouse and Meade, Inc. 2014. Topaz Solar Farms 2013 Fourth Quarter/Second Annual Report for Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. March 2014.

Althouse and Meade, Inc. 2014. Topaz Solar Farms COA 62 Year 3 First Quarter Report, January 1 – March 31, 2014 for Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. April 2014.

American Ornithologists Union. 1983. Check-list of North American Birds, 6th ed. Allen Press, Lawrence, KS. 877 pp.

Aspen Environmental Consultants. 2011. Final Environmental Impact Report for the Topaz Solar Farm. March.

Avian Power Line Interaction Committee (APLIC). 2006. *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006*. Edison Electric Institute, APLIC, and the California Energy Commission. Washington D.C. and Sacramento, CA.

Avian Power Line Interaction Committee (APLIC). 2012. *Reducing Avian Collisions with Power Lines: The State of the Art in 2012*. Edison Electric Institute and APLIC. Washington, D.C.

Bat Conservation International. 2012. U.S. Bats by State. http://www.batcon.org.

Beck, A. (First Solar) and T. Dietsch (USFWS) 2013. Personal communication regarding U.S. Fish and Wildlife Special Purpose Utility permit for avian fatality reporting.

Harvey, Michael J., J. Scott Altenbach, and Troy L. Best. 2011. Bats of the United States and Canada. The Johns Hopkins University Press.

Nowak, Ronald M. 1994. Walker's Bats of the World. The Johns Hopkins University Press.

Pierson, E. D., P. W. Collins, W. E. Rainey, P. A. Heady, and C. J. Corben. 2002. Distribution, Status and Habitat Associations of Bat Species on Vandenberg Air Force Base, Santa Barbara County, California. Santa Barbara Museum of Natural History Technical Reports – No. 1.

Western Bat Working Group. 2014. Western Bat Working Group. http://www.wbwg.org. Accessed September 30, 2014.

5.0 Exhibits

- Exhibit 1. Construction Status as of September 30, 2014.
- Exhibit 2. Active Nests July - September 2014.
- Exhibit 3. Avian Use Survey Points July – September 2014.
- Exhibit 4. Avian Fatality Survey Areas July – September 2014.

Exhibit 1. Construction Status

As of September 30, 2014

Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

First Solar.

Map Updated: September 29, 2014 10:13 AM

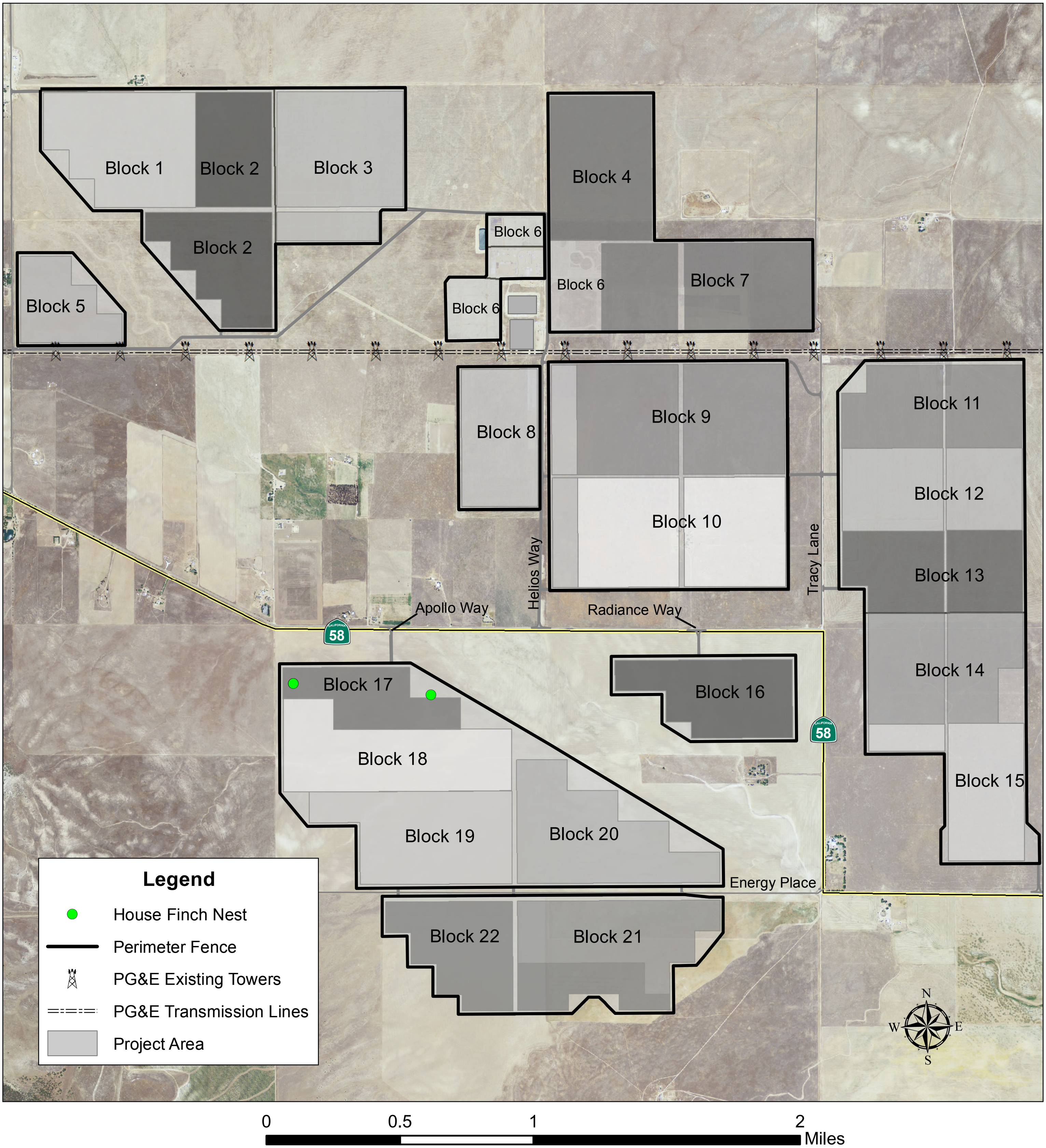
ALTHOUSE AND MEADE, INC.

Additional Documentation Attachment to Comment 2-F1

Attachment I-3

Exhibit 2. Active Nests

July 2014 to September 2014



Legend

- ● House Finch Nest
- ━ Perimeter Fence
- PG&E Existing Towers
- =·=·= PG&E Transmission Lines
- ▨ Project Area

Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

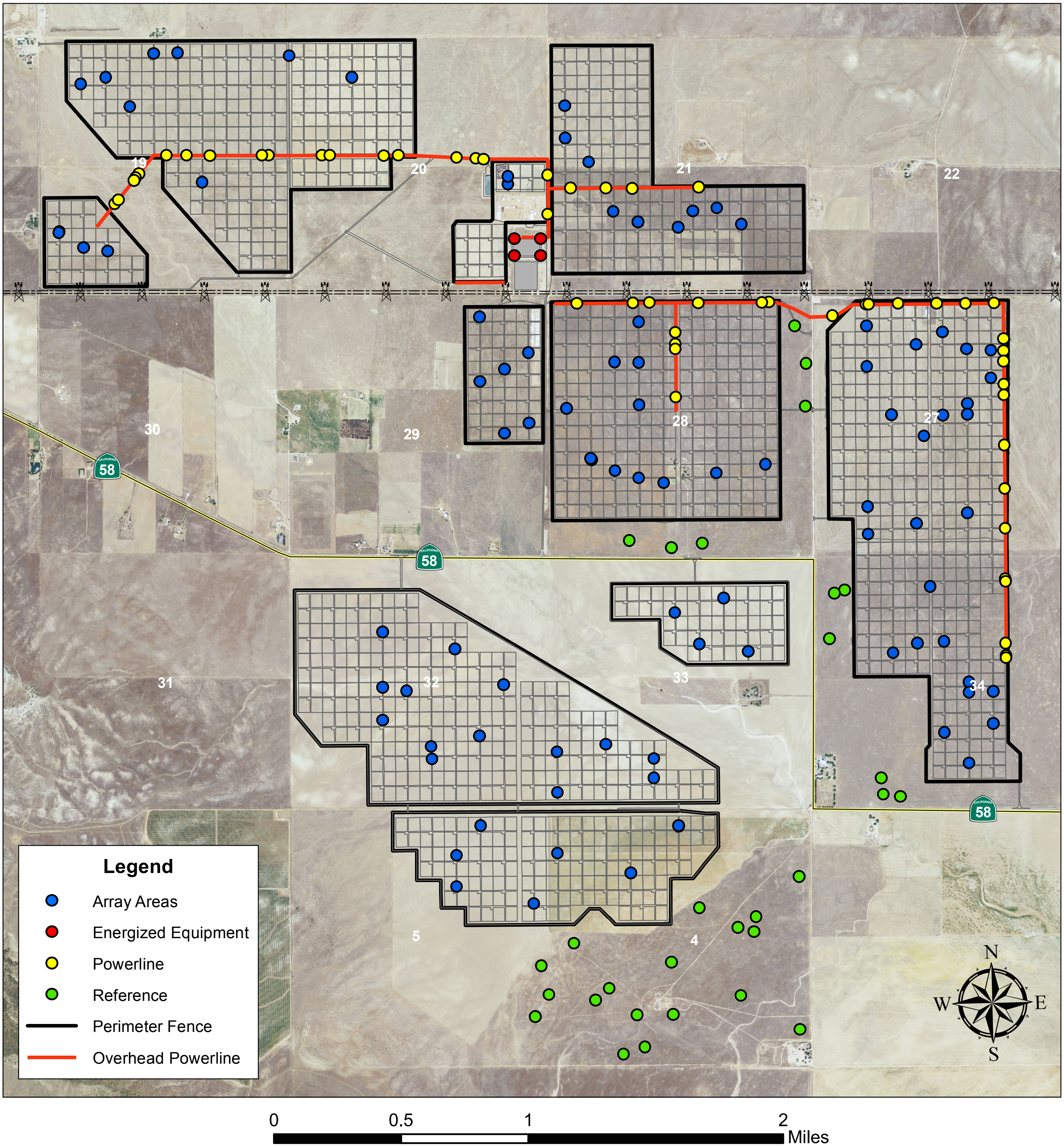
First Solar.

2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: September 29, 2014 10:32 AM

ALTHOUSE AND MEADE, INC.

Exhibit 3. Avian Use Survey Points

July 2014 to September 2014



Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

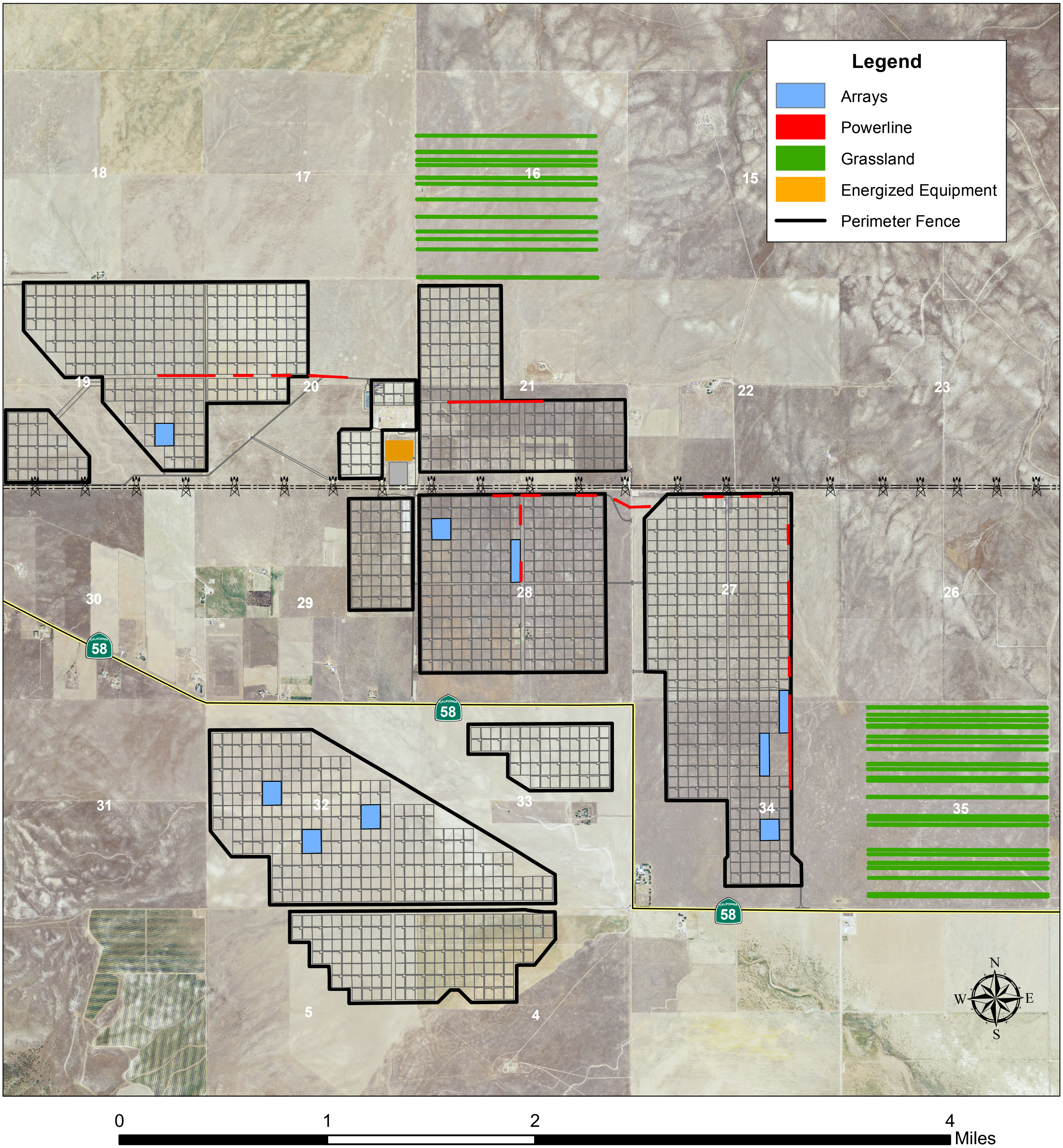
First Solar.

2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: September 29, 2014, 10:22 AM

ALTHOUSE AND MEADE, INC.

Exhibit 4. Avian Fatality Survey Areas

July 2014 to September 2014



Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

First Solar.

2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: September 29, 2014, 10:16 AM

ALTHOUSE AND MEADE, INC.

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Topaz Solar Farm
10400 Helios Way
Santa Margarita, California 93453

Delivered via Electronic Mail

Annual Report

COA 62 Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan

February 13, 2013

Discussion

This report has been prepared to address the reporting requirements for Condition of Approval (COA) 62 Bird Monitoring and Avoidance Plan (BMAP). The BMAP report was prepared to include bats and the title revised to the Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP).

In response to COA 62, the Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP) has been prepared, which further describes the approach to implementing the condition requirements.

COA 62 requires quarterly and annual reports. Following the completion of the fourth quarter of monitoring the biologist shall prepare an annual report that summarizes the year's data, analyzes any project-related bird fatalities or injuries detected, and provides recommendations (in consultation with the County) for future monitoring and any adaptive management actions needed.

Annual Reportable Items

COA 62 ABMP requires specific significance thresholds that would trigger Adaptive Management will be defined in the Year 1 annual report based on analysis of the Year 1 data, in consultation with the County, CDFW and USFWS. Significance thresholds will be based on statistical comparison of Project Site data and offsite reference plot data. Comparison with reference plots will provide insight regarding the significance of any detected fatalities, so that thresholds can be assigned with confidence. If, in the event that Year 1 data is insufficient to determine significance thresholds because the amount of construction was less than anticipated, the Year 2 annual report shall make these recommendations.

Report Data

Attached is the Annual report prepared by Althouse & Meade (COA 62 and ABPP Quarterly Monitoring Report by Althouse & Meade February 13, 2013).

If there are questions regarding this report, please contact:

Timothy J. Higdon
First Solar Site Compliance Manager
Topaz Solar Farm
10400 Helios Way
Santa Margarita, CA

ALTHOUSE AND MEADE, INC.
BIOLOGICAL AND ENVIRONMENTAL SERVICES
1602 Spring Street, Paso Robles, CA 93446
Telephone 805-237-9626

Topaz Solar Farm
10400 Helios Way
Carrisa Plains, CA

Dan Meade, Ph.D., Designated Biologist
Jason Dart, Designated Biologist

March 5, 2013

Topaz Solar Farm
Avian and Bat Protection Plan
and
Bird Monitoring and Avoidance Plan

Fourth Quarterly/First Annual Report for 2012

This Fourth Quarterly/First Annual Report provides information pertinent to the reporting obligations regarding implementation of various tasks required by the Topaz Solar Farm Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (Althouse and Meade, Inc. June 2011). The Avian and Bat Protection Plan (ABPP) and Bird Monitoring and Avoidance Plan (BMAP) are requirements of County of San Luis Obispo Conditions of Approval (COA) 61 and 62, and were prepared in consultation with USFWS and CDFW. Section 5.5 of the ABPP/BMAP document requires quarterly and annual reports to be submitted to the County of San Luis Obispo, U.S. Fish and Wildlife Service (USFW) and the California Department of Fish and Wildlife (CDFW). This Fourth Quarterly Report has been augmented to satisfy requirements of the annual reporting obligation, and thus constitutes the first annual report for the Topaz Solar Farms ABPP/BMAP. Information provided spans the period from January 1 through December 31, 2012.

Table of Contents

List of Tables

List of Figures

1.0 Avian and Bat Protection Plan

The ABPP monitoring program compiles general information on bird and bat interactions, injuries and mortality at the Topaz Solar Farm. During construction phases of the project this task is completed by the project biologists, as part of routine daily biological monitoring. Data reported for the Bird Monitoring and Avoidance Plan, which provides detailed information on bird use and bird mortality at the project site, is presented below in Section 2.0.

1.1 Bird Surveys

General bird surveys are conducted on and around the project site on a daily basis throughout the year by project biologists. Species lists are generated and maintained, and interesting bird observations are highlighted. A list of 113 bird species observed on and near the project site is included as Exhibit 3.

1.2 Nesting Activity

All nests and nest starts identified during the 2012 nesting season were documented. The month each nest and nest start were found are shown in Figure 1. A total of 9 bird species were documented nesting in or near the 2012 work areas (Table 1). Other species nesting in offsite mitigation lands or future project lands are not included in this tally. Burrowing owl was the only special concern species nesting on or near the project. Nesting was documented spanning the months of March through July, with fledgling burrowing owls observed into August. The peak nesting period, in terms of number of nests and number of species nesting was late April through May. The horned lark was the most abundant nesting species, with over 50 nests and nest starts identified in May 2012.

TABLE 1. 2012 NESTING DATA BY MONTH. The number of nests detected each month is listed for 9 species between March and July.

Species	March	April	May	June	July
Barn Owl	0	0	0	1	0
Burrowing Owl	1	1	1	1	1
Common Raven	1	6	2	4	2
European Starling	2	2	1	0	0
Horned Lark	0	16	51	8	0
House Finch	2	5	3	0	0
Mourning Dove	1	1	0	0	0
Western Meadowlark	0	13	2	0	0

Species	March	April	May	June	July
Say's Phoebe	1	0	0	0	0

Horned larks nest on the ground in a woven grass cup, often placed in a small depression. They prefer patchy short-grass conditions with bare spots. Array areas with newly vegetated ground provided a preferred nesting substrate. Although specific data was not compiled, our observations suggest horned lark nesting density was higher in array areas than in undisturbed grassland. Nest success was observed to be low in the array areas, with a high rate of predation by ravens and other wildlife. When a nest was predated, surveys of the vicinity often showed attempts to re-nest close by. Horned larks do not re-use nests. No prevention methods were utilized to keep horned larks from nesting in the arrays other than removal of nest starts. Detection of nest starts required intensive daily survey efforts, and nests with eggs or chicks were often found and left in place.

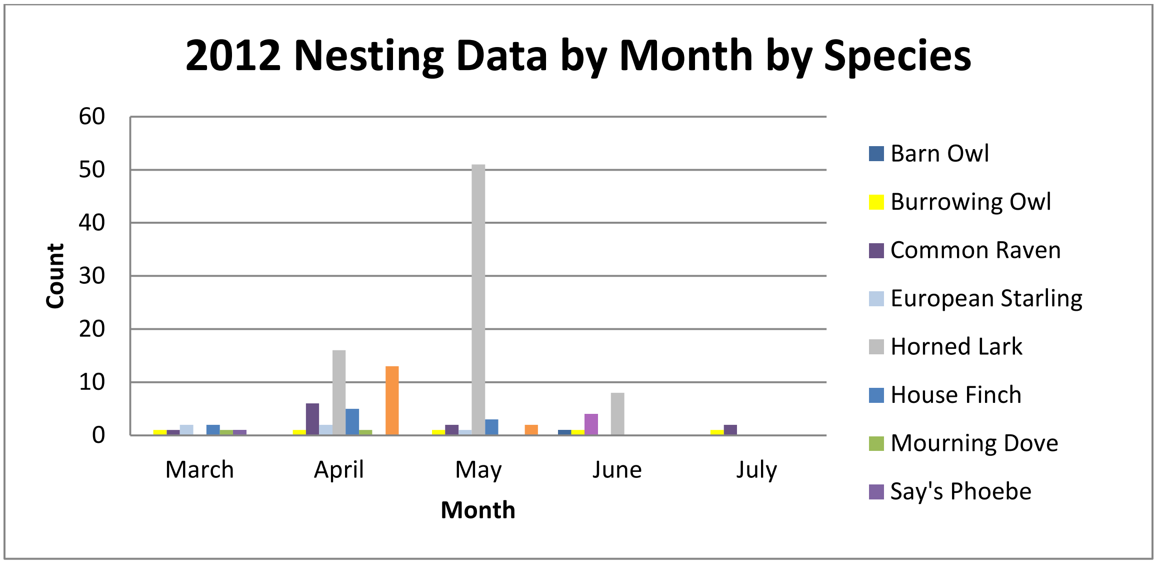
Western meadowlarks nest on the ground in taller grass habitats. All meadowlark nests identified were in future work areas containing tall grasses with abundant mustards. Mowing of tall grass fields prior to nesting activity was conducted in limited areas to prevent meadowlark nesting.

House finches nested or attempted to nest on construction equipment and materials throughout the project site. Preferred nesting areas were in small pieces of equipment, gaps in spools, and openings in cardboard boxes. Flashing tape and bird netting were used to prevent house finch nesting on materials and equipment. Both of these methods were effective.

Ravens nested on power poles within and around the project. They also attempted to nest on heavy equipment and on abandoned windmills in future work areas. Nesting materials were removed daily from some nest sites to prevent nesting. For equipment, removing nest starts and moving the equipment to a new location solved the problem. At one medium-voltage power pole within the project the nest start was removed on several occasions but eventually the ravens were allowed to nest on the pole. Unfortunately one chick died as a result of entanglement in nesting materials.

Burrowing owls nested in several locations immediately adjacent to the project. One nest attempt along Helios Way failed when one of the adults died. One nest northeast of Block 6 was observed to have 7 chicks in June 2012. Biologists observed a prairie falcon kill one of the burrowing owl chicks as it stood with the cohort at the burrow entrance. Survival of the remaining chicks was not known, but all remaining were fledged in August 2012. A third nest located west of the project successfully fledged, but the number of fledglings was not determined.

FIGURE 1. 2012 NESTING DATA BY MONTH.



1.3 Avian and other Wildlife Mortality

General biological monitoring of the Topaz work areas documented bird, bat and other wildlife mortality. All mortality identified on site from January through December 2012 is provided in Table 2. Cause of death is reported when known.

TABLE 2. BIRD AND OTHER WILDLIFE MORTALITY. Bird and other wildlife mortality detected at the Topaz Solar Farm, January through December 2012.

Species	Cause of Death	Notes
January 2012		
Horned Lark *Eremophila alpestris*	Unknown	One carcass found under powerlines along Tower Road
California Vole *Microtus californicus*	Unknown	One carcass removed from an open fence post hole
February 2012		
Mourning Dove *Zenaida macroura*	Raptor predation	One carcass found 200 yards north of Hwy 58 on Helios Way
Pacific Gopher Snake *Pituophis catenifer catenifer*	Unknown	One carcass found in grass east of Phase 1 North Array
Pacific Gopher Snake *Pituophis catenifer catenifer*	Construction activities	Hit by road grader in dust control pond area
Western Meadowlark *Sturnella neglecta*	Raptor predation	One carcass found on Tower Road
Horned Lark *Eremophila alpestris*	Predation	One carcass found in the secure laydown area
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	One carcass removed from Phase 1 North Array

Species	Cause of Death	Notes
March 2012		
Botta's Pocket Gopher *Thomomys bottae*	Unknown	One carcass found in Phase 1 South Array
Horned Lark *Eremophila alpestris*	Predation	Remains found in Phase 1 North Array
House Finch *Carpodacus mexicanus*	Predation	Three carcasses removed from the Helios laydown; house-cat is probable predator
Deer Mouse *Peromyscus maniculatus*	Unknown	One carcass found in Block 3
Savannah Sparrow *Passerculus sandwichensis*	Entanglement/Predation	One carcass caught in exclusion net and partially eaten in Helios laydown area
Heermann's Kangaroo Rat *Dipodomys heermanni*	Drowning	One carcass found in the Helios wheel wash
April 2012		
Unidentified Mice	Drowning	Two carcasses found in the Helios wheel wash
Unidentified Mice	Unknown	Two carcasses found under materials stack in Phase 1 South Array
Horned Lark *Eremophila alpestris*	Unknown	One carcass found in Phase 1 South Array
Pacific Gopher Snake *Pituophis catenifer catenifer*	Construction activities	Killed by equipment moving materials
Pacific Gopher Snake *Pituophis catenifer catenifer*	Entanglement	One carcass found in bird abatement netting in the Helios laydown area
Savannah Sparrow *Passerculus sandwichensis*	Entanglement	One carcass found in bird netting in the Helios laydown area
Botta's Pocket Gopher *Thomomys bottae*	Unknown	Two carcasses found in open fence post holes
Heermann's Kangaroo Rat *Dipodomys heermanni*	Unknown	One carcass found in open fence post hole
May 2012		
Savannah Sparrow *Passerculus sandwichensis*	Predation	Two carcasses found in Phase 1 South Array; house-cat is probable predator
Deer Mouse *Peromyscus maniculatus*	Unknown	One carcass found in trench in Phase 1 North Array
Deer Mouse *Peromyscus maniculatus*	Drowning	Two carcasses found in dust control pond well head
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	One carcass removed from Helios Way
California Ground Squirrel *Spermophilus beecheyi*	Unknown	One carcass found in Phase 1 North Array
California Ground Squirrel *Spermophilus beecheyi*	Predation	One carcass found near dust control pond
California Ground Squirrel *Spermophilus beecheyi*	Predation	One carcass found in Block 3

Species	Cause of Death	Notes
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Five carcasses removed from Helios Way
Wilson's Phalarope *Phalaropus tricolor*	Unknown; either drowning or raptor predation	One carcass found in dust control pond
Northern Pacific Rattlesnake *Crotalus oreganus oreganus*	Vehicle strike	One juvenile found in Phase 1 North Array
Horned Lark *Eremophila alpestris*	Unknown	One carcass with no visible wounds on Helios Way
Horned Lark *Eremophila alpestris*	Raptor predation	One carcass found outside Block 3 fence
Horned Lark *Eremophila alpestris*	Raptor predation	One carcass found in Block 2
House Finch *Carpodacus mexicanus*	Construction activities	One egg crushed during accidental exposure of nest built in cable roll; nest subsequently abandoned
June 2012		
Horned Lark *Eremophila alpestris*	Predation	One carcass found in Phase 1 South Array
Deer Mouse *Peromyscus maniculatus*	Unknown	One carcass found in Phase 1 South Array
Deer Mouse *Peromyscus maniculatus*	Unknown	One carcass found in Block 2
House Finch *Carpodacus mexicanus*	Predation	On material stacks. Two eggs and two dead chicks. Nest abandoned.
Unidentified Mice	Drowning	Two carcasses found in dust control pond well head
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	One carcass removed from Helios Way
California Ground Squirrel *Spermophilus beecheyi*	Drowning	Three carcasses removed from dust control pond
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	One carcass removed from Access Road A
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	One carcass removed from Helios laydown entrance
Pacific Gopher Snake *Pituophis catenifer catenifer*	Construction activities	One killed during ground preparation work in Block 1
Pacific Gopher Snake *Pituophis catenifer catenifer*	Construction activities	Two juveniles killed during ground preparation work in Block 2
Brewer's Blackbird *Euphagus cyanocephalus*	Injury	One female flew into the side of a concrete vault
July 2012		
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	One carcass removed from Helios Way
California Ground Squirrel *Spermophilus beecheyi*	Drowning	11 carcasses were removed from the dust control pond in July
Deer Mouse *Peromyscus maniculatus*	Construction activities	2 dead mice were removed from a work area, likely crushed by moving materials
Horned Lark *Eremophila alpestris*	Unknown	One carcass was removed from an array area

Species	Cause of Death	Notes
European Starling *Sturnus vulgaris*	Unknown	Carcass found near a work area perimeter fence, no apparent injuries
Western Bluebird *Sialia mexicana*	Probable vehicle strike on Highway 58 off site, carried onto site by car.	Juvenile found near cars in parking lot
Common Raven *Corvus corax*	Entanglement in nesting material	Foot of nestling was entangled in nesting material, bird died when it tried to fledge.
August 2012		
Deer Mouse *Peromyscus maniculatus*	Vehicle strike	2 carcasses were removed from project roads in August
California Ground Squirrel *Spermophilus beecheyi*	Drowning	Five carcasses removed from dust control pond
California Ground Squirrel *Spermophilus beecheyi*	Unknown	Two carcasses were removed from work areas in August
Violet-Green Swallow *Tachycineta thalassina*	Drowning	Juvenile removed alive from dust control pond; died shortly thereafter
Horned Lark *Eremophila alpestris*	Unknown	One carcass removed from array area in Block 2
Desert Cottontail *Sylvilagus auduboni*	Abandoned by parents	3 juveniles found under a pallet, two were relocated, third was dead
Cooper's Hawk *Accipiter cooperii*	Unknown	Desiccated carcass found in arrays of Block 6. CDFG and USFWS notified. Carcass was transferred to CDFG Jan 10, 2013.
September 2012		
Virginia Rail *Rallus limicola*	Collision with fence	Rail collected dead in parking area at base of chain link fence with obvious collision wound
California Ground Squirrel *Spermophilus beecheyi*	Drowning	Two carcasses were removed from the dust control pond in September
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	Two carcasses removed from work area in Block 5
Brewer's Blackbird *Euphagus cyanocephalus*	Unknown; possible entrapment or crushing by moving materials	Four carcasses were removed from between materials boxes in a laydown yard.
Botta's Pocket Gopher *Thomomys bottae*	Unknown; possible failed predation attempt	One carcass was removed from Block 1
Deer Mouse *Peromyscus maniculatus*	Crushed by materials	Reported by workers, mouse died before it could be treated or released
Deer Mouse *Peromyscus maniculatus*	Unknown	One carcass removed from Block 5
Heermann's Kangaroo Rat *Dipodomys heermanii*	Equipment strike	Mortally wounded by heavy equipment
Horned Lark *Eremophila alpestris*	Raptor predation	Reportedly dropped by a raptor, the carcass was removed by biologists
Horned Lark *Eremophila alpestris*	Raptor predation	One carcass with injuries consistent with a failed raptor predation attempt was removed from Block 8

Species	Cause of Death	Notes
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle/equipment strike	2 juvenile gopher snake carcasses were removed from work areas
Desert Cottontail *Sylvilagus audubonii*	Exposure	A juvenile rabbit was removed alive from a trench but died shortly thereafter
Common Raven *Corvus corax*	Unknown	One carcass was removed from Block 1 work area with no apparent injuries
October 2012		
Common Raven *Corvus corax*	Predation	Remains were found in Block 5
Long-billed Curlew *Numenius americanus*	Predation	Carcass found with missing head in trench in Block 1
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle/equipment strike	Mortally wounded on a project road south of Block 4; euthanized by biologists
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	Mortally wounded by a forklift in Block 2; euthanized by biologists
Horned Lark *Eremophila alpestris*	Unknown	Carcass removed from Access Road B; no visible injuries present
November 2012		
Horned Lark *Eremophila alpestris*	Unknown	Carcass found in Block 5
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Juvenile found dead on Access Road B
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	Killed by ground-breaking equipment in Block 8 East
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	Killed by a trencher in Block 4
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	Carcass found on Helios Way
Deer Mouse *Peromyscus maniculatus*	Unknown	Juvenile found dead outside of nest in materials box
Pacific Chorus Frog *Pseudacris regilla*	Equipment strike	One frog euthanized due to injuries from heavy equipment at the Cochrane site
Coyote *Canis latrans*	Unknown	Old carcass observed under debris pile at the Cochrane site
Barn Owl *Tyto alba*	Drowning/Entrapment	Old carcass observed at bottom of well at the Cochrane site
Western Meadowlark *Sturnella neglecta*	Drowning/Entrapment	Old carcass observed at bottom of well at the Cochrane site. Pre-dates project start.
Western Meadowlark *Sturnella neglecta*	Predation	Carcass found in Block 9 West
Desert Cottontail *Sylvilagus audubonii*	Unknown	Carcass found under panels in Block 2
December 2012		

Species	Cause of Death	Notes
Unidentified Mice	Entrapment	Two mice found in backfilled vault
Mourning Dove *Zenaida macroura*	Raptor predation	One carcass removed from surface of module in Block 7. Presumably dropped by raptor.
Mourning Dove *Zenaida macroura*	Predation	One headless carcass removed from the Cochrane site
Horned Lark *Eremophila alpestris*	Predation	One headless carcass removed from Block 1
House Finch *Carpodacus mexicanus*	Unknown	One carcass removed from Block 3
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	One carcass removed from Helios Way
California Ground Squirrel *Spermophilus beecheyi*	Equipment strike	One carcass removed from Block 8
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	Two snakes killed by heavy equipment at the Cochrane site
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	One carcass removed from Block 9
Western Meadowlark *Sturnella neglecta*	Injury	One carcass removed from Access Road B; bird appears to have flown into a moving vehicle
California King Snake *Lampropeltis getula californiae*	Equipment strike	One carcass removed from Block 9
Desert Cottontail *Sylvilagus auduboni*	Equipment strike	Three carcasses removed from the Cochrane site
Heermann's Kangaroo Rat *Dipodomys heermanni*	Unknown	One carcass found in open fence post hole in Block 8 West
Pacific Chorus Frog *Pseudacris regilla*	Unknown	One carcass removed from a pitfall trap at the Cochrane site

2.0 Bird Monitoring and Avoidance Plan

The BMAP study utilizes avian use surveys and avian fatality surveys to produce a risk index for various project components deemed to be potentially dangerous to birds, including array areas, overhead power lines and energized equipment (substation). Offsite grassland areas were used as reference sites to compare Bird Utilization Rates, Bird Fatality Rates, and ultimately Bird Risk Index. The BMAP study has two primary goals:

Goal 1. Provide Project owners/managers with scientifically-based risk analyses to facilitate implementation of Adaptive Management actions to minimize conflicts between Project components and birds.

Goal 2. Provide a rigorous scientific study of avian use and mortality associated with specific components of an industrial scale photovoltaic solar facility that can be used by wildlife regulators as a planning tool for future solar projects.

To accomplish these goals, the BMAP outlines five Objectives with specific Tasks:

Objective 1. Assess changes in total bird abundance, species composition, and species richness relative to development and operation of the Project compared to undeveloped reference sites;

Task 1.1: Implement Avian Use Surveys.

Task 1.2: Submit quarterly and annual monitoring reports.

Objective 2. Calculate Bird Utilization Rate, Bird Fatality Rate, and Bird Risk Index for three specific Project components (Array Areas, Overhead Power Lines, Substation/Switching Station);

Task 2.1: Implement Avian Fatality Monitoring Surveys, Searcher Efficiency Trials, and Scavenger/Carcass Removal Trials.

Task 2.2: Run calculations on survey data according to methods in Section 5.4.

Task 2.3: Submit quarterly and annual monitoring reports.

Objective 3. Conduct risk assessment analyses for each Project component based on calculated Bird Utilization Rate, Bird Fatality Rate, and Bird Risk Index;

Task 3.1: Prepare a written analysis of survey data and calculated Bird Risk Index for each Project component to be included in the annual report.

Objective 4. Inform TSF facility managers of Adaptive Management requirements when Bird Risk Index and/or Bird Fatality Rate indicates significance thresholds for avian mortality have been reached (refer to Section 6.0);

Task 4.1: Submit quarterly and annual monitoring reports.

Objective 5. Prepare a scientific paper describing the results of avian use surveys and avian fatality monitoring surveys, and the conclusion regarding the risk level that the Project poses for avian resources.

Task 5.1: Within one year of completion of the study data collection, prepare and submit a scientific paper to the County of San Luis Obispo.

2.1 Discussion regarding Year 1 Data

This Fourth Quarterly/First Annual Report of the ABPP/BMAP provides preliminary data collected for Objectives 1, 2 and 3 (Sections 2.2, 2.3 and 2.5, below). The data is considered preliminary for Year 1 since the pace of construction did not facilitate a large number of Avian Use Surveys or Avian Fatality Surveys to be completed in Array Area, Overhead Powerline and Energized Equipment survey areas, as these areas were not completed with construction until late in the year.

When the BMAP study design was prepared in 2010, prior to start of construction, it was assumed that more completed array areas and powerlines would be available earlier in the year for avian surveys. Therefore, the Year 1 annual report was the designated timeframe for establishing significance thresholds on avian mortality levels. The significance thresholds are to be determined in consultation with the U.S. Fish and Wildlife Service, California Department of Fish and Wildlife, and the County of San Luis Obispo, based on Bird Risk Index data.

We propose to modify the significance threshold determination schedule as presented in the BMAP so that data may be collected through 2013 on avian use and avian fatality at project components. Another year of data from completed project components will provide a robust foundation for the Bird Risk Index calculations, which will better inform significance determinations. If this approach is acceptable to the reviewing agencies, the Topaz Solar Farm ABPP/BMAP document will be revised and resubmitted to reflect the changes.

With respect to the proposal to postpose the significance threshold determination, Objective 4 will be reported beginning with the first quarterly report for Year 2, after significance thresholds have been determined. Objective 5 will be completed within one year after completion of the field surveys.

2.2 Avian Use Surveys

Avian Use Surveys commenced in November 2011, prior to the start of construction, to gather baseline data on bird use in the project area. Avian Use Surveys will inform the Bird Utilization Rate calculations (see Section 2.2.1, below). Construction commenced in late November 2011 in a limited footprint, and slowly expanded in area throughout 2012. Avian use surveys were conducted monthly from November 2011 through December 2012, and will continue throughout the construction period and for three years after construction is complete. Each month, 63 randomly selected survey points were completed, for a total of 882 survey points completed as of December 2012. The 63 survey points include 31 inside existing or future array areas, 18 along existing or future overhead power lines, 10 in grassland reference sites and 4 at the substation. At each point, a 10 minute bird use count is conducted within a 50 meter radius of the surveyor.

Avian Use Survey points were selected each month across all six phases of the project and in offsite grassland reference areas (Exhibit 1). Each month, as construction area increased in size, more of the survey points occurred in developed area. Those points located within future project areas that had not been developed at the time of the survey are categorized as Baseline. Baseline condition is similar to Reference site condition in that it is not developed, however it differs in being cropland habitat versus grassland habitat. Therefore, comparison of Baseline with Reference data could provide information regarding Bird Utilization Rate in different habitat types, if desired.

Forty-three bird species were detected during the avian use surveys from November 2011 through December 2012. Thirteen of these species were detected only once. Horned lark was overwhelmingly the most commonly detected species (6848 detections), followed by house finch (1416), savannah sparrow (776), long-billed curlew (604), common raven (565) and mountain bluebird (526).

For reasons outlined above in Section 2.1, the data collected for Avian Use Surveys and the subsequent analyses for Objective 1 are considered preliminary. Sections 2.2.1, 2.2.2 and 2.2.3 outline our preliminary data collected for bird abundance, species composition and species richness.

2.2.1 Preliminary bird abundance

Total bird abundance is compared in Table 3 between Array Area, Overhead Powerline, Energized Equipment, Reference Site and Baseline survey area categories. Bird abundance is calculated as average number of birds observed per Observation Point. Highest bird abundance was for the Baseline category, at 15.85 birds per Observation Point. The Baseline category represents crop stubble fields prior to start of construction. Reference Sites consisting of grassland habitat had an average of 12.19 birds per Observation Point. Completed Array Areas averaged 11.09 birds per Observation Point, Overhead Powerlines averaged 7.95 birds and Energized Equipment averaged 7.0 birds. Preliminary data suggest a reduction in total bird abundance between the Baseline category and the completed Array Area category.

TABLE 3. PRELIMINARY BIRD ABUNDANCE COMPARISON.

Survey Area Category	**Bird Abundance** **(Average # Birds/Observation Point)**
Baseline (Crop Stubble)	15.85
Reference Site (Grassland)	12.19
Overhead Powerline	7.95
Energized Equipment	7.00
Array Area	11.09

2.2.2 Preliminary species richness

Species richness is a measure of the number of different species in a given area. Table 4 lists the total number of species observed within each of the five survey area categories. Baseline Observation Points had 33 species detected, the highest of any of the survey area categories. Grassland Reference Site points had 20 species detected, both Overhead Powerline and Array Area points had 18 species detected, and Energized Equipment had 14 species.

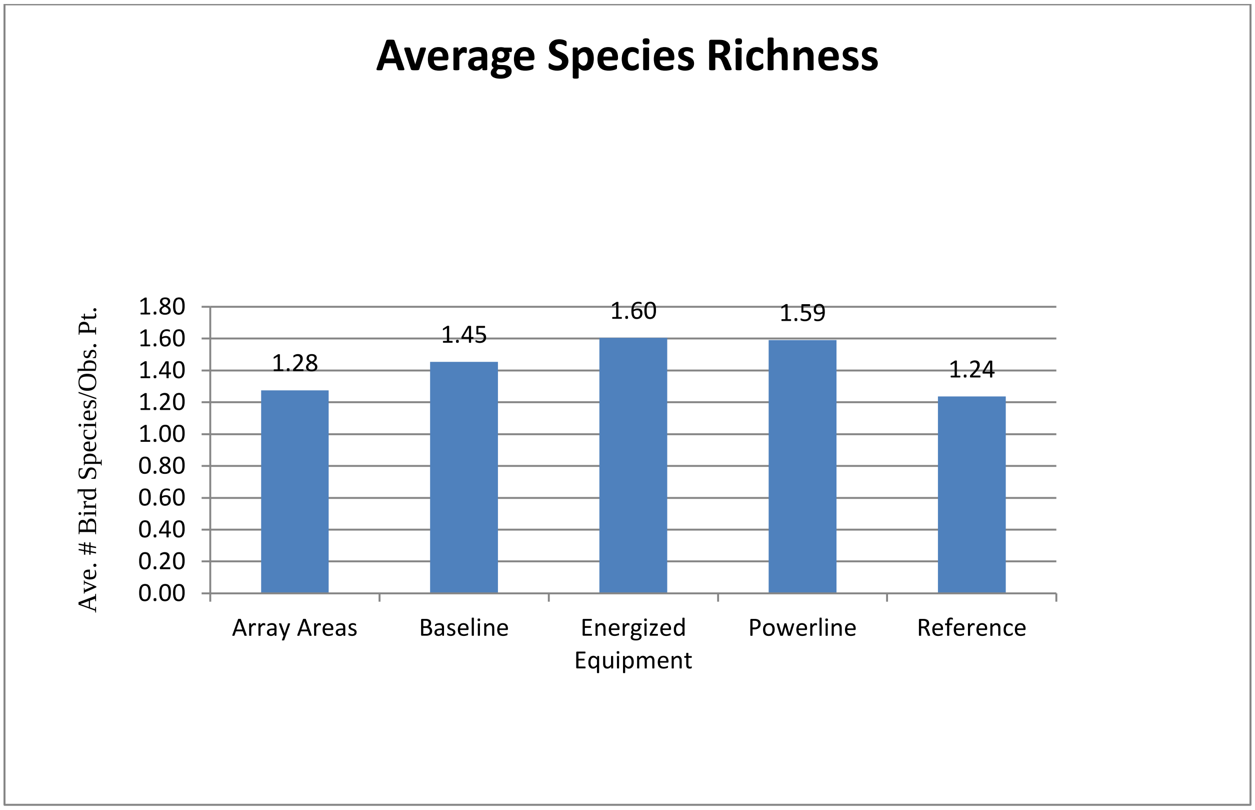
We also compared avian species richness averaged across all Observation Points in each of the five survey area categories from November 2011 through December 2012 (Table 4 and Figure 2). Species richness is markedly similar in each category. Energized Equipment and Overhead Powerlines averaged 1.60 and 1.59 bird species per Observation Point, respectively. Array Areas averaged 1.28 bird species per Observation Point, Baseline averaged 1.45 species and grassland Reference Sites averaged 1.24 species.

Preliminary data suggest a reduction in species richness between the Baseline category and the completed Array Area category.

TABLE 4. PRELIMINARY SPECIES RICHNESS COMPARISON.

Survey Area Category	Ave No. Species per Obs. Point	Total Number of Species
Baseline	**1.45**	**33**
Reference Site	**1.24**	**20**
Overhead Powerline	**1.59**	**18**
Energized Equipment	**1.60**	**14**
Array Area	**1.28**	**18**

FIGURE 2. AVERAGE SPECIES RICHNESS.



2.2.3 Preliminary species composition

Species composition refers to the relative abundance of different species in a given area. For each species we calculated the average number of birds detected for Observation Points within each of the five survey area categories (Table 5). We looked at the 6 most abundant species detected from November 2011 through December 2012: horned lark, house finch, savanna sparrow, long-billed curlew, common raven and mountain bluebird.

Of the 6 most abundant species detected, the Baseline and Reference Site categories detected all 6 species, or 100%. Both of these categories represent non-developed habitat. Overhead Powerline and Energized Equipment categories detected 5 of the 6 most abundant species (83%). Completed Array Areas detected only 4 of the 6 most abundant species, or 67% (Table 5).

TABLE 5. PRELIMINARY SPECIES COMPOSITION COMPARISON. Average number of individuals is listed for each of the 6 species within the five survey area categories. Percent of top 6 species is listed at far right.

Survey Area Category	Horned Lark Ave #	House Finch Ave #	Savanna Sparrow Ave #	Long-billed Curlew Ave #	Common Raven Ave #	Mountain Bluebird Ave #	% of Top 6 Species Recorded
Baseline	3.11	0.57	0.39	0.35	0.32	0.19	**100%**
Reference Site	2.32	1.04	0.14	0.17	0.18	0.67	**100%**
Overhead Powerline	1.72	0.35	0.34	0.00	0.02	0.01	**83%**
Energized Equipment	1.33	0.60	0.28	0.00	0.02	0.02	**83%**
Array Area	3.80	0.11	0.02	0.00	0.01	0.00	**67%**

2.2.4 2012 Bird Utilization Rate Calculations

Bird Utilization Rate (BUR) is calculated as the number of unique bird observations divided by the number of observation point counts. Each month 63 observation point counts are randomly chosen and surveyed for 10 minutes each. A unique bird observation is recorded each time a bird or group of birds enters the survey area.

We calculated Bird Utilization Rate for five survey area types: Array Areas, Overhead Powerlines, Energized Equipment (Substation), Reference Site (grassland) and Baseline (future work area, cropland or grassland). Where an Array Area, Overhead Powerline, or Energized Equipment survey point was conducted prior to construction commencement at that location, that point was categorized as a Baseline site since no construction activities or project facilities were present.

Average BUR for each survey area type was calculated for 2012 (Figure 3 and Table 6). Reference sites had the highest BUR, at 4.82. Array Areas were second highest, with an average BUR 3.66, and Baseline, Overhead Powerline and Energized Equipment were roughly similar with BUR of 2.97, 2.96 and 2.83 respectively.

Bird Utilization Rates were also calculated and graphed by month, for each of the five survey area types (Figure 4). Note that surveys in November and December 2011 did not include all survey area types since construction had not commenced.

FIGURE 3. 2012 AVERAGE BUR FOR ALL SURVEY AREA TYPES.

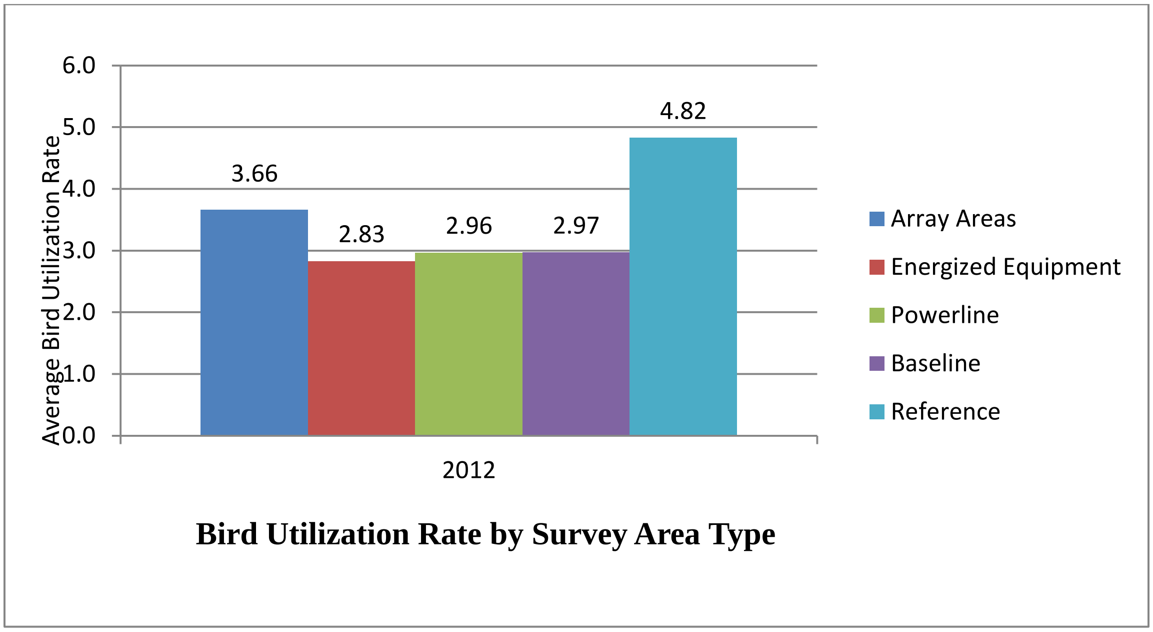
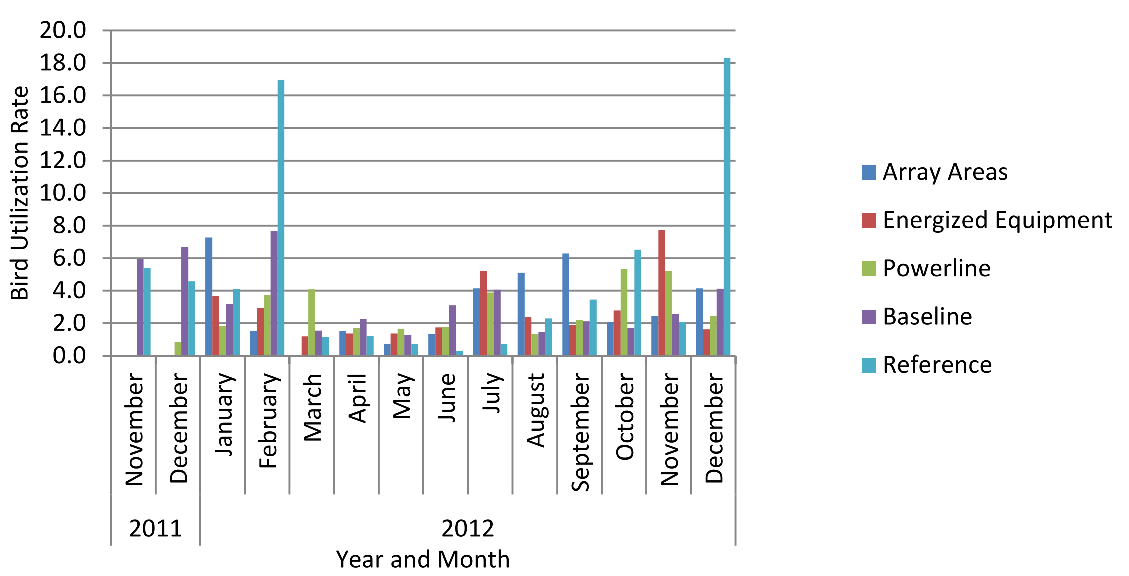


TABLE 6. BIRD UTILIZATION RATE BY SURVEY AREA TYPE. BUR is provided for each of the survey area types by month. Total monthly average BUR is provided in the last column, and average BUR for the year 2012 is provided at the bottom.

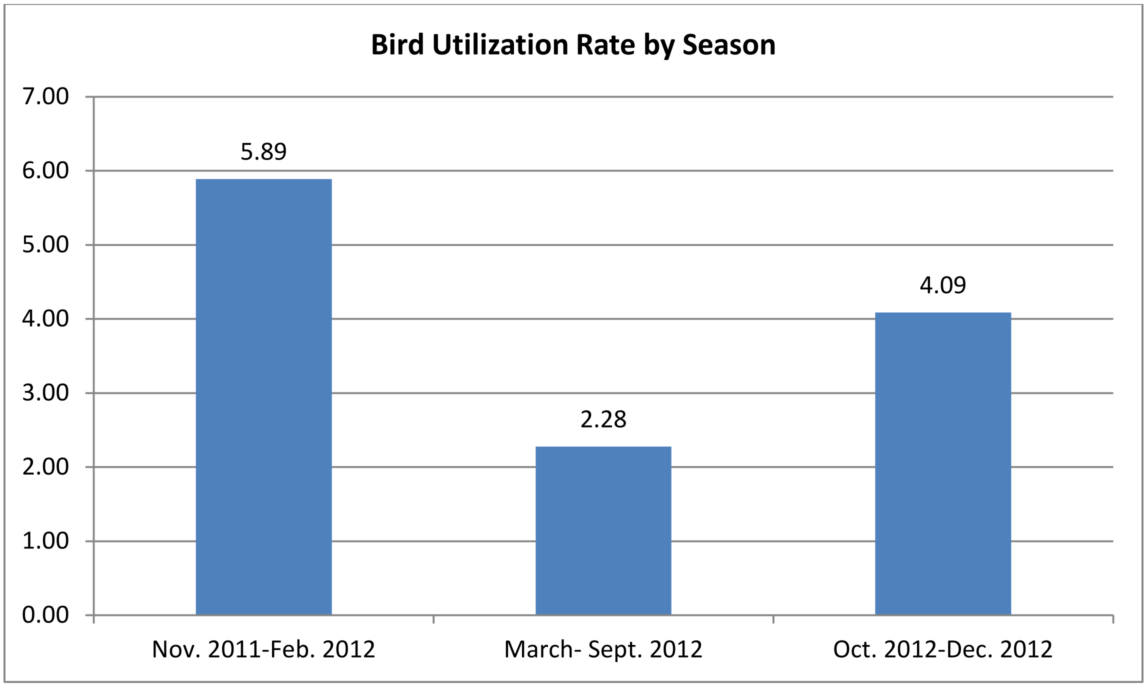
Year/Month	Array Areas	Energized Equipment	Overhead Powerline	Baseline	Reference	Average
2011 November	n/a	5.96	5.38	5.86	n/a	5.96
2011 December	0.83	6.71	4.59	6.09	0.83	6.71
2012 January	7.28	3.68	1.83	3.19	4.11	3.28
2012 February	1.50	2.92	3.75	7.67	16.98	8.31
2012 March	0.00	1.19	4.08	1.55	1.15	1.68
2012 April	1.50	1.38	1.70	2.26	1.21	1.97
2012 May	0.75	1.38	1.67	1.30	0.75	1.25
2012 June	1.33	1.75	1.79	3.11	0.30	2.30
2012 July	4.14	5.21	3.89	4.07	0.72	3.59
2012 August	5.10	2.38	1.33	1.47	2.30	2.22
2012 September	6.29	1.88	2.20	2.11	3.46	2.92
2012 October	2.08	2.79	5.35	1.72	6.53	3.18
2012 November	2.43	7.75	5.22	2.57	2.08	3.17
2012 December	4.15	1.63	2.44	4.12	18.30	5.90
Average of 2012 Monthly Surveys	**3.66**	**2.83**	**2.96**	**2.97**	**4.82**	**3.32**

FIGURE 4. MONTHLY BIRD UTILIZATION RATE. The Bird Utilization Rate is indicated for each of the five survey area types during each month from November 2011 through December 2012.



Bird Utilization Rate indicates highest general bird use during the winter period from October through February, with average BUR from November 2011 to February 2012 of 5.89 and an average BUR of 4.09 from October 2012 to December 2012. By comparison, the non-winter period spanning March to September 2012 had an average BUR of 2.28 (Figure 5). This is generally consistent with the influx of wintering birds which gather in large flocks in the Carrizo Plain during this time. Based on these preliminary results we would expect the risk of bird mortality to be higher during the winter period, if all other variables remain the same, simply due to the higher number of birds present.

FIGURE 5. BIRD UTILIZATION RATE BY SEASON. Average BUR is graphed for winter and non-winter periods.



2.3 Avian Fatality Surveys

Avian Fatality Surveys commenced upon completion of the first project components. Avian Fatality Surveys are conducted at randomly selected locations within four different survey area types: Array Areas, Overhead Powerlines, Energized Equipment (Substation) and at Reference sites[1]. Each survey area type was divided into 500 foot by 15 foot search plots. Search plots are randomly selected using an ArcGIS random point generator having defined areas as the constraining polygon. Avian Fatality Surveys are conducted within the same search plots each day for seven consecutive days every month. Repetitive surveys increase the chance of finding fatalities in a given area before predators remove the carcass. Exhibit 2 depicts the search plots covered by Avian Fatality Surveys in 2012.

During the period of July 1 through September 31, 2012 we conducted test fatality surveys at various locations during construction phases; however, no formal surveys were conducted due to incomplete project components. We used these preliminary results to guide our survey efforts in the Array Areas starting in October 2012.

In October 2012 we completed walking Avian Fatality Surveys at 168 five hundred foot transects within completed Array Area search plots, for 7 consecutive days each, totaling 1,176 search plots (111.4 linear miles, 207.3 acres) for the month. No avian fatalities

---

[1] Select Array Areas were completed and safe to conduct surveys by October 2012. The first Overhead Powerline areas were completed by the December survey. Energized Equipment areas were not complete with construction in 2012 and were therefore not surveyed.

were detected during the October survey (Table 7). Since Overhead Powerline and Substation construction were not complete, no search plots in these survey area types were conducted. We consider the October 2012 Array Area data to be a test to determine labor hours required per search plot, therefore no Reference Site search plots were conducted for comparison. This data is not included in the 4th quarter Average Fatality Rate calculation provided in Table 7, last row.

In November 2012 we completed walking avian fatality surveys at 84 five hundred foot transects within completed Array Area search plots, for 7 consecutive days each, totaling 588 search plots (55.7 linear miles, 103.7 acres). A total of 84 Grassland Reference Site search plots were completed, for 7 consecutive days each, totaling 55.7 linear miles (101.8 acres). One bird fatality was detected in the Array Area search plots and four fatalities were detected in the Reference Site search plots. The Array Area fatality was a very old mourning dove feather pile in which the cause of death could not be determined. The fatalities recorded in the Reference Site search plots consisted of two American kestrels, one domestic chicken, and one unidentified species. Each of these fatalities consisted of feather piles, and in one case (the unidentified species), a bone fragment. Cause of death could not be determined for any of the fatalities, however predation was presumed to be the likely cause for each.

In December 2012 we completed walking Avian Fatality Surveys at 126 five hundred foot transects within completed Array Area search plots, for 7 consecutive days each, totaling 882 search plots (83.5 linear miles, 155.5 acres). Powerline search plots included 3 five hundred foot transects, surveyed for 7 consecutive days each, totaling 2.0 linear miles (3.6 acres). A total of 12 grassland Reference Site search plots were completed, for 7 consecutive days each, totaling 84 linear miles (152.7 acres). One fatality was recorded in the Array Area search plots. The fatality was a domestic chicken in which only feathers were found. The cause of death was determined to be predation. No fatalities were recorded in the Powerline or Reference Site search plots.

2.3.1 2012 Bird Fatality Rate Calculations

Bird Fatality Rate (BFR) is calculated for three of the four survey area types as the number of unique bird carcasses detected divided by the number of plots searched (Table 7). Energized Equipment (Substation) was not completed in 2012 and was therefore not surveyed. The highest 4th Quarter (November and December 2012) BFR was recorded for the Reference Site search plots (0.003). The Array Area search plots had a BFR of 0.001. No bird fatalities were recorded in the Overhead Powerline search plots, so the BFR is zero.

TABLE 7. BIRD FATALITY RATE DATA.

2012 Data	**Array Areas**	**Energized Equipment**	**Overhead Powerline**	**Reference (Grassland)**
Number of Search Plots				
October Search Plots	**1,176**	**0**	**0**	**0**
November Search Plots	**588**	**0**	**0**	**591**
December Search Plots	**882**	**0**	**21**	**887**

2012 Data	**Array Areas**	**Energized Equipment**	**Overhead Powerline**	**Reference (Grassland)**
Number of Bird Fatalities				
October Bird Fatalities	**0**	--	--	--
November Bird Fatalities	**1**	--	--	**4**
December Bird Fatalities	**1**	--	**0**	**0**
Bird Fatality Rate (No. Fatalities/No. Search Plots)				
October Bird Fatality Rate	**0**	--	--	--
November Bird Fatality Rate	**0.002**	--	--	**0.007**
December Bird Fatality Rate	**0.001**	--	**0**	**0**
4th Quarter Average Fatality Rate (Nov. & Dec data)	**0.001**	--	**0**	**0.003**

2.4 Scavenger Trials and Searcher Efficiency Trials

Scavenger trials and searcher efficiency trials are proposed to determine any bias in the fatality survey results. These trials will not commence until construction is complete in designated project component areas[2].

2.5 Preliminary Bird Risk Index Calculations

Bird Risk Index (BRI) is calculated in order to quantify multiple measures into a single number to facilitate comparison of the different survey area types and to monitor for trends over time. For this BMAP study, BRI is calculated as the Bird Fatality Rate divided by the Bird Use Rate (Table 8). We are providing a preliminary BRI for each survey area type in this first annual report, but acknowledge that insufficient fatality surveys were completed in 2012 to provide a strong conclusion. Significance thresholds should not be based on these preliminary results.

The offsite grassland Reference Site search plots had a Bird Risk Index double that of the Array Area search plots. Bird fatality detections were extremely low in both the Array Area and Reference Site search plots. No bird fatalities were detected in the Overhead Powerline search plots, however we surveyed significantly fewer search plots within this survey area type compared with Array Areas and Reference Sites.

---

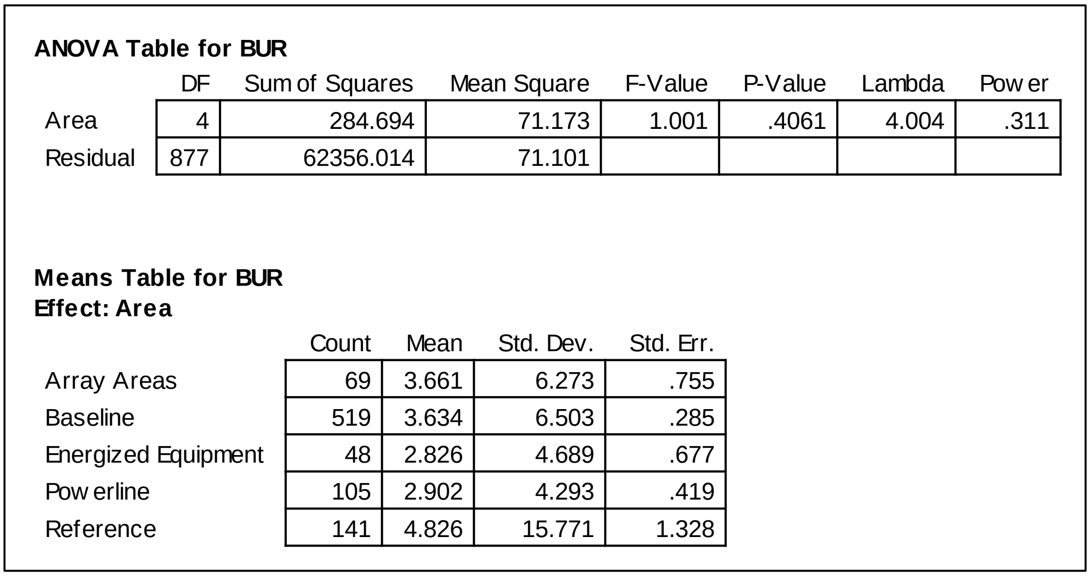
[2] Scavenger trials and searcher efficiency trials commenced in February 2013.

TABLE 8. PRELIMINARY BIRD RISK INDEX. BUR, BFR and BRI are provided for the Array Area, Overhead Powerline, Energized Equipment and Reference Site search plots.

Survey Area Type	Bird Utilization Rate (BUR)	Bird Fatality Rate (BFR)	Bird Risk Index (BRI)
Array Area	3.66	0.001	0.0003
Overhead Powerline	2.96	0	0
Energized Equipment	2.83	n/a	n/a
Reference Site	4.82	0.003	0.0006

Statistical analysis of the BUR found no difference among treatment types (areas) across the study area. This is due to the large variation in the bird observation point data results (Table 9).

TABLE 9. BUR STATISTICAL ANALYSIS.



ANOVA Table for BUR

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Area	4	284.694	71.173	1.001	.4061	4.004	.311
Residual	877	62356.014	71.101				

Means Table for BUR
Effect: Area

	Count	Mean	Std. Dev.	Std. Err.
Array Areas	69	3.661	6.273	.755
Baseline	519	3.634	6.503	.285
Energized Equipment	48	2.826	4.689	.677
Powerline	105	2.902	4.293	.419
Reference	141	4.826	15.771	1.328

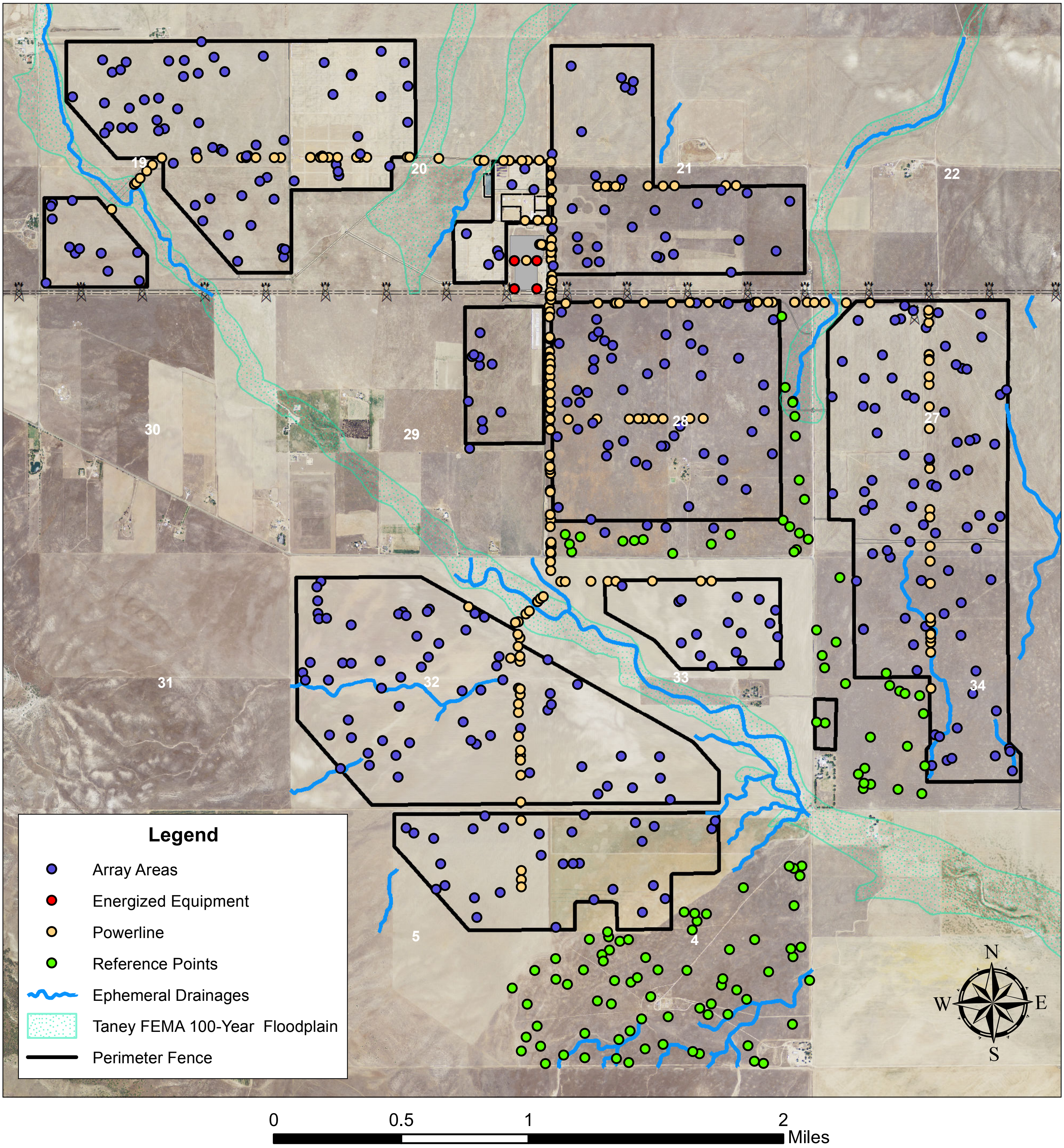
3.0 Discussion

Avian Use Surveys were conducted for all 12 months of 2012. A total of 63 observation points were surveyed each month, for a total of 756 for the year. For observation points in Array Areas where panels were installed, observer visibility was limited. This effect could potentially reduce the number of unique bird detections per observation point compared with open Reference Site observation points. Although we anticipated this effect, we are concerned that the severity of the sight limitation may be worse than anticipated. Therefore we decided to change the parameters of our random selection criteria for 2013 so that observation points for the Array Areas only fall on interior north-south oriented access roads. This selection criterion will only choose observation points that allow visibility to the 50 meter survey area extent to the north and south along the narrow access road, as well as to the east and west down the panel rows, while still collecting data on bird use within the Array Areas.

A total of 250.6 linear miles of 15-foot wide Avian Fatality Survey search plots were systematically surveyed on foot by project biologists within completed Array Areas; two bird fatalities were recorded. One fatality was a domestic chicken that was obviously brought to the location by a predator. The other fatality was an old mourning dove feather pile that suggested raptor predation; however cause of death was recorded as unknown. Grassland Reference Site search plots covered a total of 139.7 linear miles of 15-foot wide search plots. Four fatalities were recorded in the Reference Site search plots. Cause of death could not be determined for any of these fatalities, however predation was presumed to be the likely cause for all. General fatality rates appear to be very low in work areas (1 fatality every 125 miles of array rows).

Searcher efficiency trials and scavenger/carcass removal trials will be conducted in 2013 to provide insight into the accuracy of Avian Fatality Survey data. Results of these trials will be reported in the first quarterly report for 2013, and the second annual report will include Fatality Survey data adjusted to account for the results of the trials.

Exhibit 1. 2012 Avian Use Survey Points



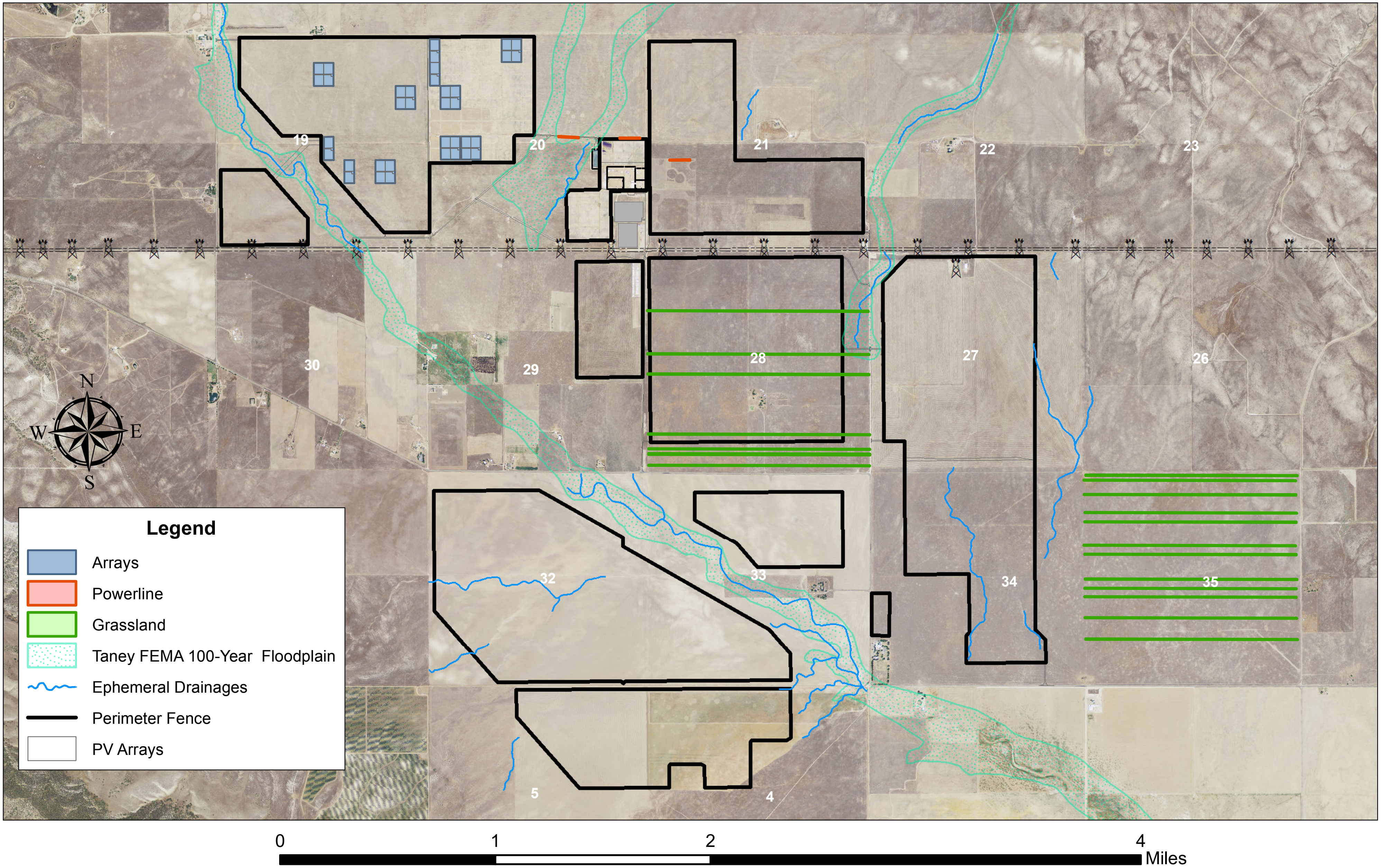
First Solar.
Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: February 13, 2013, 11:46 AM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Exhibit 2. 2012 Avian Fatality Survey Areas



Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: February 13, 2013, 11:42 AM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Exhibit 3. Topaz Solar Farm Bird List

Seasons are defined as:

SPRING: MARCH through MAY

SUMMER: JUNE through JULY

FALL: AUGUST through NOVEMBER

WINTER: DECEMBER through FEBRUARY

OBSERVERS: Peter A. Gaede (PAG), Bruce Reitherman (BR), Jason Dart (JD), Curtis Brumit (CB), Mike Hill (MH), Christina Williams (CW), Jeremy Pohlman (JP), Audrey Weichert (AW), Monica Brick (MB), Alex Stewart (AS), Greg Salas (GS), Kara Hagedorn (KH)

DCP = Dust Control Pond, Section 20.

KR = Kuhnle Residence, northern edge of Section 19.

CPS = Carrisa Plain Elementary School.

TEL = Tule Elk Lane pond: Private pond on Hwy 58 and Tule Elk Lane (one mile east of Bitterwater Rd).

JCR = Jan Cooper Residence, southeast corner of Section 4.

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
GEESE & DUCKS						
Northern Shoveler			X	X		3 at DCP, 11SEP12; PAG/BR (ph PAG). 1 at DCP, 10Dec12; BR.
Canada Goose			X			Flock fly-over, 30Oct12; CW.
Gadwall	X					Pair at DCP, 28May12; AW.
Cinnamon Teal	X					Pair at DCP, 24May12; JP.
Green-winged Teal				X		1 at DCP, 10Dec12; BR.
AVOCETS & STILTS						
American Avocet	X					Two at DCP, 25May12; AW.
GREBES						
Western Grebe			X			1 at DCP, 18-20OCT12; CW (ph)
CORMORANTS						
Double-crested Cormorant				X		1, TEL, 18-19DEC12; PAG (ph).
HERONS, BITTERN & ALLIES						

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
Great Blue Heron			X			1 over Block 5, 17Sept12; AS.
Great Egret			X			05Nov12; AS.
IBIS						
White-faced Ibis	X		X			2 adults at DCP, 21May12; JD. 1, DCP, 17Sept12; AS.
NEW WORLD VULTURES						
Turkey Vulture	X	X	X	X		
OSPREYS						
Osprey	X					1, Section 28, 02MAR12; PAG/BR (ph PAG).
HAWKS, KITES & EAGLES						
Bald Eagle				X		
Northern Harrier	X	X	X	X		
Sharp-shinned Hawk			X			1 juv., Section 28 (ranch); 01NOV12; PAG/CW.
Cooper's Hawk			X	X		1, dead in Block 6A, 27Aug12; CB.
Swainson's Hawk	X	X				3 imm., Section 33 field, 14MAY12; PAG (ph). 3 light-morph imms., 16MAY12; PAG.
Red-tailed Hawk	X	X	X	X	YES	Successful nest in tree in Section 33 (ranch). Nestlings in nest, BR/PAG (ph).
Red-shouldered Hawk			X			16Oct12; AS
Ferruginous Hawk	X		X	X		First of Fall observation on 12Sept12 in Block 4; CB.
Rough-legged Hawk			X	X		1, Block 9, 16NOV12 and DEC, A&M staff/BR (ph).
Golden Eagle	X	X	X	X		
RAILS, GALLINULES & COOTS						
Virginia Rail			X			1, collision with fence, move-on, 11Sept12; MH.
American Coot			X			DCP, 18-19Nov12; MB.
PLOVERS						

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
Killdeer	**X**	**X**	**X**	**X**	**YES**	3 juvs at cattle pond with adult sin Section 28 (ranch), 04JUN12, PAG.
Mountain Plover	**X**			**X**		
SANDPIPERS & PHALAROPES						
Greater Yellowlegs			**X**			1 fly-over, calling, near DCP, 16OCT12; PAG.
Long-billed Curlew	**X**	**X**	**X**	**X**		
Whimbrel	**X**	**X**	**X**			1, Section 34, 25APR12; PAG. 1, Helios Way, 31July12-01Aug12; MB.
Western Sandpiper		**X**	**X**			3 at cattle pond in Section 28, 18JUL12; PAG/BR. 1 fly-over, Section 19, 17OCT12; PAG.
Short-billed Dowitcher		**X**		**X**		1 at DCP, calls described as Short-billed, 18JUL12; JP. 2 near Block 6A, 06Feb12; BR.
Long-billed Dowitcher	**X**					2, 06Mar12; BR.
Wilson's Phalarope	**X**					1 at DCP, 08May12; AW.
PIGEONS & DOVES						
Rock Pigeon	**X**	**X**	**X**	**X**		
Eurasian Collared Dove	**X**	**X**	**X**	**X**	**YES**	Nest remnants found in Section 33 (ranch), 03JUN10, PAG/JD.
Mourning Dove	**X**	**X**	**X**	**X**	**YES**	Nest in Section 33 (ranch), 03JUN10, JD.
Band-tailed Pigeon			**X**	**X**		
OWLS						
Barn Owl		**X**	**X**	**X**		1 day roosting Section 33 (ranch), 11SEP12; PAG. 1 adult observed roosting at Section 28 Cochrane Ranch.
Burrowing Owl	**X**	**X**	**X**	**X**	**YES**	
Short-eared Owl	**X**		**X**	**X**		Flushed 5 adults from field south of Helios laydown, 09Mar12; JD. First of Fall obs in Section 16, 17Sept12; JD.
Long-eared Owl		**X**	**X**	**X**		4, CPS, 20JUL12; JD. 1, CPS, 05DEC12; PAG.
HUMMINGBIRDS						

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
Anna's Hummingbird		X	X	X		10 (high count) at JCR, 03JUN10; PAG. 1 at CPS, 07DEC12, PAG.
Black-chinned Hummingbird		X				2 at JCR, 03JUN10, PAG.
Costa's Hummingbird		X	X			1 (late date), 02NOV12; PAG (ph).
WOODPECKERS						
Red-breasted Sapsucker			X	X		1, Section 33 (ranch), 01NOV12; PAG (ph). 1, Section 33 (ranch), 18Dec12; PAG.
Williamson's Sapsucker				X		1 male, CPS, 05DEC12; PAG/BR (ph).
Northern Flicker [Red-shafted Flicker subspecies]	X		X	X		1, CPS, 30Mar12; BR. 1, Section 33 (ranch), 04 DEC12; BR.
Nuttall's Woodpecker			X	X		1, Section 33 (ranch), 17OCT12; PAG. Up to 2 regularly seen at CPS.
QUAIL						
California Quail			X			Calls heard at Cochrane, 18Nov12; MH.
FALCONS						
American Kestrel	X	X	X	X		
Merlin	X		X	X		First of Fall obs 27Sept12; AS.
Prairie Falcon	X	X	X	X		
Peregrine Falcon	X		X	X		
FLYCATCHERS						
Willow Flycatcher		X				1 (migrant); Section 33 (ranch), 05JUN12; PAG (ph).
Pacific-slope Flycatcher	X					1 (migrant); Section 21, 23APR12; PAG.
Black Phoebe	X	X	X	X	YES	
Say's Phoebe	X	X	X	X	YES	2 fledglings in Section 33 (ranch), 23APR12; PAG (ph).
Ash-throated Flycatcher		X				1 at Section 33 (ranch), 05June12; PAG.
Cassin's Kingbird	X	X	X		YES	Nest found in Sycamore at JCR, 03JUN10; PAG. Pair in Sec 33 (ranch), 03JUN10, PAG.
Western Kingbird	X	X	X			

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
SHIRIKE						
Loggerhead Shrike	**X**	**X**	**X**	**X**	**YES**	Fledglings seen at KR; PAG/BR. Family group at Section 28 (ranch), 18JUL12; PAG
VIREOS						
Warbling Vireo	**X**					3, Section 33 (ranch), 14MAY12; PAG.
CROWS & JAYS						
American Crow	**X**	**X**	**X**	**X**	**YES**	Nest in Tree of Heaven, Section 28 (ranch); 3 fledglings on 04JUN12 ; PAG (ph).
Common Raven	**X**	**X**	**X**	**X**	**YES**	High count 513, 17OCT12; PAG/BR/JD.
LARKS						
Horned Lark	**X**	**X**	**X**	**X**	**YES**	
SWALLOWS						
Tree Swallow			**X**	**X**		3, fly-over, 16OCT12; PAG.
Northern Rough-winged Swallow			**X**			
Cliff Swallow	**X**	**X**				62 (migrants) over Section 4, 05JUN12; PAG.
Barn Swallow	**X**	**X**				1 ad. seen on 20JUL12; PAG.
Violet-green Swallow	**X**		**X**			4, 05Mar12; BR. 1 juvenile at DCP, 28Aug12; AS/CW.
TITMICE & CHICKADEES						
Oak Titmouse			**X**			06Nov12; GS.
KINGLETS						
Ruby-crowned Kinglet			**X**	**X**		Multiple fall and winter observations at both ranches (Sections 28 and 33).
BLUEBIRDS & THRUSHES						
Western Bluebird		**X**	**X**			5, Section 33 (ranch), 01NOV12; PAG. Pair in Section 5, 05June12; PAG.

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
Mountain Bluebird	X		X	X		
Hermit Thrush	X					1 (migrant), Section 28, 31MAR12; PAG
American Robin			X	X		1, Section 34, 02Dec11; JD. 1, Section 33 (ranch), 07DEC12; KH.
MOCKINGBIRDS & THRASHERS						
Northern Mockingbird	X	X	X	X		
Sage Thrasher	X			X		1, Section 21, 06MAR12; PAG. 1 at Ledezma Property, 26Mar12; JP.
STARLINGS						
European Starling	X	X	X	X	YES	
PIPITS						
American Pipit	X		X	X		
WAXWINGS						
Cedar Waxwing			X			1, Section 33 (ranch), 17OCT12; PAG
LONGSPURS						
Lapland Longspur	X					1 fly-over, calling, 06MAR12; PAG.
WOOD WARBLERS						
Virginia's Warbler			X			1, KR, 17OCT12; PAG.
Yellow Warbler			X			1, Section 33 (ranch), 11SEP12; PAG.
Yellow-rumped Warbler	X		X	X		
Black-throated Gray Warbler			X			2, Section 33 (ranch), 16OCT12; PAG.
Hermit Warbler			X			1, HY female, Section 28 (ranch), 13SEP12; PAG (ph).
Wilson's Warbler	X					2, Section 33 (ranch), 14MAY12; PAG.
EMBERIZIDS						
Chipping Sparrow			X			3, KR, 17OCT12; PAG.
Vesper Sparrow				X		3, Section 4/33 Boundary, 23FEB12; PAG.
Lark Sparrow	X		X	X		

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
Savannah Sparrow	**X**		**X**	**X**		
Grasshopper Sparrow	**X**			**X**		
White-crowned Sparrow	**X**		**X**	**X**		
Dark-eyed Junco				**X**		
Golden-crowned Sparrow				**X**		05Jan12; JD.
Sage Sparrow				**X**		1, Section 33 ranch, 18Dec12; PAG.
NUTHATCHES						
Red-breasted Nuthatch			**X**	**X**		2 at CPS, 17OCT12 PAG. 1 at CPS, 07DEC12, PAG.
BLACKBIRDS & ORIOLES						
Red-winged Blackbird	**X**	**X**	**X**	**X**		
Tricolored Blackbird	**X**	**X**	**X**	**X**		Seen sporadically throughout the project area, e.g. Sections 19, 20, 27
Western Meadowlark	**X**	**X**	**X**	**X**	**YES**	
Yellow-headed Blackbird	**X**					Pair (migrants) at move-on, 16April12; JD.
Brewer's Blackbird	**X**	**X**	**X**	**X**	**YES**	One fledgling being fed by adult, Section 33 (ranch), 04JUN12, PAG.
Great-tailed Grackle	**X**	**X**				1 adult male in Block 6A, 01May12; JD. 1 female at DCP, 20JUL12; PAG.
Brown-headed Cowbird	**X**	**X**		**X**		
Bullock's Oriole	**X**	**X**				1 at Tracy Security, 24Mar12; JD. 1 at JCR, 06JUN12; PAG.
FINCHES & ALLIES						
House Finch	**X**	**X**	**X**	**X**	**YES**	
Pine Siskin			**X**	**X**		13 at Helios and Highway 58, 15Oct12; PAG.
Lesser Goldfinch	**X**		**X**	**X**		
Lawrence's Goldfinch	**X**	**X**	**X**			7 near Solar Switching Station (one HY), 05JUN12; PAG.
American Goldfinch	**X**		**X**	**X**		
OLD WORLD SPARROWS						

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
House Sparrow	X	X	X	X		

Topaz Solar Farm
10400 Helios Way
Santa Margarita, California 93453

Delivered via Electronic Mail

Annual Report

COA 62 Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan

March 12, 2014

Discussion

This report has been prepared to address the reporting requirements for Condition of Approval (COA) 62 Bird Monitoring and Avoidance Plan (BMAP). The BMAP report was prepared to include bats and the title revised to the Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP).

In response to COA 62, the Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP) has been prepared, which further describes the approach to implementing the condition requirements.

COA 62 requires quarterly and annual reports. Following the completion of the fourth quarter of monitoring the biologist shall prepare an annual report that summarizes the year's data, analyzes any project-related bird fatalities or injuries detected, and provides recommendations (in consultation with the County) for future monitoring and any adaptive management actions needed.

Annual Reportable Items

COA 62 BMAP requires specific significance thresholds that would trigger Adaptive Management will be defined in the Year 1 annual report based on analysis of the Year 1 data, in consultation with the County, CDFW and USFWS. Significance thresholds will be based on statistical comparison of Project Site data and offsite reference plot data. Comparison with reference plots will provide insight regarding the significance of any detected fatalities, so that thresholds can be assigned with confidence. If, in the event that Year 1 data is insufficient to determine significance thresholds because the amount of construction was less than anticipated, the Year 2 annual report shall make these recommendations.

Report Data

Attached is the Annual report prepared by Althouse & Meade (COA 62 and ABPP Quarterly Monitoring Report by Althouse & Meade March 12, 2014).

If there are questions regarding this report, please contact:

Timothy J. Higdon
First Solar Site Compliance Manager
Topaz Solar Farm
10400 Helios Way
Santa Margarita, CA

First Solar

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Topaz Solar Farms

2013 Fourth Quarter/Second Annual Report

for

Avian and Bat Protection Plan

and

Bird Monitoring and Avoidance Plan


Merlin (left), horned lark nest (center), Western meadow lark (right), Topaz Solar Farms 2013. Photographs by P. Gaede

Prepared for

Topaz Solar Farms LLC
10400 Helios Way
Santa Margarita, CA 93453

By

ALTHOUSE AND MEADE, INC.
BIOLOGICAL AND ENVIRONMENTAL SERVICES
1602 Spring Street
Paso Robles, CA 93446
(805) 237-9626

March 2014

654.48

Table of Contents

Tables

Figures

Abbreviations and Acronyms

Birds		
Abbreviation	**Common Name**	**Scientific Name**
AMCO	American Coot	*Fulica americana*
BNOW	Barn Owl	*Tyto alba*
BUOW	Burrowing Owl	*Athene cunicularia*
CORA	Common Raven	*Corvus corax*
EAGR	Eared Grebe	*Podiceps nigricollis*
EUST	European Starling	*Sturnus vulgaris*
GRRO	Greater Roadrunner	*Geococcyx californianus*
HOFI	House Finch	*Haemorhous mexicanus*
HOLA	Horned Lark	*Eremophila alpestris*
HOSP	House Sparrow	*Passer domesticus*
LEGO	Lesser Goldfinch	*Spinus psaltria*
MODO	Mourning Dove	*Zenaida macroura*
ROPI	Rock Pigeon	*Columba livia*
SAVS	Savannah Sparrow	*Passerculus sandwichensis*
SORA	Sora	*Porzana carolina*
WEME	Western Meadowlark	*Sturnella neglecta*

Agencies	
Abbreviation	**Description**
CDFW	California Department of Fish and Wildlife Service
County	San Luis Obispo County
USFWS	United States Fish and Wildlife Service
Other	
ABPP	Avian and Bat Protection Plan
ANOVA	Analysis of Variance
BMAP	Bird Monitoring and Avoidance Plan
BUR	Bird Utilization Rate
BRI	Bird Risk Index
BFR	Bird Fatality Rate
COA	Conditions of Approval (by the County)
DCP	Dust Control Pond
O&M	Operations and Maintenance
TSF	Topaz Solar Farms
WBWG	Western Bat Working Group

1.0 Introduction

This Fourth Quarter/Second Annual Report (Report) provides information specific to reporting obligations for implementation of tasks required by the Topaz Solar Farms Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (Althouse and Meade, Inc. June 2011). The Avian and Bat Protection Plan (ABPP) and Bird Monitoring and Avoidance Plan (BMAP) are requirements of County of San Luis Obispo (County) Conditions of Approval (COA) 61 and 62, and were prepared in consultation with the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Wildlife (CDFW). They were combined to form the ABPP/BMAP document. Section 5.5 of the ABPP/BMAP document requires quarterly and annual reports to be submitted to the County, USFW, and CDFW. This Report is prepared to satisfy requirements of the annual reporting obligation, and thus constitutes the second annual report for the Topaz Solar Farms ABPP/BMAP. Information provided spans the period from January 1 through December 31, 2013.

Construction at Topaz Solar Farms began on December 5, 2011. As of December 31, 2013, work had occurred in Phases 1 through 6 of the project. Construction activities included but were not limited to grading and leveling land; creating roads; installing posts, rails, and photovoltaic panels; installing overhead and underground electrical lines; installing two stream crossings consisting of articulated concrete blankets; erecting San Joaquin kit fox friendly fencing around solar arrays; installing artificial burrowing owl dens and kit fox escape dens; and removal of unneeded barbed wire fencing. As of December 31, 2013, construction was complete in Blocks 1 through 9 (Exhibit 1). These Blocks were turned over to Operations and Maintenance (O&M) in 2013. Construction was still occurring on Blocks 10 through 18, and had not begun on Blocks 19 through 22. Blocks under construction during 2013 are anticipated to be completed in 2014.

2.0 Avian and Bat Protection Plan

The ABPP monitoring program compiles general information on bird and bat interactions, injuries, and mortality at Topaz Solar Farms (TSF). During construction phases of the project, this task is completed by the project biologists as part of routine daily biological monitoring. Data reported for the Bird Monitoring and Avoidance Plan, which provides detailed information on bird use and bird mortality at the project site to inform a bird risk analysis, is presented below in Section 3.0. Abbreviations that are used throughout this document are listed on page iv.

2.1 Bird Surveys

General bird surveys are conducted on and around the TSF project site on a daily basis throughout the year by project biologists. Lists of bird species observed by each biological monitor are written on daily construction survey forms, which are then scanned, archived, and reviewed by project ornithologists Peter Gaede and Jason Dart. A cumulative list is then generated by the project ornithologists and updated throughout the year. An annotated list of the 139 species recorded at the TSF project site since 2011 is included as Appendix C, which includes information on seasonal occurrence, status within the greater Carrizo Plain region, and 2013 breeding status. Structured Avian Use Surveys are conducted monthly as part of the

BMAP to gather data on bird use within and near the TSF project. These surveys and results are discussed in Section 3.1.

2.1.1 Waterbird observations

Waterbirds are defined here as birds that are predominantly associated with water. This includes a diverse group of species that are ecologically tied to water, for at least part of their lives. The non-passerine groups of waterbirds that have been recorded at Topaz Solar Farms include waterfowl (geese and ducks, Photo 1), grebes (Photo 2), egrets, herons, ibis, osprey, eagle (Photo 3), rails, coots, avocet, stilt, plovers, shorebirds, and gulls. Most of these species are spring/fall migrants and/or winter visitors to the region. A total of 36 waterbird species and 5 unidentified waterbirds have been observed at the TSF project site (TABLE 1).

Documentation of waterbirds occurring at TSF have been made since the beginning of project construction in an effort to address the question of whether the reflective nature of installed photovoltaic array panels can potentially appear as bodies of water when viewed from the air. Most of the waterbirds documented at the site have been found at a temporary dust control pond (DCP), which was built on site during the initial phases of construction. Although small in size (approximately 415 by 120 feet), this body of water represents a very visible attractant to birds that associate with water in an otherwise dry environment, and is similar in size to many other human-made ponds in the area.

The diversity of waterbird species observed at TSF increased in 2013. A total of 34 species were recorded in 2013 compared with 23 species in 2012. The majority of waterfowl observed at the TSF site were at the DCP or were fly-over observations. Duration of presence at the DCP was generally for only a very short period of time (typically less than one day), as no food is available. Data is not available to support any conclusions for why the waterbirds came into the project area, whether due to the presence of the DCP itself or due to the panels appearing like water from the air. A green-winged teal was found standing on the ground in the Block 11 arrays (see Photo 4 below) in 2013, and there were two observations of American coot walking in the arrays. In fall 2013 flocks of shorebirds flew up from the ground in array areas (a flock of 20 Western sandpipers and 53 small, unidentified shorebirds in Block 3 on August 20; and a flock of Western sandpipers in Block 11 on October 7). Sora and Virginia rail are both small, secretive birds generally associated with freshwater marshes. Both species are migratory and winter south of the Carrizo region; the birds found at the project site in 2013 were both juvenile fall migrants. The two records for this group in 2013 include a Virginia rail found exhausted under panels in Block 11 on September 9 and a sora found dead on Helios Way on October 8 with no visible injuries. Herons, egrets, and ibis were observed at the site primarily in spring and fall. All members of the waterfowl group (great blue heron, great egret, snowy egret, green heron, and white-faced ibis) are considered uncommon to rare on the Carrizo Plain, and observations of these species are considered noteworthy. Most were observed flying over the arrays or briefly visiting the DCP. One individual, a great blue heron, was observed perched on a module table in Block 8.

Osprey and bald eagle are raptors that typically nest near large bodies of water, and in the case of the former, feed exclusively on fish. Both of these species were observed at the project site seasonally before and during construction. A bald eagle (see Photo 3 below) was observed flying over the project site in winter 2012/13 and again in winter 2013/2014, and was occasionally seen on the ground (presumably hunting) in nearby fields. Most of the shorebirds observed at the site are long-distance migrants that travel through the area in spring and fall. Given the dry conditions in 2013 and the overall lack of suitable stop-over habitat in the region, it is not surprising that birds were seen in greater numbers at the DCP.

TABLE 1. 2012-2013 WATERBIRD OBSERVATIONS. Listed are 41 waterbird species, including 5 identified only to genus, that were observed at the TSF project site in 2012 and 2013. A ✓ indicates that the species was observed.

Common Name	2012 Observations	2013 Observations
Ross's Goose		✓
Canada Goose	✓	✓
Gadwall	✓	
Mallard		✓
Cinnamon Teal	✓	✓
teal sp.		✓
Northern Shoveler	✓	✓
Green-winged Teal	✓	✓
Bufflehead		✓
Hooded Merganser		✓
Ruddy Duck		✓
duck sp.		✓
Eared Grebe		✓
Western Grebe	✓	✓
Great Blue Heron	✓	✓
Great Egret	✓	✓
Snowy Egret		✓
Green Heron		✓
White-faced Ibis	✓	✓
Osprey	✓	✓
Bald Eagle	✓	✓
Virginia Rail	✓	✓
Sora		✓
American Coot	✓	✓
American Avocet	✓	✓
Black-necked Stilt		✓
Killdeer	✓	✓
Spotted Sandpiper	✓	✓
Greater Yellowlegs	✓	✓
Willet		✓
Whimbrel	✓	
Long-billed Curlew	✓	✓
Least Sandpiper		✓
Western Sandpiper	✓	✓
Long-billed Dowitcher	✓	✓
Dowitcher sp.	✓	
Wilson's Phalarope	✓	✓

Common Name	2012 Observations	2013 Observations
Red-necked Phalarope		✓
Sandpiper sp.		✓
California Gull		✓
Gull sp.		✓
Totals	**23 species (+1 unidentified)**	**34 species (+4 unidentified)**

Photo 1. Northern shoveler at the DCP. Photograph by P. Gaede.

Photo 2. Eared grebe at the DCP. Photograph by P. Gaede.

Photo 3. Bald eagle flying over the project site. Photograph by P. Gaede.

Photo 4. Green-winged teal standing on the ground under panel arrays. Photograph by P. Gaede.

2.2 Nesting Activity

All nests and nest starts identified within or near[1] the project during the 2012 and 2013 nesting seasons were documented (Exhibit 2). The month each nest was found during 2013 is shown in Figure 1[2]. A total of ten bird species were documented nesting in or near the 2012-2013 work areas (Table 2 and Figure 1). Additional species that were found nesting in offsite Mitigation Lands or future project lands are not included in this tally. Burrowing owl was the only special concern species nesting within or near the project site. Loggerhead shrike is known to nest in the vicinity of the TSF project, but was not found on or within setback distance of the project site. Nesting was documented spanning the months of February through August. The peak nesting period, in terms of number of nests and number of species nesting was late April through May. The horned lark was the most abundant nesting species, with 15 nests documented within or near the project in 2013.

According to the approved Topaz Construction Phase Programmatic Nesting Bird Management Plan (Althouse and Meade, Inc. April 2013, revised August 2013) a “nest start” is defined as “a new nest that is under construction but that has not yet been completed, and that does not contain eggs or young.” Nest starts were removed when the presence of a complete nest would conflict with construction activities or would present a danger to the birds. Sixteen nest starts were removed in 2013 from active construction areas. In some cases, nesting material was removed from the same location and replaced by the same birds multiple times. Nest starts of four bird species and one unidentified species were removed: mourning dove, house finch, common raven, and Western kingbird.

---

[1] Within setback distance of the project, typically 250 feet but may vary.

[2] Month nest was found does not always indicate month nesting was initiated.

TABLE 2. WORK AREA NEST DATA 2012-2013 BY MONTH. The number of nests detected each month is listed for ten species between February and August.

Species	Feb. 2012	Feb. 2013	March 2012	March 2013	April 2012	April 2013	May 2012	May 2013	June 2012	June 2013	July 2012	July 2013	Aug. 2012	Aug. 2013	2012 Total	2013 Total
Rock Pigeon	0	0	0	**2**	0	0	0	0	0	0	0	0	0	0	**0**	**2**
Mourning Dove	0	0	0	0	0	**2**	0	**1**	0	**1**	0	0	0	**1**	**0**	**5**
Barn Owl	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	**0**	**1**
Burrowing Owl	0	**1**	**1**	0	**1**	**1**	0	0	0	0	0	0	0	0	**2**	**2**
Common Raven	0	0	0	**3**	**1**	0	0	0	**2**	0	0	0	0	0	**3**	**3**
Horned Lark	0	0	0	0	**9**	**13**	**32**	**1**	**6**	0	0	0	0	0	**47**	**14**
European Starling	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	**1**	**1**
Western Meadowlark	0	0	0	0	**7**	0	**1**	0	0	0	0	0	0	0	**8**	**0**
House Finch	0	0	0	0	0	**2**	**2**	**4**	0	**3**	0	**1**	0	0	**2**	**10**
House Sparrow	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	**0**	**1**
Totals	**0**	**1**	**1**	**5**	**18**	**18**	**36**	**9**	**8**	**4**	**0**	**1**	**0**	**1**	**63**	**39**

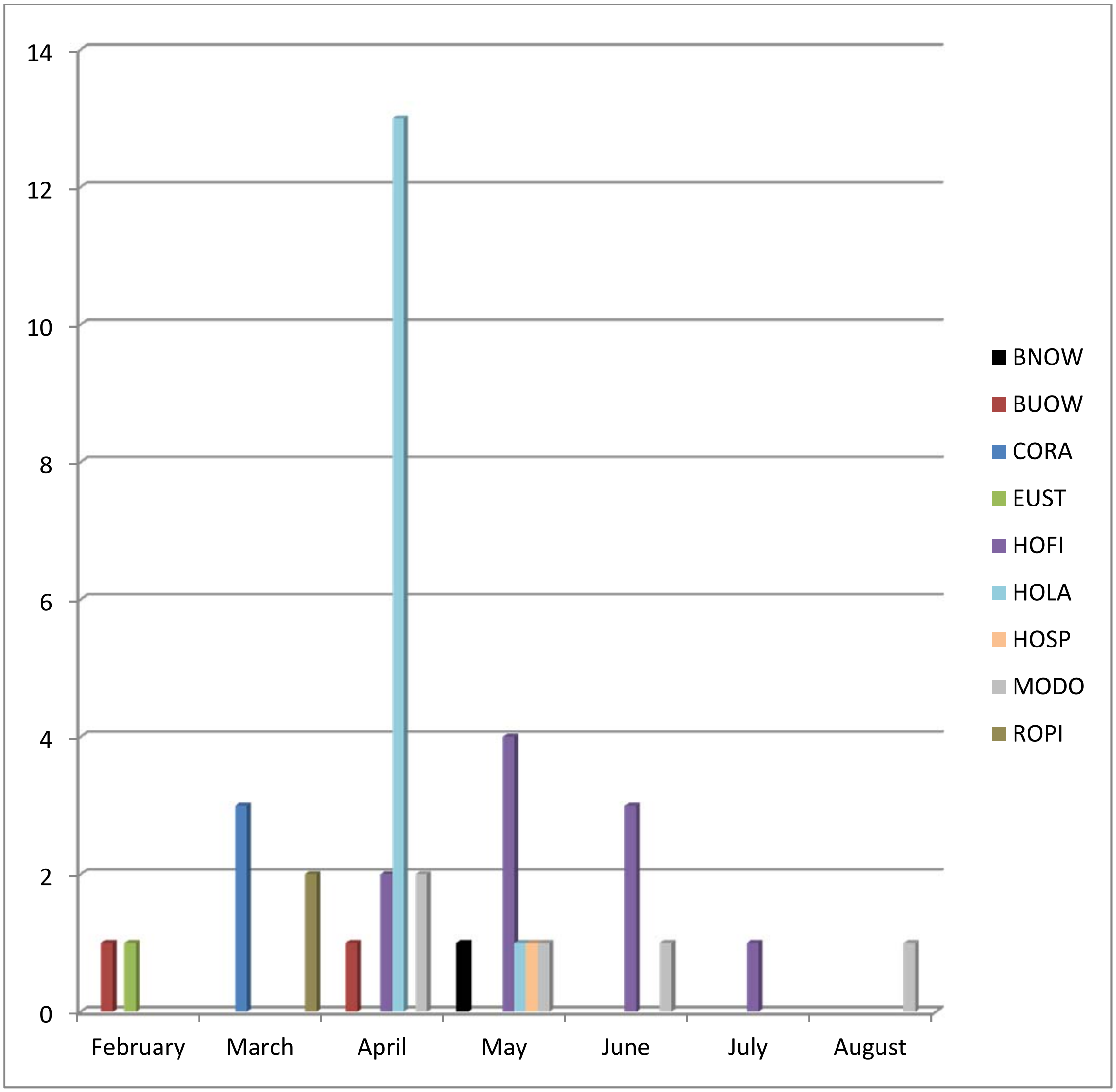


FIGURE 1. 2013 NESTING DATA BY MONTH. The number of nests located within or near the TSF project area for each species in 2013. Bird acronyms are defined on page iv, above.

2.2.1 Discussion of nesting by species 2012-2013

Horned Lark: Horned larks nest on the ground in a woven grass cup, often placed in a small depression. They prefer patchy short-grass conditions with bare spots. Array areas with newly vegetated ground provided a preferred nesting substrate. Vegetated areas adjacent to based roads were also preferable nesting sites for horned larks.

In 2013, a total of 14 active horned lark nests were located and monitored within and near the TSF project (Table 2 and Figure 1). In comparison, 47 active horned lark nests were located and monitored in 2012. Although the area covered by nest surveys each year differed in size and habitat structure, the comparison is consistent with a general reduction in nesting activity observed during 2013. Severe drought is likely responsible for fewer nests being found in 2013. Substantially lower annual rainfall occurred throughout California that year. For example rainfall totals for Atascadero, California (34 miles to the west of the TSF) for the calendar year 2012 and 2013 were 15.34 and 2.93 inches, respectively. Vegetation production observed in the Carrizo Plain was correspondingly low, and affected food availability for nesting birds.

Eleven of the 14 nests found in 2013 failed before nestlings fledged, putting nest success at 21.5 percent (3 fledged nests) and nest failure at 78.5 percent. All 11 failures were determined to be depredated by ravens, ground squirrels, and other wildlife. Nest monitoring observations indicated that ravens were the most frequent predator. Interestingly, we noticed that nestling survival appeared to be higher for nests near or adjacent to heavily utilized access roads and work areas. One of the three successful horned lark nests was located within three feet of the main site access road (Helios Way). In general, nests that were closer to active access roads remained intact for a longer period of time without predation, when compared to nests in the arrays. Proximity to active work areas or roads appeared to deter predators to some degree, thereby reducing predation rates.

Western Meadowlark: Western meadowlarks nest on the ground in taller grassland habitats. No meadowlark nests were found in current or future work areas in 2013. This was likely due to the severe drought that greatly limited grass production and the lack of suitable nesting habitat in the work areas during this timeframe.

House Finch: House finches nested or attempted to nest on construction equipment and materials throughout the project site (Photo 5). Preferred nesting areas were in the electrical coils temporarily hung on solar panels during the panel installation process (Photo 6), and openings in cardboard boxes containing tilt brackets. The number of house finch nests increased from two nests in 2012 to ten nests in 2013 (Figure 2). This increase in numbers of nests coincided with a relatively abundant nesting substrate (panel electrical wiring), which was not as common on site in 2012. Nest success in 2013 was 20 percent (2 of 10).

Photo 5. Example of house finch nests in panel supports. Photograph of P. Gaede.

Photo 6. Example of house finch nest in electrical coils. Photograph by P. Gaede.

Mourning Dove: Mourning doves are opportunistic with nest placement. Nests are a platform of twigs with little formation of the nest. Mourning doves nested or attempted to nest on the ground, under pallets, on construction equipment, and on the ledges of material and cardboard in various areas of the project site. While nests were infrequent, the overall nesting behavior lasted longer than for other nesting birds on the site, with nesting behavior noted until August 2013. Of the five mourning dove nests located in 2013 work areas, none successfully fledged any young. Predation appeared to be the primary factor in nest failure.

Common Raven: This species nested almost exclusively on power poles within and around the project site. They also attempted to nest on heavy equipment. Nesting materials were removed regularly from some nest sites to prevent nesting near work areas or locations deemed dangerous for the birds. For nest starts on equipment, removing the initial nesting material and moving the equipment to a new location proved to be the most successful method of discouraging nesting by this species. Three common raven nests were active near the project site in 2013; additional nests were detected on PG&E transmission towers and other power poles in the general vicinity of TSF.

Burrowing Owl: Burrowing owls nested in two locations immediately adjacent to the TSF project site. One nest successfully fledged in Block 10 with four young. One nest west of Block 15 was observed to have two chicks in July 2013. It is not known if both fledged successfully. A third nest (not reported in Table 2) was located between Blocks 3 and 4 on CDFW Mitigation Land. It had two chicks in June 2013. It was not known if chicks fledged; there were no observations of chicks in July and August of 2013.

Barn Owl: Barn owls occupied an abandoned building at the former Arco solar plant in what is now Block 11. Two fledglings were present in May 2013; however both of these young owls may have died. One barn owl carcass was found offsite in June, and another was found in the vicinity of the Arco building in August 2013. Cause of death was not determined for either carcass.

Rock Pigeon: Rock pigeons inhabited the abandoned building at the former Arco solar plant area in what is now Block 11. Two pigeon nests were found in the building with eggs in March 2013, both of which were presumed to have fledged.

House Sparrow: One house Sparrow nest was located in a storage container along the western perimeter road of Block 14 in May. Nesting success was unknown.

European Starling: One European starling nest was located in the handle of a storage container at the Topaz construction trailers in February 2013. Nesting success was unknown.

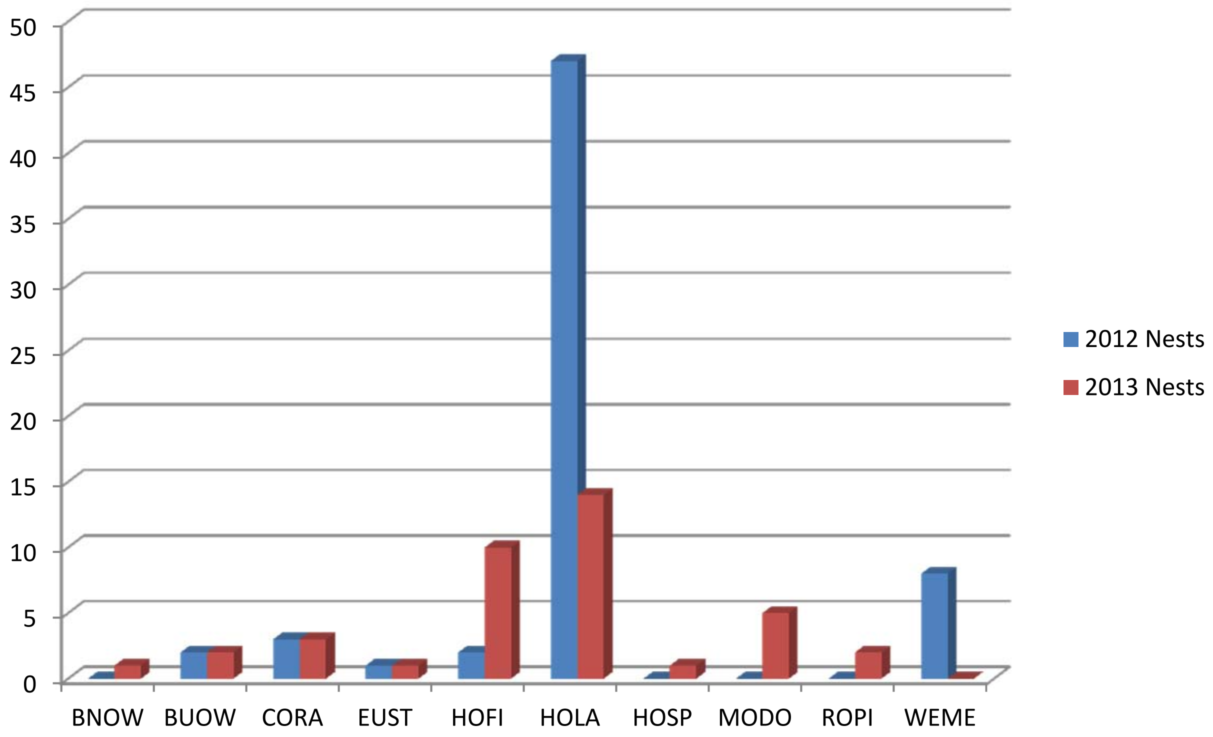


FIGURE 2. 2012-2013 NEST COMPARISON. The number of nests located within or near the TSF project area for each species is provided for 2012 and 2013. Bird acronyms are defined on page iv, above.

2.3 Nest Deterrents

Flashing tape and bird netting were used to prevent nesting on materials and equipment. Both of these methods were effective. Flashing tape was used effectively to keep house finches from nesting on equipment. Bird netting was used on tilt bracket boxes and other material stacks. When adequately secured and maintained, netting was very effective at keeping birds from nesting on materials stacks, but wildlife entrapment and entanglement was a risk. A concerted effort by workers to maintain netting in good condition minimized entrapment and entanglement. Flashing tape was often used on netting to make it more visible to birds. One avian fatality in 2013 was attributed to entanglement, a rock pigeon in the Block 11 laydown area.

Medium-voltage collector line power poles across the site were fitted with nest and perch diverters when installed. The steel power poles have a seven-inch diameter at the top where it was determined that raptors and ravens could potentially construct nests. Nest deterrents included installation of “Zena Cones” fitted to the top of the pole which eliminated the possibility of nest construction. The cones are made of high density polyethelyne and are bolted to the steel pole (Zena Design 2013).

Perch diverters of two types were used on power poles. Four inch tall spike strips were glued to the tops of the steel power pole cross-arms to prevent raptors from using the poles as hunting perches. Observations suggest the spike strips are largely ineffective at preventing raptors from perching on the cross-arms, as biologists have made numerous observations of red-tailed hawks and golden eagles perching on them. Triangle perch diverters were used on narrow cross-arms found on the wooden power poles used to provide power to the Topaz construction trailers, as well as on the narrow support brackets on the steel riser poles. Ravens had no problem perching and attempting to nest on the cross-arms and support brackets that had triangle perch diverters installed. Raptors, however, did not attempt to perch or nest on cross-arms either before or after diverter installation.

2.4 Avian and Other Wildlife Fatalities

General biological monitoring of the Topaz Solar Farms work areas documented bird, bat, and other wildlife fatalities. Avian fatalities are shown in Exhibit 5. Additionally, structured avian fatality surveys were conducted as part of the BMAP that were focused specifically on avian fatality detections. All avian and other wildlife fatalities identified on site from January through December 2013 are provided in Appendices A and B. Cause of death is provided in the tables when known, and is summarized in Table 3, below.

A total of 66 avian fatalities were documented on or near the TSF project site in 2013 (Table 3). Cause of death was not determined for 36 of the 66 fatalities (54.5 percent). For many of the incidents where the cause of death was undetermined, predation was the most likely culprit, but it was often times difficult to rule out other causes, such as those cases when only feather piles were found. Predation (presumed or confirmed) accounted for 21.2 percent (14 birds) of the fatalities. Peregrine and prairie falcons are likely the most prevalent predator of birds in the area; however, common ravens, other raptors, and canids are also potential predators that occur commonly within the project site. Electrocutions accounted for 12.1 percent (8 common ravens). All eight electrocutions were due to a single cause: faulty wildlife protector caps on the medium-voltage overhead power line riser poles. Replacement of the wildlife protector caps with a new design eliminated the electrocutions (see Section 2.4.1 for details regarding adaptive management for electrocutions on riser poles). Entanglement was listed as cause of death for one bird in 2013, a rock pigeon found beneath netting in the Block 11 laydown (1.5 percent). Collision was presumed to be the cause of death for one fatality in 2013, a lesser goldfinch that was found beneath an array table under construction, with no module in place. No collision deaths were confirmed or presumed of birds flying into solar panels. An unidentified bird carcass was removed from the wheel wash station water tank where it presumably fell through the grates; cause of death was listed as drowning. Five avian fatalities were associated with nests: a nestling European starling that apparently fell out of the nest, and a house finch nest that was incidentally damaged during movement of materials that resulted in loss of four eggs. The nest was not known to be in the materials until workers discovered it damaged.

Table 3 lists the total number of fatalities recorded and cause of death. Additionally, the table lists whether any of the fatalities were related to construction activities or operation activities. Analysis of avian fatality data collected for the BMAP is provided in Section 3.2. The survey methodology used for BMAP studies allows calculation of bird fatality rate as a measure of the number of fatalities per unit area per unit time.

TABLE 3. 2013 AVIAN MORTALITY CAUSE OF DEATH. Breakdown of causes of death for all avian fatalities recorded at the TSF project site in 2013.

Cause of Death	Species	Number of Fatalities	Related to Construction Activities	Related to Operation Activities
Unknown	AMCO, GRRO, HOLA, MODO, HOFI, BNOW, SASP, CORA, SORA, ROPI, Unidentified, Domestic chicken	36	Unknown	Unknown
Predation	CORA, MODO, HOLA, BUOW, ROPI, BNOW, EAGR, Domestic chicken	12	No	No
Presumed Predation	AMCO, MODO	2	No	No
Electrocution	CORA	8	No	Yes
Entanglement	ROPI	1	Yes	No
Collision	LEGO	1	Yes	No
Drowning	Unidentified	1	Yes	No
Nest Damage	HOFI	4 (eggs)	Yes	No
Fell out of Nest	EUST	1 (nestling)	Yes	No
Total		**66**	**8**	**8**

2.4.1 Adaptive Management

The Year 2 first quarter period of January to March 2013 was the first reporting period where medium-voltage collector lines were energized. Energized overhead lines extended from the west side of Block 1 east to Block 7 during this period. For the second quarter period of April to June 2013, Blocks 8-10 were in the process of becoming energized. Overhead collector lines extend south from Block 7 to the northwest corner of Block 9, east to the center of Block 9, then south into Block 10.

The first quarter monitoring report discussed the electrocution of six common ravens on riser poles associated with the medium-voltage collector lines. Two additional common raven electrocutions occurred in early April.

By design, there are no exposed live parts on the riser poles. The cables are insulated and energized components of the lightning arrestors that are not individually insulated have insulated wildlife protector caps on top of them preventing exposure to wildlife and workers (note arrow on Photo 7). It was determined that the common denominator between the electrocutions was a dislodged wildlife protector cap on the lightning arrestors, and suspected that raven nest-building activity dislodged the caps, exposing the ravens to live parts which, if touched, would complete a phase-to-phase or phase-to-ground circuit resulting in electrocution of the bird.

The problem was determined to be the lightning arrestor cap design, so a different style of cap was installed. This new cap was installed on each lightning arrestor on all energized riser poles by April 22, 2013. For future phases of construction, all riser poles will also be outfitted with the new lightning arrestor caps. The last documented bird electrocution was April 14, 2013. At that time a total of eight common ravens had been electrocuted on riser poles. After wildlife protector caps were replaced, No electrocutions have occurred since the wildlife protector caps were replaced.

Photo 7. Riser pole showing insulated cables and insulated wildlife protector caps (arrow) covering energized un-insulated parts of the lighting arrestors.

2.5 Bat Surveys

An acoustic monitoring survey for bats on the project site was conducted on the night of August 14, 2013 using a Pettersson D240x (Pettersson Elektronik, Sweden) bat detector and Sonobat® (v.3.1 US west; DNDesign, Arcata, CA) acoustic analysis software. The detector was placed on the south fence of the Dust Control Pond (DCP) and recorded bat calls from 20:00 to 23:07. All detected bat calls were analyzed and identified using the analysis software. Table 4 provides a list of 6 bat species detected and assigned with a discrimination probability of 0.95 or higher. A seventh bat species, the little brown bat (*Myotis lucifugus*), was possibly detected, but the call did not have a high enough discrimination probability (0.549) to be assigned with confidence.

TABLE 4. TOPAZ SOLAR FARMS BAT LIST. Six bat species detected at the Topaz Solar Farms project site in 2013 are listed. Special status designations from CDFW and Western Bat Working Group (WBWG) are provided, as well as the highest discrimination probability for each species from the recorded calls.

Common Name	Scientific Name	CDFW Status	WBWG Status	Highest Discrimination Probability
Big Brown Bat	*Eptesicus fuscus*	None	Low	1.0000
Silver-haired Bat	*Lasionycteris noctivagans*	Special Animal	Medium	0.9558
Western Small-footed Bat [=Western Small-footed Myotis]	*Myotis ciliolabrum*	Special Animal	Medium	0.9999
Yuma Bat [=Yuma Myotis]	*Myotis yumaensis*	Special Animal	Low-Medium	0.9995
Canyon Bat [=Western Pipistrelle]	*Parastrellus hesperus*	None	Low	1.0000
Mexican Free-tailed Bat [=Brazilian Free-tailed Bat]	*Tadarida brasiliensis*	None	Low	1.0000

No bat roosts are known to be present within or near the Topaz project site. Since construction started in December 2011, two bats have been found, in separate incidents, roosting beneath cloth tarps on dumpster bins. Biologists kept workers from the areas until the bats left at night, and the following morning the bats had not returned and the tarps were better secured to prevent entry.

One bat has been found dead at the project site since start of construction. A worker reported a bat carcass in a module box that was unloaded from a transport container box in August 2013. The container had not been opened since shipping from Malaysia. The bat was tentatively identified as a Malaysian fruit bat; the specimen was preserved and submitted to the Santa Barbara Museum of Natural History for further evaluation.

3.0 Bird Monitoring and Avoidance Plan

The BMAP study utilizes avian use surveys and avian fatality surveys to produce a risk index for various project components deemed to be potentially dangerous to birds, including Array Areas, Overhead Powerlines, and Energized Equipment (Substation). Offsite grassland areas were used as Reference sites to compare Bird Utilization Rates, Bird Fatality Rates, and ultimately, Bird Risk Index. The BMAP study has two primary goals:

Goal 1. Provide Project owners/managers with scientifically-based risk analyses to facilitate implementation of Adaptive Management actions to minimize conflicts between Project components and birds.

Goal 2. Provide a rigorous scientific study of avian use and mortality associated with specific components of an industrial scale photovoltaic solar facility that can be used by wildlife regulators as a planning tool for future solar projects.

To accomplish these goals, the BMAP outlines five Objectives with specific Tasks:

Objective 1. Assess changes in total bird abundance, species composition, and species richness relative to development and operation of the Project compared to undeveloped reference sites;

Task 1.1: Implement Avian Use Surveys.

Task 1.2: Submit quarterly and annual monitoring reports.

Objective 2. Calculate Bird Utilization Rate, Bird Fatality Rate, and Bird Risk Index for three specific Project components (Array Areas, Overhead Powerlines, Substation/Switching Station);

Task 2.1: Implement Avian Fatality Monitoring Surveys, Searcher Efficiency Trials, and Scavenger/Carcass Removal Trials.

Task 2.2: Run calculations on survey data according to methods in Section 5.4.

Task 2.3: Submit quarterly and annual monitoring reports.

Objective 3. Conduct risk assessment analyses for each Project component based on calculated Bird Utilization Rate, Bird Fatality Rate, and Bird Risk Index;

Task 3.1: Prepare a written analysis of survey data and calculated Bird Risk Index for each Project component to be included in the annual report.

Objective 4. Inform TSF facility managers of Adaptive Management requirements when Bird Risk Index and/or Bird Fatality Rate indicates significance thresholds for avian mortality have been reached (refer to Section 6.0);

Task 4.1: Submit quarterly and annual monitoring reports.

Objective 5. Prepare a scientific paper describing the results of avian use surveys and avian fatality monitoring surveys, and the conclusion regarding the risk level that the Project poses for avian resources.

Task 5.1: Within one year of completion of the study data collection, prepare and submit a scientific paper to the County of San Luis Obispo.

3.1 Avian Use Surveys

Avian Use Surveys commenced in November 2011, prior to the start of construction, to gather baseline data on bird use in the project area. Avian Use Survey data informs the species composition, species abundance and species richness calculations (Section 3.1.3) and Bird Utilization Rate calculations (Section 3.2.3). Bird Utilization Rate is ultimately used in Bird Risk Index calculations (Section 3.5). Construction of the TSF project commenced in December 2011 in a limited footprint, and slowly expanded in area throughout 2012 and 2013. Avian Use Surveys were conducted monthly from November 2011 through December 2013.

3.1.1 Methods

Sixty-three randomly selected survey points were selected monthly across all six phases of the TSF project site in active construction areas and future work areas, as well as offsite reference sites (Exhibit 3). Each month, as the construction area increased in size, more of the survey points occurred in developed areas. Points located within future project areas that are not developed at the time of the survey are categorized as Baseline. The Baseline category is represented by cropland habitat[3], whereas the Reference Site category is grassland. The 63 survey points conducted each month included 31 inside existing or future array areas, 18 along existing or future overhead power lines, 10 in grassland reference sites and 4 at the substation.

The five Survey Area Categories covered by Avian Use Surveys are:

- Array Area (built solar arrays);
- Energized Equipment (substation yard);
- Overhead Powerlines (linear areas under medium-voltage collector lines);
- Reference (undisturbed grasslands outside of the project footprint); and
- Baseline (cropland areas to be developed into solar arrays).

Each survey point consisted of a circular survey area with a 50 meter radius (1.94 acre), within which a ten minute bird use point count was conducted between first light and 11:00 a.m. Bird use counts differ from bird abundance counts by tallying every bird that enters the survey area, including birds that leave and re-enter the survey area. For each bird detection within the survey area, data is recorded for number of each species, behavior (e.g. fly-over, on the ground, perching, foraging, etc.), height, and interactions with facility components.

3.1.2 Results

Between November 2011 and December 2013 a total of 1,638 survey points were selected. Of these points, seven were missed during the surveys and an additional 83 points were dropped from the analyses because their Survey Area Category became obsolete due to changes in

---

[3] Blocks 14 and 15 were built on natural grassland habitat, therefore surveys conducted in Blocks 14 and 15 prior to start of construction were counted as Reference Site instead of Baseline.

construction. Data from 126 point counts conducted in November and December 2011 was also omitted so the analysis would encompass seasonal variation between two full years of surveys.

In 2012 and 2013, we completed 1,422 point counts covering approximately 2,759 acres of land to inform species composition, species abundance, species richness, Bird Utilization Rate and Bird Risk Index (Table 5). The number of survey points conducted increased from 2012 to 2013 for the three categories that consist of project components: Array Areas, Energized Equipment and Overhead Powerlines. Baseline points decreased, as there was less undeveloped area in 2013.

The Baseline category had a total of 621 observation point counts, the highest of all categories, covering approximately 1205 acres of cropland habitat. As more of the project site becomes developed, the gap between baseline and Array Areas will decrease. Array Areas had 296 point counts covering approximately 574 acres of land. Reference Sites had 233 point counts, covering approximately 452 acres of grassland habitat. Overhead Powerlines had 172 point counts, covering approximately 334 acres of developed land beneath and immediately adjacent to power lines. A total of 100 point counts were conducted at the substation for the Energized Equipment category, covering 1,194 acres of land within and surrounding the substation.

TABLE 5. AVIAN USE SURVEY POINT COUNTS. The number of point counts conducted in 2012 and 2013 is listed for each of the five Survey Area Categories. Cumulative total and acreage is also listed.

Survey Area Category	Number of Obs. Pt. Counts 2012	Number of Obs. Pt. Counts 2013	Total Number of Obs. Pt. Counts	Total Survey Area (Acres)
Array Areas	69	227	296	574.24
Energized Equipment	48	52	100	194.00
Overhead Powerline	64	108	172	333.68
Reference Site (Grassland)	120	113	233	452.02
Baseline (Cropland)	416	205	621	1204.74
Total	**717**	**705**	**1,422**	**2,758.68**

The five Survey Area Categories used as treatment types in this study comprise different habitat elements that influence species composition, abundance and richness.

The Array Area category includes point counts conducted within solar array areas during active construction and in completed form. The habitat consists of rows of passive (non-moving) photovoltaic solar panels mounted to steel racking ranging from approximately 2 to 5 feet off the ground. The ground is seeded with a native seed mix to revegetate array areas to naturalized grassland habitat; vegetation density varied from 0 to 60 percent cover. Array Area survey points may also include perimeter fences, photovoltaic combining switchgear houses, as well as array roads.

The Energized Equipment category includes point counts conducted around the perimeter of the substation. The survey area includes the substation perimeter fence, transformers, power lines, and other electrical components. Within the substation fence the ground is gravel with no vegetation. Outside the perimeter fence, the ground is bare dirt with some patches of grass.

Overhead Powerline surveys represent areas underneath medium-voltage collector lines within the project. Vegetation varies depending on location; most powerlines are along array or access roads, however some locations are outside the fenced project areas in annual grassland habitat.

Reference Sites included point counts conducted on mitigation lands owned by California Department of Fish and Wildlife. Reference Sites are composed of annual grassland habitat.

The Baseline survey category represents point count locations that were conducted in cropland habitat that will be developed into Array Areas. The habitat consists of large open areas of crop stubble.

3.1.3 Species composition, species abundance and species richness

Avian Use Surveys conducted at the TSF project were designed to collect data on *bird use* within a predetermined survey area; data were not collected on the actual number of individual birds in that area. In this section we compare 2012 and 2013 bird use data among the five Survey Area Categories) as species composition, species abundance and species richness. Data from 2011 is omitted for reasons discussed above in Section 3.1.2. Species composition looks at which bird species were detected in the Survey Area Categories. Species abundance is a measure of how abundant each of the species were within each category. Species richness is a measure of the number of different species in a given area.

Species composition consisted of 48 bird species and three unidentified bird species in 2012 and 2013 (Table 6).

Species abundance is examined in the following two ways:

- Overall Total No. Detections per Species
- Average No. Detections per Observation Point within each Survey Area Category

Overall total number of detections per species is simply a count of detections for all observation points in all five Survey Area Categories combined. This number shows how abundantly each of the species were detected by the surveys overall. It is helpful in understanding overall abundance of each species relative to abundance of other species within and near the TSF project, but does not provide comparative information among treatment types. Average number of detections per Observation Point takes this into account, and provides better understanding of how abundantly each species occurred within the different Survey Area Categories. This number is calculated using the same formula as Bird Utilization Rate (see Section 3.2.5), except that it is per species, whereas Bird Utilization Rate is overall bird use for all species. Combined with habitat description information, this number suggests preferred habitat areas for each species (see descriptions above, in Section 3.2.2).

The 10 most abundantly detected species, listed in decreasing order of abundance, were: horned lark (5,392 detections), house finch (1,416), common raven (677), savannah sparrow (473), long-billed curlew (466), brewer’s blackbird (450), Western meadowlark (311), mountain bluebird (221), mourning dove (190), and European starling (182). The most frequently encountered species, the horned lark, was detected more than three times as often as that of that of the second most frequently encountered species, the house finch. Horned larks are abundant year-around residents that commonly form large flocks in winter on the Carrizo Plain. Both the horned lark and house finch were detected in high numbers in Baseline areas consisting of cropland habitat, and were also frequently detected in project areas. Long-billed curlew and mountain plover had high detections in Baseline and Reference Site areas in 2012, almost no detections in the 2012 project areas, and were not detected at all in 2013. Both of these species are winter visitors to the Carrizo Plain and fluctuate widely in local distribution and numbers from year to year. They are almost exclusively associated with undeveloped habitats. Nineteen species were represented by a single detection consisting of a single bird.

Table 6. Species Composition and Abundance. All bird species detected during Avian Use Surveys in 2012 and 2013 are listed, with the average number of bird use detections per observation point calculated for each of the five survey area categories. Total detections for each species are provided at far right. Species are listed in decreasing order of abundance according to the total detections column.

Species	**Array Area** Ave. Detections per Obs. Pt.	**Energized Equipment** Ave. Detections per Obs. Pt	**Overhead Powerline** Ave. Detections per Obs. Pt	**Reference Site** Ave. Detections per Obs. Pt	**Baseline** Ave. Detections per Obs. Pt	**Total Detections**
Horned Lark	5.34	2.79	3.23	4.10	3.26	**5392**
House Finch	0.36	1.26	0.87	1.51	1.10	**1416**
Common Raven	0.14	0.09	0.19	0.32	0.84	**677**
Savannah Sparrow	0.11	0.38	0.27	0.09	0.54	**473**
Long-billed Curlew	0	0	0	0.24	0.66	**466**
Brewer's Blackbird	0.83	0.46	0.49	0.14	0.07	**450**
Western Meadowlark	0.28	0.08	0.15	0.26	0.22	**311**
Mountain Bluebird	0	0.03	0	0.03	0.34	**221**
Mourning Dove	0.22	0.1	0.17	0.09	0.10	**190**
European Starling	0.03	0.11	0.01	0.01	0.25	**182**
Rock Pigeon	0.07	0	0.09	0.02	0.05	**74**
American Pipit	0.04	0.01	0	0	0.06	**50**
American Goldfinch	0	0	0.01	0.05	0.04	**37**
Cliff Swallow	0	0	0	0	0.06	**37**
Unidentified Shorebird	0.10	0	0	0	0	**30**
Say's Phoebe	0.02	0.04	0	0.01	0.01	**20**
Unidentified Blackbird	0.03	0	0	0	0.02	**20**
Turkey Vulture	0.03	0	0.02	0.004	0.005	**17**
Western Kingbird	0.003	0.09	0	0.009	0.002	**13**
Tricolored Blackbird	0.03	0	0	0	0.003	**12**
White-Crowned Sparrow	0.04	0	0	0	0	**12**

Species	**Array Area** Ave. Detections per Obs. Pt.	**Energized Equipment** Ave. Detections per Obs. Pt	**Overhead Powerline** Ave. Detections per Obs. Pt	**Reference Site** Ave. Detections per Obs. Pt	**Baseline** Ave. Detections per Obs. Pt	**Total Detections**
Grasshopper Sparrow	0	0	0	0	0.02	**11**
Lark Sparrow	0.003	0	0	0.04	0	**11**
American Kestrel	0	0.01	0	0.01	0.002	**5**
Ferruginous Hawk	0	0	0	0.009	0.003	**4**
Loggerhead Shrike	0.003	0	0	0.004	0.003	**4**
Merlin	0	0	0	0	0.005	**3**
Prairie Falcon	0.003	0	0.01	0.004	0	**3**
Red-tailed Hawk	0	0.01	0.01	0	0	**3**
Northern Rough-winged Swallow	0	0	0.01	0	0.002	**2**
Pacific-slope Flycatcher	0	0	0	0	0.003	**2**
Short-billed Dowitcher	0	0	0.01	0	0	**2**
Burrowing Owl	0	0	0	0	0.002	**1**
American Crow	0	0	0	0	0.002	**1**
Anna's Hummingbird	0.003	0	0	0	0	**1**
Brown-headed Cowbird	0	0	0	0	0.002	**1**
Golden Eagle	0	0	0.01	0	0	**1**
House Sparrow	0.003	0	0	0	0	**1**
Unidentified Hummingbird	0	0	0.01	0	0	**1**
Mountain Plover	0	0	0	0	0.002	**1**
Northern Harrier	0.003	0	0	0	0	**1**
Northern Mockingbird	0	0	0.01	0	0	**1**
Peregrine Falcon	0	0.01	0	0	0	**1**
Rough-legged Hawk	0	0	0	0	0.002	**1**
Red-winged Blackbird	0	0	0	0.004	0	**1**
Swainson's Hawk	0	0	0	0	0.002	**1**
Tree Swallow	0	0	0	0.004	0	**1**
Vesper Sparrow	0	0	0	0	0.002	**1**
Violet-Green Swallow	0.003	0	0	0	0	**1**
Western Sandpiper	0.003	0	0	0	0	**1**
Yellow-rumped Warbler	0.003	0	0	0	0	**1**

Similar to species abundance, species richness is examined in the following two ways (Table 7):

- Total No. Species Detected Per Survey Area Category
- Average No. Species per Observation Point within each Survey Area Category

Table 7 and Figure 3 present species richness as the total number of species observed in all Observation Points within each Survey Area Category, by year and overall. This calculation accurately portrays the difference in annual species richness, 39 species in 2012 and 32 species in 2013, as the number of Observation Points is similar (717 and 705, respectively; see Table 5, above). However, direct comparison of species richness calculated in this manner for each of the survey area categories provides an inaccurate assessment due to the significant differences in number of Observation Points among the treatment types and from year to year. Average number of species per Observation Point within each of the treatment types is a better method for evaluating the difference in species richness among treatment types. For example, the Array Area category had an increase in the total number of species detected from 2012 to 2013, but the average number of species per Observation Point decreased from 1.28 to 1.18. The number of Observation Points increased from 69 in 2012 to 227 in 2013 (Table 5), creating this difference. The same is true for Overhead Powerline.

All five Survey Area Categories showed a decline in species richness from 2012 to 2013 based on average number of species detected per Observation Point. With severe drought conditions present in 2013, this decline is consistent with our general observations of fewer birds, and overall nesting declines for most species in the area (refer to Section 2.3).

Among the treatment types, Energized Equipment had the highest species richness with an overall average of 1.33 species detected per Observation Point. A high number of species detected in 2012 contributed to this result. Interestingly, the substation was under construction and was not energized in 2012 as it was in 2013. Array Area and Overhead Powerline categories were similar, with 1.20 and 1.19 species detected per Observation Point. As these two treatment types are in close proximity to each other and contain similar and at times overlapping habitat features, this result was expected. Reference Site and Baseline categories represent the two undeveloped habitat areas. Reference Sites recorded an average of 1.12 species per Observation Point, while Baseline had 0.89 species per point. This result is interesting in light of the fact that Baseline had almost three times as many Observation Points completed as Reference Site (621 and 233, respectively). Therefore, it can be said that species richness in offsite annual grasslands is higher than in fallow croplands. Species richness is also higher in all three project component categories than in the two offsite undeveloped categories.

TABLE 7. SPECIES RICHNESS 2012-2013. Species richness is listed separately for 2012, 2013 and overall for the two years as total number of species detected within each category. Additionally, species richness is listed as average number of species detected per observation point.

Survey Area Category	2012 Total Species	2013 Total Species	Overall Total Species 2012-13	Average No. Species per Obs. Pt. 2012	Average No. Species per Obs. Pt. 2013	Overall Average No. Species per Obs. Pt.
Array Area	18	20	26	1.28	1.18	1.20
Energized Equipment (Substation)	14	10	15	1.60	1.08	1.33
Overhead Powerline	12	15	18	1.39	1.06	1.19
Reference Site (Grassland)	18	13	22	1.22	0.90	1.12
Baseline (Cropland)	29	15	33	1.03	0.75	0.89
Totals	**39**	**32**	**51**	-	-	-

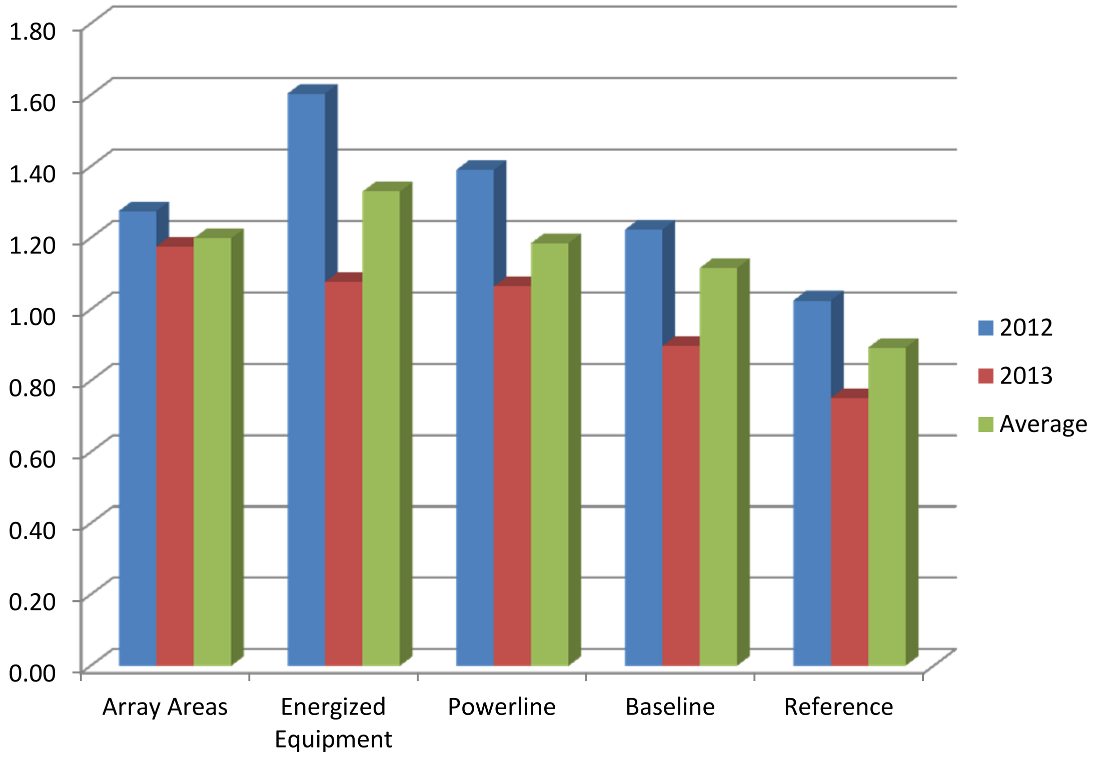


FIGURE 3. SPECIES RICHNESS 2012-2013. Species Richness is indicated as the average number of species detected per observation point for each survey area category, by year and overall.

3.1.4 Bird Utilization Rate

Bird Utilization Rate (BUR) is calculated as the average number of birds observed per Observation Point count[4]. With each Observation Point count consisting of a 10 minute tally of bird use within a circular survey area totaling 1.94 acres, the result is a rate that indicates bird use per unit time (10 minutes) per unit area (1.94 acres). This rate can be extrapolated in a variety of ways for project to project comparisons (refer to discussion in Section 4.0).

We calculated Bird Utilization Rate for five Survey Area Categories for 2012 and 2013 separately and cumulatively (Table 8): Array Areas, Overhead Powerlines, Energized Equipment (Substation), Reference Site (grassland) and Baseline (cropland).

Array Area and Baseline have the highest cumulative BUR at 7.72 and 7.66 birds per Observation Point. With 6.97 birds per Observation Point, Reference Site category had the third highest BUR, and Overhead Powerline and Energized Equipment had the lowest BUR at 5.55 and 5.47 birds per Observation Point.

Compared to 2012, BUR declined for all five Survey Area Categories in 2013. Array Areas declined the least (-39.6 percent) while Overhead Powerline declined the most (-62.6 percent).

TABLE 8 BIRD UTILIZATION RATE. BUR is calculated as the average number of birds observed per Observation Point for 2012 and 2013, as well as cumulatively for both years for each of the five Survey Area Categories. Percent change from 2012 to 2013 is also listed.

Survey Area Category	2012 BUR	2013 BUR	Percent Change	Cumulative BUR 2012-13
Array Area	11.1	6.7	-39.6%	7.72
Energized Equipment (Substation)	7.1	3.9	-45.1%	5.47
Overhead Powerline	9.1	3.4	-62.6%	5.55
Reference Site (Grassland)	9.1	4.7	-48.4%	6.97
Baseline (Cropland)	9.3	4.2	-54.8%	7.66

---

[4] ABPP document and 2012 annual report calculate BUR as average number of unique bird observations per observation point. This method counts a multi-bird observation such as a flock as a single unique observation. For this annual report and future reports we modified the calculation of BUR as average number of birds observed per observation point. This method yields a more meaningful result in terms of bird use per unit time per unit area. This method will be incorporated into the next ABPP/BMAP revision.

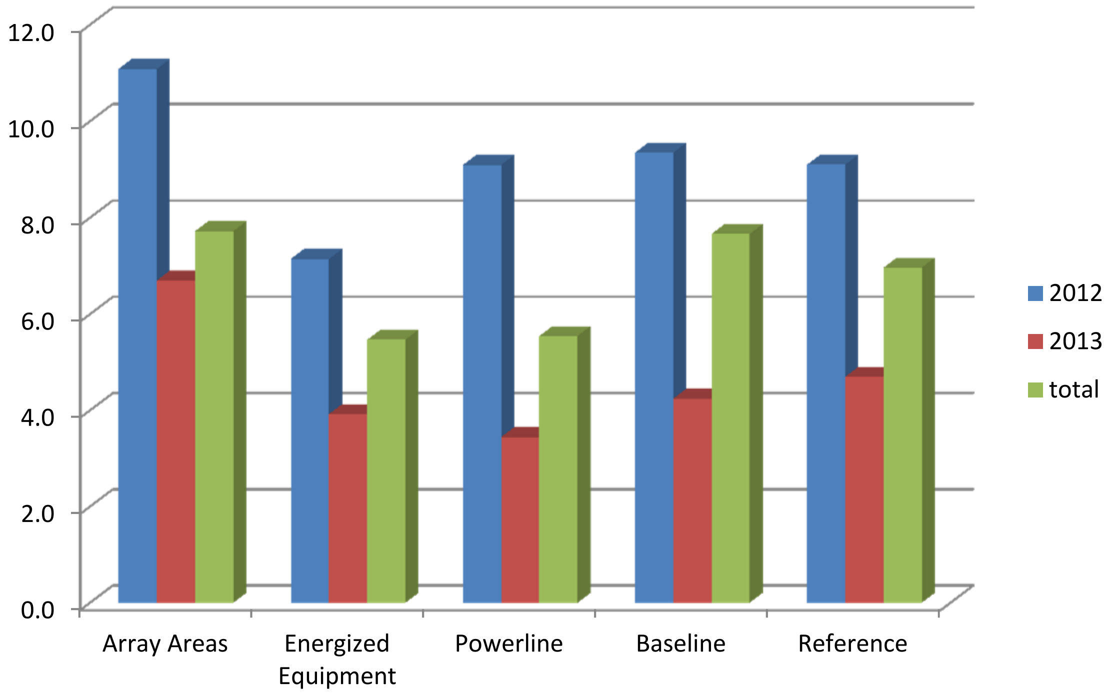


FIGURE 4. BIRD UTILIZATION RATE. Calculated as the average number of birds observed per Observation Point, BUR is compared for 2012, 2013 and an overall cumulative total.

3.2 Avian Fatality Surveys

Avian Fatality Surveys commenced upon completion of the first project components. Avian Fatality Surveys are conducted monthly at randomly selected locations within four different Survey Area Categories: Array Area, Overhead Powerline, Energized Equipment (Substation) and Reference Site. Select Array Areas were completed with construction and safe to conduct avian fatality surveys starting in October 2012. The first Overhead Powerline search plots were completed by the December 2012 survey. Energized Equipment areas were not completed with construction in 2012 and were therefore not surveyed; surveys started in February 2013.

3.2.1 Methods

Search Plots within each of the four Survey Area Categories were defined in ArcGIS as an area 480 feet long by 14 feet wide[5], which is the standard length of an array aisle, minus the bisecting road. Search plots are randomly selected each month using an ArcGIS random point generator having defined areas as the constraining polygon. Avian Fatality Surveys are conducted within

---

[5] Search plots were previously listed as 500 feet long, based on plan sheets prior to start of construction. It was decided to remove the 20 foot wide center road from transects to better account for distance surveyed within the arrays, thus transects are now considered 480 feet long.

the same search plots each day for seven consecutive days every month. Repetitive surveys increase the chance of finding fatalities in a given area before predators remove the carcass. As the TSF project progressed in construction, increasing numbers of Search Plots were surveyed monthly. By the end of 2013, a total of 114 search plots were selected in Array Area, 6 in Overhead Powerline, 4 in Energized Equipment and 114 in Reference Site. Exhibit 4 depicts the search plots covered by Avian Fatality Surveys in 2012 and 2013.

Avian Fatality Surveys are conducted on foot by trained biologists. Surveyors scan the ground and project components for bird carcasses, feathers, and marks indicating collision. When a fatality is found, data is collected on species, age and sex, location, carcass condition, cause of death, proximity to project components, and general notes.

3.2.2 Results

To date 12,656 search plots covering 1,952.4 acres (1150.5 linear miles) have been surveyed in Array Areas, resulting in detection of 14 avian fatalities (Table 9). For offsite Reference Sites, 12,365 search plots were surveyed covering 1,888.1 acres (1112.6 linear miles), resulting in detection of 26 avian fatalities. Along Overhead Powerlines, one fatality was detected in 49 search plots totaling 79.7 acres (47.0 linear miles). Energized Equipment surveys covered 304 search plots totaling 48.8 acres (28.8 linear miles), without detecting a single avian fatality (Table 9).

Cause of death was recorded for all fatalities, when known. The 41 fatalities documented during formal Avian Fatality Surveys were the result of three causes: predation, entrapment and unknown. No confirmed collisions or electrocutions were recorded in any of the Survey Area Categories. Predation was determined to be the likely cause of death in 6 Array Area fatalities and 14 Reference Site fatalities. Most of these incidents were due to raptors killing and plucking passerines such as horned lark, meadowlark and mourning dove. Four of the Predation incidents, all in Array Areas, involved domestic chickens that were likely brought onto the site by canid predators from an adjacent private residence. Predation as a cause of death is likely much higher than reported, as often times a feather pile could not be confidently linked to a predation event as opposed to a scavenging event. In these cases, cause of death was listed as Unknown[6]. Entanglement was listed as cause of death for one incident in the Reference Site category. This was a common raven chick that got tangled in nesting material. Cause of death could not be determined for 20 (48.8 percent) fatalities, 8 in the Array Areas, 1 in Overhead Powerline and 11 in Reference Site. Eleven of these occurred in Reference Site areas where predation was the likely cause of death. Nine of them occurred in project areas, all of which were described as feather piles. Our observations suggest a feather pile is the result of raptor predation, where a live bird is killed and plucked at or near the kill site. If a bird collides with something or

---

[6] Recent guidance from the U.S. Fish and Wildlife Service suggests attributing cause of death to a specific factor and including a confidence percent to indicate how confident the determination was. Data for 2014 is being collected in this manner and cause of death for all prior incidents may also be annotated as such.

otherwise dies and ends up whole on the ground, scavenging by birds or mammals results in the carcass simply disappearing rather than becoming a feather pile.

TABLE 9. CAUSE OF DEATH FOR AVIAN FATALITY SURVEY RESULTS. Cause of death is tallied for avian fatalities detected within each of the four survey area categories, 2012-2013, during formal avian fatality surveys.

Survey Area Category	Collision	Electrocution	Predation	Entanglement	Unknown	Total
Array Area	0	0	6	0	8	**14**
Energized Equipment (Substation)	0	0	0	0	0	**0**
Overhead Powerline	0	0	0	0	1	**1**
Reference Site (Grassland)	0	0	14	1	11	**26**
Totals	**0**	**0**	**20**	**1**	**20**	**41**

3.2.3 Bird Fatality Rate

Bird Fatality Rate (BFR) is calculated as the number of unique bird carcasses detected divided by the number of plots searched (Table 10). For this analysis, data is cumulative for 2012 and 2013.

Overhead Powerline and Reference Site had the highest BFR (0.0020 and 0.0021, respectively). This equates to one fatality in 79.7 acres (47.0 linear miles) of Overheard Powerlines, and one fatality in 72.6 acres (42.7 linear miles) of grassland. It should be noted that cause of death for the one fatality near the Powerlines was not determined, and cause of death for 42 percent of the Reference Site fatalities was not determined. BFR for Array Areas is 0.0011, or 14 fatalities in 12,656 search plots. This is equivalent to one fatality per 139.5 acres (82.2 linear miles). No fatalities were recorded in the Energized Equipment search plots, so the BFR is zero.

TABLE 10. BIRD FATALITY RATE. BFR is indicated for each of the four survey area categories, cumulatively for 2012 and 2013.

Survey Area Category	# Search Plots	Linear Miles	Acres	Acres per Fatality	Total # Fatalities	Bird Fatality Rate
Array Area	12,656	1150.5	1952.4	139.5	14	0.0011
Energized Equipment (Substation)	304	28.8	48.8	-	0	0.0000
Overhead Powerline	496	47.0	79.7	79.7	1	0.0020
Reference Site (Grassland)	12,365	1112.6	1888.1	72.6	26	0.0021

BFR at Reference Site areas (0.0021) was nearly double that of Array Area (0.0011), with a similar number of search plots completed (12,365 and 12,656 respectively). To test for difference in bird mortality between Array Area (completed project area) and Reference Site (natural grassland) we used a one-way ANOVA. BFR for Array Area and Reference Site were compared, and found to be significantly different. Natural grassland areas had a significantly higher number of bird fatalities per transect than did array areas (F = 3.892, p=0.0485).

TABLE 11. ANOVA BFR RESULTS. One-way ANOVA results for test between fatality number per search plot (BFR) in Array Area and Reference Site areas. The two types were significantly different with respect to the number of dead birds discovered per search plot.

ANOVA Table for Fatality
Inclusion criteria: Criteria 2 from Mortality by treatment.svd

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Treatment	1	.006	.006	3.892	.0485	3.892	.491
Residual	25019	39.930	.002				

Means Table for Fatality
Effect: Treatment
Inclusion criteria: Criteria 2 from Mortality by treatment.svd

	Count	Mean	Std. Dev.	Std. Err.
Array	12656	.0011	.0332	.0003
Reference/Grassland	12365	.0021	.0458	.0004

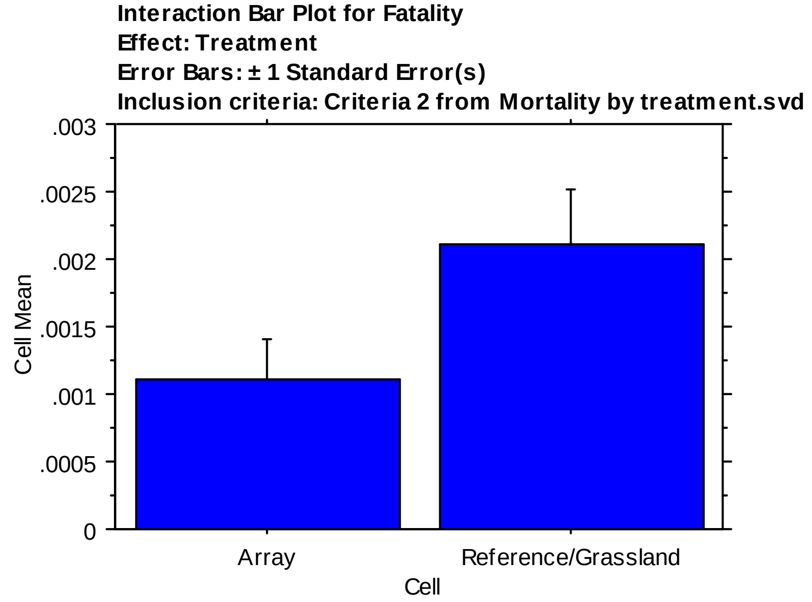

Interaction Bar Plot for Fatality
Effect: Treatment
Error Bars: ± 1 Standard Error(s)
Inclusion criteria: Criteria 2 from Mortality by treatment.svd

FIGURE 5. BIRD MORTALITY PER TRANSECT. Mean and standard errors are shown for bird mortality per search plot (0.15 acres) between Array Area and natural grassland Reference Sites. Bird mortality found in natural grasslands was almost twice that of array areas.

3.3 Scavenger/Carcass Removal Trial and Searcher Efficiency Trial

The BMAP study requires two types of trials to determine bias in the data. The scavenger/carcass removal trial investigates how fast a carcass gets scavenged within each of the four Survey Area Categories. The searcher efficiency trial provides a percent of known carcasses that are found by surveyors. Data from these trials is provided as background information to evaluate potential significance of these types of bias, but is not included in the final calculations used to determine Bird Risk Index. Carcasses used in the trials were unfrozen Japanese quail purchased from a reptile feed supplier. The quail are brownish overall and are about the size of a Western meadowlark, which is roughly the average size of common bird species present at TSF.

3.3.1 Scavenger/carcass removal trial

Scavenger/carcass removal trials were conducted in May and July 2013. Carcasses were randomly placed by the trial administrator in project areas and in offsite grasslands. The carcasses were numbered and labeled with a small band of green tape around one leg.

Carcass monitoring procedures outlined in the ABPP/BMAP require carcasses to be checked the first three consecutive days after placement, twice a week for the next two weeks, and then once a week for the remainder of the 60 day trial. Monitoring stopped when 100 percent of the carcasses were scavenged (Table 12). Upon routine monitoring of the carcasses, notes are recorded of the status and condition of the carcass. In these trials, with the exception of a few feathers, the carcass was simply present or not present.

As suspected, carcasses did not last long after they were placed in the field by the trial administrator. For onsite areas, 93.3 and 94.4 percent of the carcasses were scavenged within the first three days. For offsite areas, 86.7 and 100 percent of the carcasses were scavenged within the same time period. The maximum length of time a carcass remained in place was 18 days, which was twice the length of time any other carcass remained before being scavenged.

TABLE 12. PERCENT SCAVENGED BY DAY (CUMULATIVE). Cumulative percent of carcasses scavenged by day, separated by trial number. Included is the maximum number of days a carcass remained in the field before being scavenged.

Trial	**Location**	**Number of Carcasses**	**Day 1**	**Day 2**	**Day 3**	**Wk 2 (Day 1)**	**Wk 2 (Day 2)**	**Wk 3 (Day 1)**	**Wk 3 (Day 2)**	**Max. Days Present**
			Percent Scavenged							
1	Onsite	18	88.9	94.4	94.4	94.4	94.4	94.4	100	18
	Offsite	15	60.0	100	--	--	--	--	--	2
2	Onsite	15	33.3	80	93.3	100	--	--	--	8
	Offsite	15	33.3	53.3	86.7	93.3	100	--	--	9
Onsite Average			**63.6**							**13**
Offsite Average			**46.7**							**5.5**

3.3.2 Searcher efficiency trial

Searcher efficiency trials were conducted in May and December of 2013. Prior to the commencement of the day's Avian Fatality Surveys, dead Japanese quail were randomly placed by the trial administrator in the search plots of the scheduled Avian Fatality Surveys, both on and offsite. The trial was conducted blind, meaning carcasses were placed without the knowledge of the surveyors.

After the survey crew completed the day's surveys, the trial administrator performed a follow-up on all the carcasses placed prior to the trial. This was to determine how many of the original carcasses were in place, therefore available for detection, and how many carcasses had been scavenged by wildlife. The carcasses determined to be scavenged by the time of the follow-up were removed from the detection rate equation, since it could not be confirmed if the carcass was actually present when the surveyors were in that area.

Table 13 provides detection rates for onsite and offsite carcass placements in the two trials, and an average of the two trials. The detection rate is calculated by dividing the number of carcasses found by the number of carcasses placed minus any that were predated. Onsite detection rates averaged 70.8 percent, while offsite detection rates averaged 60 percent. Detection rate was assumed to be higher in the onsite survey plots than in the grassland plots because of minimal vegetation within the onsite survey plots that provided greater visibility of the ground surface.

Onsite in the arrays, surveyors are exposed to repetitive aisles between solar panels which cast harsh shadows to the ground. Often, half of the aisle is bright with sunlight and the other half under the panels and next to the support posts is contrastingly dark with shadow. This visibility issue may affect searcher efficiency rate.

Offsite, in the grassland plot transects, surveyors are exposed to ever-changing vegetation and debris within the search plots. Offsite plots were once grazed by cattle. The remaining dry cattle dung patties spread across the landscape look very similar to the dead Japanese quail used for the searcher efficiency trial. The landscape is also covered in small divots that carcasses may lay in and be hard to detect. The vegetation is drab, as are the quail and most of the avian species present in the area.

TABLE 13. SEARCHER EFFICIENCY TRIAL. Detection rates are provided for onsite and offsite searcher efficiency trials.

Trial #	**Location**	**Carcasses Placed**	**Carcasses Scavenged**	**Carcasses Available for Detection**	**Carcasses Found**	**Carcasses Not Detected**	**Detection Rate** (percent of available)
1	Onsite	18	6	12	9	3	75.0%
	Offsite	15	4	11	6	5	54.5%
2	Onsite	15	3	12	8	4	66.6%
	Offsite	13	4	9	6	3	66.6%
Average	**Onsite**	33	9	24	17	7	**70.8%**
Average	**Offsite**	28	8	20	12	8	**60.0%**

3.4 Bird Risk Index

Bird Risk Index (BRI) is calculated in order to quantify multiple measures into a single number to facilitate comparison of the different Survey Area Categories and to monitor for trends over time. For this study, BRI is calculated as Bird Fatality Rate (BFR) divided by Bird Utilization Rate (BUR). The risk index number therefore reflects differences in bird mortality and bird use among the treatment types. Table 14 lists BUR, BFR, and BRI, calculated from avian use survey data and avian fatality survey data collected in 2012 and 2013.

The Overhead Powerline survey category had the highest BRI, at 0.00036. Although only one bird fatality was detected at powerline search plots, the total number of powerline search plots was low compared to other survey area categories, resulting in a high fatality rate and BRI. Reference Site had the second highest BRI, at 0.00030. Twenty-six fatalities were recorded in 2012 and 2013 in over 12,000 search plots, resulting in a BFR similar to that for Overhead Powerline, and a BRI only slightly lower. Array Areas had a BRI of 0.00041, approximately a quarter of that calculated for Overhead Powerline, and a third of the BRI calculated for Reference Site. No mortality was documented at the Energized Equipment category, therefore the BRI is zero.

TABLE 14. BIRD RISK INDEX. BUR, BFR, and BRI are provided for the Array Area, Overhead Powerline, Energized Equipment and Reference Site search plots.

Survey Area Category	Bird Utilization Rate (BUR)	Bird Fatality Rate (BFR)	Bird Risk Index (BRI)
Array Area	7.72	0.0011	0.00014
Energized Equipment (Substation)	5.47	0.0000	0
Overhead Powerline	5.55	0.0020	0.00036
Reference Site (Grassland)	6.97	0.0021	0.00030

3.5 Adjusted Avian Fatality Rates

Searcher efficiency and scavenger removal trials were conducted to account for systematic reduction of fatality detections resulting from sampling procedure (bias). The trials were each repeated twice. Results between the original and repeat trial efforts were very different; therefore to obtain accurate measure of searcher efficiency these trials need more repetitions. For this reason, we consider trial bias data utilized here as preliminary, yet useful for fatality estimates.

Preliminary scavenger removal data collected in 2013 indicates that 64 percent of onsite carcasses and 47 percent of offsite carcasses are scavenged in the first 24 hours of the carcass being present. This means that at only 36 percent of the onsite and 53 percent of the offsite carcasses are available for detection after one day. With searcher efficiency at 71 percent of the available onsite carcasses and 66 percent of the available offsite carcasses, we adjusted avian fatality data to indicate a maximum of likely total fatalities (Table 15).

Using fatality data collected in 2012 and 2013 during formal avian fatality surveys, we calculated number of fatalities per acre per day for each of the four Survey Area Categories and extrapolated that to estimated number of fatalities per site per year, where site equals the total area of those components when the project is completed. Our fatality survey method consists of seven consecutive days of surveying the same transects. Since the first day could potentially contain carcasses present for several days, if not months, we excluded those fatalities detected on the first day and based the number of fatalities per acre per day calculation on carcasses found each of the remaining six days. This number is provided as a minimum number of fatalities detected. Using trial bias data, this number is adjusted to provide a maximum potential number of fatalities per unit area per unit time (Table 15).

For Array Area, we detected 7 fatalities (after excluding data from the first day of surveys, see explanation in paragraph above), representing the minimum number of fatalities per 1,674 acres of survey area per 95 days. Projected maximum number of fatalities for the same area and time, adjusted for trial data, is 27.4. For the completed TSF project, with 2,659 acres of array transects, we can expect a range of 42.7 to 167.2 avian fatalities per year.

For Overhead Powerline areas, we detected only one fatality in 68 acres over 80 days. Potential maximum fatalities for the same area and time, adjusted for trial data, is 3.9. For the completed TSF project, with 21.9 acres of power line transects, extrapolating and adjusting fatality number by searcher efficiency and scavenger removal trial data, we calculate a range of 1.5 to 5.7 fatalities per year.

For Energized Equipment, no fatalities were detected in 287 acres over 64 days. With a base fatality rate of zero, projected maximum fatalities would also be zero.

For Reference Site, we detected 19 fatalities in 1,622 acres over 84 days. Potential maximum fatalities based on trial data is 54.3 fatalities. To compare Reference Site range of potential fatalities with Array Area, Overhead Powerline and Energized Equipment, we calculated the number of fatalities per year per area of each category using Reference Site fatality rate. Thus, for an equivalent area of grassland as Array Area (2,659 acres), we would expect a range of 135.4 to 387.0 avian fatalities. For an equivalent area of Overhead Powerline (21.9 acres), we would expect a range of 1.1 to 3.2 avian fatalities. For an equivalent area of grassland as Energized Equipment (287 acres), we would expect a range of 0.2 to 0.7 avian fatalities.

The most interesting fatality rate comparison is between Array Area and Reference Site, where actual fatalities are 3.17 times higher and projected maximum fatalities are 2.3 times higher in offsite grassland habitat than in project array fields (see Table 15 and Figure 6):

- Array Area: 42.7 to 167.2 avian fatalities per year
- Reference Site: 135.4 to 387.0 avian fatalities per year

TABLE 15. ADJUSTED FATALITY RATES. Fatality data is indicated for minimum and maximum bird mortality rates for each of the Survey Area Categories per year, accounting for searcher efficiency and scavenger bias rate data. Calculations are shown for number of fatalities per acre per year, fatalities per site per year, and fatalities per site per year based on Reference Site fatality rate.

Survey Area Category	**Days Surveyed**	**Survey Area (acres)**	**Cause of Death**	**No. Fatalities**		**Fatalities/Ac/Yr**		**Fatalities/Site/Yr**		**Fatalities/Site/Yr (Reference Site Rate)**	
				Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Array Area	95	1674	Predation	3	11.7	0.007	0.027	18.3	71.7	64.1	183.3
			Unknown	4	15.6	0.009	0.036	24.4	95.5	71.3	203.7
			Total	**7**	**27.4**	**0.016**	**0.063**	**42.7**	**167.2**	**135.4**	**387.0**
Overhead Powerline	80	68	Predation	1	3.9	0.066	0.261	1.5	5.7	0.5	1.5
			Unknown	0	0	0	0	0	0	0.6	1.7
			Total	**1**	**3.9**	**0.066**	**0.261**	**1.5**	**5.7**	**1.1**	**3.2**
Energized Equipment (Substation)	64	287	Predation	0	0	0	0	0	0	0.1	0.3
			Unknown	0	0	0	0	0	0	0.1	0.3
			Total	**0**	**0**	**0**	**0**	**0**	**0**	**0.2**	**0.7**
Reference Site	84	1622	Predation	9	25.7	0.024	0.069	-	-	-	-
			Unknown	10	28.6	0.027	0.077	-	-	-	-
			Total	**19**	**54.3**	**0.051**	**0.146**	**-**	**-**	**-**	**-**

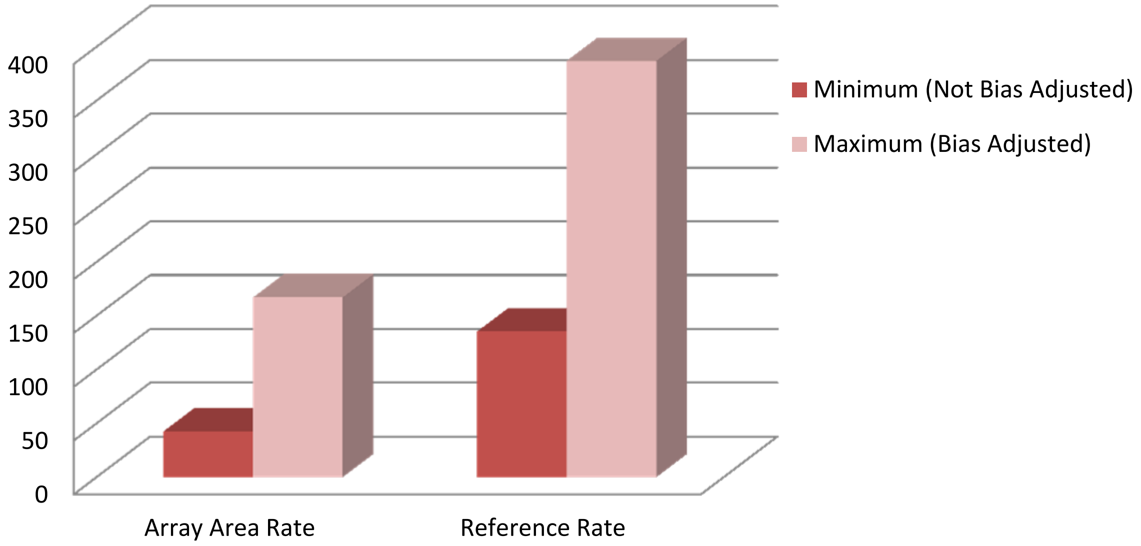


FIGURE 6. ADJUSTED FATALITY RATES. Minimum and maximum fatality rates are indicated for Array Area and Reference Site, where minimum rates are actual fatality detections, and maximum is projected adjusted by scavenger and searcher efficiency bias data. Reference Site rates are calculated based on Array Area acreage of 1,674 acres.

4.0 Discussion

4.1 General 2013 Avian Fatality Overview

Data collected during general monitoring surveys and focused Avian Fatality Surveys indicates that bird mortality at the TSF project site is lower than natural grassland reference sites, with cause of death (where cause was determined) due primarily to predation. There have been no confirmed bird collisions with solar arrays or overhead powerlines at the TSF project site. Electrocutions were confirmed for 8 common ravens in 2013, accounting for 12.1 percent of all 2013 fatalities. The electrocutions were due to dislodged wildlife protector caps on overhead powerline riser pole lightning arrestors. After all wildlife protector caps were replaced, electrocutions ceased. Overall, in 2013, a majority of the bird fatalities detected on the project site were associated with construction areas and not operation areas, suggesting that birds within construction areas are at a higher risk than those in operation areas of a passive photovoltaic solar plant.

4.2 Bird Risk Index and Cross-Project Data Comparisons

The Bird Monitoring and Avoidance Plan requires collection of data on bird use and bird mortality to inform a Bird Risk Index calculation that can be used to determine avian mortality significance thresholds. This study was designed in 2010 in consultation with the U.S. Fish and Wildlife Service (USFWS), and was modeled after studies conducted for wind energy projects. Determining significance thresholds is a requirement of the study, and is to be done in consultation with USFWS and California Department of Fish and Wildlife (CDFW) in early 2014. Since 2010, we have learned that this type of risk index study may not be part of bird mortality studies being conducted on other solar projects in California. Without similarly calculated bird risk index data from other solar projects, the calculations from Topaz Solar Farms do not have a strong frame of reference to help scientists and regulators understand the significance of bird mortality rates from Topaz versus other solar projects.

However, data collected for our BMAP study can be compared with other locations. Analysis of data for bird use and bird mortality in terms of birds or fatalities per unit time per unit area can be comparable between project sites, despite different survey methodologies. From our Avian Use Surveys we can calculate bird use per acre per day for different survey area categories (eg: Array Areas, Overhead Powerlines, etc.). Likewise, our avian fatality survey data can be used to calculate number of bird fatalities per acre per day. This type of calculation should be available from datasets collected by the various methods of fatality surveys and bird point counts conducted on other solar projects, and can be used to provide annual fatality estimates or risk assessments based on total size of array fields.

4.3 Causes of Avian Mortality

Cause of death was not determined for 54.5 percent of all avian fatalities recorded in 2013. Predation accounted for 31 percent. Most of the “unknown” fatality incidents were likely the result of predation of live birds. In these cases, all that remains is a feather pile. During scavenger removal trials, test carcasses were either there or not there, and never were reduced to a feather pile. This suggests that if a bird collides with a module and dies, it would be present as a whole carcass and would be entirely gone when scavenged. Based on guidance from USFWS, we will be modifying cause of death determination method for 2014. Instead of classifying a carcass or feather pile as "Unknown" when there is insufficient information to know with certainty, we will be classifying carcasses with the best cause of death determination based on information collected at the time of discovery, and qualifying the determination with a percent confidence.

Mortality in offsite grassland areas sampled as Reference Site was nearly double that detected in Array Areas. Because a large portion of the fatalities are the result of predation, it appears that array areas provide more structure and protection from predators. Anecdotal evidence indicates the highest rate of predation is from raptors, primarily falcons such as prairie, peregrine and merlin. These birds are powerful aerial predators that would have higher success of captures in the open grasslands than in the arrays.

Collision with solar panels as a cause of bird fatalities has not been documented at the TSF project site. We understand that collisions with panels have occurred on other industrial scale solar plants in California. If bird collisions with panels are occurring at the TSF project, it has not been detectable with current survey methods.

Trials have shown that approximately 64 percent of whole carcasses are scavenged within 24 hours within the arrays, and searcher efficiency at finding the remaining 36 percent of carcasses is 71 percent, indicating that a large proportion of bird fatalities go undetected (see searcher efficiency and scavenger removal trial data in Section 3.3, and adjusted avian fatality data in Section 3.5).

4.4 Future Work

Searcher efficiency trials and scavenger trials will be repeated to test consistency of results. We plan on repeating these two studies several times in 2014 and comparing results to previous trials.

BUR and BRI suggests array areas are less risky to birds than offsite reference grasslands. This raises several questions worth further investigation including: is duration of use by individual birds lower in array areas, is predation risk higher in grasslands without cover, are sick or morbid individuals not frequenting array areas as often, is habitat type of energized equipment areas not conducive to use by birds? Also, as the habitat in the array areas develops and matures over time, will use by birds increase within the solar plant? Some of these questions fall outside of the scope of this current study, and present an opportunity for future examination and investigation.

5.0 References

Althouse and Meade, Inc. 2011. Topaz Solar Farms Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. June 2011.

Althouse and Meade, Inc. 2013. Topaz Construction Phase Programmatic Nesting Bird Management Plan. April 2013, revised August 2013.

Anderson, Richard et al. 1999. Studying Wind Energy/Bird Interactions: A Guidance Document. Metrics and Methods for Determining or Monitoring Potential Impacts on Birds at Existing and Proposed Wind Energy Sites. Prepared for the Avian Subcommittee and National Wind Coordinating Committee. December.

Anderson, Richard et al. Avian Monitoring and Risk Assessment at Tehachapi Pass and San Gorgonio Pass Wind Resource Areas, California: Phase 1 Preliminary Results.

Avian Power Line Interaction Committee (APLIC) and U.S. Fish and Wildlife Service (USFWS). 2005. Avian Protection Plan (APP) Guidelines. April.

Avian Power Line Interaction Committee (APLIC). 2006. Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006. Edison Electric Institute, APLIC, and the California Energy Commission. Washington D.C. and Sacramento, CA.

Avian Power Line Interaction Committee (APLIC). 2012. Reducing Avian Collisions with Power Lines: The State of the Art in 2012. Edison Electric Institute and APLIC. Washington D.C. October.

California Energy Commission (CEC), Public Interest Energy Research (PIER) Program. 2002. A Roadmap for PIER Research on Avian Collisions with Power Lines in California. P500-02-071F. December.

McCrary, Michael D. et al. 1986. Avian Mortality at a Solar Energy Power Plant. J. Field Ornithology, 57(2):135-141. Spring.

National Renewable Energy Laboratory (NREL) 2005. Avian Monitoring and Risk Assessment at the San Gorgonio Wind Resource Area, Phase I Field Work, March 3, 1997 – May 29, 1998, Phase II Field Work, August 18, 1999 – August 11, 2000. August.

United States Fish and Wildlife Service (USFWS). 2010. Eagle Take Permitting under the Bald and Golden Eagle Protection Act, U.S. Fish and Wildlife Service Region 8: Interim Guidance for External Partners. May.

United States Fish and Wildlife Service (USFWS). 2010. Region 8 Interim Guidelines for the Development of a Project Specific Avian and Bat Protection Plan for Solar Energy Plants and Related Transmission Facilities. Pacific Southwest Region. September.

United States Fish and Wildlife Service (USFWS). 2011. Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach. Pacific Southwest Region, May 2.

Zena Design. 2013. www.zenadesign.com.

6.0 Exhibits

Exhibit 1: Construction Status as of December 31, 2013.

Exhibit 2: Active Nests January 2012 to December 2013.

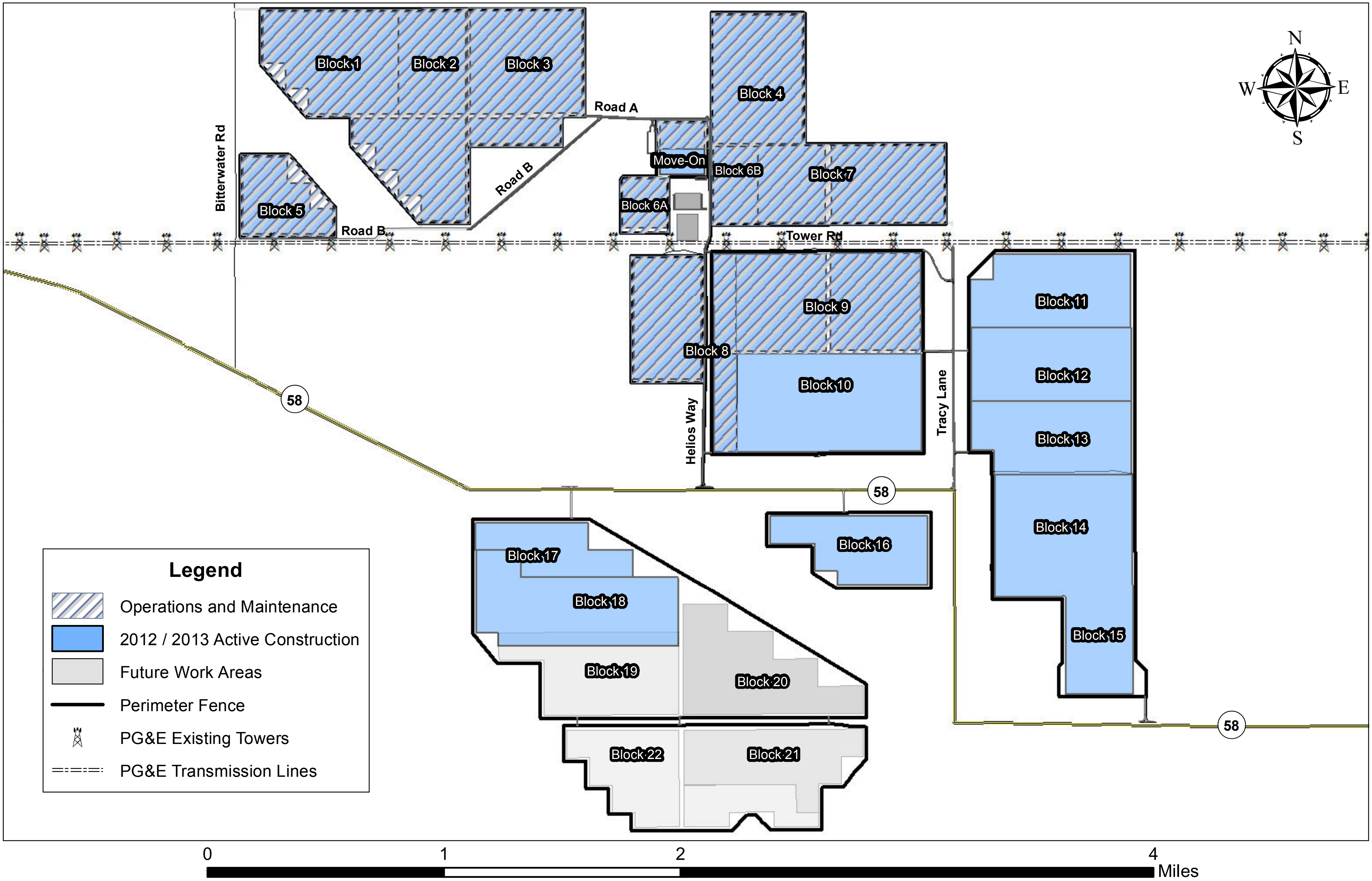
Exhibit 3: Avian Use Survey Points January 2013 to December 2013.

Exhibit 4: Avian Fatality Survey Areas January 2013 to December 2013.

Exhibit 5: Onsite Avian Fatalities

Exhibit 1. Construction Status

As of December 31, 2013



Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

First Solar.

Map Updated: March 25, 2014 10:34 AM

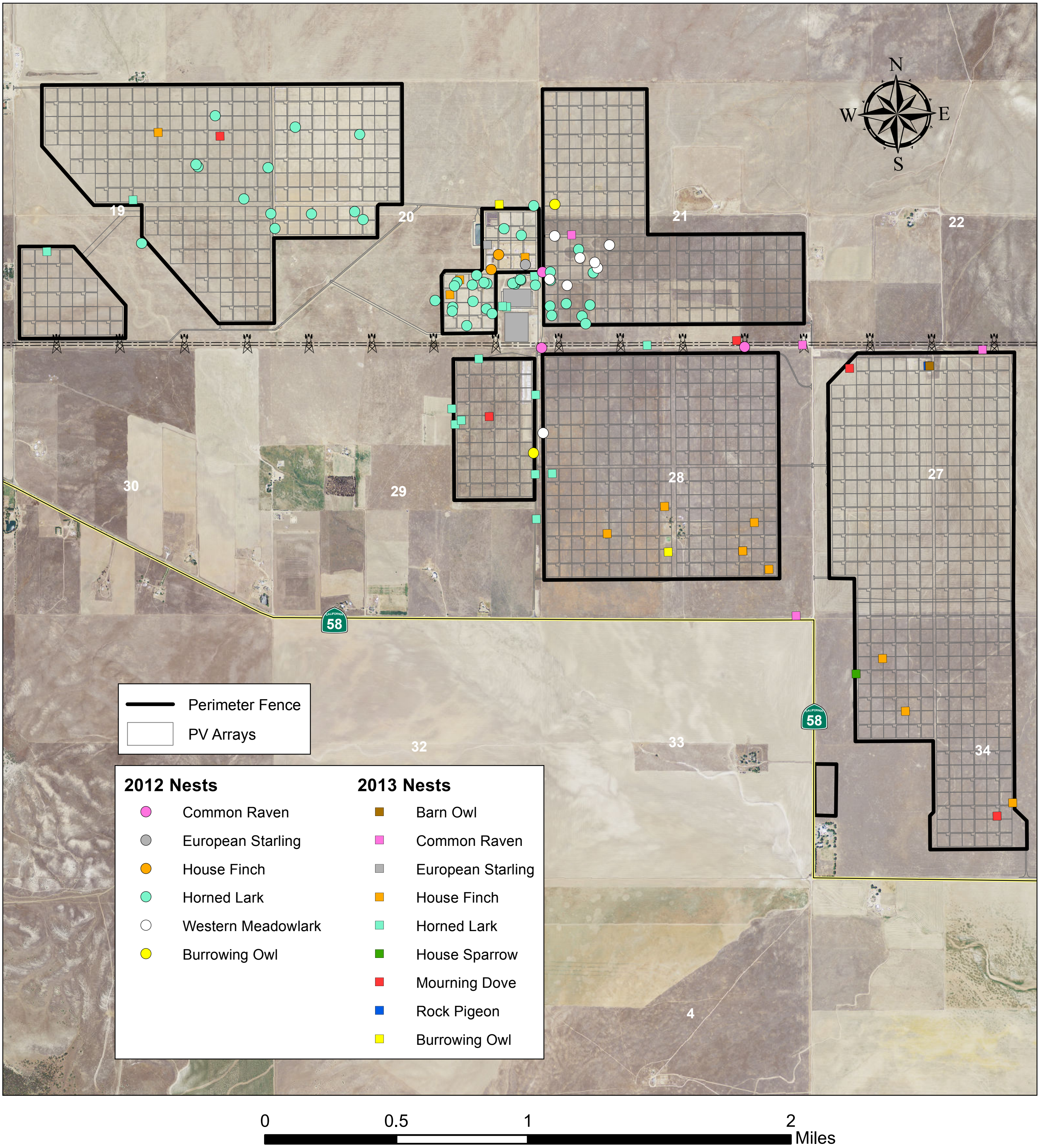
Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Additional Documentation Attachment to Comment 2-F1

Attachment I-3

Exhibit 2. Active Nests

January 2012 to December 2013



Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

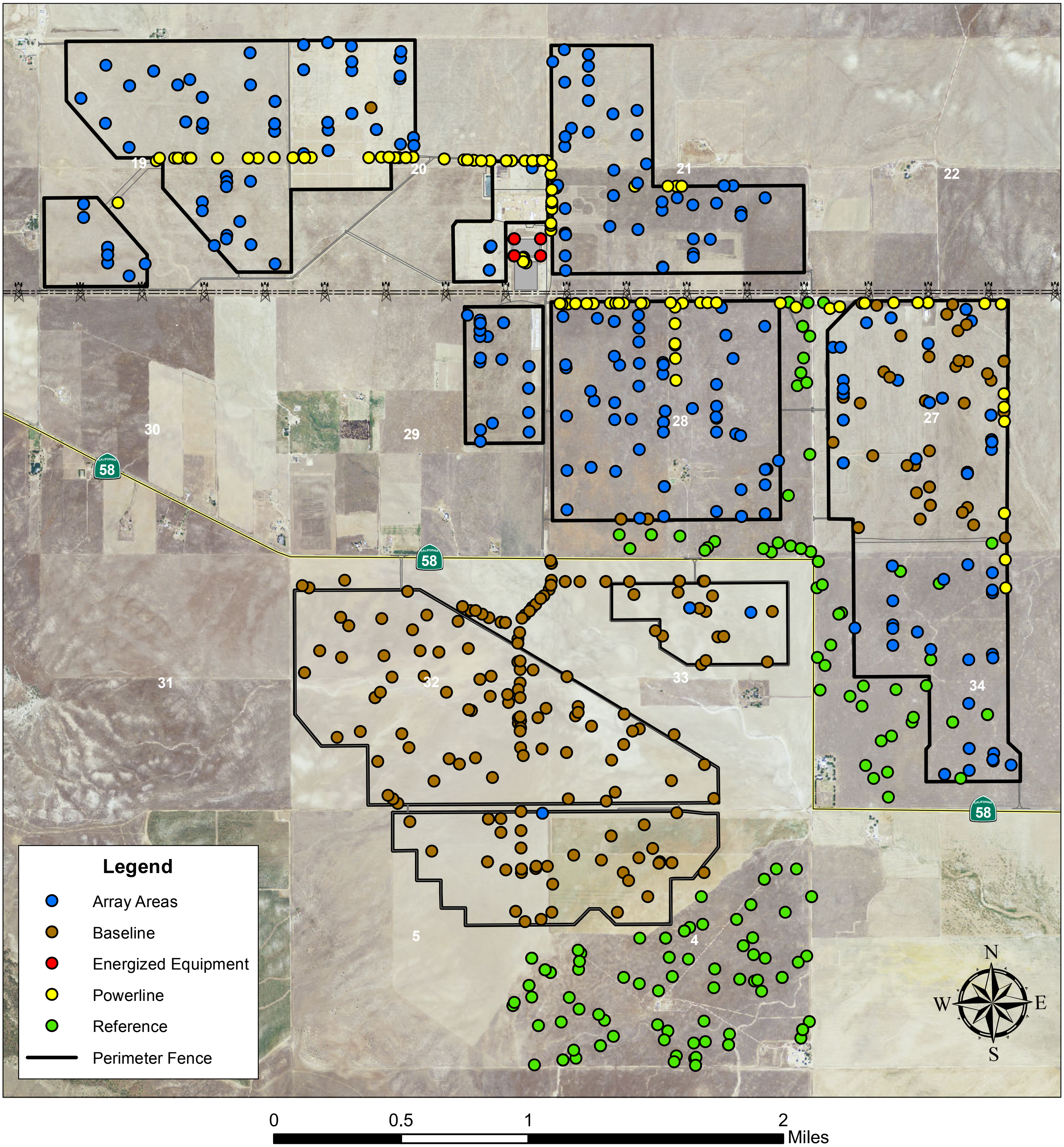
2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: January 15, 2014 03:26 PM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Exhibit 3. Avian Use Survey Points

January 2013 to December 2013



First Solar.
Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

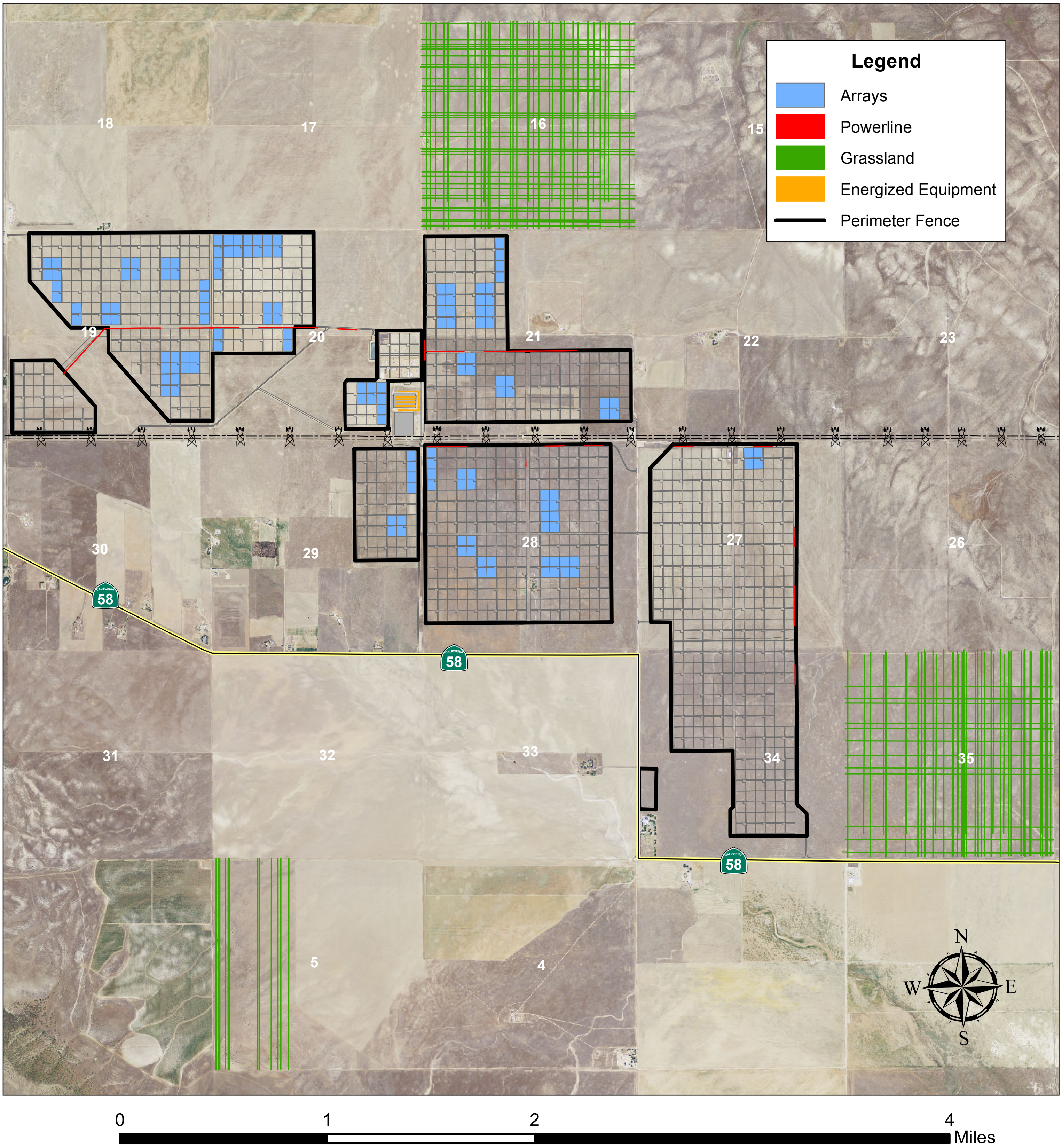
2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: March 12, 2014, 11:14 AM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Exhibit 4. Avian Fatality Survey Areas

January 2013 to December 2013



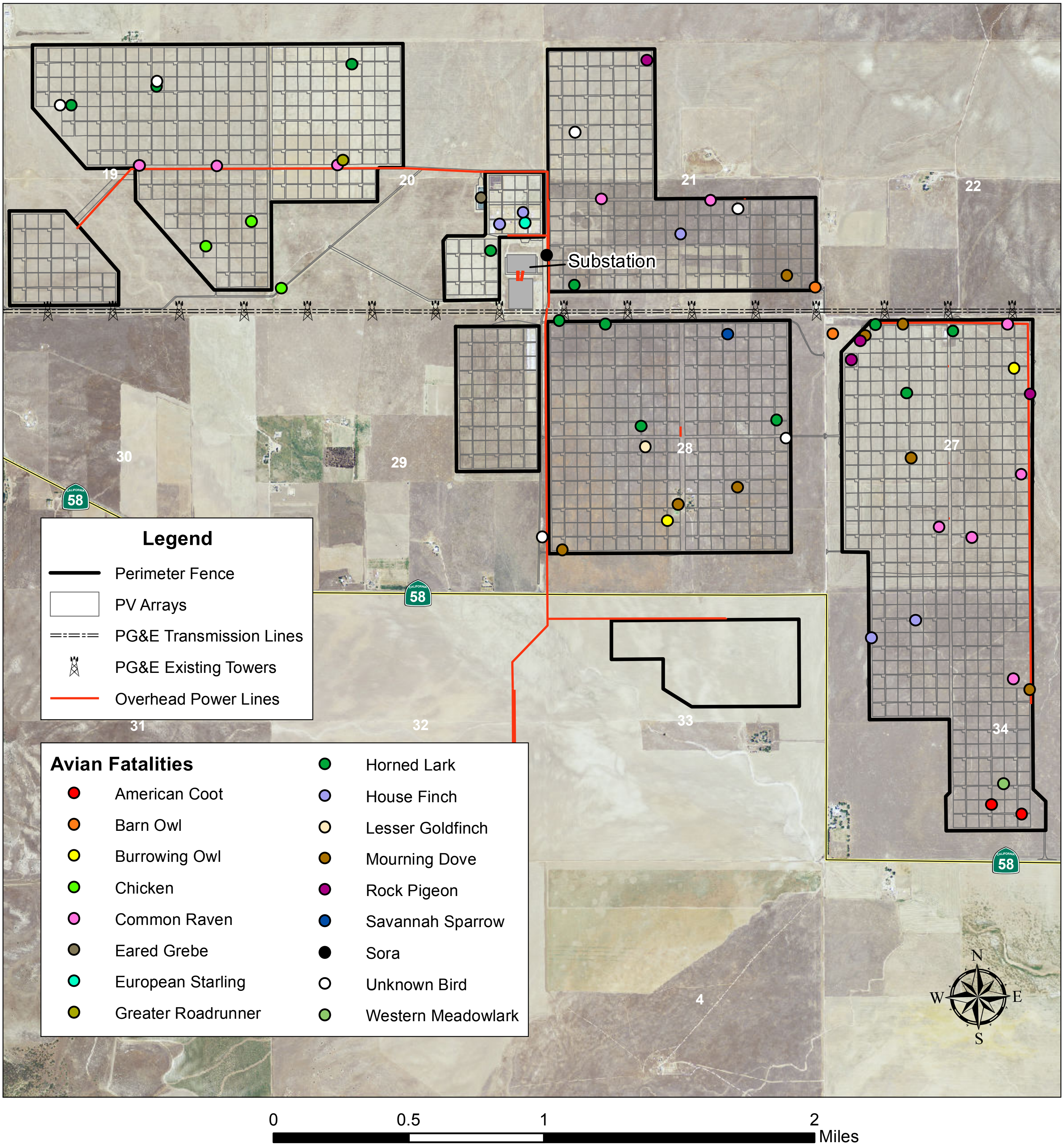
First Solar. Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: January 15, 2014, 03:27 PM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Exhibit 5. Onsite Avian Fatalities

January 2013 to December 2013



Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: March 17, 2014, 12:14 PM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Appendix A – Avian Fatalities 2013

Avian fatalities detected at the Topaz Solar Farms, January through December 2013.

Species	Cause of Death	Notes
January 2013		
Horned Lark *Eremophila alpestris*	Unknown	Found about 15 feathers in Block 3 Array 4
Horned Lark *Eremophila alpestris*	Unknown	Feather pile of approximately 50 feathers in Block 1
Mourning Dove *Zenaida macroura*	Unknown	Feathers found in Cochrane area
Bird Species unidentified	Unknown	Two wings found in Block 7
Bird Species unidentified	Unknown	Primary, secondary, down, and tail feathers found in Block 1
House Finch *Haemorhous mexicanus*	Unknown	Found in Conti Laydown
Horned Lark *Eremophila alpestris*	Unknown	Feathers only in north perimeter fence of Block 8 east
Barn Owl *Tyto alba*	Unknown	Found dead on top of fence post in Block 7
February 2013		
Horned Lark *Eremophila alpestris*	Unknown	Feather pile found in Block 1
Horned Lark *Eremophila alpestris*	Unknown	Found on ground next to post in Block 9 Array 32; intact with very minor blood spots on bill and breast
Bird Species unidentified	Unknown	Feathers found in Block 1; sheared with broken tips, from mammal
Bird Species unidentified	Unknown	Feathers found in Block 4
House Finch *Haemorhous mexicanus*	Unknown	Female found on ground next to large stack of pallets in Block 7 recycling yard
Mourning Dove *Zenaida macroura*	Presumed Predation	Feather pile near a pole on the Hotline route
March 2013		
Common Raven *Corvus corax*	Electrocution	Found dead below power pole at PCVS1; feathers of one wing charred. Wildlife protector cap replaced April 22, 2013
Horned Lark *Eremophila alpestris*	Unknown	Found in trench in Block 9 Array 27; mostly feathers and bone
Mourning Dove *Zenaida macroura*	Unknown	Feather pile in Block 11 laydown; some on top of stack of tables and some on ground
Rock Pigeon *Columba livia*	Presumed entanglement	Found at bottom corner of net in Block 11 laydown
Lesser Goldfinch *Spinus psaltria*	Presumed collision	Found in Block 10 Array 3; Presumed collision with rails or arms
Bird Species unidentified	Unknown	Feather pile found in Block 10 east

Species	Cause of Death	Notes
Common Raven *Corvus corax*	Electrocution	Found at bottom of Hotline pole at PCVS4; wildlife protector cap replaced April 22, 2013
House Finch *Haemorhous mexicanus*	Unknown	Found at the Topaz Office lot; cause of death unknown
Common Raven *Corvus corax*	Electrocution	Found below power pole at PVCS1; wildlife protector cap replaced April 22, 2013
Horned Lark *Eremophila alpestris*	Unknown	Pile of feathers in Block 6
Savannah Sparrow *Passerculus sandwichensis*	Unknown	Found dead lying on a roll of wire that was hanging on the end of a rail in Block 9 Array 6
Common Raven *Corvus corax*	Electrocution	Found hanging from pole at PCVS7; wildlife protector cap replaced April 22, 2013
Common Raven *Corvus corax*	Electrocution	Found at Block 2 PVCS2; wildlife protector cap replaced April 22, 2013
Common Raven *Corvus corax*	Electrocution	Found dead on ground at PVCS3; wildlife protector cap replaced April 22, 2013
April 2013		
Chicken *Gallus gallus domesticus*	Unknown	Feather pile in Block 2 with coyote scat next to pile
Chicken *Gallus gallus domesticus*	Predation	Feather pile; feather tips sheared off
Common Raven *Corvus corax*	Electrocution	Riser pole at PVCS7; wildlife protector cap replaced April 22, 2013
Common Raven *Corvus corax*	Electrocution	Riser pole at PVCS1; wildlife protector cap replaced April 22, 2013
Bird Species unidentified	Drowning	Fell into vehicle wheel wash water tank
House Finch *Haemorhous mexicanus*	Nest damage	Failed nest; four broken eggs found on rails/tables in Block 14 Array 8
Mourning Dove *Zenaida macroura*	Unknown	Decomposed, carcass intact, downy feathers in Block 8 east
May 2013		
European Starling *Sturnus vulgaris*	Fell out of nest	Nestling found near water storage container at Move-on
Mourning Dove *Zenaida macroura*	Predation	Mourning dove kill site in Block 11 Hotline Route
Horned Lark *Eremophila alpestris*	Unknown	Feather pile west of Hotline Route, south of Tower Road
House Finch *Haemorhous mexicanus*	Unknown	Found in Block 14 west; appeared to have been dead at least one week; neck possibly broken
June 2013		
Horned Lark *Eremophila alpestris*	Predation	Male east of Arco Building in Block 11
Horned Lark *Eremophila alpestris*	Predation	Headless fledgling in Block 9 Array 2
July 2013		

Species	Cause of Death	Notes
Common Raven *Corvus corax*	Unknown	Feather pile found in Block 13 Array 12; no carcass
August 2013		
Rock Pigeon *Columba livia*	Unknown	Feather pile found in Block 4
Mourning Dove *Zenaida macroura*	Predation	Wing collected in Block 12
Common Raven *Corvus corax*	Unknown	Numerous common raven feathers Block 13
Barn Owl *Tyto alba*	Predation	Juvenile; rest of carcass found near Arco building Hotline Route between Blocks 9 and 11
Burrowing Owl *Athene cunicularia*	Presumed predation	Approximately 30 flight feathers; San Joaquin kit fox scat on feather pile Cochrane Pond buffer
September 2013		
Greater Roadrunner *Geococcyx californianus*	Unknown	Feather pile in Block 3
Horned Lark *Eremophila alpestris*	Unknown	Feather pile found in Block 6A
October 2013		
Chicken *Gallus gallus domesticus*	Presumed predation	Found in completed Block 2
Sora *Porzana carolina*	Unknown	Found on Helios Way; no visual injuries
American Coot *Fulica americana*	Presumed predation	Feather pile found in array road in Block 15 Array 17 with San Joaquin kit fox scat in middle of pile
Eared Grebe *Podiceps nigricollis*	Presumed predation	Found floating in Dust Control Pond; head injured, top of cranium missing.
November 2013		
Mourning Dove *Zenaida macroura*	Unknown	Feathers found in Block 7
Horned Lark *Eremophila alpestris*	Unknown	Approximately 100 body feathers found in Block 11 Array 16
American Coot *Fulica americana*	Unknown	Block 15 Array 18
Common Raven *Corvus corax*	Unknown	25-30 feathers found scattered just south of north perimeter road in Block 11
Rock Pigeon *Columba livia*	Unknown	Feather pile found scattered throughout quadrant A in Block 11 Array 7
December 2013		
Burrowing Owl *Athene cunicularia*	Predation	Headless and wingless carcass found on top of inverter at vault in Block 11 Array 13
Rock Pigeon *Columba livia*	Predation	Bloody feathers found in Block 11 perimeter road at pole 63

Species	Cause of Death	Notes
Rock Pigeon *Columba livia*	Unknown	Feathers found in Block 11 Array 1
Common Raven *Corvus corax*	Presumed predation	Feathers found in Block 12 Array 21;
Common Raven *Corvus corax*	Unknown	Wing and feathers found in Block 14 laydown

Appendix B – Other Wildlife Fatalities

Other wildlife mortality detected at the Topaz Solar Farms, January through December 2013.

Species	Cause of Death	Notes
January 2013		
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	Found in road at Well Road and Road B intersection
Deer Mouse *Peromyscus maniculatus*	Moving materials	Found in Secure Laydown; crushed
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	Found at Block 4 access road; vehicle strike
Desert Cottontail *Sylvilagus auduboni*	Equipment strike	Found in Block 8 east against tilt stack; fork lift appeared to have pierced abdominal area
California Ground Squirrel *Spermophilus beecheyi*	Predation	Found in Block 9 Array 5; predation from raptor
Northern Pacific Rattlesnake *Crotalus oreganus oreganus*	Equipment strike	Found at Cochrane demolition; injured during excavation, broken back, posterior end
Northern Pacific Rattlesnake *Crotalus oreganus oreganus*	Equipment strike	Block 10 Cochrane demolition site, killed by equipment
Desert Cottontail *Sylvilagus auduboni*	Equipment strike	Dead rabbit found at Cochrane pond; killed by excavation
Desert Cottontail *Sylvilagus auduboni*	Equipment strike	Dead rabbit found at Cochrane pond; killed by excavation
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	Killed at excavation site at Cochrane
California Ground Squirrel *Spermophilus beecheyi*	Equipment strike	Casualty of excavation at Cochrane demolition
Desert Cottontail *Sylvilagus auduboni*	Unknown	Found at irrigation pond at Cochrane; hind feet and head all that remained
California Ground Squirrel *Spermophilus beecheyi*	Unknown	Found dead at Helios Way trench northeast of Guard Shack
California Ground Squirrel *Spermophilus beecheyi*	Presumed predation	Found tail of squirrel and fresh coyote prints in Block 7 Array 19
February 2013		
Deer Mouse *Peromyscus maniculatus*	Unknown	Found at Topaz Office
California Ground Squirrel *Spermophilus beecheyi*	Presumed predation	Found in Block 9 along access road; common raven observed picking at it; did not appear to be hit by equipment; possible predation.
California Ground Squirrel *Spermophilus beecheyi*	Unknown	Found at Guard Shack
California Ground Squirrel *Spermophilus beecheyi*	Presumed predation	Found in Block 9 Array 7; appeared to be a raptor kill; only fur/skin left, no body cavity
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	Killed while trenching in Block 8 Array 16; long slice through length of body
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	Found at the bottom of trench in Block 8 east Array 22; killed by trencher.
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	Squirrel found on Tracy Lane; vehicle strike

Species	Cause of Death	Notes
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	Found in CSI Laydown Yard; appeared to be vehicle strike
California Ground Squirrel *Spermophilus beecheyi*	Equipment strike	Found in Block 7 Array 22; appeared to have been struck by something on its back
Deer Mouse *Peromyscus maniculatus*	Unknown	Found in Block 5 recycling yard; juvenile
Deer Mouse *Peromyscus maniculatus*	Unknown	Found in Block 5 recycling yard; juvenile
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	Found on Road A at Dust Control Pond; most likely vehicle strike
March 2013		
Deer Mouse *Peromyscus maniculatus*	Entrapment	Found at bottom of auger hole for Powerline pole #94
Western Spadefoot Toad *Spea hammondii*	Vehicle strike	Found on road in Block 10 Array 6; run over by forklift
Deer Mouse *Peromyscus maniculatus*	Entrapment	Fell into Powerline Pole 94 augur hole
Deer Mouse *Peromyscus maniculatus*	Entrapment	Fell into Powerline Pole 110 augur hole
Deer Mouse *Peromyscus maniculatus*	Unknown	Found dead inside PCVS3 shelter in Block 5; appeared crushed
Western Toad *Bufo boreas*	Vehicle strike	Found at Road B; vehicle strike
Black Tailed Jackrabbit *Lepus californicus*	Unknown	One newborn dead at Block 21 Grain Silo
Black Tailed Jackrabbit *Lepus californicus*	Equipment strike	Adult crushed due to demolition activities at Block 21 Grain Silo
Desert Cottontail *Sylvilagus auduboni*	Moving materials	Baby cottontail killed while pallets were being moved in Block 8 Array 18
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Found in Block 9 road
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Found in Block 15 west perimeter road
Deer Mouse *Peromyscus maniculatus*	Unknown	Found dead in Block 7 PCVS18
Side-blotched lizard *Uta stansburiana*	Moving materials	Found under pallet pile in Block 10 Array 8
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Found on Helios Way
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Found dead in perimeter road of Block 15
Valley Pocket Gopher *Thomomys bottae*	Unknown	Found dead juvenile gopher in Block 8 Array 21 road
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Found on Block 14 access road
April 2013		
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	Found on Road A
California Ground Squirrel *Spermophilus beecheyi*	Drowning	Found floating in Dust Control Pond

Species	Cause of Death	Notes
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	Helios Way
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	Helios Way
California King Snake *Lampropeltis getula californiae*	Vehicle strike	Juvenile; Block 9/10 access road
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	Block 10 Array 9
Heermann's Kangaroo Rat *Dipodomys heermanni*	Drowning	Fell into vehicle wheel wash water tank
California Ground Squirrel *Spermophilus beecheyi*	Drowning	Fell into vehicle wheel wash water tank
Deer Mouse *Peromyscus maniculatus*	Vehicle strike	Mechanics yard
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Southeast Block 15
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	Found dead on Helios Way
Northern Pacific Rattlesnake *Crotalus oreganus oreganus*	Vehicle strike	Block 14 laydown
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Block 14
May 2013		
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Block 9 "S" Road
Pacific Gopher Snake *Pituophis catenifer catenifer*	Predation	Being eaten by a common raven south of Road A
California Ground Squirrel *Spermophilus beecheyi*	Predation	Carcass partially eaten in Block 8 Array 14
Desert Cottontail *Sylvilagus auduboni*	Unknown	Ravens picking at carcass in Block 10
Mouse Species unidentified	Construction activities	Found where post pounding was occurring in Block 15 Array 15
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Helios Way
Heermann's Kangaroo Rat *Dipodomys heermanni*	Drowning	Fell into vehicle wheel wash water tank
Desert Cottontail *Sylvilagus auduboni*	Crushed when moving materials	Juvenile in Block 11 laydown
Desert Cottontail *Sylvilagus auduboni*	Crushed when moving materials	Juvenile in Block 11 laydown
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Move-on near fueling area
Heermann's Kangaroo Rat *Dipodomys heermanni*	Drowning	Fell into vehicle wheel wash water tank
Heermann's Kangaroo Rat *Dipodomys heermanni*	Drowning	Fell into vehicle wheel wash water tank
Heermann's Kangaroo Rat *Dipodomys heermanni*	Drowning	Fell into vehicle wheel wash water tank
Desert Cottontail *Sylvilagus auduboni*	Drowning	Fell into vehicle wheel wash water tank

Species	Cause of Death	Notes
California Ground Squirrel *Spermophilus beecheyi*	Predation	Found dead inside Dust Control Pond fence; not a fatality of the Dust Control Pond, had been dropped there by ravens
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Helios Way
California Ground Squirrel *Spermophilus beecheyi*	Drowning	Found in hand wash container of a port-o-john in Block 14 east
California Ground Squirrel *Spermophilus beecheyi*	Drowning	Found in hand wash container of a port-o-john in Block 14 east
June 2013		
Western Toad *Bufo boreas*	Unknown	Found at hydration area at CSI laydown; adult
Opossum *Didelphis virginiana*	Unknown	Found under bus on drip pan in Move-on
Desert Cottontail *Sylvilagus auduboni*	Unknown	Juvenile found near perimeter fence of Dust Control Pond (not in pond); no obvious injury
Heermann's Kangaroo Rat *Dipodomys heermanni*	Vehicle strike	Helios Way
July 2013		
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle Strike	Block 11
California Ground Squirrel *Spermophilus beecheyi*	Drowning	Removed ground squirrel carcass from Dust Control Pond
California Ground Squirrel *Spermophilus beecheyi*	Vehicle Strike	Found in middle of the east perimeter road in Block 14 Array 6
California Ground Squirrel *Spermophilus beecheyi*	Predation	Found in Block 14 Array 19; head, front feet, and half of abdomen removed
August 2013		
Domestic Cat *Felis catus*	Unknown	Found under metal conex/storage container in secure laydown. Appears to have been deceased for months as only skeleton, dentition, and fur remained. No soft tissue. Secure Laydown
Bat Species unidentified	Unknown	Bat found in Block 15 Array 5 after it was removed from a transport container; container was picked up by driver at the Port of Los Angeles
September 2013		
Snake Species unidentified	Presumed equipment strike	Block 12 Array 15
October 2013		
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Found in Block 12 Array 18
California Ground Squirrel *Spermophilus beecheyi*	Drowning	Removed from Dust Control Pond

Species	Cause of Death	Notes
American Coot *Fulica americana*	Unknown	Pile feathers in middle array road in Block 15 Array 17; San Joaquin kit fox scat in middle of feather pile
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	Dead on Block 12 west road
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Young juvenile; found on Blocks 9/10 split road; minor cut along lower tail, slightly flattened throat near trachea
Desert Cottontail *Sylvilagus auduboni*	Unknown	Found in Block 10 Array 21; juvenile
Northern Pacific Rattlesnake *Crotalus oreganus oreganus*	Likely vehicle strike	Found at Arco Building demolition site
Pacific Gopher Snake *Pituophis catenifer catenifer*	Likely vehicle strike	Block 14 perimeter road
November 2013		
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle Strike	Road A
December 2013		
California Ground Squirrel *Spermophilus beecheyi*	Drowning	Found in the Dust Control Pond

Appendix C – Topaz Solar Farms 2013 Bird List

BIRDS RECORDED AT TOPAZ PROJECT SITE: 2010-2013	**SEASONAL OCCURRENCE AT PROJECT SITE: 2010-2013** **SPRING**: MARCH through MAY **SUMMER**: JUNE through JULY **FALL:** AUGUST through NOVEMBER **WINTER**: DECEMBER through FEBRUARY				**STATUS in the CARRIZO PLAIN** **M** = Migrant **R** = Resident **W** = Winter Visitor **SB** = Summer Breeder	**BREEDING: 2013** **C**=Confirmed **S**=Suspected	**OBSERVED: 2013**	**LOCATION CODES: 2013** **KR** = Kuhnle Residence, northern edge of Section 19 (35.396031°, -120.085892°) **DCP** = Topaz Dust Control Pond, Section 20. **LJ** = Lowery Jopling Property (DFG Mitigation Land), Section 33, (35.358135°, -120049684°) **Cochrane** = Cochrane Property, Section 28, Block 10 (35.370935°, -120.049684)
Species (2010-2013)	**Spring**	**Summer**	**Fall**	**Winter**	**Status**	**Breeding**	**2013**	**Date and Location**
GEESE & DUCKS								
Ross's Goose				**X**	**M, W**		**X**	DCP: 08JAN2013
Canada Goose				**X**	**M, W**		**X**	Flock flew over project site: 27JAN2013
Gadwall	**X**				**M, W**			
Mallard	**X**				**M, W**		**X**	DCP: 02MAY2013.
Cinnamon Teal	**X**		**X**	**X**	**M, W**		**X**	DCP: 22FEB, 08AUG, 17AUG2013
teal sp.			**X**				**X**	DCP: 08AUG2013
Northern Shoveler	**X**	**X**	**X**	**X**	**M, W**		**X**	DCP: 18MAR, , 31JUL, 02OCT, 10-11NOV and 21DEC2013
Green-winged Teal				**X**	**M, W**		**X**	Block 11: 05DEC2013; DCP: 08DEC and 21DEC2013
Bufflehead				**X**	**M, W**		**X**	DCP: 19JAN2013
Hooded Merganser			**X**		**M, W**		**X**	DCP: 15NOV2013
Ruddy Duck	**X**				**M, W**		**X**	DCP, 15MAR2013
duck sp.			**X**		**M, W**		**X**	10 flew over site in V formation: 18OCT2013
QUAIL								
California Quail	**X**				**R**		**X**	Block 10: 14MAR2013
GREBES								
Eared Grebe			**X**	**X**	**M**		**X**	DCP: 03JAN, 28SEP13, WK; [03, 04, 06, 08, 09 and 10OCT, then found dead in DCP and collected 16OCT2013]
Western Grebe			**X**		**M**		**X**	DCP: 23AUG2013
HERONS, BITTERN & ALLIES								
Great Blue Heron	**X**	**X**	**X**		**M**		**X**	DCP: 25FEB, 02MAY, 09AUG, 21AUG and 02OCT2013
Great Egret	**X**		**X**		**M**		**X**	DCP: 02MAY and 16MAY2013; fly-over southeast of Blocks 11-14, all 2013
Snowy Egret	**X**		**X**		**M**		**X**	Along 12 access road: 04OCT2013; Block 12 east of Pronghorn Plains Road: 04OCT2013
Green Heron	**X**				**M**		**X**	DCP: 30APR and 02MAY2013
IBIS								
White-faced Ibis	**X**		**X**		**M**		**X**	DCP: 14SEP2013
NEW WORLD VULTURES								
Turkey Vulture	**X**	**X**	**X**	**X**	**R**		**X**	
OSPREYS								
Osprey	**X**		**X**		**M**		**X**	South of Section 35: 06SEP2013
HAWKS, KITES & EAGLES								
White-tailed Kite	**X**				**M**		**X**	Southwest of LJ: 10MAR2013
Bald Eagle				**X**	**W**		**X**	[Various locations between 18DEC2012—05FEB2013]
Northern Harrier	**X**	**X**	**X**	**X**	**M, W**		**X**	Section 14: 14MAY2013; South of Block 5: 27SEP2013
Sharp-shinned Hawk			**X**	**X**	**M, W**		**X**	Substation: 07DEC2013
Cooper's Hawk			**X**	**X**	**M, W**		**X**	LJ: 06SEP, 24SEP, 18OCT, 14NOV2013; Section 5, 13DEC2013
Red-shouldered Hawk		**X**	**X**		**M**		**X**	LJ: 24JUL2013
Swainson's Hawk	**X**		**X**		**M**		**X**	Fly-over Block 9/10: 27SEP2013
Red-tailed Hawk	**X**	**X**	**X**	**X**	**M, R, SB**	**C**	**X**	
Ferruginous Hawk	**X**	**X**	**X**	**X**	**M, W**		**X**	Section 8: 17SEP2013
Rough-legged Hawk			**X**	**X**	**M, W**			
Golden Eagle	**X**		**X**	**X**	**R**		**X**	
RAILS, GALLINULES & COOTS								

BIRDS RECORDED AT TOPAZ PROJECT SITE: 2010-2013	**SEASONAL OCCURRENCE AT PROJECT SITE: 2010-2013**				**STATUS in the CARRIZO PLAIN**	**BREEDING: 2013**	**OBSERVED: 2013**	**LOCATION CODES: 2013**
Virginia Rail			X		M		X	Block 11: 09SEP2013
Sora			X		M		X	1 juv found dead along Helios Way and collected: 08OCT2013
American Coot			X		R		X	Block 15, Array 17: 10OCT13; a bird in Block 15: 16NOV was found dead the following day, 17NOV2013
STILTS & AVOCETS								
American Avocet	X	X		X	R		X	DCP: 07JAN and 7JUN2013
Black-necked Stilt	X		X		M		X	DCP: 19MAY and 15AUG2013
PLOVERS								
Killdeer	X	X	X	X	R		X	DCP: 31JUL2013
Mountain Plover	X			X	W		X	Section 35: 08DEC2013
SANDPIPERS & PHALAROPES								
Spotted Sandpiper	X	X	X		M		X	DCP: 04MAY, 09MAY, 19MAY, 23JUL, 31JUL, 01AUG, 02AUG, 03AUG, and 13AUG2013
Greater Yellowlegs		X	X		M		X	DCP: 20JUL2013; Cochrane: 26JUL2013; fly-over Block 11: 13SEP2013; fly-over Block 10: 24OCT2013
Willet			X		M		X	Block 15: 04AUG2013
Whimbrel	X		X		M			
Long-billed Curlew	X	X	X	X	M		X	
Least Sandpiper			X		M		X	Block 11: 13SEP2013
Western Sandpiper		X	X		M		X	Block 3: 20AUG2013; DCP, 21AUG2013; Block 11: 07OCT2013
Long-billed Dowitcher	X	X		X	M		X	Section 28: 8MAY2013; DCP: 22JUL2013
dowitcher sp.		X			M			
Wilson's Phalarope	X	X	X		M		X	DCP: 20JUL and 03AUG2013
Red-necked Phalarope			X		M		X	DCP: 03AUG, 09-11AUG, 21-22AUG, 23-24AUG and 27AUG2013
sandpiper sp.			X		M		X	Block 3: 20AUG2013; Block 12: 13DEC2013
GULLS								
California Gull			X		M		X	Block 10: 19AUG2013
gull sp.			X		M		X	Block 11: 09OCT2013
PIGEONS & DOVES								
Rock Pigeon	X	X	X	X	R	C	X	
Eurasian Collared Dove	X	X	X	X	R		X	KR: May 2013; Block 9, Array 25: 07DEC2013
Mourning Dove	X	X	X	X	R	C	X	
CUCKOOS & ALLIES								
Greater Roadrunner	X	X	X		R		X	Helios Way: 04JUL2013; Block 4: 31JUL2013; Tenplex: 16AUG2013; Tracy Ln: 20AUG2013; Block 4: 22AUG2013; Access Rd A: 29AUG2013; DCP, 30AUG2013; Block 5: 16OCT2013
BARN OWLS								
Barn Owl	X	X	X	X	R	C	X	Multiple observations in 2013; Nested inside Arco Building: 2013--2 nestlings there: 28MAY2013; and 2 juvs with 2 adults: 10JUL2013
TYPICAL OWLS								
Great Horned Owl		X			R		X	LJ: spring 2013
Burrowing Owl	X	X	X	X	M, R, SB	C	X	
Short-eared Owl	X			X	W			
SWIFTS								
Vaux's Swift			X		M		X	Hwy 58 at Helios Way: 19SEP2013
White-throated Swift	X			X	R, SB		X	Section 34: 15JAN2013; Fly-over Block 7: 23MAY2013
HUMMINGBIRDS								
Anna's Hummingbird		X	X		R, SB		X	LJ: 20SEP and 03OCT2013
Costa's Hummingbird		X	X		M			
selasphorus sp. (Rufous/Allen's)			X		M		X	KR: 20AUG2013
WOODPECKERS								
Red-breasted Sapsucker			X	X	W		X	LJ: 01NOV *thru* 06FEB2013; KR: 19NOV2013
Nuttall's Woodpecker			X	X	R		X	LJ: 06FEB13
Northern Flicker			X	X	R		X	LJ: 10OCT2013; LJ: 16OCT2013; Block 16, 11NOV2013

BIRDS RECORDED AT TOPAZ PROJECT SITE: 2010-2013	SEASONAL OCCURRENCE AT PROJECT SITE: 2010-2013				STATUS in the CARRIZO PLAIN	BREEDING: 2013	OBSERVED: 2013	LOCATION CODES: 2013
FALCONS								
American Kestrel	X	X	X	X	R		X	
Merlin	X		X	X	W		X	Block 15: 19SEP2013
Peregrine Falcon	X	X	X	X	R		X	LJ: 07MAR2013; Tower Road:22JUL2013
Prairie Falcon	X	X	X	X	R, SB		X	
FLYCATCHERS								
Western Wood-Pewee	X				M		X	LJ, 8-9MAY and 22-23MAY2013
Willow Flycatcher	X	X			M		X	KR: 15MA20Y13; LJ: 20-21MAY2013
Hammond's Flycatcher	X				M		X	LJ: 25APR2013
Pacific-slope Flycatcher	X		X		M		X	LJ: 25APR, 10MAY, and 17SEP2013
Black Phoebe	X	X	X	X	R	S	X	
Say's Phoebe	X	X	X	X	R	C	X	Successful nest at LJ: 07MAY2013
Ash-throated Flycatcher	X	X	X		SB		X	
Cassin's Kingbird	X	X	X		SB	C	X	Nest attempt at LJ: 2013
Western Kingbird	X	X	X		SB	S	X	
SHIRIKE								
Loggerhead Shrike	X	X	X	X	R, SB	C	X	
VIREOS								
Cassin's Vireo	X				M		X	LJ: 25APR2013
Warbling Vireo	X		X		M		X	LJ: 25APR13, 14MAY and 06SEP2013; 1 at Cochrane: 16SEP2013
CROWS & JAYS								
American Crow	X	X	X	X	R, SB	C	X	Nest attempt at LJ: spring 2013
Common Raven	X	X	X	X	R, SB	C	X	Block 11 east of Tracy: 04OCT2013
LARKS								
Horned Lark	X	X	X	X	R, SB	C	X	
SWALLOWS								
Tree Swallow			X	X	M		X	
Violet-green Swallow	X				M		X	Fly-over Block 5: 25MAY2013
Northern Rough-winged Swallow	X		X		M		X	LJ: 5MAR2013; Fly-over: 17SEP2013
Bank Swallow			X		M		X	Fly-over Block 15: 03SEP2013
Cliff Swallow	X	X			M		X	Block 8: 19JUN2013; DCP: 08JUL13
Barn Swallow	X	X	X		M		X	Cochrane: 30APR2013; Section 33: 24JUL13; DCP, 19SEP2013; LJ: 20SEP and 27SEP2013; Fly-over project site: 03OCT2013
TITMICE & CHICKADEES								
Oak Titmouse			X		R			
NUTHATCHES								
White-breasted Nuthatch			X		M, W		X	LJ: 19SEP2013; [1 at LJ, 20SEP, 26SEP and 03OCT2013]
KINGLETS								
Ruby-crowned Kinglet	X		X	X	M, W		X	Multiple fall and winter observations at both LJ and Cochrane; late date at Cochrane: 30APR2013
BLUEBIRDS & THRUSHES								
Western Bluebird			X		R, SB		X	LJ: 12SEP2013
Mountain Bluebird	X		X	X	W		X	
Hermit Thrush	X		X		M		X	LJ: 25APR, 25APR, 02OCT, and 16OCT2013
American Robin			X	X	M, W		X	LJ: 07DEC, 05NOV and 14NOV2013
MOCKINGBIRDS & THRASHERS								
Sage Thrasher	X			X	W			
Northern Mockingbird	X	X	X	X	R, S	S	X	resident at KR; Solar Swtching Station: 19SEP2013
STARLINGS								
European Starling	X	X	X	X	R, S	C	X	

BIRDS RECORDED AT TOPAZ PROJECT SITE: 2010-2013	**SEASONAL OCCURRENCE AT PROJECT SITE: 2010-2013**				**STATUS in the CARRIZO PLAIN**	**BREEDING: 2013**	**OBSERVED: 2013**	**LOCATION CODES: 2013**
PIPITS								
American Pipit	**X**		**X**	**X**	**W**		**X**	High count of 85 in Block 2: 21MAR13
WAXWINGS								
Cedar Waxwing			**X**		**W**		**X**	LJ: 27SEP2013
SILKY-FLYCATCHERS								
Phainopepla			**X**		**R, SB**		**X**	LJ, 19SEP2013
LONGSPURS								
Lapland Longspur	**X**				**W**		**X**	Block 17: 16DEC2013
Chestnut-collared Longspur				**X**	**W**		**X**	Block 14: 22JAN2013
WOOD WARBLERS								
Orange-crowned Warbler	**X**		**X**		**M**		**X**	LJ: 20SEP and 27SEP2013
Virginia's Warbler			**X**		**M**			
MacGillivray's Warbler	**X**				**M**		**X**	LJ: 25APR2013
Yellow Warbler	**X**		**X**		**M**		**X**	LJ: 21MAY, 12SEP, 17SEP and 19-20SEP and 03-04OCT2013
Yellow-rumped Warbler	**X**		**X**	**X**	**M, W**		**X**	LJ: 27SEP, 01OCT and 03OCT2013; Block 4: 03OCT2013; LJ: 16OCT2013
Black-throated Gray Warbler			**X**		**M**		**X**	LJ: 16OCT12, PAG; 1 at LJ, 06SEP13, JP; 1 at Klock ranch, 17SEP13, PAG; 1 at LJ, 20SEP13, WK; 2 at LJ, 24SEP13, KW; 2 at LJ, 26SEP13, KW/AE; 1 at LJ, 03-04OCT13, WK, GS;
Hermit Warbler	**X**		**X**		**M**		**X**	LJ: 25APR2013
Wilson's Warbler	**X**		**X**		**M**		**X**	LJ: 25AP3, 02MAY13, and 23MAY, 10SEP, and 26SEP2013
Yellow-breasted Chat	**X**				**M**			
EMBERIZIDS								
Spotted Towhee			**X**		**R, SB**		**X**	LJ: 07OCT2013
Chipping Sparrow			**X**		**M**			
spizella sp.			**X**				**X**	LJ: 03OCT2013
Vesper Sparrow			**X**	**X**	**W**		**X**	Block 11 (Arco): 14OCT2013
Lark Sparrow	**X**		**X**	**X**	**R, SB**		**X**	
Bell's/Sagebrush Sparrow				**X**	**R, SB**		**X**	North side of Block 11: 02DEC2013
Savannah Sparrow	**X**		**X**	**X**	**M, W**		**X**	
Grasshopper Sparrow	**X**				**SB**	**S**	**X**	
Lincoln's Sparrow			**X**		**W**		**X**	LJ: 23SEP2013
White-crowned Sparrow	**X**		**X**	**X**	**M, W**		**X**	LJ: 02MAY, 26SEP, 27SEP and 04OCT2013
Golden-crowned Sparrow			**X**	**X**	**M, W**		**X**	LJ: 27SEP2013; DCP: 27SEP2013
Dark-eyed Junco (Oregon)			**X**		**W**		**X**	Substation: 05NOV2013
CARDINALS & ALLIES								
Western Tanager	**X**		**X**		**M**		**X**	LJ: 25APR, 09MAY, 12AUG and 03OCT2013; Kuhnle: 15MAY2013
Black-headed Grosbeak	**X**				**M**		**X**	LJ: 25APR13
BLACKBIRDS & ORIOLES								
Red-winged Blackbird	**X**	**X**	**X**	**X**	**R, SB**		**X**	
Tricolored Blackbird	**X**	**X**	**X**	**X**	**R, SB**		**X**	Seen sporadically throughout the project area.
Western Meadowlark	**X**	**X**	**X**	**X**	**R, SB**	**S**	**X**	
Yellow-headed Blackbird	**X**	**X**			**M**		**X**	DCP: 09MAY2013
Brewer's Blackbird	**X**	**X**	**X**	**X**	**R, SB**	**C**	**X**	Nest attempt at LJ: MAY2013
Great-tailed Grackle	**X**	**X**			**M**		**X**	Fly over, 09MAY2013
Brown-headed Cowbird	**X**	**X**		**X**			**X**	
Bullock's Oriole	**X**	**X**			**SB**		**X**	Nest attempt at LJ: spring 2013; Block 2: 07JUN2013
FINCHES & ALLIES								
House Finch	**X**	**X**	**X**	**X**	**R, SB**	**C**	**X**	
Pine Siskin			**X**		**W**			
Lesser Goldfinch	**X**		**X**	**X**	**M, W**		**X**	LJ: 19SEP2013

BIRDS RECORDED AT TOPAZ PROJECT SITE: 2010-2013	**SEASONAL OCCURRENCE AT PROJECT SITE: 2010-2013**				**STATUS in the CARRIZO PLAIN**	**BREEDING: 2013**	**OBSERVED: 2013**	**LOCATION CODES: 2013**
Lawrence's Goldfinch	**X**	**X**	**X**		**M**		**X**	LJ: 08OCT2013
American Goldfinch	**X**		**X**	**X**	**W**		**X**	
OLD WORLD SPARROWS								
House Sparrow	**X**	**X**	**X**	**X**	**R, SB**	**S**	**X**	

Topaz Solar Farm
10400 Helios Way
Santa Margarita, California 93453

Delivered via Electronic Mail

Quarterly Report

COA 62 Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan Quarterly Report

February 13, 2013

Discussion

This report has been prepared to address the reporting requirements for Condition of Approval (COA) 62 Bird Monitoring and Avoidance Plan. The BMAP report was prepared to include bats and the title revised to the Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP).

In response to COA 62, the Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP) has been prepared, which further describes the approach to implementing the condition requirements.

COA 62 requires quarterly and annual reports. Quarterly reports are required during construction and for three years following the beginning of the solar farm operation.

Following the completion of the fourth quarter of monitoring the biologist shall prepare an annual report that summarizes the year's data, analyzes any project-related bird fatalities or injuries detected, and provides recommendations (in consultation with the County) for future monitoring and any adaptive management actions needed.

Quarterly Reportable Items

COA 62 ABMP requires quarterly reports describing the dates, durations, and results of monitoring and data collection. The quarterly reports shall provide a detailed description of any project-related bird or wildlife deaths or injuries detected during the monitoring study or at any other time.

Report Data

Attached is the quarterly report prepared by Althouse & Meade (COA 62 and ABPP Quarterly Monitoring Report by Althouse & Meade February 13, 2013).

If there are questions regarding this report, please contact:

Timothy J. Higdon
First Solar Site Compliance Manager
Topaz Solar Farm
10400 Helios Way
Santa Margarita, CA

First Solar

www.firstsolar.com

ALTHOUSE AND MEADE, INC.

BIOLOGICAL AND ENVIRONMENTAL SERVICES
1602 Spring Street, Paso Robles, CA 93446
Telephone 805-237-9626

Topaz Solar Farm
10400 Helios Way
Carrisa Plains, CA

Dan Meade, Ph.D., Designated Biologist
Jason Dart, Designated Biologist

March 5, 2013

Topaz Solar Farm
Avian and Bat Protection Plan
and
Bird Monitoring and Avoidance Plan

Fourth Quarterly/First Annual Report for 2012

This Fourth Quarterly/First Annual Report provides information pertinent to the reporting obligations regarding implementation of various tasks required by the Topaz Solar Farm Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (Althouse and Meade, Inc. June 2011). The Avian and Bat Protection Plan (ABPP) and Bird Monitoring and Avoidance Plan (BMAP) are requirements of County of San Luis Obispo Conditions of Approval (COA) 61 and 62, and were prepared in consultation with USFWS and CDFW. Section 5.5 of the ABPP/BMAP document requires quarterly and annual reports to be submitted to the County of San Luis Obispo, U.S. Fish and Wildlife Service (USFW) and the California Department of Fish and Wildlife (CDFW). This Fourth Quarterly Report has been augmented to satisfy requirements of the annual reporting obligation, and thus constitutes the first annual report for the Topaz Solar Farms ABPP/BMAP. Information provided spans the period from January 1 through December 31, 2012.

Table of Contents

List of Tables

List of Figures

1.0 Avian and Bat Protection Plan

The ABPP monitoring program compiles general information on bird and bat interactions, injuries and mortality at the Topaz Solar Farm. During construction phases of the project this task is completed by the project biologists, as part of routine daily biological monitoring. Data reported for the Bird Monitoring and Avoidance Plan, which provides detailed information on bird use and bird mortality at the project site, is presented below in Section 2.0.

1.1 Bird Surveys

General bird surveys are conducted on and around the project site on a daily basis throughout the year by project biologists. Species lists are generated and maintained, and interesting bird observations are highlighted. A list of 113 bird species observed on and near the project site is included as Exhibit 3.

1.2 Nesting Activity

All nests and nest starts identified during the 2012 nesting season were documented. The month each nest and nest start were found are shown in Figure 1. A total of 9 bird species were documented nesting in or near the 2012 work areas (Table 1). Other species nesting in offsite mitigation lands or future project lands are not included in this tally. Burrowing owl was the only special concern species nesting on or near the project. Nesting was documented spanning the months of March through July, with fledgling burrowing owls observed into August. The peak nesting period, in terms of number of nests and number of species nesting was late April through May. The horned lark was the most abundant nesting species, with over 50 nests and nest starts identified in May 2012.

TABLE 1. 2012 NESTING DATA BY MONTH. The number of nests detected each month is listed for 9 species between March and July.

Species	March	April	May	June	July
Barn Owl	0	0	0	1	0
Burrowing Owl	1	1	1	1	1
Common Raven	1	6	2	4	2
European Starling	2	2	1	0	0
Horned Lark	0	16	51	8	0
House Finch	2	5	3	0	0
Mourning Dove	1	1	0	0	0
Western Meadowlark	0	13	2	0	0

Species	March	April	May	June	July
Say's Phoebe	1	0	0	0	0

Horned larks nest on the ground in a woven grass cup, often placed in a small depression. They prefer patchy short-grass conditions with bare spots. Array areas with newly vegetated ground provided a preferred nesting substrate. Although specific data was not compiled, our observations suggest horned lark nesting density was higher in array areas than in undisturbed grassland. Nest success was observed to be low in the array areas, with a high rate of predation by ravens and other wildlife. When a nest was predated, surveys of the vicinity often showed attempts to re-nest close by. Horned larks do not re-use nests. No prevention methods were utilized to keep horned larks from nesting in the arrays other than removal of nest starts. Detection of nest starts required intensive daily survey efforts, and nests with eggs or chicks were often found and left in place.

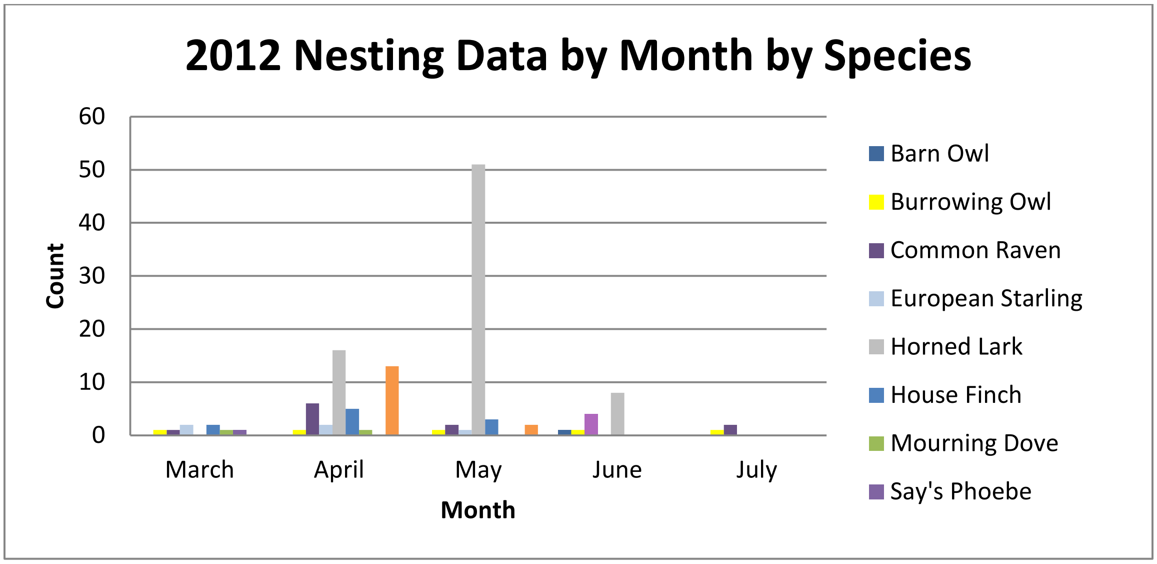
Western meadowlarks nest on the ground in taller grass habitats. All meadowlark nests identified were in future work areas containing tall grasses with abundant mustards. Mowing of tall grass fields prior to nesting activity was conducted in limited areas to prevent meadowlark nesting.

House finches nested or attempted to nest on construction equipment and materials throughout the project site. Preferred nesting areas were in small pieces of equipment, gaps in spools, and openings in cardboard boxes. Flashing tape and bird netting were used to prevent house finch nesting on materials and equipment. Both of these methods were effective.

Ravens nested on power poles within and around the project. They also attempted to nest on heavy equipment and on abandoned windmills in future work areas. Nesting materials were removed daily from some nest sites to prevent nesting. For equipment, removing nest starts and moving the equipment to a new location solved the problem. At one medium-voltage power pole within the project the nest start was removed on several occasions but eventually the ravens were allowed to nest on the pole. Unfortunately one chick died as a result of entanglement in nesting materials.

Burrowing owls nested in several locations immediately adjacent to the project. One nest attempt along Helios Way failed when one of the adults died. One nest northeast of Block 6 was observed to have 7 chicks in June 2012. Biologists observed a prairie falcon kill one of the burrowing owl chicks as it stood with the cohort at the burrow entrance. Survival of the remaining chicks was not known, but all remaining were fledged in August 2012. A third nest located west of the project successfully fledged, but the number of fledglings was not determined.

FIGURE 1. 2012 NESTING DATA BY MONTH.



1.3 Avian and other Wildlife Mortality

General biological monitoring of the Topaz work areas documented bird, bat and other wildlife mortality. All mortality identified on site from January through December 2012 is provided in Table 2. Cause of death is reported when known.

TABLE 2. BIRD AND OTHER WILDLIFE MORTALITY. Bird and other wildlife mortality detected at the Topaz Solar Farm, January through December 2012.

Species	Cause of Death	Notes
January 2012		
Horned Lark *Eremophila alpestris*	Unknown	One carcass found under powerlines along Tower Road
California Vole *Microtus californicus*	Unknown	One carcass removed from an open fence post hole
February 2012		
Mourning Dove *Zenaida macroura*	Raptor predation	One carcass found 200 yards north of Hwy 58 on Helios Way
Pacific Gopher Snake *Pituophis catenifer catenifer*	Unknown	One carcass found in grass east of Phase 1 North Array
Pacific Gopher Snake *Pituophis catenifer catenifer*	Construction activities	Hit by road grader in dust control pond area
Western Meadowlark *Sturnella neglecta*	Raptor predation	One carcass found on Tower Road
Horned Lark *Eremophila alpestris*	Predation	One carcass found in the secure laydown area
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	One carcass removed from Phase 1 North Array

Species	Cause of Death	Notes
March 2012		
Botta's Pocket Gopher *Thomomys bottae*	Unknown	One carcass found in Phase 1 South Array
Horned Lark *Eremophila alpestris*	Predation	Remains found in Phase 1 North Array
House Finch *Carpodacus mexicanus*	Predation	Three carcasses removed from the Helios laydown; house-cat is probable predator
Deer Mouse *Peromyscus maniculatus*	Unknown	One carcass found in Block 3
Savannah Sparrow *Passerculus sandwichensis*	Entanglement/Predation	One carcass caught in exclusion net and partially eaten in Helios laydown area
Heermann's Kangaroo Rat *Dipodomys heermanni*	Drowning	One carcass found in the Helios wheel wash
April 2012		
Unidentified Mice	Drowning	Two carcasses found in the Helios wheel wash
Unidentified Mice	Unknown	Two carcasses found under materials stack in Phase 1 South Array
Horned Lark *Eremophila alpestris*	Unknown	One carcass found in Phase 1 South Array
Pacific Gopher Snake *Pituophis catenifer catenifer*	Construction activities	Killed by equipment moving materials
Pacific Gopher Snake *Pituophis catenifer catenifer*	Entanglement	One carcass found in bird abatement netting in the Helios laydown area
Savannah Sparrow *Passerculus sandwichensis*	Entanglement	One carcass found in bird netting in the Helios laydown area
Botta's Pocket Gopher *Thomomys bottae*	Unknown	Two carcasses found in open fence post holes
Heermann's Kangaroo Rat *Dipodomys heermanni*	Unknown	One carcass found in open fence post hole
May 2012		
Savannah Sparrow *Passerculus sandwichensis*	Predation	Two carcasses found in Phase 1 South Array; house-cat is probable predator
Deer Mouse *Peromyscus maniculatus*	Unknown	One carcass found in trench in Phase 1 North Array
Deer Mouse *Peromyscus maniculatus*	Drowning	Two carcasses found in dust control pond well head
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	One carcass removed from Helios Way
California Ground Squirrel *Spermophilus beecheyi*	Unknown	One carcass found in Phase 1 North Array
California Ground Squirrel *Spermophilus beecheyi*	Predation	One carcass found near dust control pond
California Ground Squirrel *Spermophilus beecheyi*	Predation	One carcass found in Block 3

Species	Cause of Death	Notes
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Five carcasses removed from Helios Way
Wilson's Phalarope *Phalaropus tricolor*	Unknown; either drowning or raptor predation	One carcass found in dust control pond
Northern Pacific Rattlesnake *Crotalus oreganus oreganus*	Vehicle strike	One juvenile found in Phase 1 North Array
Horned Lark *Eremophila alpestris*	Unknown	One carcass with no visible wounds on Helios Way
Horned Lark *Eremophila alpestris*	Raptor predation	One carcass found outside Block 3 fence
Horned Lark *Eremophila alpestris*	Raptor predation	One carcass found in Block 2
House Finch *Carpodacus mexicanus*	Construction activities	One egg crushed during accidental exposure of nest built in cable roll; nest subsequently abandoned
June 2012		
Horned Lark *Eremophila alpestris*	Predation	One carcass found in Phase 1 South Array
Deer Mouse *Peromyscus maniculatus*	Unknown	One carcass found in Phase 1 South Array
Deer Mouse *Peromyscus maniculatus*	Unknown	One carcass found in Block 2
House Finch *Carpodacus mexicanus*	Predation	On material stacks. Two eggs and two dead chicks. Nest abandoned.
Unidentified Mice	Drowning	Two carcasses found in dust control pond well head
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	One carcass removed from Helios Way
California Ground Squirrel *Spermophilus beecheyi*	Drowning	Three carcasses removed from dust control pond
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	One carcass removed from Access Road A
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	One carcass removed from Helios laydown entrance
Pacific Gopher Snake *Pituophis catenifer catenifer*	Construction activities	One killed during ground preparation work in Block 1
Pacific Gopher Snake *Pituophis catenifer catenifer*	Construction activities	Two juveniles killed during ground preparation work in Block 2
Brewer's Blackbird *Euphagus cyanocephalus*	Injury	One female flew into the side of a concrete vault
July 2012		
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	One carcass removed from Helios Way
California Ground Squirrel *Spermophilus beecheyi*	Drowning	11 carcasses were removed from the dust control pond in July
Deer Mouse *Peromyscus maniculatus*	Construction activities	2 dead mice were removed from a work area, likely crushed by moving materials
Horned Lark *Eremophila alpestris*	Unknown	One carcass was removed from an array area

Species	Cause of Death	Notes
European Starling *Sturnus vulgaris*	Unknown	Carcass found near a work area perimeter fence, no apparent injuries
Western Bluebird *Sialia mexicana*	Probable vehicle strike on Highway 58 off site, carried onto site by car.	Juvenile found near cars in parking lot
Common Raven *Corvus corax*	Entanglement in nesting material	Foot of nestling was entangled in nesting material, bird died when it tried to fledge.
August 2012		
Deer Mouse *Peromyscus maniculatus*	Vehicle strike	2 carcasses were removed from project roads in August
California Ground Squirrel *Spermophilus beecheyi*	Drowning	Five carcasses removed from dust control pond
California Ground Squirrel *Spermophilus beecheyi*	Unknown	Two carcasses were removed from work areas in August
Violet-Green Swallow *Tachycineta thalassina*	Drowning	Juvenile removed alive from dust control pond; died shortly thereafter
Horned Lark *Eremophila alpestris*	Unknown	One carcass removed from array area in Block 2
Desert Cottontail *Sylvilagus auduboni*	Abandoned by parents	3 juveniles found under a pallet, two were relocated, third was dead
Cooper's Hawk *Accipiter cooperii*	Unknown	Desiccated carcass found in arrays of Block 6. CDFG and USFWS notified. Carcass was transferred to CDFG Jan 10, 2013.
September 2012		
Virginia Rail *Rallus limicola*	Collision with fence	Rail collected dead in parking area at base of chain link fence with obvious collision wound
California Ground Squirrel *Spermophilus beecheyi*	Drowning	Two carcasses were removed from the dust control pond in September
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	Two carcasses removed from work area in Block 5
Brewer's Blackbird *Euphagus cyanocephalus*	Unknown; possible entrapment or crushing by moving materials	Four carcasses were removed from between materials boxes in a laydown yard.
Botta's Pocket Gopher *Thomomys bottae*	Unknown; possible failed predation attempt	One carcass was removed from Block 1
Deer Mouse *Peromyscus maniculatus*	Crushed by materials	Reported by workers, mouse died before it could be treated or released
Deer Mouse *Peromyscus maniculatus*	Unknown	One carcass removed from Block 5
Heermann's Kangaroo Rat *Dipodomys heermanii*	Equipment strike	Mortally wounded by heavy equipment
Horned Lark *Eremophila alpestris*	Raptor predation	Reportedly dropped by a raptor, the carcass was removed by biologists
Horned Lark *Eremophila alpestris*	Raptor predation	One carcass with injuries consistent with a failed raptor predation attempt was removed from Block 8

Species	Cause of Death	Notes
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle/equipment strike	2 juvenile gopher snake carcasses were removed from work areas
Desert Cottontail *Sylvilagus audubonii*	Exposure	A juvenile rabbit was removed alive from a trench but died shortly thereafter
Common Raven *Corvus corax*	Unknown	One carcass was removed from Block 1 work area with no apparent injuries
October 2012		
Common Raven *Corvus corax*	Predation	Remains were found in Block 5
Long-billed Curlew *Numenius americanus*	Predation	Carcass found with missing head in trench in Block 1
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle/equipment strike	Mortally wounded on a project road south of Block 4; euthanized by biologists
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	Mortally wounded by a forklift in Block 2; euthanized by biologists
Horned Lark *Eremophila alpestris*	Unknown	Carcass removed from Access Road B; no visible injuries present
November 2012		
Horned Lark *Eremophila alpestris*	Unknown	Carcass found in Block 5
Pacific Gopher Snake *Pituophis catenifer catenifer*	Vehicle strike	Juvenile found dead on Access Road B
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	Killed by ground-breaking equipment in Block 8 East
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	Killed by a trencher in Block 4
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	Carcass found on Helios Way
Deer Mouse *Peromyscus maniculatus*	Unknown	Juvenile found dead outside of nest in materials box
Pacific Chorus Frog *Pseudacris regilla*	Equipment strike	One frog euthanized due to injuries from heavy equipment at the Cochrane site
Coyote *Canis latrans*	Unknown	Old carcass observed under debris pile at the Cochrane site
Barn Owl *Tyto alba*	Drowning/Entrapment	Old carcass observed at bottom of well at the Cochrane site
Western Meadowlark *Sturnella neglecta*	Drowning/Entrapment	Old carcass observed at bottom of well at the Cochrane site. Pre-dates project start.
Western Meadowlark *Sturnella neglecta*	Predation	Carcass found in Block 9 West
Desert Cottontail *Sylvilagus audubonii*	Unknown	Carcass found under panels in Block 2
December 2012		

Species	Cause of Death	Notes
Unidentified Mice	Entrapment	Two mice found in backfilled vault
Mourning Dove *Zenaida macroura*	Raptor predation	One carcass removed from surface of module in Block 7. Presumably dropped by raptor.
Mourning Dove *Zenaida macroura*	Predation	One headless carcass removed from the Cochrane site
Horned Lark *Eremophila alpestris*	Predation	One headless carcass removed from Block 1
House Finch *Carpodacus mexicanus*	Unknown	One carcass removed from Block 3
California Ground Squirrel *Spermophilus beecheyi*	Vehicle strike	One carcass removed from Helios Way
California Ground Squirrel *Spermophilus beecheyi*	Equipment strike	One carcass removed from Block 8
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	Two snakes killed by heavy equipment at the Cochrane site
Pacific Gopher Snake *Pituophis catenifer catenifer*	Equipment strike	One carcass removed from Block 9
Western Meadowlark *Sturnella neglecta*	Injury	One carcass removed from Access Road B; bird appears to have flown into a moving vehicle
California King Snake *Lampropeltis getula californiae*	Equipment strike	One carcass removed from Block 9
Desert Cottontail *Sylvilagus auduboni*	Equipment strike	Three carcasses removed from the Cochrane site
Heermann's Kangaroo Rat *Dipodomys heermanni*	Unknown	One carcass found in open fence post hole in Block 8 West
Pacific Chorus Frog *Pseudacris regilla*	Unknown	One carcass removed from a pitfall trap at the Cochrane site

2.0 Bird Monitoring and Avoidance Plan

The BMAP study utilizes avian use surveys and avian fatality surveys to produce a risk index for various project components deemed to be potentially dangerous to birds, including array areas, overhead power lines and energized equipment (substation). Offsite grassland areas were used as reference sites to compare Bird Utilization Rates, Bird Fatality Rates, and ultimately Bird Risk Index. The BMAP study has two primary goals:

Goal 1. Provide Project owners/managers with scientifically-based risk analyses to facilitate implementation of Adaptive Management actions to minimize conflicts between Project components and birds.

Goal 2. Provide a rigorous scientific study of avian use and mortality associated with specific components of an industrial scale photovoltaic solar facility that can be used by wildlife regulators as a planning tool for future solar projects.

To accomplish these goals, the BMAP outlines five Objectives with specific Tasks:

Objective 1. Assess changes in total bird abundance, species composition, and species richness relative to development and operation of the Project compared to undeveloped reference sites;

Task 1.1: Implement Avian Use Surveys.

Task 1.2: Submit quarterly and annual monitoring reports.

Objective 2. Calculate Bird Utilization Rate, Bird Fatality Rate, and Bird Risk Index for three specific Project components (Array Areas, Overhead Power Lines, Substation/Switching Station);

Task 2.1: Implement Avian Fatality Monitoring Surveys, Searcher Efficiency Trials, and Scavenger/Carcass Removal Trials.

Task 2.2: Run calculations on survey data according to methods in Section 5.4.

Task 2.3: Submit quarterly and annual monitoring reports.

Objective 3. Conduct risk assessment analyses for each Project component based on calculated Bird Utilization Rate, Bird Fatality Rate, and Bird Risk Index;

Task 3.1: Prepare a written analysis of survey data and calculated Bird Risk Index for each Project component to be included in the annual report.

Objective 4. Inform TSF facility managers of Adaptive Management requirements when Bird Risk Index and/or Bird Fatality Rate indicates significance thresholds for avian mortality have been reached (refer to Section 6.0);

Task 4.1: Submit quarterly and annual monitoring reports.

Objective 5. Prepare a scientific paper describing the results of avian use surveys and avian fatality monitoring surveys, and the conclusion regarding the risk level that the Project poses for avian resources.

Task 5.1: Within one year of completion of the study data collection, prepare and submit a scientific paper to the County of San Luis Obispo.

2.1 Discussion regarding Year 1 Data

This Fourth Quarterly/First Annual Report of the ABPP/BMAP provides preliminary data collected for Objectives 1, 2 and 3 (Sections 2.2, 2.3 and 2.5, below). The data is considered preliminary for Year 1 since the pace of construction did not facilitate a large number of Avian Use Surveys or Avian Fatality Surveys to be completed in Array Area, Overhead Powerline and Energized Equipment survey areas, as these areas were not completed with construction until late in the year.

When the BMAP study design was prepared in 2010, prior to start of construction, it was assumed that more completed array areas and powerlines would be available earlier in the year for avian surveys. Therefore, the Year 1 annual report was the designated timeframe for establishing significance thresholds on avian mortality levels. The significance thresholds are to be determined in consultation with the U.S. Fish and Wildlife Service, California Department of Fish and Wildlife, and the County of San Luis Obispo, based on Bird Risk Index data.

We propose to modify the significance threshold determination schedule as presented in the BMAP so that data may be collected through 2013 on avian use and avian fatality at project components. Another year of data from completed project components will provide a robust foundation for the Bird Risk Index calculations, which will better inform significance determinations. If this approach is acceptable to the reviewing agencies, the Topaz Solar Farm ABPP/BMAP document will be revised and resubmitted to reflect the changes.

With respect to the proposal to postpose the significance threshold determination, Objective 4 will be reported beginning with the first quarterly report for Year 2, after significance thresholds have been determined. Objective 5 will be completed within one year after completion of the field surveys.

2.2 Avian Use Surveys

Avian Use Surveys commenced in November 2011, prior to the start of construction, to gather baseline data on bird use in the project area. Avian Use Surveys will inform the Bird Utilization Rate calculations (see Section 2.2.1, below). Construction commenced in late November 2011 in a limited footprint, and slowly expanded in area throughout 2012. Avian use surveys were conducted monthly from November 2011 through December 2012, and will continue throughout the construction period and for three years after construction is complete. Each month, 63 randomly selected survey points were completed, for a total of 882 survey points completed as of December 2012. The 63 survey points include 31 inside existing or future array areas, 18 along existing or future overhead power lines, 10 in grassland reference sites and 4 at the substation. At each point, a 10 minute bird use count is conducted within a 50 meter radius of the surveyor.

Avian Use Survey points were selected each month across all six phases of the project and in offsite grassland reference areas (Exhibit 1). Each month, as construction area increased in size, more of the survey points occurred in developed area. Those points located within future project areas that had not been developed at the time of the survey are categorized as Baseline. Baseline condition is similar to Reference site condition in that it is not developed, however it differs in being cropland habitat versus grassland habitat. Therefore, comparison of Baseline with Reference data could provide information regarding Bird Utilization Rate in different habitat types, if desired.

Forty-three bird species were detected during the avian use surveys from November 2011 through December 2012. Thirteen of these species were detected only once. Horned lark was overwhelmingly the most commonly detected species (6848 detections), followed by house finch (1416), savannah sparrow (776), long-billed curlew (604), common raven (565) and mountain bluebird (526).

For reasons outlined above in Section 2.1, the data collected for Avian Use Surveys and the subsequent analyses for Objective 1 are considered preliminary. Sections 2.2.1, 2.2.2 and 2.2.3 outline our preliminary data collected for bird abundance, species composition and species richness.

2.2.1 Preliminary bird abundance

Total bird abundance is compared in Table 3 between Array Area, Overhead Powerline, Energized Equipment, Reference Site and Baseline survey area categories. Bird abundance is calculated as average number of birds observed per Observation Point. Highest bird abundance was for the Baseline category, at 15.85 birds per Observation Point. The Baseline category represents crop stubble fields prior to start of construction. Reference Sites consisting of grassland habitat had an average of 12.19 birds per Observation Point. Completed Array Areas averaged 11.09 birds per Observation Point, Overhead Powerlines averaged 7.95 birds and Energized Equipment averaged 7.0 birds. Preliminary data suggest a reduction in total bird abundance between the Baseline category and the completed Array Area category.

TABLE 3. PRELIMINARY BIRD ABUNDANCE COMPARISON.

Survey Area Category	**Bird Abundance** **(Average # Birds/Observation Point)**
Baseline (Crop Stubble)	15.85
Reference Site (Grassland)	12.19
Overhead Powerline	7.95
Energized Equipment	7.00
Array Area	11.09

2.2.2 Preliminary species richness

Species richness is a measure of the number of different species in a given area. Table 4 lists the total number of species observed within each of the five survey area categories. Baseline Observation Points had 33 species detected, the highest of any of the survey area categories. Grassland Reference Site points had 20 species detected, both Overhead Powerline and Array Area points had 18 species detected, and Energized Equipment had 14 species.

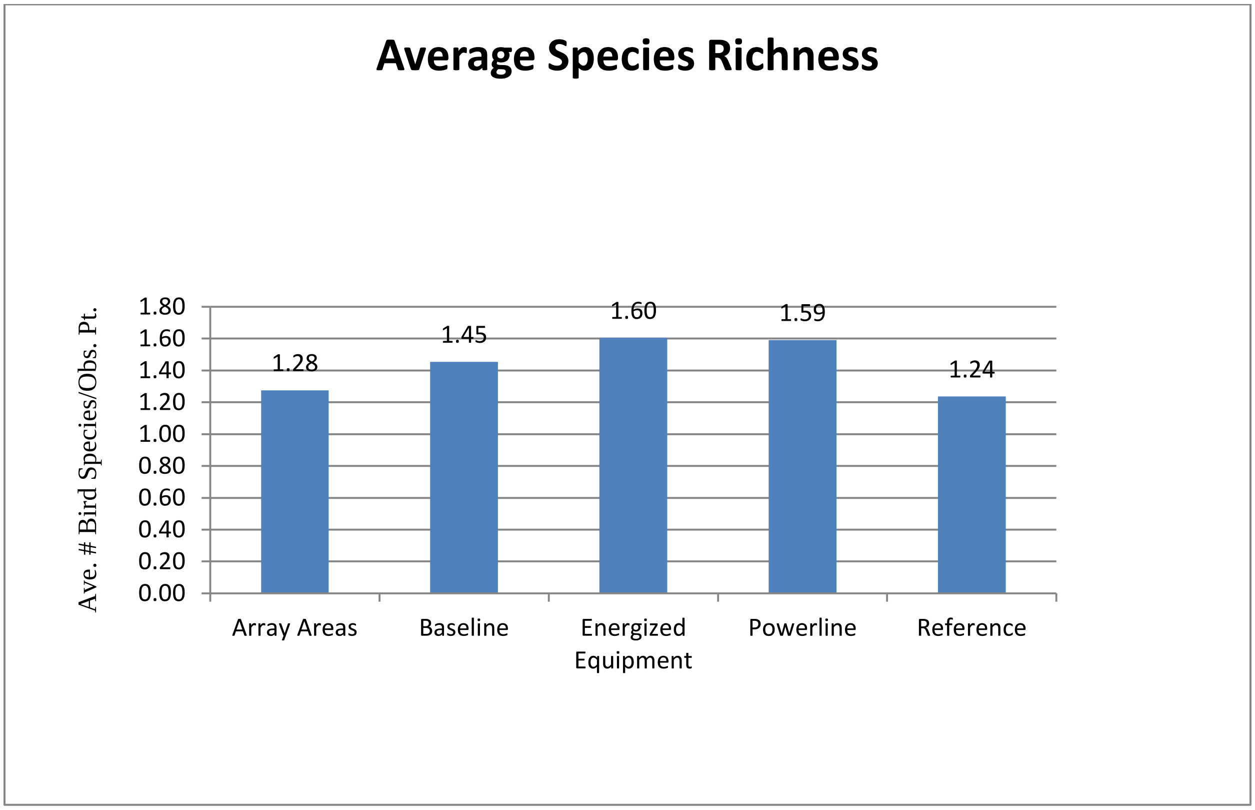
We also compared avian species richness averaged across all Observation Points in each of the five survey area categories from November 2011 through December 2012 (Table 4 and Figure 2). Species richness is markedly similar in each category. Energized Equipment and Overhead Powerlines averaged 1.60 and 1.59 bird species per Observation Point, respectively. Array Areas averaged 1.28 bird species per Observation Point, Baseline averaged 1.45 species and grassland Reference Sites averaged 1.24 species.

Preliminary data suggest a reduction in species richness between the Baseline category and the completed Array Area category.

TABLE 4. PRELIMINARY SPECIES RICHNESS COMPARISON.

Survey Area Category	Ave No. Species per Obs. Point	Total Number of Species
Baseline	**1.45**	**33**
Reference Site	**1.24**	**20**
Overhead Powerline	**1.59**	**18**
Energized Equipment	**1.60**	**14**
Array Area	**1.28**	**18**

FIGURE 2. AVERAGE SPECIES RICHNESS.



2.2.3 Preliminary species composition

Species composition refers to the relative abundance of different species in a given area. For each species we calculated the average number of birds detected for Observation Points within each of the five survey area categories (Table 5). We looked at the 6 most abundant species detected from November 2011 through December 2012: horned lark, house finch, savanna sparrow, long-billed curlew, common raven and mountain bluebird.

Of the 6 most abundant species detected, the Baseline and Reference Site categories detected all 6 species, or 100%. Both of these categories represent non-developed habitat. Overhead Powerline and Energized Equipment categories detected 5 of the 6 most abundant species (83%). Completed Array Areas detected only 4 of the 6 most abundant species, or 67% (Table 5).

TABLE 5. PRELIMINARY SPECIES COMPOSITION COMPARISON. Average number of individuals is listed for each of the 6 species within the five survey area categories. Percent of top 6 species is listed at far right.

Survey Area Category	Horned Lark Ave #	House Finch Ave #	Savanna Sparrow Ave #	Long-billed Curlew Ave #	Common Raven Ave #	Mountain Bluebird Ave #	% of Top 6 Species Recorded
Baseline	3.11	0.57	0.39	0.35	0.32	0.19	**100%**
Reference Site	2.32	1.04	0.14	0.17	0.18	0.67	**100%**
Overhead Powerline	1.72	0.35	0.34	0.00	0.02	0.01	**83%**
Energized Equipment	1.33	0.60	0.28	0.00	0.02	0.02	**83%**
Array Area	3.80	0.11	0.02	0.00	0.01	0.00	**67%**

2.2.4 2012 Bird Utilization Rate Calculations

Bird Utilization Rate (BUR) is calculated as the number of unique bird observations divided by the number of observation point counts. Each month 63 observation point counts are randomly chosen and surveyed for 10 minutes each. A unique bird observation is recorded each time a bird or group of birds enters the survey area.

We calculated Bird Utilization Rate for five survey area types: Array Areas, Overhead Powerlines, Energized Equipment (Substation), Reference Site (grassland) and Baseline (future work area, cropland or grassland). Where an Array Area, Overhead Powerline, or Energized Equipment survey point was conducted prior to construction commencement at that location, that point was categorized as a Baseline site since no construction activities or project facilities were present.

Average BUR for each survey area type was calculated for 2012 (Figure 3 and Table 6). Reference sites had the highest BUR, at 4.82. Array Areas were second highest, with an average BUR 3.66, and Baseline, Overhead Powerline and Energized Equipment were roughly similar with BUR of 2.97, 2.96 and 2.83 respectively.

Bird Utilization Rates were also calculated and graphed by month, for each of the five survey area types (Figure 4). Note that surveys in November and December 2011 did not include all survey area types since construction had not commenced.

FIGURE 3. 2012 AVERAGE BUR FOR ALL SURVEY AREA TYPES.

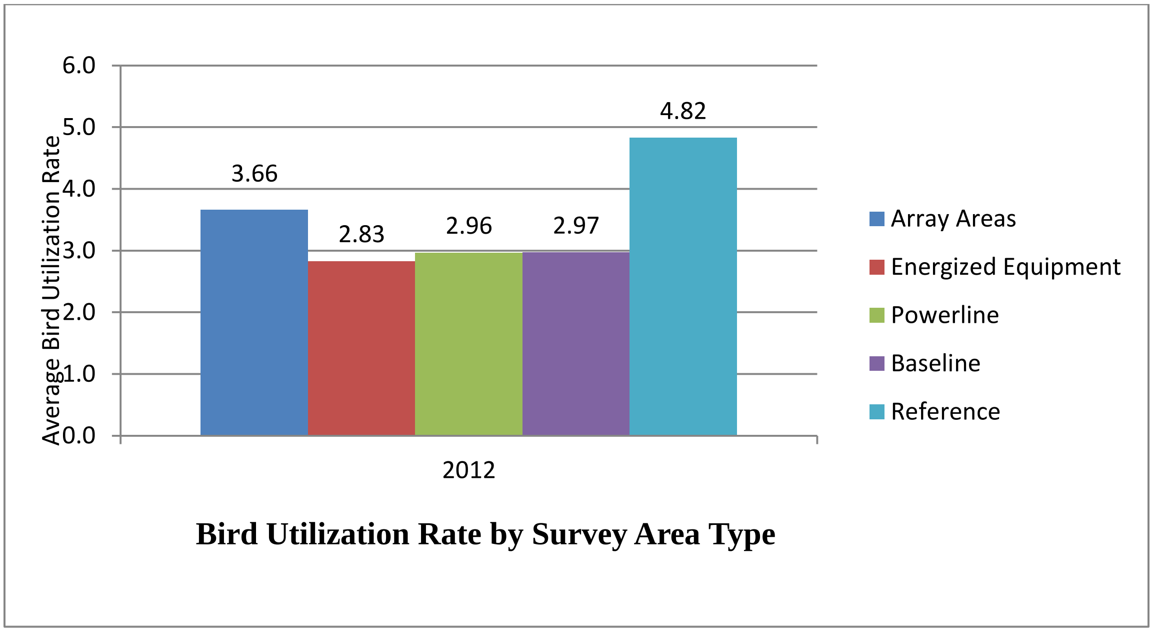
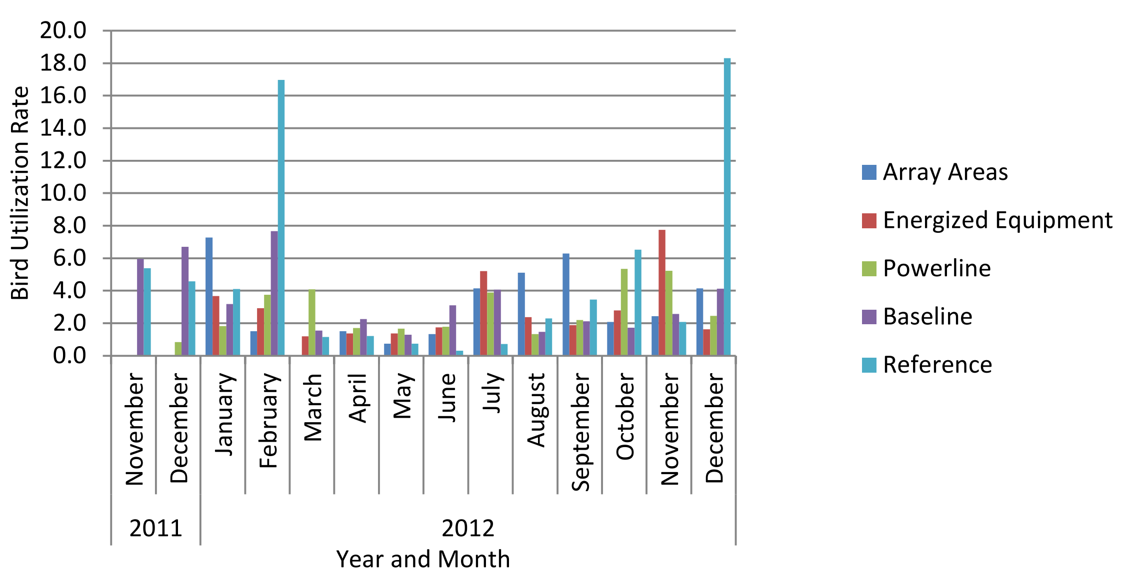


TABLE 6. BIRD UTILIZATION RATE BY SURVEY AREA TYPE. BUR is provided for each of the survey area types by month. Total monthly average BUR is provided in the last column, and average BUR for the year 2012 is provided at the bottom.

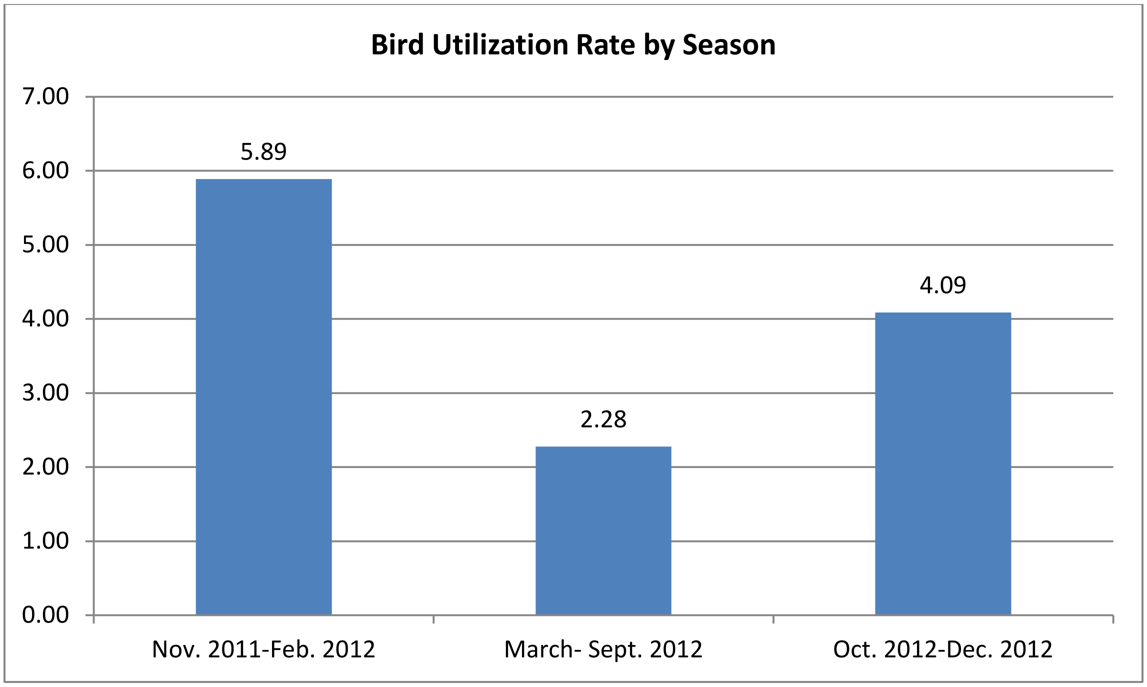
Year/Month	Array Areas	Energized Equipment	Overhead Powerline	Baseline	Reference	Average
2011 November	n/a	5.96	5.38	5.86	n/a	5.96
2011 December	0.83	6.71	4.59	6.09	0.83	6.71
2012 January	7.28	3.68	1.83	3.19	4.11	3.28
2012 February	1.50	2.92	3.75	7.67	16.98	8.31
2012 March	0.00	1.19	4.08	1.55	1.15	1.68
2012 April	1.50	1.38	1.70	2.26	1.21	1.97
2012 May	0.75	1.38	1.67	1.30	0.75	1.25
2012 June	1.33	1.75	1.79	3.11	0.30	2.30
2012 July	4.14	5.21	3.89	4.07	0.72	3.59
2012 August	5.10	2.38	1.33	1.47	2.30	2.22
2012 September	6.29	1.88	2.20	2.11	3.46	2.92
2012 October	2.08	2.79	5.35	1.72	6.53	3.18
2012 November	2.43	7.75	5.22	2.57	2.08	3.17
2012 December	4.15	1.63	2.44	4.12	18.30	5.90
Average of 2012 Monthly Surveys	**3.66**	**2.83**	**2.96**	**2.97**	**4.82**	**3.32**

FIGURE 4. MONTHLY BIRD UTILIZATION RATE. The Bird Utilization Rate is indicated for each of the five survey area types during each month from November 2011 through December 2012.



Bird Utilization Rate indicates highest general bird use during the winter period from October through February, with average BUR from November 2011 to February 2012 of 5.89 and an average BUR of 4.09 from October 2012 to December 2012. By comparison, the non-winter period spanning March to September 2012 had an average BUR of 2.28 (Figure 5). This is generally consistent with the influx of wintering birds which gather in large flocks in the Carrizo Plain during this time. Based on these preliminary results we would expect the risk of bird mortality to be higher during the winter period, if all other variables remain the same, simply due to the higher number of birds present.

FIGURE 5. BIRD UTILIZATION RATE BY SEASON. Average BUR is graphed for winter and non-winter periods.



2.3 Avian Fatality Surveys

Avian Fatality Surveys commenced upon completion of the first project components. Avian Fatality Surveys are conducted at randomly selected locations within four different survey area types: Array Areas, Overhead Powerlines, Energized Equipment (Substation) and at Reference sites[1]. Each survey area type was divided into 500 foot by 15 foot search plots. Search plots are randomly selected using an ArcGIS random point generator having defined areas as the constraining polygon. Avian Fatality Surveys are conducted within the same search plots each day for seven consecutive days every month. Repetitive surveys increase the chance of finding fatalities in a given area before predators remove the carcass. Exhibit 2 depicts the search plots covered by Avian Fatality Surveys in 2012.

During the period of July 1 through September 31, 2012 we conducted test fatality surveys at various locations during construction phases; however, no formal surveys were conducted due to incomplete project components. We used these preliminary results to guide our survey efforts in the Array Areas starting in October 2012.

In October 2012 we completed walking Avian Fatality Surveys at 168 five hundred foot transects within completed Array Area search plots, for 7 consecutive days each, totaling 1,176 search plots (111.4 linear miles, 207.3 acres) for the month. No avian fatalities

---

[1] Select Array Areas were completed and safe to conduct surveys by October 2012. The first Overhead Powerline areas were completed by the December survey. Energized Equipment areas were not complete with construction in 2012 and were therefore not surveyed.

were detected during the October survey (Table 7). Since Overhead Powerline and Substation construction were not complete, no search plots in these survey area types were conducted. We consider the October 2012 Array Area data to be a test to determine labor hours required per search plot, therefore no Reference Site search plots were conducted for comparison. This data is not included in the 4th quarter Average Fatality Rate calculation provided in Table 7, last row.

In November 2012 we completed walking avian fatality surveys at 84 five hundred foot transects within completed Array Area search plots, for 7 consecutive days each, totaling 588 search plots (55.7 linear miles, 103.7 acres). A total of 84 Grassland Reference Site search plots were completed, for 7 consecutive days each, totaling 55.7 linear miles (101.8 acres). One bird fatality was detected in the Array Area search plots and four fatalities were detected in the Reference Site search plots. The Array Area fatality was a very old mourning dove feather pile in which the cause of death could not be determined. The fatalities recorded in the Reference Site search plots consisted of two American kestrels, one domestic chicken, and one unidentified species. Each of these fatalities consisted of feather piles, and in one case (the unidentified species), a bone fragment. Cause of death could not be determined for any of the fatalities, however predation was presumed to be the likely cause for each.

In December 2012 we completed walking Avian Fatality Surveys at 126 five hundred foot transects within completed Array Area search plots, for 7 consecutive days each, totaling 882 search plots (83.5 linear miles, 155.5 acres). Powerline search plots included 3 five hundred foot transects, surveyed for 7 consecutive days each, totaling 2.0 linear miles (3.6 acres). A total of 12 grassland Reference Site search plots were completed, for 7 consecutive days each, totaling 84 linear miles (152.7 acres). One fatality was recorded in the Array Area search plots. The fatality was a domestic chicken in which only feathers were found. The cause of death was determined to be predation. No fatalities were recorded in the Powerline or Reference Site search plots.

2.3.1 2012 Bird Fatality Rate Calculations

Bird Fatality Rate (BFR) is calculated for three of the four survey area types as the number of unique bird carcasses detected divided by the number of plots searched (Table 7). Energized Equipment (Substation) was not completed in 2012 and was therefore not surveyed. The highest 4th Quarter (November and December 2012) BFR was recorded for the Reference Site search plots (0.003). The Array Area search plots had a BFR of 0.001. No bird fatalities were recorded in the Overhead Powerline search plots, so the BFR is zero.

TABLE 7. BIRD FATALITY RATE DATA.

2012 Data	**Array Areas**	**Energized Equipment**	**Overhead Powerline**	**Reference (Grassland)**
Number of Search Plots				
October Search Plots	**1,176**	**0**	**0**	**0**
November Search Plots	**588**	**0**	**0**	**591**
December Search Plots	**882**	**0**	**21**	**887**

2012 Data	Array Areas	Energized Equipment	Overhead Powerline	Reference (Grassland)
Number of Bird Fatalities				
October Bird Fatalities	**0**	--	--	--
November Bird Fatalities	**1**	--	--	**4**
December Bird Fatalities	**1**	--	**0**	**0**
Bird Fatality Rate (No. Fatalities/No. Search Plots)				
October Bird Fatality Rate	**0**	--	--	--
November Bird Fatality Rate	**0.002**	--	--	**0.007**
December Bird Fatality Rate	**0.001**	--	**0**	**0**
4th Quarter Average Fatality Rate (Nov. & Dec data)	**0.001**	--	**0**	**0.003**

2.4 Scavenger Trials and Searcher Efficiency Trials

Scavenger trials and searcher efficiency trials are proposed to determine any bias in the fatality survey results. These trials will not commence until construction is complete in designated project component areas[2].

2.5 Preliminary Bird Risk Index Calculations

Bird Risk Index (BRI) is calculated in order to quantify multiple measures into a single number to facilitate comparison of the different survey area types and to monitor for trends over time. For this BMAP study, BRI is calculated as the Bird Fatality Rate divided by the Bird Use Rate (Table 8). We are providing a preliminary BRI for each survey area type in this first annual report, but acknowledge that insufficient fatality surveys were completed in 2012 to provide a strong conclusion. Significance thresholds should not be based on these preliminary results.

The offsite grassland Reference Site search plots had a Bird Risk Index double that of the Array Area search plots. Bird fatality detections were extremely low in both the Array Area and Reference Site search plots. No bird fatalities were detected in the Overhead Powerline search plots, however we surveyed significantly fewer search plots within this survey area type compared with Array Areas and Reference Sites.

---

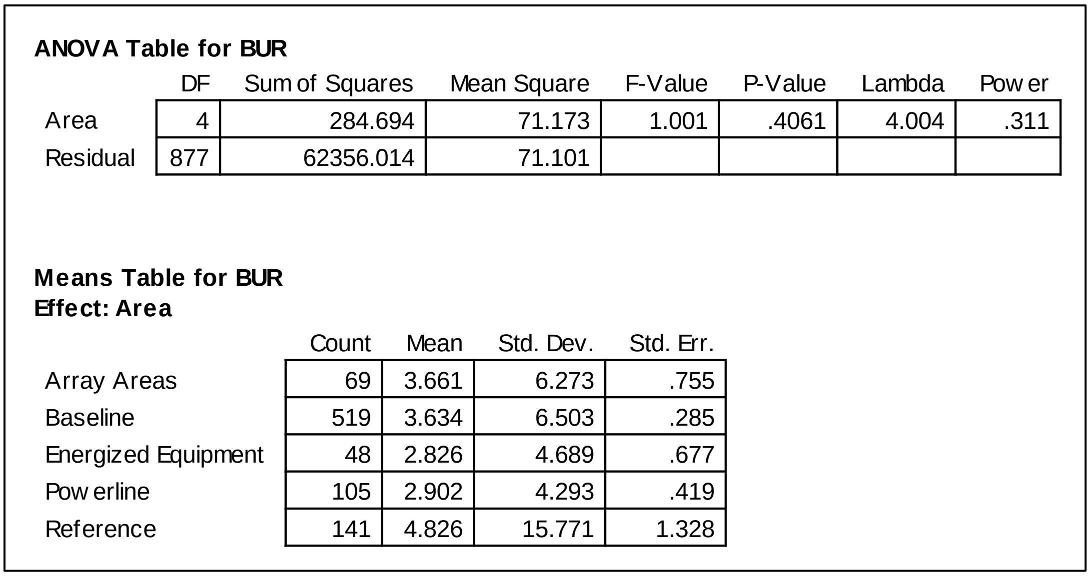
[2] Scavenger trials and searcher efficiency trials commenced in February 2013.

TABLE 8. PRELIMINARY BIRD RISK INDEX. BUR, BFR and BRI are provided for the Array Area, Overhead Powerline, Energized Equipment and Reference Site search plots.

Survey Area Type	Bird Utilization Rate (BUR)	Bird Fatality Rate (BFR)	Bird Risk Index (BRI)
Array Area	3.66	0.001	0.0003
Overhead Powerline	2.96	0	0
Energized Equipment	2.83	n/a	n/a
Reference Site	4.82	0.003	0.0006

Statistical analysis of the BUR found no difference among treatment types (areas) across the study area. This is due to the large variation in the bird observation point data results (Table 9).

TABLE 9. BUR STATISTICAL ANALYSIS.



ANOVA Table for BUR

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Area	4	284.694	71.173	1.001	.4061	4.004	.311
Residual	877	62356.014	71.101				

Means Table for BUR
Effect: Area

	Count	Mean	Std. Dev.	Std. Err.
Array Areas	69	3.661	6.273	.755
Baseline	519	3.634	6.503	.285
Energized Equipment	48	2.826	4.689	.677
Powerline	105	2.902	4.293	.419
Reference	141	4.826	15.771	1.328

3.0 Discussion

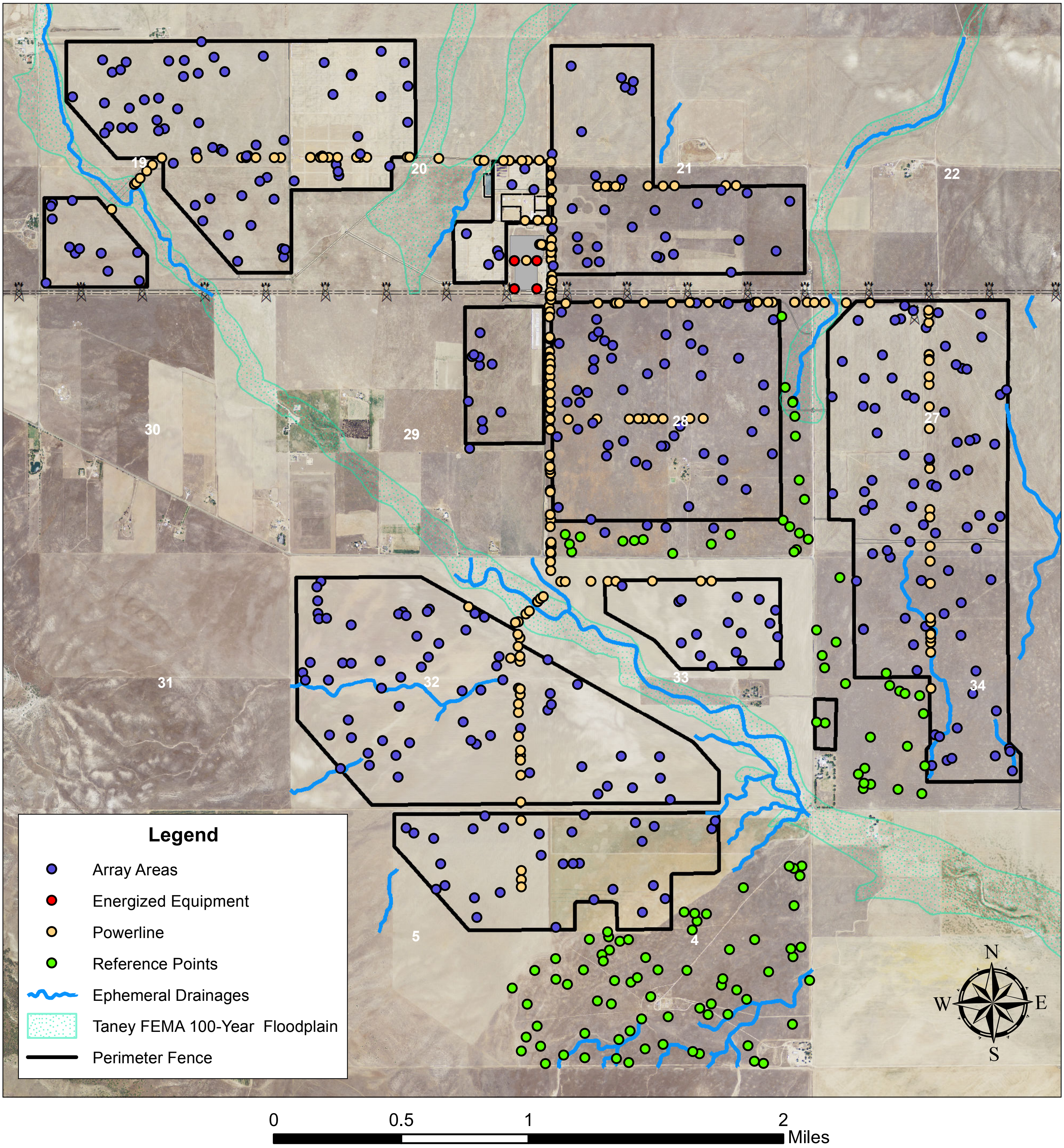
Avian Use Surveys were conducted for all 12 months of 2012. A total of 63 observation points were surveyed each month, for a total of 756 for the year. For observation points in Array Areas where panels were installed, observer visibility was limited. This effect could potentially reduce the number of unique bird detections per observation point compared with open Reference Site observation points. Although we anticipated this effect, we are concerned that the severity of the sight limitation may be worse than anticipated. Therefore we decided to change the parameters of our random selection criteria for 2013 so that observation points for the Array Areas only fall on interior north-south oriented access roads. This selection criterion will only choose observation points that allow visibility to the 50 meter survey area extent to the north and south along the narrow access road, as well as to the east and west down the panel rows, while still collecting data on bird use within the Array Areas.

A total of 250.6 linear miles of 15-foot wide Avian Fatality Survey search plots were systematically surveyed on foot by project biologists within completed Array Areas; two bird fatalities were recorded. One fatality was a domestic chicken that was obviously brought to the location by a predator. The other fatality was an old mourning dove feather pile that suggested raptor predation; however cause of death was recorded as unknown. Grassland Reference Site search plots covered a total of 139.7 linear miles of 15-foot wide search plots. Four fatalities were recorded in the Reference Site search plots. Cause of death could not be determined for any of these fatalities, however predation was presumed to be the likely cause for all. General fatality rates appear to be very low in work areas (1 fatality every 125 miles of array rows).

Searcher efficiency trials and scavenger/carcass removal trials will be conducted in 2013 to provide insight into the accuracy of Avian Fatality Survey data. Results of these trials will be reported in the first quarterly report for 2013, and the second annual report will include Fatality Survey data adjusted to account for the results of the trials.

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Exhibit 1. 2012 Avian Use Survey Points



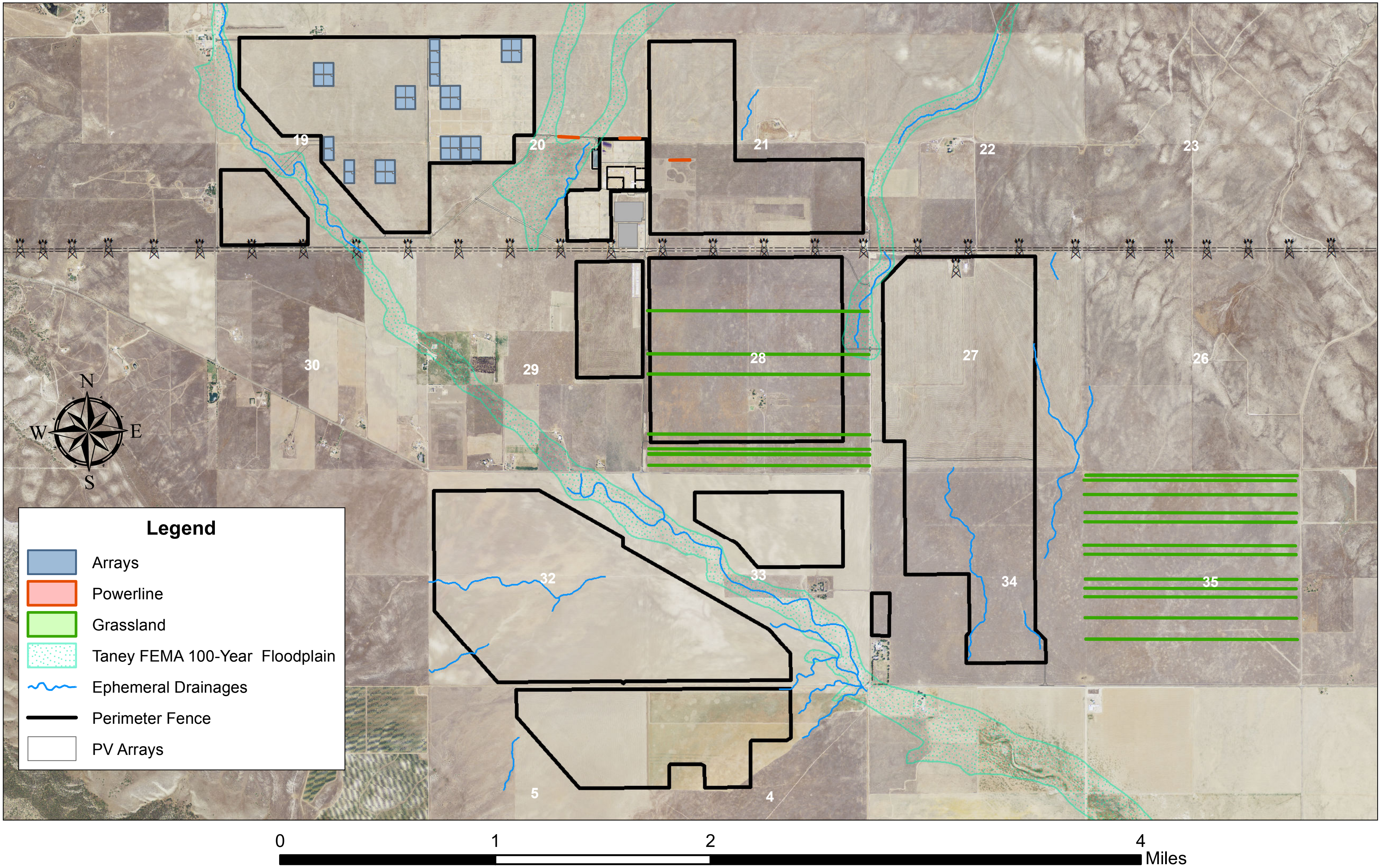
Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: February 13, 2013, 11:46 AM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Exhibit 2. 2012 Avian Fatality Survey Areas



First Solar.

Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: February 13, 2013, 11:42 AM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Exhibit 3. Topaz Solar Farm Bird List

Seasons are defined as:

SPRING: MARCH through MAY

SUMMER: JUNE through JULY

FALL: AUGUST through NOVEMBER

WINTER: DECEMBER through FEBRUARY

OBSERVERS: Peter A. Gaede (PAG), Bruce Reitherman (BR), Jason Dart (JD), Curtis Brumit (CB), Mike Hill (MH), Christina Williams (CW), Jeremy Pohlman (JP), Audrey Weichert (AW), Monica Brick (MB), Alex Stewart (AS), Greg Salas (GS), Kara Hagedorn (KH)

DCP = Dust Control Pond, Section 20.

KR = Kuhnle Residence, northern edge of Section 19.

CPS = Carrisa Plain Elementary School.

TEL = Tule Elk Lane pond: Private pond on Hwy 58 and Tule Elk Lane (one mile east of Bitterwater Rd).

JCR = Jan Cooper Residence, southeast corner of Section 4.

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
GEESE & DUCKS						
Northern Shoveler			X	X		3 at DCP, 11SEP12; PAG/BR (ph PAG). 1 at DCP, 10Dec12; BR.
Canada Goose			X			Flock fly-over, 30Oct12; CW.
Gadwall	X					Pair at DCP, 28May12; AW.
Cinnamon Teal	X					Pair at DCP, 24May12; JP.
Green-winged Teal				X		1 at DCP, 10Dec12; BR.
AVOCETS & STILTS						
American Avocet	X					Two at DCP, 25May12; AW.
GREBES						
Western Grebe			X			1 at DCP, 18-20OCT12; CW (ph)
CORMORANTS						
Double-crested Cormorant				X		1, TEL, 18-19DEC12; PAG (ph).
HERONS, BITTERN & ALLIES						

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
Great Blue Heron			X			1 over Block 5, 17Sept12; AS.
Great Egret			X			05Nov12; AS.
IBIS						
White-faced Ibis	X		X			2 adults at DCP, 21May12; JD. 1, DCP, 17Sept12; AS.
NEW WORLD VULTURES						
Turkey Vulture	X	X	X	X		
OSPREYS						
Osprey	X					1, Section 28, 02MAR12; PAG/BR (ph PAG).
HAWKS, KITES & EAGLES						
Bald Eagle				X		
Northern Harrier	X	X	X	X		
Sharp-shinned Hawk			X			1 juv., Section 28 (ranch); 01NOV12; PAG/CW.
Cooper's Hawk			X	X		1, dead in Block 6A, 27Aug12; CB.
Swainson's Hawk	X	X				3 imm., Section 33 field, 14MAY12; PAG (ph). 3 light-morph imms., 16MAY12; PAG.
Red-tailed Hawk	X	X	X	X	YES	Successful nest in tree in Section 33 (ranch). Nestlings in nest, BR/PAG (ph).
Red-shouldered Hawk			X			16Oct12; AS
Ferruginous Hawk	X		X	X		First of Fall observation on 12Sept12 in Block 4; CB.
Rough-legged Hawk			X	X		1, Block 9, 16NOV12 and DEC, A&M staff/BR (ph).
Golden Eagle	X	X	X	X		
RAILS, GALLINULES & COOTS						
Virginia Rail			X			1, collision with fence, move-on, 11Sept12; MH.
American Coot			X			DCP, 18-19Nov12; MB.
PLOVERS						

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
Killdeer	X	X	X	X	YES	3 juvs at cattle pond with adult sin Section 28 (ranch), 04JUN12, PAG.
Mountain Plover	X			X		
SANDPIPERS & PHALAROPES						
Greater Yellowlegs			X			1 fly-over, calling, near DCP, 16OCT12; PAG.
Long-billed Curlew	X	X	X	X		
Whimbrel	X	X	X			1, Section 34, 25APR12; PAG. 1, Helios Way, 31July12-01Aug12; MB.
Western Sandpiper		X	X			3 at cattle pond in Section 28, 18JUL12; PAG/BR. 1 fly-over, Section 19, 17OCT12; PAG.
Short-billed Dowitcher		X		X		1 at DCP, calls described as Short-billed, 18JUL12; JP. 2 near Block 6A, 06Feb12; BR.
Long-billed Dowitcher	X					2, 06Mar12; BR.
Wilson's Phalarope	X					1 at DCP, 08May12; AW.
PIGEONS & DOVES						
Rock Pigeon	X	X	X	X		
Eurasian Collared Dove	X	X	X	X	YES	Nest remnants found in Section 33 (ranch), 03JUN10, PAG/JD.
Mourning Dove	X	X	X	X	YES	Nest in Section 33 (ranch), 03JUN10, JD.
Band-tailed Pigeon			X	X		
OWLS						
Barn Owl		X	X	X		1 day roosting Section 33 (ranch), 11SEP12; PAG. 1 adult observed roosting at Section 28 Cochrane Ranch.
Burrowing Owl	X	X	X	X	YES	
Short-eared Owl	X		X	X		Flushed 5 adults from field south of Helios laydown, 09Mar12; JD. First of Fall obs in Section 16, 17Sept12; JD.
Long-eared Owl		X	X	X		4, CPS, 20JUL12; JD. 1, CPS, 05DEC12; PAG.
HUMMINGBIRDS						

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
Anna's Hummingbird		X	X	X		10 (high count) at JCR, 03JUN10; PAG. 1 at CPS, 07DEC12, PAG.
Black-chinned Hummingbird		X				2 at JCR, 03JUN10, PAG.
Costa's Hummingbird		X	X			1 (late date), 02NOV12; PAG (ph).
WOODPECKERS						
Red-breasted Sapsucker			X	X		1, Section 33 (ranch), 01NOV12; PAG (ph). 1, Section 33 (ranch), 18Dec12; PAG.
Williamson's Sapsucker				X		1 male, CPS, 05DEC12; PAG/BR (ph).
Northern Flicker [Red-shafted Flicker subspecies]	X		X	X		1, CPS, 30Mar12; BR. 1, Section 33 (ranch), 04 DEC12; BR.
Nuttall's Woodpecker			X	X		1, Section 33 (ranch), 17OCT12; PAG. Up to 2 regularly seen at CPS.
QUAIL						
California Quail			X			Calls heard at Cochrane, 18Nov12; MH.
FALCONS						
American Kestrel	X	X	X	X		
Merlin	X		X	X		First of Fall obs 27Sept12; AS.
Prairie Falcon	X	X	X	X		
Peregrine Falcon	X		X	X		
FLYCATCHERS						
Willow Flycatcher		X				1 (migrant); Section 33 (ranch), 05JUN12; PAG (ph).
Pacific-slope Flycatcher	X					1 (migrant); Section 21, 23APR12; PAG.
Black Phoebe	X	X	X	X	YES	
Say's Phoebe	X	X	X	X	YES	2 fledglings in Section 33 (ranch), 23APR12; PAG (ph).
Ash-throated Flycatcher		X				1 at Section 33 (ranch), 05June12; PAG.
Cassin's Kingbird	X	X	X		YES	Nest found in Sycamore at JCR, 03JUN10; PAG. Pair in Sec 33 (ranch), 03JUN10, PAG.
Western Kingbird	X	X	X			

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
SHIRIKE						
Loggerhead Shrike	X	X	X	X	YES	Fledglings seen at KR; PAG/BR. Family group at Section 28 (ranch), 18JUL12; PAG
VIREOS						
Warbling Vireo	X					3, Section 33 (ranch), 14MAY12; PAG.
CROWS & JAYS						
American Crow	X	X	X	X	YES	Nest in Tree of Heaven, Section 28 (ranch); 3 fledglings on 04JUN12 ; PAG (ph).
Common Raven	X	X	X	X	YES	High count 513, 17OCT12; PAG/BR/JD.
LARKS						
Horned Lark	X	X	X	X	YES	
SWALLOWS						
Tree Swallow			X	X		3, fly-over, 16OCT12; PAG.
Northern Rough-winged Swallow			X			
Cliff Swallow	X	X				62 (migrants) over Section 4, 05JUN12; PAG.
Barn Swallow	X	X				1 ad. seen on 20JUL12; PAG.
Violet-green Swallow	X		X			4, 05Mar12; BR. 1 juvenile at DCP, 28Aug12; AS/CW.
TITMICE & CHICKADEES						
Oak Titmouse			X			06Nov12; GS.
KINGLETS						
Ruby-crowned Kinglet			X	X		Multiple fall and winter observations at both ranches (Sections 28 and 33).
BLUEBIRDS & THRUSHES						
Western Bluebird		X	X			5, Section 33 (ranch), 01NOV12; PAG. Pair in Section 5, 05June12; PAG.

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
Mountain Bluebird	**X**		**X**	**X**		
Hermit Thrush	**X**					1 (migrant), Section 28, 31MAR12; PAG
American Robin			**X**	**X**		1, Section 34, 02Dec11; JD. 1, Section 33 (ranch), 07DEC12; KH.
MOCKINGBIRDS & THRASHERS						
Northern Mockingbird	**X**	**X**	**X**	**X**		
Sage Thrasher	**X**			**X**		1, Section 21, 06MAR12; PAG. 1 at Ledezma Property, 26Mar12; JP.
STARLINGS						
European Starling	**X**	**X**	**X**	**X**	**YES**	
PIPITS						
American Pipit	**X**		**X**	**X**		
WAXWINGS						
Cedar Waxwing			**X**			1, Section 33 (ranch), 17OCT12; PAG
LONGSPURS						
Lapland Longspur	**X**					1 fly-over, calling, 06MAR12; PAG.
WOOD WARBLERS						
Virginia's Warbler			**X**			1, KR, 17OCT12; PAG.
Yellow Warbler			**X**			1, Section 33 (ranch), 11SEP12; PAG.
Yellow-rumped Warbler	**X**		**X**	**X**		
Black-throated Gray Warbler			**X**			2, Section 33 (ranch), 16OCT12; PAG.
Hermit Warbler			**X**			1, HY female, Section 28 (ranch), 13SEP12; PAG (ph).
Wilson's Warbler	**X**					2, Section 33 (ranch), 14MAY12; PAG.
EMBERIZIDS						
Chipping Sparrow			**X**			3, KR, 17OCT12; PAG.
Vesper Sparrow				**X**		3, Section 4/33 Boundary, 23FEB12; PAG.
Lark Sparrow	**X**		**X**	**X**		

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
Savannah Sparrow	**X**		**X**	**X**		
Grasshopper Sparrow	**X**			**X**		
White-crowned Sparrow	**X**		**X**	**X**		
Dark-eyed Junco				**X**		
Golden-crowned Sparrow				**X**		05Jan12; JD.
Sage Sparrow				**X**		1, Section 33 ranch, 18Dec12; PAG.
NUTHATCHES						
Red-breasted Nuthatch			**X**	**X**		2 at CPS, 17OCT12 PAG. 1 at CPS, 07DEC12, PAG.
BLACKBIRDS & ORIOLES						
Red-winged Blackbird	**X**	**X**	**X**	**X**		
Tricolored Blackbird	**X**	**X**	**X**	**X**		Seen sporadically throughout the project area, e.g. Sections 19, 20, 27
Western Meadowlark	**X**	**X**	**X**	**X**	**YES**	
Yellow-headed Blackbird	**X**					Pair (migrants) at move-on, 16April12; JD.
Brewer's Blackbird	**X**	**X**	**X**	**X**	**YES**	One fledgling being fed by adult, Section 33 (ranch), 04JUN12, PAG.
Great-tailed Grackle	**X**	**X**				1 adult male in Block 6A, 01May12; JD. 1 female at DCP, 20JUL12; PAG.
Brown-headed Cowbird	**X**	**X**		**X**		
Bullock's Oriole	**X**	**X**				1 at Tracy Security, 24Mar12; JD. 1 at JCR, 06JUN12; PAG.
FINCHES & ALLIES						
House Finch	**X**	**X**	**X**	**X**	**YES**	
Pine Siskin			**X**	**X**		13 at Helios and Highway 58, 15Oct12; PAG.
Lesser Goldfinch	**X**		**X**	**X**		
Lawrence's Goldfinch	**X**	**X**	**X**			7 near Solar Switching Station (one HY), 05JUN12; PAG.
American Goldfinch	**X**		**X**	**X**		
OLD WORLD SPARROWS						

Species	Spring	Summer	Fall	Winter	Breeding Documented ?	Date/Location/Observer
House Sparrow	X	X	X	X		

Topaz Solar Farm
10400 Helios Way
Santa Margarita, California 93453

Delivered via Electronic Mail

Quarterly Report

COA 62 Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan Quarterly Report

April 10, 2014

Discussion

This report has been prepared to address the reporting requirements for Condition of Approval (COA) 62 Bird Monitoring and Avoidance Plan. The BMAP report was prepared to include bats and the title revised to the Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP).

In response to COA 62, the Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP) has been prepared, which further describes the approach to implementing the condition requirements.

COA 62 requires quarterly and annual reports. Quarterly reports are required during construction and for three years following the beginning of the solar farm operation.

Following the completion of the fourth quarter of monitoring the biologist shall prepare an annual report that summarizes the year's data, analyzes any project-related bird fatalities or injuries detected, and provides recommendations (in consultation with the County) for future monitoring and any adaptive management actions needed.

Quarterly Reportable Items

COA 62 BMAP requires quarterly reports describing the dates, durations, and results of monitoring and data collection. The quarterly reports shall provide a detailed description of any project-related bird or wildlife deaths or injuries detected during the monitoring study or at any other time.

Report Data

Attached is the quarterly report prepared by Althouse & Meade (COA 62 and ABPP Quarterly Monitoring Report by Althouse & Meade January 1 – March 31, 2014).

If there are questions regarding this report, please contact:

Jason Dart

Biology/Compliance
Topaz Solar Farm
10400 Helios Way
Santa Margarita, CA

Topaz Solar Farms

COA 62 Year 3 First Quarter Report

January 1 – March 31, 2014

for

Avian and Bat Protection Plan

and

Bird Monitoring and Avoidance Plan

Merlin (left), horned lark nest (center), Western meadow lark (right), Topaz Solar Farms 2013. Photographs by P. Gaede

Prepared for

Topaz Solar Farms LLC
10400 Helios Way
Santa Margarita, CA 93453

By

ALTHOUSE AND MEADE, INC.
BIOLOGICAL AND ENVIRONMENTAL SERVICES
1602 Spring Street
Paso Robles, CA 93446
(805) 237-9626

April 2014

654.48

Table of Contents

Tables

Figures

1.0 Introduction

This Year 3 First Quarter report provides information pertinent to the reporting obligations regarding implementation of various tasks required by the Topaz Solar Farms Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (Althouse and Meade, Inc. June 2011). Section 5.5 of this plan requires quarterly reports to be submitted to the County of San Luis Obispo, U.S. Fish and Wildlife Service (USFW) and the California Department of Fish and Wildlife (CDFW). The Avian and Bat Protection Plan (ABPP) and Bird Monitoring and Avoidance Plan (BMAP) are requirements of County of San Luis Obispo Conditions of Approval (COA) 61 and 62, and were prepared in consultation with USFWS and CDFW.

2.0 Avian and Bat Protection Plan

The ABPP monitoring program compiles general information on bird and bat interactions, injuries, and mortality at the Topaz Solar Farms. During construction phases of the project this task is completed by the project biologists, as part of routine daily biological monitoring. Information regarding a detailed bird use and mortality risk assessment study is reported below under the BMAP section.

This quarterly report provides information spanning the period from January 1 through March 31, 2014. Construction of Blocks 1 through 10 was completed in 2013. Blocks 14 and 15 were completed during the current reporting quarter (January - March 2014). Blocks 1 through 10, 14, and 15 are now managed through Operations and Maintenance (O&M) and Blocks 11, 12, and 13 are managed by Commissioning. Blocks 16 through 22 are active construction areas as of March 31, 2014. Figure 1 illustrates construction status of blocks through March 2014.

2.1 General Bird Surveys

2.1.1 Methods

General bird surveys are conducted on and around the TSF project site on a daily basis seven days a week throughout the year by project biologists. Lists of bird species observed by each biological monitor are recorded on daily construction survey forms, which are then scanned, archived, and reviewed by project ornithologists Peter Gaede and Jason Dart.

2.1.2 Results

Monitors recorded a total of 69 species of birds in January, February, and March 2014 and an additional three species that could only be identified to genus. Of those 69 species, 15 were waterbirds and 12 were raptors. Most waterbirds were observed at or near the dust control pond (DCP); some were seen flying over the project site without using project features as habitat. Table 1 lists all bird species observed in this quarter with information on observation frequency.

Table 1. January – March 2014 General bird Survey Observations. All species observed this quarter are listed below. Bolded species were the top twenty species most frequently observed; blue type represents a waterbird.

American Coot
American Crow
American Goldfinch
American Kestrel
American Pipet
Anna's Hummingbird
Bald Eagle
Barn Swallow
Black Phoebe
Brewer's Blackbird
Bullock's Oriole
Burrowing Owl
California Thrasher
California Towhee
Canada Goose
Cassin's Kingbird
Cinnamon Teal
Cliff Swallow
Common Raven
Cooper's Hawk
Dark-Eyed Junco
Eurasian Collared Dove
European Starling
Ferruginous Hawk
Golden Eagle
Greater Roadrunner
Greater Yellowlegs
Horned Lark
House Finch
House Sparrow
Killdeer
Lapland Longspur
Lark Sparrow
Lawrence's Goldfinch
Lesser Goldfinch
Loggerhead Shrike
Long-Billed Curlew
Long-Billed Dowitcher
Mallard
McCown's Longspur
Merlin
Mountain Bluebird
Mourning Dove
Northern Flicker
Northern Harrier
Northern Mockingbird
Northern Pintail
Northern Shoveler
Orange-Crowned Warbler
Osprey
Prairie Falcon
Red-Tailed Hawk
Red-Winged Blackbird
Rock Pigeon
Ruby-Crowned Kinglet
Ruddy Duck
Savannah Sparrow
Say's Phoebe
Sharp Shinned Hawk
Snowy Egret
Tree Swallow
Tri-Colored Blackbird
Turkey Vulture
Violet-Green Swallow
Western Kingbird
Western Meadowlark
Whimbrel
White-Crowned Sparrow
Yellow-Rumped Warbler
Hummingbird sp.
Swallow sp.
Yellowlegs sp.

2.2 Nesting Activity

2.2.1 Methods

Focused nest surveys were conducted daily on and around the project site by biological monitors starting February 1, 2014. All nest surveys were conducted on foot by trained biologists. Strategically selected array areas were identified at the beginning of each week where surveyors walked all rows searching for nests on the ground or structures. Additionally, areas up to 300 feet outside the perimeter fences were surveyed twice per week. Laydowns were surveyed as often as possible to prevent birds establishing nests in equipment and materials. Nest starts were removed when the presence of a complete nest would conflict with construction activities or would present a danger to the birds. All nests and nest starts identified from January to March 2014 were documented.

2.2.2 Results

The results of surveys from January through March 2014 are provided in Table 2. Other species identified nesting offsite (e.g. mitigation lands, future project lands, or areas managed by Operations and Maintenance) are not included in this table. Additionally, as of March 31, there are at least two burrows occupied by burrowing owl pairs outside project perimeter fences. At this time, no chicks have been documented outside the burrows. Fourteen horned lark nest starts have been removed from or near project areas during this quarter as well as three house finch nest starts from material stacks and a common raven nest start from a crane boom. All nest starts were removed prior to being deemed complete, which is defined as a nest that is lined and ready to accept eggs. Common ravens and red-tailed hawks are currently building nests on the PG&E transmission lines, power poles, and the TSF's medium voltage collector line poles. At the end of March, a female red-tailed hawk was seen sitting in a nest north of Block 11 on a PG&E transmission tower and will be monitored in April to determine whether or not the nest is considered active. A map of active nests for January to March 2014 is attached (Figure 2).

TABLE 2. JANUARY – MARCH 2014 BIRD NESTS. Bird nests detected at the Topaz Solar Farms from January to March 2014.

Month	Species	Date Found	Location	Current Status
Jan.	-	-	-	-
Feb.	-	-	-	-
Mar.	Horned Lark	13-Mar-14	North of Block 17	Potentially depredated
		25-Mar-14	Block 18	Inactive with cold eggs in nest
		26-Mar-14	West of Block 22	Active with female incubating eggs
		28-Mar-14	North of Block 17	Nest being built
		31-Mar-14	North of Block 20	Active with eggs and female attending

2.3 Avian and Other Wildlife Mortality

General biological monitoring of the Topaz work areas documented bird, bat, and other wildlife mortality. All mortality identified on site during this reporting period is provided in Table 3. Cause of death is reported when known. This table includes all fatalities found in active construction areas as well as areas managed by Commissioning or Operations and Maintenance.

TABLE 3. JANUARY – MARCH 2014 AVIAN AND OTHER WILDLIFE MORTALITY. Bird and other wildlife mortality detected at the Topaz Solar Farms from January to March 2014.

Month	**Species**	**Location**	**Cause of Death**	**Notes**
Jan.	American Kestrel	Block 19	Predation	Seen eaten by Cooper's hawk
	Burrowing Owl	Block 7	Unknown	Feathers only
	Common Raven	Block 14 Laydown	Unknown	Wing and feathers
	Common Raven	Block 9	Predation	Feathers only
	Common Raven	Block 7	Unknown	Feathers only
	Horned Lark	Block 18	Predation	Seen eaten by kestrel
	Horned Lark	Block 9	Unknown	Feathers only
	Mourning Dove	Block 9	Unknown	Feathers only
	Mourning Dove	Block 8	Unknown	Feathers only
	Mourning Dove	Block 6a	Predation	Feathers only
	Cottontail Rabbit	Block 16	Unknown	
	Cottontail Rabbit	Helios Way	Vehicle Strike	
	Gopher Snake	Block 21 Laydown	Equipment Strike	
	Ground Squirrel (6)	Dust Control Pond	Drowning	
Feb.	Horned Lark	Block 17	Unknown	Feathers only
	Horned Lark	Block 19	Presumed Collision	Potentially collided with post
	Mourning Dove	Block 3	Unknown	Feathers only
	Western Meadowlark	Block 2	Predation	Feathers only
	Gopher Snake	Phase 6 Road	Vehicle Strike	
	Ground Squirrel	Block 13	Unknown	
	Ground Squirrel	Block 18	Vehicle Strike	
	Jack Rabbit	Papich Laydown	Predation	
	Pocket Mouse	Block 16	Exposure	
Mar.	Barn Owl	Block 1	Predation	Head, spine, and wings
	Common Raven	Block 14	Unknown	Feathers and flesh
	Common Raven	Block 13	Unknown	Full carcass
	Horned Lark	Block 18	Collision	Potentially collided with post
	Horned Lark	Block 20	Collision	Potentially collided with post
	Cottontail Rabbit	Block 16	Unknown	

2.4 Adaptive Management

No adaptive management practices were implemented during the period from January to March 2014.

2.5 Bat Surveys

Acoustic monitoring surveys for bats on the project site were conducted at least one night per month using a Pettersson D240x (Pettersson Elektronik, Sweden) bat detector and Sonobat® (v.3.1 US west; DNDesign, Arcata, CA) acoustic analysis software. On January 24, 2014 the detector was placed on the south fence of the Dust Control Pond (DCP) and in February and March, the detector was placed on an extendable pole on a t-post between the Topaz Solar Farms substation and the PG&E switching station. All detected bat calls were identified using the analysis software.

Only one species of bat was detected from January through March, Mexican free-tailed bat (*Tadarida brasiliensis*). Mexican free-tailed bats are one of the most widely distributed mammalian species in the Western Hemisphere. They may fly more than 50 km a night to reach foraging areas. The results of the March 19 survey showed no bat detections, however, sound files from the survey suggest the presence of acoustic interference with the detector. Table 4 provides a list of the number of detections of each bat species detected from January through March 2014. Each detection was assigned to species with a discrimination probability of 0.95 or higher.

TABLE 4. TOPAZ SOLAR FARMS JANUARY TO MARCH 2014 BAT SURVEYS. Bat acoustic monitoring survey dates, bat species detected at the Topaz Solar Farms project, and number of detections. Special status designations from CDFW and Western Bat Working Group (WBWG) are provided.

Survey Date	Location	Total Detections	Common Name	Scientific Name	CDFW Status	WBWG Status
24-Jan-14	DCP	1	Mexican [=Brazilian] free-tailed bat	*Tadarida brasiliensis*	None	Low
14-Feb-14	Substation	10	Mexican [=Brazilian] free-tailed bat	*Tadarida brasiliensis*	None	Low
19-Mar-14	Substation	0	--	--	--	--
28-Mar-14	Substation	3	Mexican [=Brazilian] free-tailed bat	*Tadarida brasiliensis*	None	Low

No bat roosts are known to be present within or near the Topaz project site.

3.0 Bird Monitoring and Avoidance Plan

The BMAP study analyzes avian use surveys and avian fatality surveys to produce a risk index for various project components deemed to be potentially dangerous to birds, including array areas, overhead power lines and the Substation.

3.1 Avian Use Surveys

3.1.1 Methods

Avian Use Surveys were conducted monthly from November 2011 through March 2014, and will continue throughout the construction period and for three years after construction is complete. Each month, 63 randomly selected survey points are completed, including 31 inside existing array areas, 18 along existing overhead power lines, 10 in grassland reference sites and 4 at the energized equipment (substation). At each point, a 10 minute bird use count is conducted within a 50 meter radius of the surveyor. Avian Use Survey points were randomly selected each month across all six phases of the project and in offsite grassland reference areas (Figure 3).

3.1.2 Results

The four Survey Area Categories used as treatment types in this study comprise different habitat elements that influence species composition, abundance, and richness.

The Array Area category includes point counts conducted within solar array areas during active construction and in completed form. The habitat consists of rows of passive (non-moving) photovoltaic solar panels mounted to steel racking ranging from approximately 2 to 5 feet off the ground. The ground is seeded with a native seed mix to revegetate array areas to naturalized grassland habitat; vegetation density varied from 0 to 60 percent cover. Array Area survey points may also include perimeter fences, photovoltaic combining switchgear houses, as well as array roads.

The Energized Equipment category includes point counts conducted around the perimeter of the substation. The survey area includes the substation perimeter fence, transformers, power lines, and other electrical components. Within the substation fence the ground is gravel with no vegetation. Outside the perimeter fence, the ground is bare dirt with some patches of grass.

Overhead Powerline surveys represent areas underneath medium-voltage collector lines within the project. Vegetation varies depending on location; most powerlines are along array or access roads, however some locations are outside the fenced project areas in annual grassland habitat.

Reference Sites are composed of annual grassland habitat. They included point counts conducted on mitigation lands owned by California Department of Fish and Wildlife or annual grasslands not yet developed by TSF.

In January, February, and March 2014, 183[1] point counts were conducted in the four survey area categories totaling 356.12 acres. During these surveys, 18 different species were observed (Table 5). The 10 most abundantly detected species, listed in decreasing order of abundance, were: horned lark (916 detections), brewer's blackbird (125), mourning dove (88), common raven (66), house finch (52), European starling (49), western meadowlark (32), tree swallow (29), rock

---

[1] 6 survey points were missed from the proposed total of 189 points (63 points x 3 months).

pigeon (20), and savannah sparrow (7). The most frequently encountered species, the horned lark, was detected more than seven times as often as that of that of the second most frequently encountered species, the brewer's blackbird. Horned larks are abundant year-around residents that commonly form large flocks in winter on the Carrizo Plain. Both the horned lark and brewer's blackbird were detected in high numbers in all project component categories and up to 51 percent less frequently in the grassland reference category.

TABLE 5. SPECIES COMPOSITION AND ABUNDANCE. All bird species detected during Avian Use Surveys in January – March 2014, with the average number of bird use detections per observation point calculated for each of the four survey area categories. Total detections for each species are provided in far right column. Species are listed in decreasing order of abundance according to the total detections column.

Species	**Array Area** Ave. Detections per Obs. Pt.	**Energized Equipment** Ave. Detections per Obs. Pt.	**Overhead Powerline** Ave. Detections per Obs. Pt.	**Grassland/ Reference** Ave. Detections per Obs. Pt.	**Total Detections**
Horned Lark	5.13	5.58	5.92	3.00	916
Brewer's Blackbird	0.40	0.00	1.62	0.15	125
Mourning Dove	0.49	0.00	0.83	0.06	88
Common Raven	0.46	0.00	0.30	0.33	66
House Finch	0.51	0.17	0.13	0.00	52
European Starling	0.02	0.17	0.85	0.00	49
Western Meadowlark	0.20	0.67	0.09	0.09	32
Tree Swallow	0.09	0.00	0.40	0.00	29
Rock Pigeon	0.01	0.00	0.32	0.06	20
Savannah Sparrow	0.04	0.00	0.08	0.00	7
Say's Phoebe	0.02	0.08	0.00	0.03	4
Tri-Colored Blackbird	0.00	0.00	0.06	0.00	3
Red-Tailed Hawk	0.00	0.00	0.06	0.00	3
American Crow	0.02	0.00	0.00	0.00	2
Cliff Swallow	0.00	0.00	0.02	0.00	1
American Kestrel	0.01	0.00	0.00	0.00	1
Ferruginous Hawk	0.00	0.00	0.02	0.00	1
Golden Eagle	0.01	0.00	0.00	0.00	1

Among the treatment types, Overhead Powerline had the highest species richness with an overall average of 1.40 species detected per Observation Point. Array Area and Energized Equipment categories were similar, with 1.20 and 1.17 species detected per Observation Point. Grassland Reference Site recorded an average of 0.97 species per Observation Point. Species richness is higher in all three project component categories than in the offsite undeveloped category.

Bird Utilization Rate (BUR) is calculated as the average number of birds observed per Observation Point count. We calculated Bird Utilization Rate for the four Survey Area Categories for January – March 2014 (Table 6). Overhead Powerline had the highest BUR at 10.70 birds per Observation Point. With 7.41 and 6.75 birds per Observation Point, Array Area and Energized Equipment categories had the second and third highest BUR, and Grassland had the lowest BUR at 3.79 birds per Observation Point.

TABLE 6. AVIAN USE SURVEY POINT COUNTS AND DETECTIONS. The number of point counts conducted and total area surveyed in January – March 2014 is listed for each of the four Survey Area Categories. Species richness and bird utilization rate (BUR) is also listed.

Type	Number of Obs. Pt. Counts	Total Area Surveyed (Acres)	Total No. Species	Average No. Species per Obs. Pt (Species Richness)	Average No. Birds per Obs. Pt (BUR)
Array Area	85	165.41	14	1.20	7.41
Overhead Powerline	53	103.14	14	1.40	10.70
Grassland/Reference	33	64.22	7	0.97	3.79
Energized Equipment	12	23.35	5	1.17	6.75
Total	**183**	**356.12**	**18**	**1.17**	**7.67**

3.2 Avian Fatality Surveys

3.2.1 Methods

Avian Fatality Surveys commenced upon completion of the first project components. Avian Fatality Surveys are conducted at randomly selected locations within four different survey area types: Array areas, overhead power lines, energized equipment (Substation) and at reference sites. Transects walked in each category were 14 feet wide. Survey areas are randomly selected using an ArcGIS random point generator having defined areas as the constraining polygon. Avian Fatality Surveys are conducted within the same search plots each day for seven consecutive days every month. Repetitive surveys increase the chance of finding fatalities in a given area before predators remove the carcass, and allow calculation of number of fatalities per day.

3.2.2 Results

Each month, January through March, we completed walking Avian Fatality Surveys Areas for 7 consecutive days each. Powerline survey areas were completed for 7 consecutive days each, totaling 3.8 linear miles (6.5 acres). Grassland reference site survey areas were completed, for 7 consecutive days each, totaling 72.5 linear miles (123.1 acres). Array search areas were completed for 7 consecutive days each, totaling (123.1 acres). Onsite energized equipment was also surveyed in its entirety for 7 consecutive days, totaling 31.3 acres. See Figure 4 (attached) for a map of Avian Fatality Survey areas for January to March 2014.

Three months of surveys yielded a total distance of 513.8 linear miles and coverage of 872.1 acres. These surveys resulted in discovery of eleven fatalities, five each in grassland and arrays, and one underneath powerlines. See Table 7 for a fatality rate in each of the four categories for a comparison of fatalities found to area surveyed.

TABLE 7. BIRD FATALITY DENSITY. The survey results and efforts are indicated for each of the four survey area categories for the first quarter of 2014.

Plot Type	Linear Miles	Acres	Total Fatalities	Acres/Fatality	Fatality/Acre
Array	217.6	369.3	5	73.9	0.014
Powerline	23.2	39.4	1	39.4	0.025
Grassland/Reference	217.6	369.3	5	73.9	0.014
Energized Equipment	55.4	94.1	0	-	0.000
Total	**513.8**	**872.1**	**11**	**1.7**	**0.053**

Cause of death was recorded for all fatalities, when known. The eleven fatalities documented during Avian Fatality Surveys were the result of two causes: predation and unknown. No confirmed collisions or electrocutions were recorded in any of the Survey Area Categories during survey efforts. Since it is difficult to determine cause of death with certainty, recent guidance from the U.S. Fish and Wildlife Service suggests attributing cause of death to a specific factor and including a confidence percent to indicate how confident the determination was (Table 8; A. Beck and T. Dietsch 2013). Predation as a cause of death is likely much higher than reported, as often times a feather pile could not be confidently linked to a predation event as opposed to a scavenging event.

TABLE 8. CAUSE OF DEATH FOR AVIAN FATALITY SURVEY RESULTS. Cause of death tallied for avian fatalities detected within each of the four survey area categories, January – March, during formal avian fatality surveys. Percentages indicate confidence level.

Plot Type	Unknown	Predation Valid (>90%)	Predation Probable (>50%)	Predation Possible (1-50%)
Array	3	0	1	1
Powerline	1	0	0	0
Grassland/Reference	3	1	1	0
Energized Equipment	0	0	0	0
Total	**7**	**1**	**2**	**1**

Using fatality data collected in the first quarter of 2014 during formal avian fatality surveys, we calculated number of fatalities per acre per day for each of the four Survey Area Categories and extrapolated that to estimated number of fatalities per site per year, where site equals the total area of those components when the project is completed. Our fatality survey method consists of seven consecutive days of surveying the same transects. Since the first day could potentially contain carcasses present for several days, if not months, we excluded those fatalities detected on the first day and based the number of fatalities per acre per day calculation on carcasses found and areas surveyed each of the remaining six days. These data are provided as a bird fatality rate (Table 9). For this analysis, predation fatalities with a confidence level of less than fifty percent were moved to the unknown category for cause of death.

TABLE 9. BIRD FATALITY RATE. Bird fatality rate is indicated for each of the four survey area categories, cumulatively for January, February, and March 2014. Values shown exclude the first days' data. Calculations are shown for number of fatalities per acre per year, fatalities per site per year, and fatalities per site per year based on Reference Site fatality rate.

Plot Type	**Days Surveyed**	**Survey Area (Acres)**	**Cause of Death**	**Total Fatalities**	**Fatalities/Ac**	**Fatalities/Ac/ Yr**	**Fatalities/Site/ Yr**	**Fatalities/Site/ Yr (Reference Rate)**
Array	18	316.6	Predation	1	0.003	0.064	170.3	170.3
			Unknown	2	0.006	0.128	340.6	340.6
			Total	**3**	**0.010**	**0.192**	**511.1**	**511.1**
Powerline	18	33.8	Predation	0	0.000	0.000	0.0	--
			Unknown	0	0.000	0.000	0.0	--
			Total	**0**	**0.000**	**0.000**	**0.0**	**4.2**
Grassland/ Reference	18	316.6						
			Predation	1	0.003	0.064	170.3	--
			Unknown	2	0.006	0.128	340.6	--
			Total	**3**	**0.010**	**0.192**	**511.1**	**--**
Energized Equipment	18	80.6						
			Predation	0	0.000	0.000	0.0	--
			Unknown	0	0.000	0.000	0.0	--
			Total	**0**	**0.000**	**0.000**	**0.0**	**0.9**

3.3 Scavenger/Carcass Removal Trials and Searcher Efficiency Trials

No trials were required or conducted for this reporting period.

4.0 References

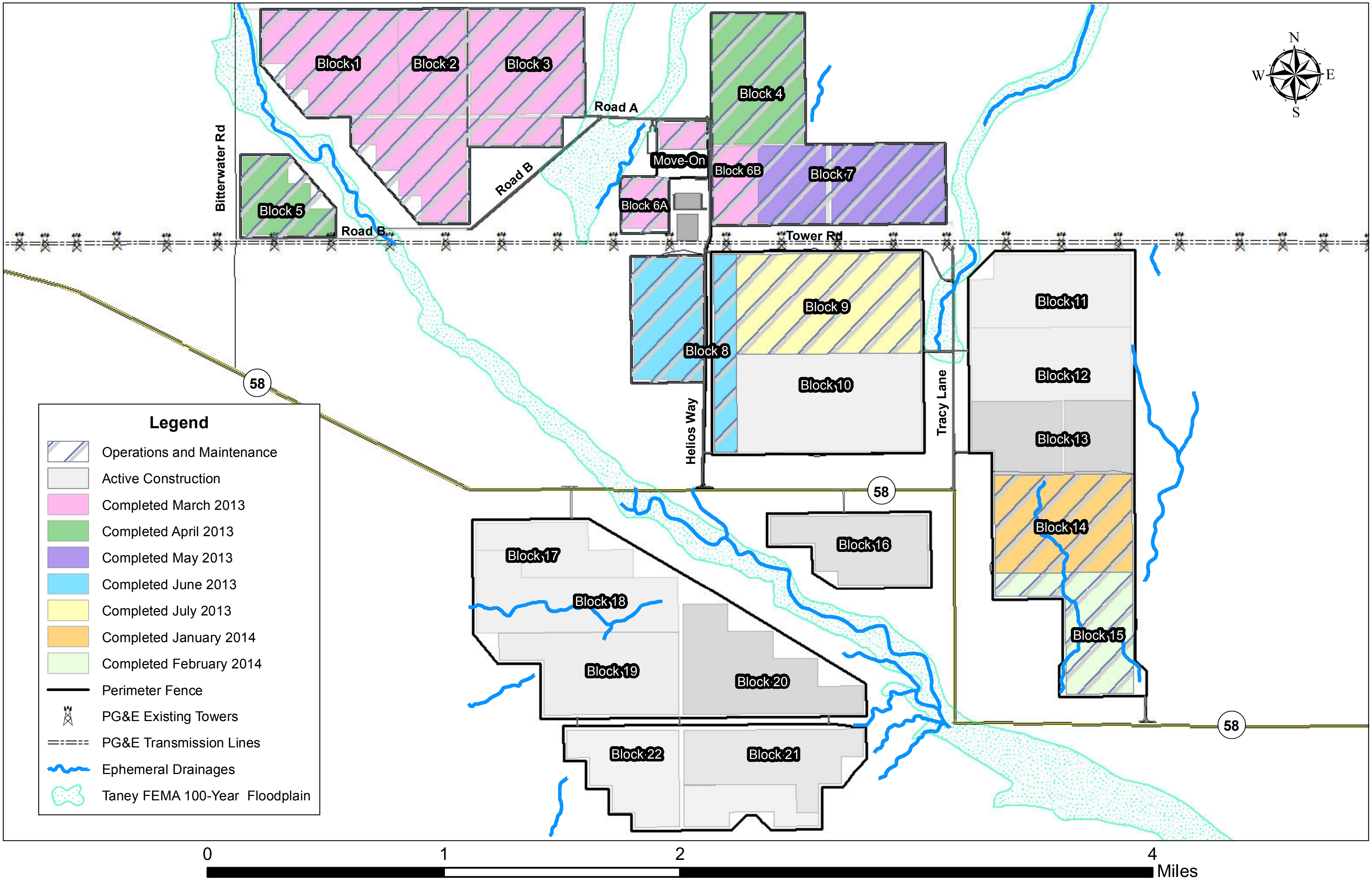
Althouse and Meade, Inc. 2011. Topaz Solar Farms Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. June 2011.

Beck, A. (First Solar) and T. Dietsch (USFWS) 2013. Personal communication regarding U.S. Fish and Wildlife Special Purpose Utility permit for avian fatality reporting.

5.0 Figures

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Figure 1. Construction Status As of March 31, 2014



First Solar.

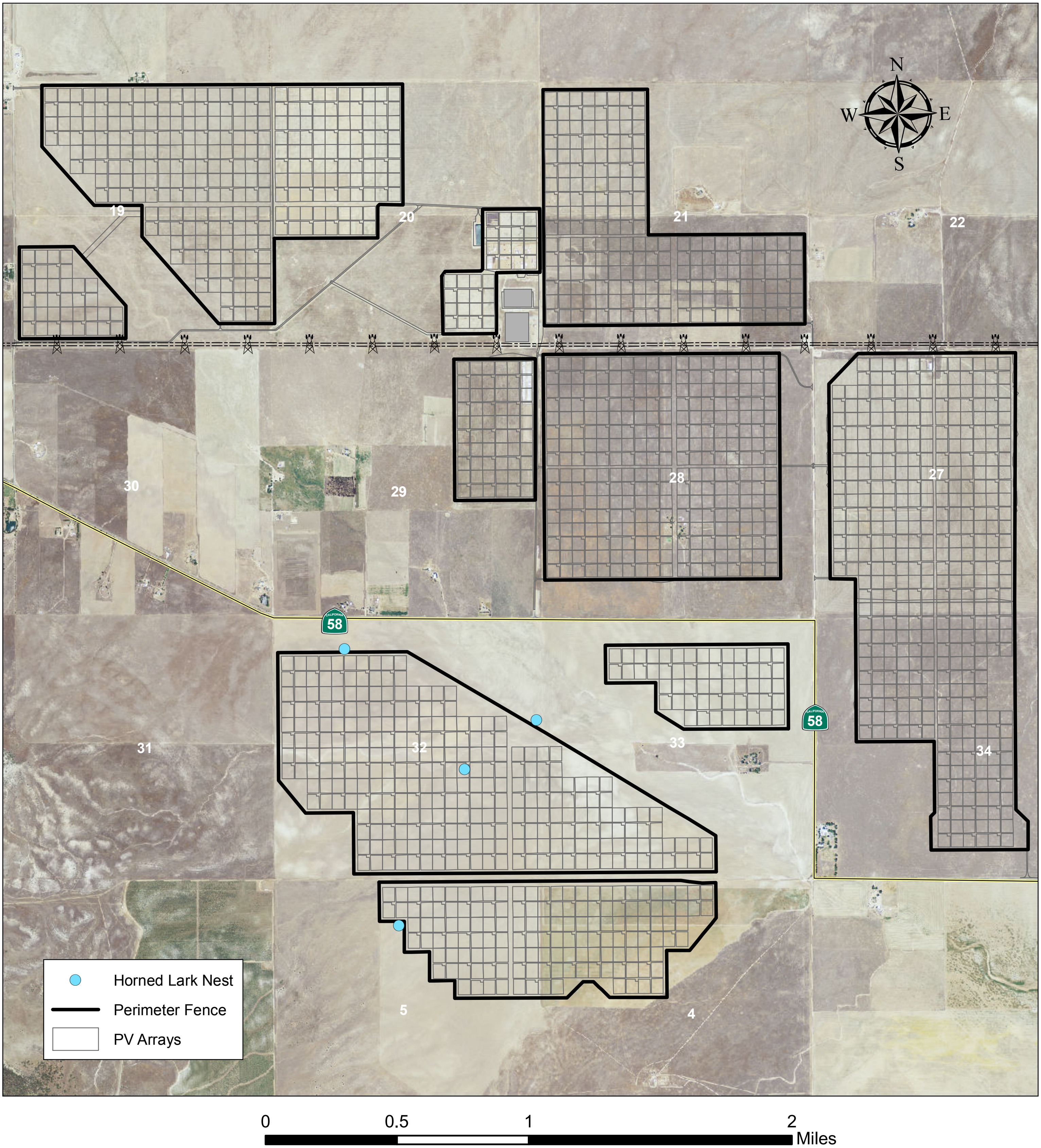
Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

Map Updated: April 10, 2014 02:09 PM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Figure 2. Active Nests

January 2014 to March 2014



Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

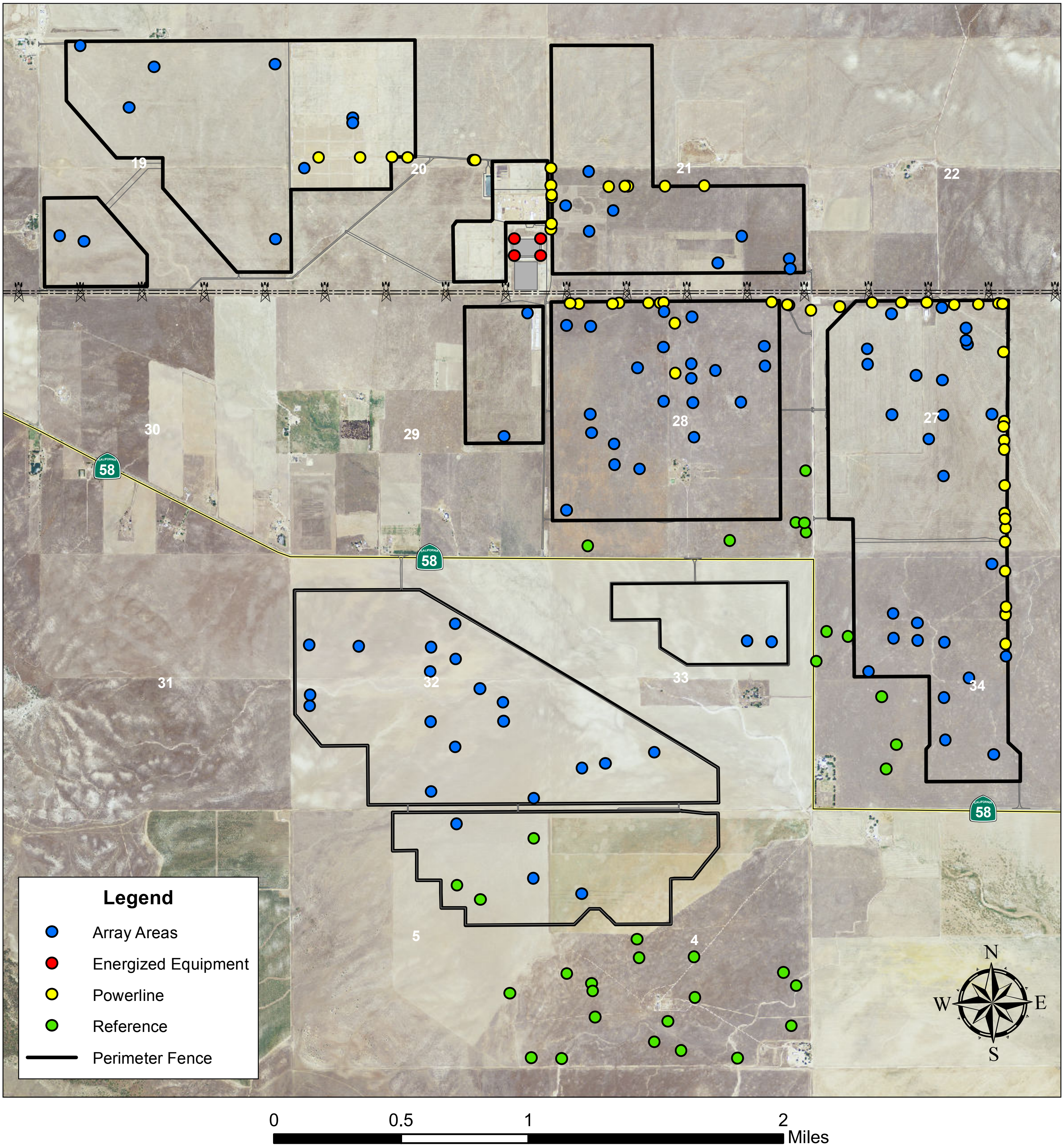
2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: April 10, 2014 03:03 PM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Figure 3. Avian Use Survey Points

January 2014 to March 2014



First Solar.

Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

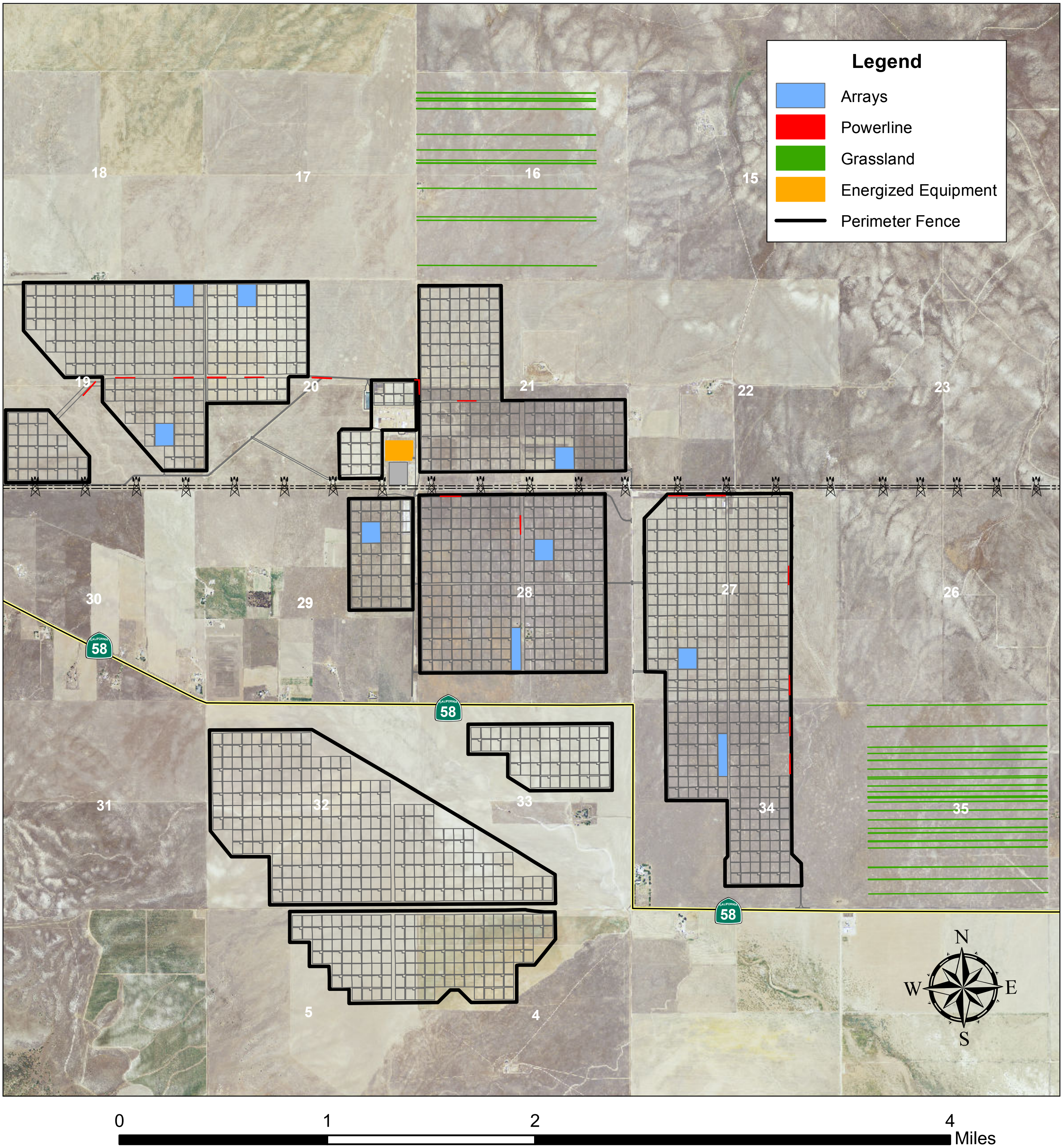
2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: April 10, 2014, 03:07 PM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Figure 4. Avian Fatality Survey Areas

January 2014 to March 2014



Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453
First Solar.

2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: April 10, 2014, 03:13 PM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Topaz Solar Farm

CA Department of Fish and Wildlife Transmittal

1st Quarter 2014

Topaz Solar Farm
10400 Helios Way
Santa Margarita, California 93453

Delivered via Electronic Mail

Quarterly Report

COA 62 Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan Quarterly Report

October 14, 2013

Discussion

This report has been prepared to address the reporting requirements for Condition of Approval (COA) 62 Bird Monitoring and Avoidance Plan. The BMAP report was prepared to include bats and the title revised to the Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP).

In response to COA 62, the Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP) has been prepared, which further describes the approach to implementing the condition requirements.

COA 62 requires quarterly and annual reports. Quarterly reports are required during construction and for three years following the beginning of the solar farm operation.

Following the completion of the fourth quarter of monitoring the biologist shall prepare an annual report that summarizes the year's data, analyzes any project-related bird fatalities or injuries detected, and provides recommendations (in consultation with the County) for future monitoring and any adaptive management actions needed.

Quarterly Reportable Items

COA 62 BMAP requires quarterly reports describing the dates, durations, and results of monitoring and data collection. The quarterly reports shall provide a detailed description of any project-related bird or wildlife deaths or injuries detected during the monitoring study or at any other time.

Report Data

Attached is the quarterly report prepared by Althouse & Meade (COA 62 and ABPP Quarterly Monitoring Report by Althouse & Meade October 15, 2013).

If there are questions regarding this report, please contact:

Timothy J. Higdon
First Solar Site Compliance Manager
Topaz Solar Farm
10400 Helios Way
Santa Margarita, CA

First Solar

ALTHOUSE AND MEADE, INC.
BIOLOGICAL AND ENVIRONMENTAL SERVICES
1602 Spring Street, Paso Robles, CA 93446
Telephone 805-237-9626

Topaz Solar Farms
10400 Helios Way
Carrisa Plains, CA

Dan Meade, Ph.D., Principal Biologist
Jason Dart, Project Ornithologist
Peter Gaede, Project Ornithologist

October 15, 2013

Avian and Bat Protection Plan

and

Bird Monitoring and Avoidance Plan

Quarterly Report for July 1 – September 30, 2013

This third quarterly report provides information pertinent to the reporting obligations regarding implementation of various tasks required by the Topaz Solar Farms Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (Althouse and Meade, Inc. June 2011). Section 5.5 of this plan requires quarterly reports to be submitted to the County of San Luis Obispo, U.S. Fish and Wildlife Service (USFW) and the California Department of Fish and Wildlife (CDFW). The Avian and Bat Protection Plan (ABPP) and Bird Monitoring and Avoidance Plan (BMAP) are requirements of County of San Luis Obispo Conditions of Approval (COA) 61 and 62, and were prepared in consultation with USFWS and CDFW.

Avian and Bat Protection Plan

The ABPP monitoring program compiles general information on bird and bat interactions, injuries, and mortality at the Topaz Solar Farms. During construction phases of the project this task is completed by the project biologists, as part of routine daily biological monitoring. Information regarding a detailed bird use and mortality risk assessment study is reported below under the BMAP section.

This quarterly report provides information spanning the period from July 1 through September 30, 2013. Construction of Blocks 1, 2, 3, and 6 (A and B) was completed by the end of the first quarter (March 2013); Blocks 4, 5, 7, and 8 were completed by end of the second quarter (June 2013); and Block 9 was completed during the current reporting quarter (July - September 2013). Blocks 1 through 9 are now managed through Operations and Maintenance (O&M). Blocks 10-15 are active construction areas as of September 30, 2013. Figure 1 illustrates construction status of blocks through September 2013.

Nesting Activity

General bird surveys were conducted on and around the project site by biological monitors. All nests and nest starts identified from July to September 2013 were documented. The results of surveys from July to September 2013 are provided in Table 1. Other species nesting offsite (e.g. mitigation lands or future project lands) are not included in this tally. A map of active nests for July to September is attached (Figure 2).

TABLE 1. BIRD NESTS. Bird nests detected at the Topaz Solar Farms from July through September 2013.

ID	Species	Date Found	Location	Buffer Size	Date Predated	Date Fledged	Date Inactive	Current Status	Notes
AE8	Burrowing Owl	7/1/13	West of Block 15 Stewardship Land	None (Outside Project Site)	n/a	Unknown	8/31/13	Inactive	There were two adults and two nestlings in July, last survey 8/31 no owls present
PG19	House Finch	7/8/13	Block 14 Array 19	75 feet to the north and south, 100 feet to the east and west	n/a	n/a	8/1/13	Inactive	Nest located in electrical coil; nestling found deceased on 8/1
GS46	Mourning Dove	8/30/13	Block 15 Array 15	25 feet	n/a	n/a	9/3/13	Inactive	Eggs determined to be not viable upon inspection following surveys

Avian and Other Wildlife Mortality

General biological monitoring of the Topaz work areas documented bird, bat, and other wildlife mortality. All mortality identified on site from July through September 2013 is provided in Table 2. Cause of death is reported when known.

TABLE 2. AVIAN AND OTHER WILDLIFE MORTALITY. Bird and other wildlife mortality detected at the Topaz Solar Farms from July through September 2013.

Species	Location	Cause of Death	Notes
July 2013			
Pacific Gopher Snake *Pituophis catenifer catenifer*	Block 11	Vehicle Strike	
Common Raven *Corvus corax*	Block 13	Presumed predation	Common raven kill site
California Ground Squirrel *Spermophilus beecheyi*	Dust Control Pond	Drowning	Removed ground squirrel carcass from DCP
California Ground Squirrel *Spermophilus beecheyi*	East perimeter road Block 14 Array 6	Vehicle Strike	Found in middle of road; probable vehicle strike
Common Raven *Corvus corax*	Block 13 Array 12	Unknown	Feather pile; no carcass; cause of death unknown
California Ground Squirrel *Spermophilus beecheyi*	Block 14 Array 19	Predation	Head, front feet, and half of abdomen removed; likely predation
August 2013			
Mourning Dove *Zenaida macroura*	Block 12	Unknown	Wing collected at fatality site
Common Raven *Corvus corax*	Block 13	Potential predation	Numerous common raven feathers
Barn Owl *Tyto alba*	Hotline Route between Blocks 9 and 11	Unknown	Juvenile; rest of carcass found near Arco building
Bat	Block 15 Array 5 in shipping container		Bat found by forklift operator on a panel box after it was removed from a transport container. Container was picked up by driver at the Port of Los Angeles.
Burrowing Owl (*Athene cunicularia*)	Cochrane Pond buffer	Presumed predation	Approximately 30 flight feathers; San Joaquin kit fox scat on feather pile
Domestic Cat *Felis catus*	Secure Laydown		Found crushed under metal conex/storage container in secure laydown. Appears to have been deceased for months as only skeleton, dentition, and fur remained. No soft tissue
September 2013			

Species	Location	Cause of Death	Notes
Unidentified Snake	Block 12 Array 15	Presumed equipment strike	

Adaptive Management

No adaptive management practices were implemented during the period from July 1 through September 30.

Bird Monitoring and Avoidance Plan

The BMAP study utilizes avian use surveys and avian fatality surveys to produce a risk index for various project components deemed to be potentially dangerous to birds, including array areas, overhead power lines and the Substation.

Avian Use Surveys

Avian Use Surveys commenced in November 2011, prior to the start of construction, to gather baseline data on bird use in the project area. Avian Use Surveys will inform the Bird Utilization Rate calculations. Construction commenced in late November 2011 in a limited footprint, and has expanded in area. Avian use surveys were conducted monthly from November 2011 through September 2013, and will continue throughout the construction period and for three years after construction is complete. Each month, 63 randomly selected survey points were completed, for a total of 1,450 survey points completed as of September 2013. The 63 survey points include 31 inside existing or future array areas, 18 along existing or future overhead power lines, 10 in grassland reference sites and 4 at the Substation. At each point, a 10 minute bird use count is conducted within a 50 meter radius of the surveyor.

Avian Use Survey points were randomly selected each month across all six phases of the project and in offsite grassland reference areas (Figure 3). Each month, as construction area increased in size, more of the survey points occurred in developed area. Those points located within future project areas that had not been developed at the time of the survey are categorized as baseline. Baseline condition is similar to reference site condition in that it is not developed, however it differs in being cropland habitat versus grassland habitat.

Avian Fatality Surveys

Avian Fatality Surveys commenced upon completion of the first project components. Avian Fatality Surveys are conducted at randomly selected locations within four different survey area types: Array areas, overhead power lines, energized equipment (Substation) and at reference sites. Each survey area type was divided into 500 foot by 15 foot search plots. Search plots are randomly selected using an ArcGIS random point generator having defined areas as the constraining polygon. Avian Fatality Surveys are conducted within the same search plots each day for seven consecutive days every month. Repetitive surveys increase the chance of finding fatalities in a given area before predators remove the carcass.

Each month, July through September, we completed walking Avian Fatality Surveys at 126 five hundred foot transects within completed Array area search plots, for 7 consecutive days each, totaling 882 search plots (83.5 linear miles, 155.5 acres). Powerline search plots included 3 five hundred foot transects, surveyed for 7 consecutive days each, totaling 2.0 linear miles (3.6 acres). A total of 12 one mile grassland reference site search plots were completed, for 7 consecutive days each, totaling 84 linear miles (152.7 acres). See Figure 4 (attached) for a map of Avian Fatality Survey areas for July to September 2013.

Scavenger/Carcass Removal Trials and Searcher Efficiency Trials

Scavenger Trials and Searcher Efficiency Trials are implemented to identify bias in the Fatality Survey data. For 2013, two Searcher Efficiency Trials will be conducted, one in spring and one in winter. Four Scavenger/Carcass Removal Trials will be conducted in 2103, one each in spring, summer, fall and winter. For the 3rd quarter reporting period, one Scavenger/Carcass Removal trial was conducted; no Searcher Efficiency Trials were conducted.

For both trials we used young commercially-available frozen Coturnix quail. The size and coloration of these birds is similar to meadowlarks and other native birds in the area, and therefore are deemed a suitable surrogate for local native birds. Data collected during the trials will be used to adjust the Year 2 Fatality Survey data that will be compiled in the annual report.

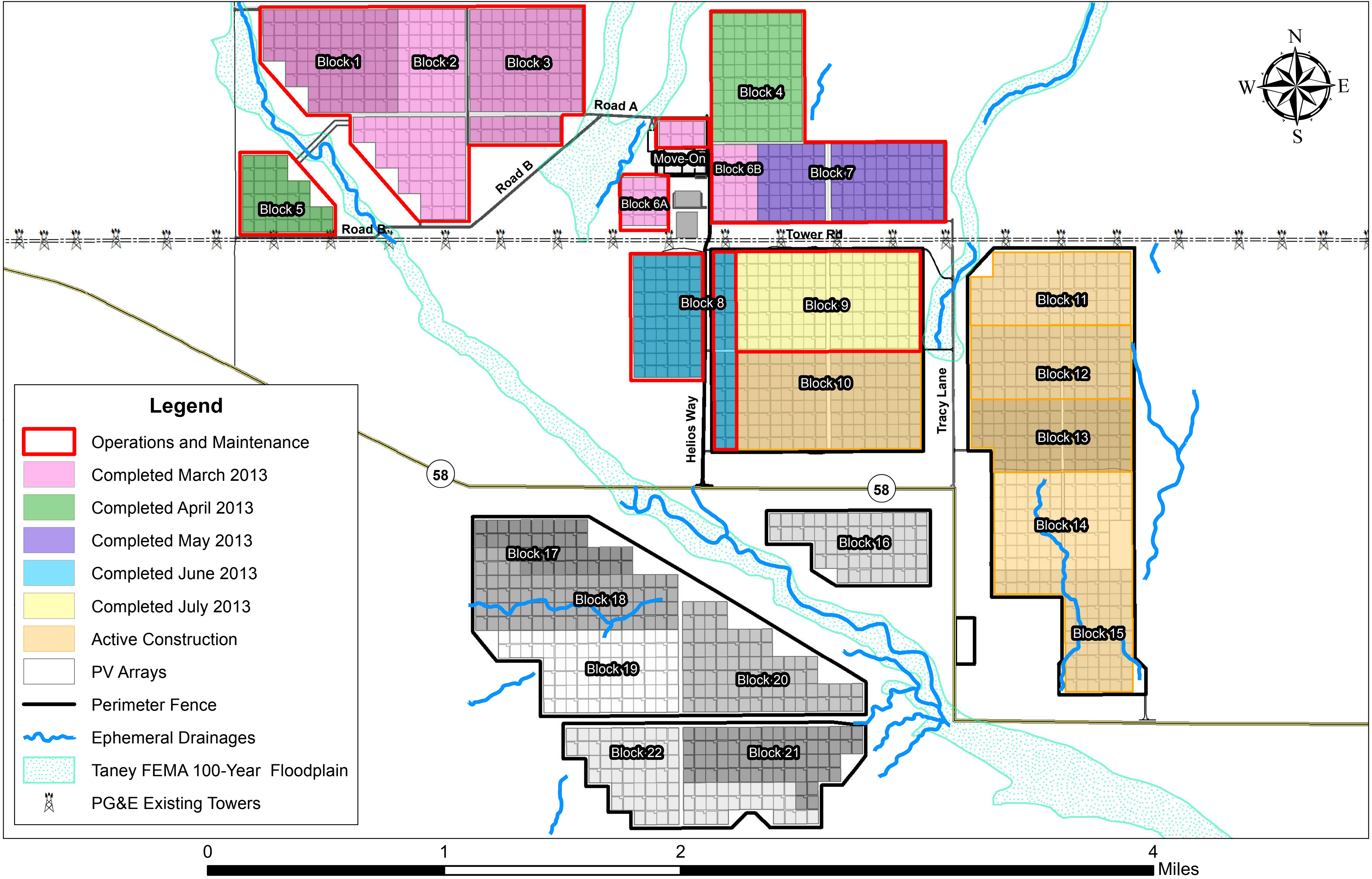
For the Scavenger/Carcass Removal trial, 30 birds were distributed in three treatment areas: 15 thawed quail were randomly placed in completed array area search plots, 15 in grassland reference site search plots, and 2 below overhead power lines.

For the Scavenger/Carcass Removal Trials, we set out the same number and arrangement of birds in each of the three search plot types. Carcasses were checked every day for the first three days after placement, twice a week for the next two weeks, then once per week for the remainder of the 60-day trial, or until all birds were gone.

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Figure 1. Construction Status

As of September 30, 2013

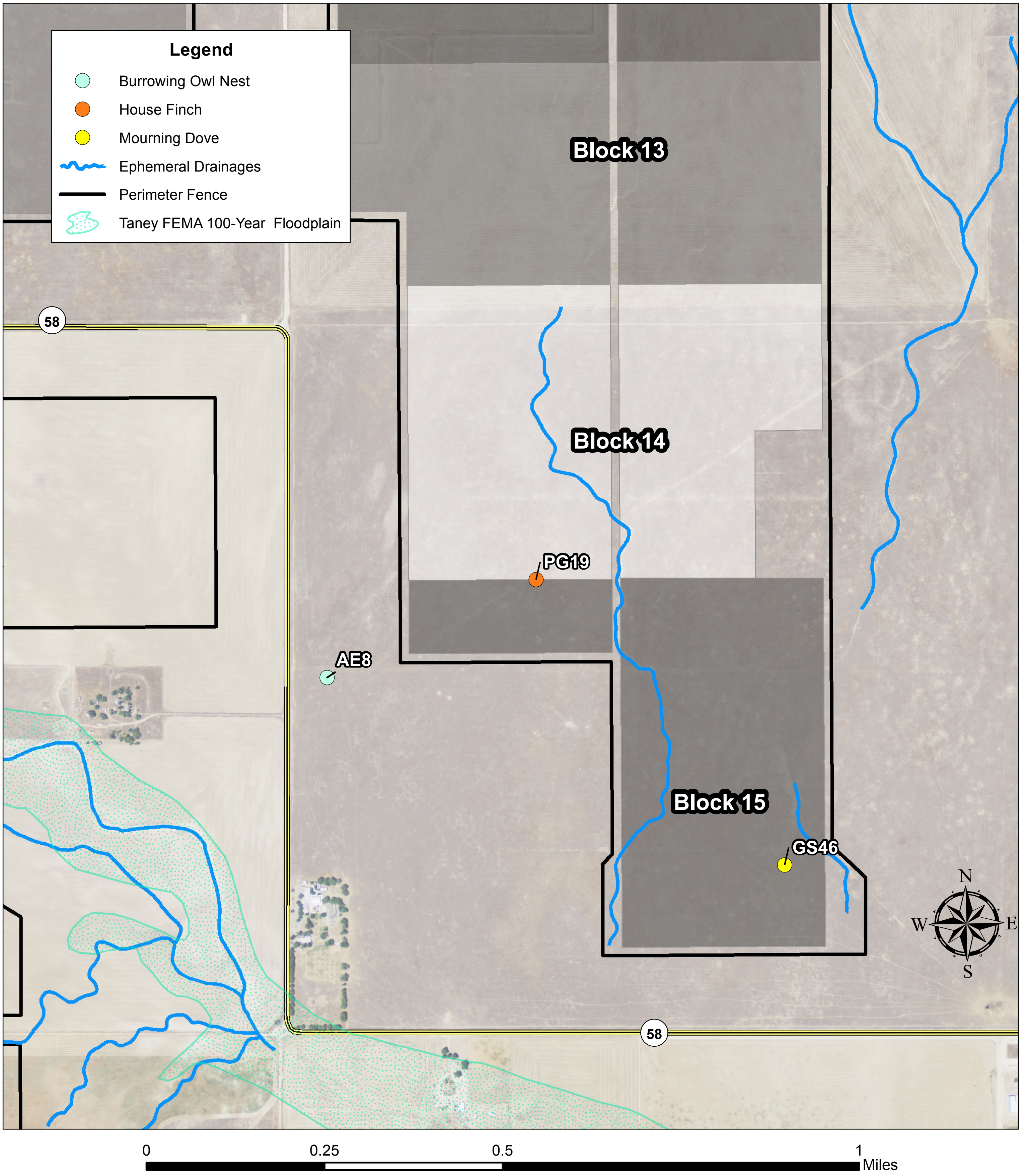


First Solar.
Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

Map Updated: October 10, 2013 08:56 AM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Figure 2. Active Bird Nests
July 1 - September 30, 2013

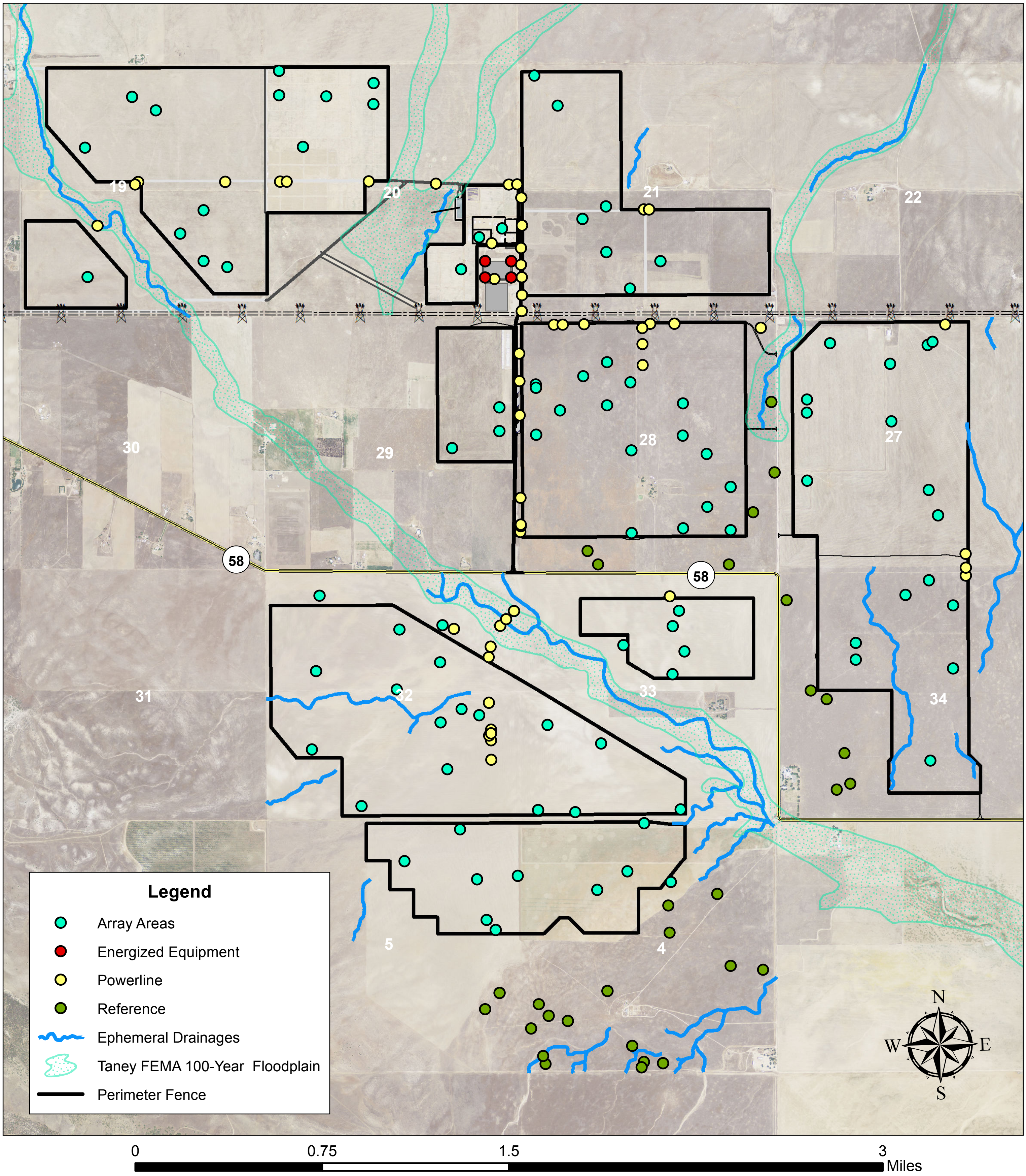


Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

Map Updated: October 15, 2013 08:34 AM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Figure 3. Avian Use Survey Points
July 1 - September 30, 2013



Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

Map Updated: October 10, 2013 10:02 AM

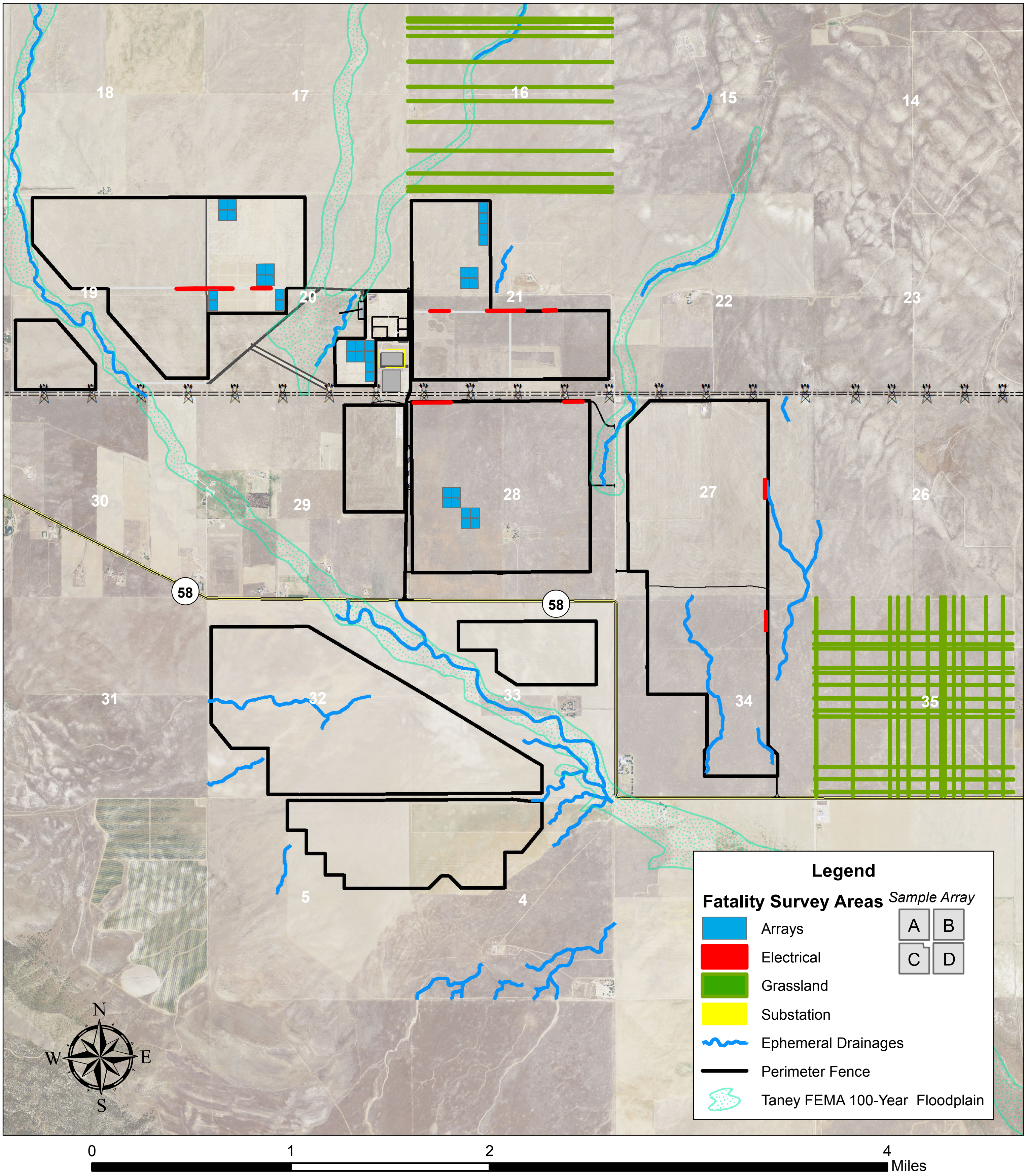
Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

Additional Documentation Attachment to Comment 2-F1

Attachment I-3

Figure 4. Avian Fatality Survey Areas

July 1 - September 30, 2013



Topaz Solar Farms, LLC
10400 Helios Way
Santa Margarita, CA 93453

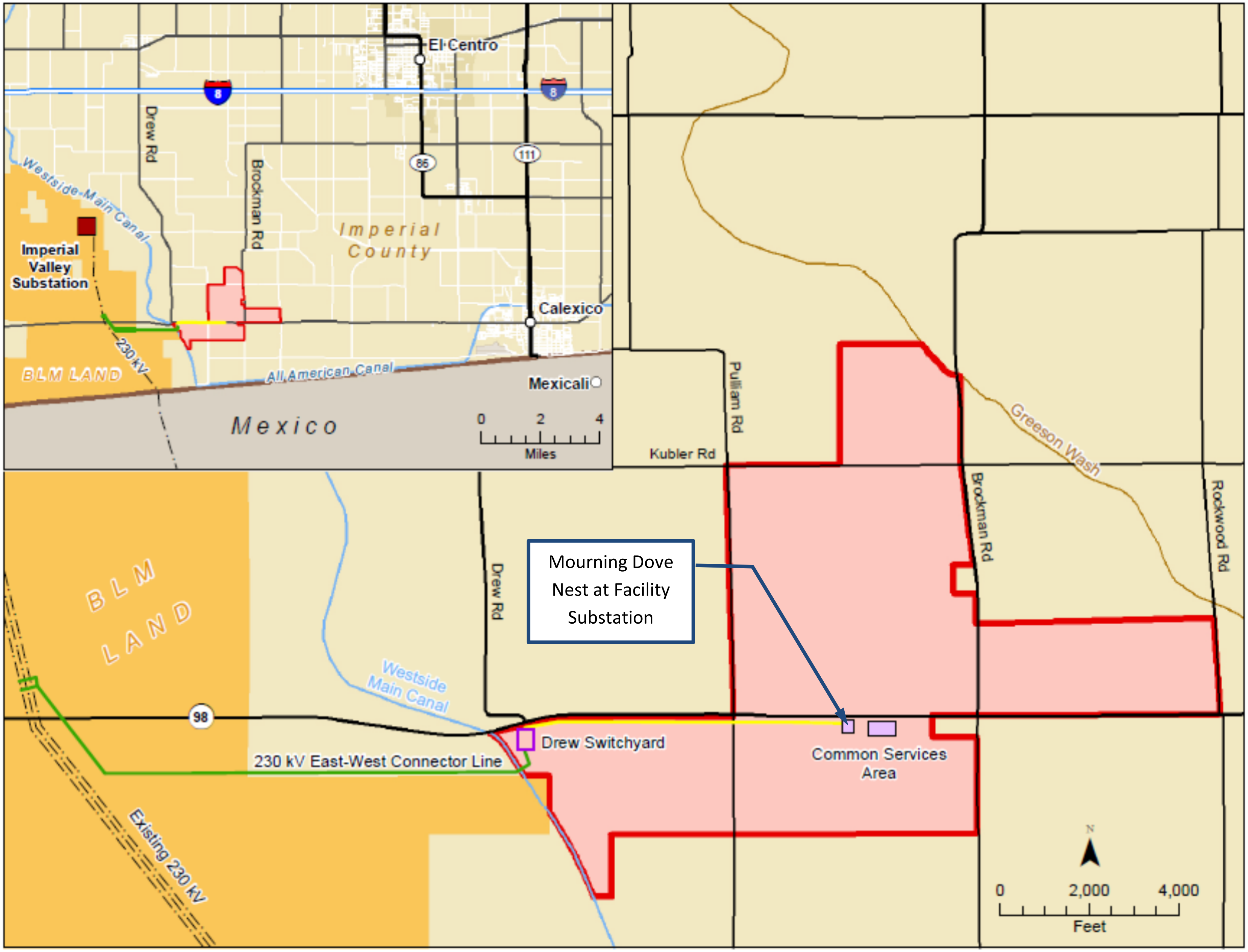
Map Updated: October 10, 2013 10:17 AM

Althouse and Meade, Inc.
1602 Spring Street
Paso Robles, CA 93446

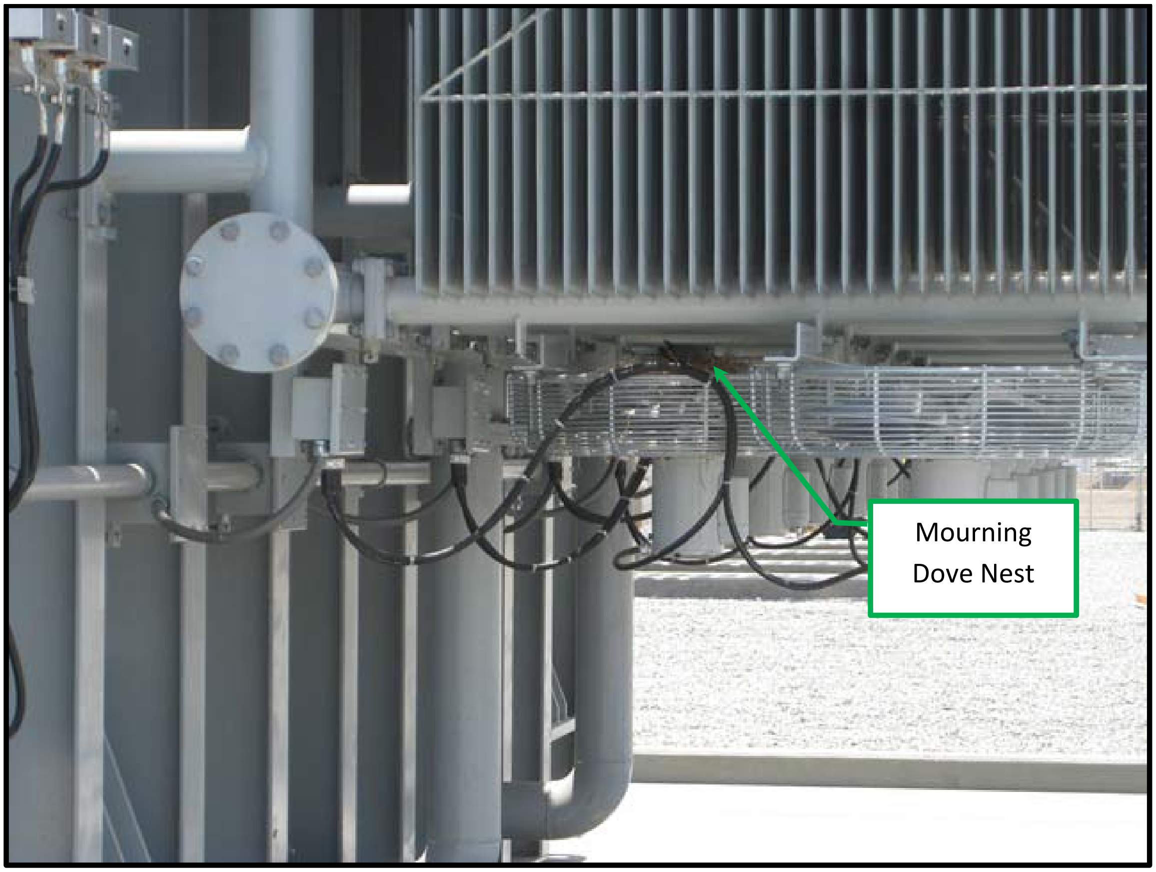
Topaz Solar Farm

CA Department of Fish and Wildlife Transmittal

3rd Quarter 2013


El Centro
8
8
Drew Rd
Brockman Rd
86
111
Westside Main Canal
Imperial County
Imperial Valley Substation
Calexico
230 kV
BLM LAND
All American Canal
Mexicali
Mexico
0
2
4
Miles
Pulliam Rd
Kubler Rd
Greeson Wash
Brockman Rd
Rockwood Rd
Mourning Dove Nest at Facility Substation
Drew Rd
BLM LAND
Westside Main Canal
98
Drew Switchyard
Common Services Area
230 kV East-West Connector Line
Existing 230 kV
N
0
2,000
4,000
Feet


Mourning Dove Nest Underneath Transformer


Mourning Dove Nest

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Southwest Region
2800 Cottage Way, Suite W-2606
Sacramento, California 95825

In Response Reply To:
FWS/R8/MB

September 11, 2014

Susan Comensky
External & Regulatory Affairs VP
Campo Verde Solar, LLC
600 North 18th Streeet
Birmingham, AL 35203

Dear Ms. Comensky,

Enclosed is your new Special Purpose Utility Permit for Campo Verde Solar, LLC The permit authorizes you and subpermittees to collect, transport and temporarily possess carcasses and partial remains of birds protected under the Migratory Bird Treaty Act (16 U.S.C. 703 et seq.) found on project property and rights-of-way, in accordance with permit conditions. Please read your permit carefully.

Following the permit conditions, bird carcasses may be used for searcher efficiency and scavenger removal trials; carcasses used in trials must be reported to the Service as outlined in Condition E(4) and H(1)(d). You may also transfer carcasses to authorized entities as allowed by the terms of this permit. To comply with your permit reporting requirements, we ask that you submit your data using the "R8 SPUT mortality reporting" spreadsheet we have provided via email.

Feel free to contact me if you have any questions regarding your permit.

Sincerely,

Heather Beeler

Heather Beeler
Eagle Permit Coordinator/Energy Permit Specialist

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

30 January 2014

Justin Sloan
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
1130 E. Shaw Ave., Suite 206
Fresno, CA 93710

John McKenzie
Senior Environmental Planner
SLO County Planning & Building Department
Environmental Division
976 Osos Street, Room 200
San Luis Obispo, CA 93408

Dave Hacker
Environmental Scientist
California Department of Fish and Wildlife
Region 4 Renewable Energy Projects
3196 Higuera Street, Suite A
San Luis Obispo, CA 93401

Subject: California Valley Solar Ranch Project Avian Bat Protection Plan 2013 Avian Activity Surveys Report

Dear Sirs:

On behalf of High Plains Ranch II LLC, we are submitting the 2013 Avian Activity Surveys Report for the California Valley Solar Ranch (CVSR) Project, San Luis Obispo, California. This report is being submitted per the reporting requirements of the CVSR Avian Bat Protection Plan in compliance with the U.S. Fish and Wildlife Service Biological Opinion (81420-2011-F-0511) and San Luis Obispo County Conditional Use Permit (DRC2008-00097) for the California Valley Solar Ranch, San Luis Obispo California. As required to satisfy, San Luis Obispo County Condition of Approval #58 of the CVSR Project Conditional Use Permit, we are submitting these reports to the County, U.S. Fish and Wildlife Service, and California Department of Fish and Wildlife.

If you should have any questions or comments, please do not hesitate to contact me at (408) 426-7326 or jklingmann@harveyecology.com.

Sincerely,

Julie Klingmann
Associate, Senior Wildlife Ecologist

cc: Dave Hacker, California Department of Fish and Wildlife
Office of the General Counsel, California Department of Fish and Wildlife w/o enclosure
Climate Science and Renewable Energy Program, California Department of Fish and Wildlife w/o enclosure
Justin Sloan, US Fish and Wildlife Service
Ray Kelly, NRG Solar, LLC
Bill Cotton, NRG Solar, LLC
Paul Zavesoff, High Plains Ranch II, LLC

Cal Poly Technology Park, Building 83, Suite 1B • San Luis Obispo, CA 93407 • Ph: 805.756.7400 • F: 805.756.7441

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

10 April 2014

Justin Sloan
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
1130 E. Shaw Ave., Suite 206
Fresno, CA 93710

John McKenzie
Senior Environmental Planner
SLO County Planning & Building Department
Environmental Division
976 Osos Street, Room 200
San Luis Obispo, CA 93408

Dave Hacker
Environmental Scientist
California Department of Fish and Wildlife
Region 4 Renewable Energy Projects
3196 Higuera Street, Suite A
San Luis Obispo, CA 93401

Subject: California Valley Solar Ranch Project Avian Bat Protection Plan Annual Fatality Report

Dear Sirs:

On behalf of High Plains Ranch II LLC, we are submitting the Annual Fatality Report for the California Valley Solar Ranch (CVSR) Project, San Luis Obispo, California. This report is being submitted per the reporting requirements of the CVSR Avian Bat Protection Plan in compliance with the U.S. Fish and Wildlife Service Biological Opinion (81420-2011-F-0511) and San Luis Obispo County Conditional Use Permit (DRC2008-00097) for the California Valley Solar Ranch, San Luis Obispo California. As required to satisfy, San Luis Obispo County Condition of Approval #58 of the CVSR Project Conditional Use Permit, we are submitting these reports to the County, U.S. Fish and Wildlife Service, and California Department of Fish and Wildlife.

If you should have any questions or comments, please do not hesitate to contact me at (408) 426-7326 or jklingmann@harveyecology.com.

Sincerely,

Julie Klingmann
Associate, Senior Wildlife Ecologist

cc: Ray Kelly, NRG Solar, LLC
Bill Cotton, NRG Solar, LLC
Paul Zavesoff, High Plains Ranch II, LLC
Brian Boroski, H. T. Harvey & Associates

Cal Poly Technology Park, Building 83, Suite 1B • San Luis Obispo, CA 93407 • Ph: 805.756.7400 • F: 805.756.7441

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch Project Avian and Bat Protection Plan Annual Postconstruction Fatality Report

16 August 2012 – 15 August 2013

Prepared for:

HPR II, LLC
California Valley Solar Ranch
13505 Carissa Highway, Highway 58
Santa Margarita, CA 93453
Attn: Bill Cotton

Prepared by:

H. T. Harvey & Associates
Project # 3326-03

Prepared per:

Avian And Bat Protection Plan for the California Valley Solar Ranch Project

U.S. Fish and Wildlife Service
Biological Opinion (81420-2011-F-0511)
San Luis Obispo County
Conditional Use Permit (DRC2008-00097)

28 March 2014

Executive Summary

Background

The California Valley Solar Ranch Project (CVSR Project) is a 250-megawatt photovoltaic solar power plant recently constructed within an approximately 4685-acre site (Project site), located mostly south of State Route (SR) 58, about 6.4 kilometers (km) east of Soda Lake Road, immediately north of the California Valley subdivision, in the Shandon-Carrizo planning area of San Luis Obispo County (Figure 1). The Conditional Use Permit for the CVSR Project required that an Avian and Bat Protection Plan be prepared and implemented to monitor the impacts of the CVSR Project on birds and bats after construction. In compliance with the resultant Avian and Bat Protection Plan, this Annual Postconstruction Fatality Report documents the number of avian and bat fatalities counted during postconstruction monitoring of the Project between 16 August 2012 and 15 August 2013.

Methods

H. T. Harvey & Associates (HTH) biologists conducted weekly surveys in the following CVSR Project elements: Array 1, Array 2, Array 2 Serengeti, Array 4, Array 5, Array 8, the Medium-voltage Overhead (MVOH) Line, and the Generation-tie (Gen-Tie) Line. During the reporting period, all arrays were surveyed each week at 20% of their total area, with the exception of Arrays 1 and 2, which were surveyed with 100% coverage to inform and strengthen our sampling methods. By collecting data at 100%coverage of these arrays, we were able to determine the spatial pattern of fatalities within the arrays and determine how much of the arrays would need to be surveyed to attain a given confidence level for developing an accurate fatality estimate for increasing our understanding of impacts to avian species from operating solar energy facilities. Further, these arrays were surveyed at 100% for a full year to detect whether or not the distribution of fatalities varied by season. For each of the arrays listed, biologists also surveyed portions of the surrounding fence. Additionally, to help identify the proportion of fatalities found that could be attributed to natural mortality rates, we surveyed control plots, located in Conservation Lands surrounding the CVSR Project site.

In addition to performing weekly surveys, HTH biologists conducted a series of repeat surveys: 5-day repeat surveys, in which biologists searched the same subset of a Project element for 5 consecutive days, and 1-day repeat surveys, in which biologists searched a subset of an area that was searched 1 day previously by either 5-day repeat searchers or weekly searchers. The purpose of these repeat surveys was to check the efficiency of searchers and evaluate the consistency of results; however, as reported herein, not all of the repeat surveys proved necessary.

To estimate the rate of avian and bat fatalities occurring on the site, we used Huso's Fatality Estimator (2010). In formulating a fatality estimate, it was necessary to determine 1) the rate of scavenging that occurs on the site, and 2) how well searchers find different-size carcasses in different amounts of vegetation cover. These determinations were made by 1) planting fresh carcasses of birds of various sizes and placing camera traps on them to identify scavenger species and the exact time of carcass removal, and 2) planting both carcasses and feather spots of different sizes in different vegetation classes while regular weekly and repeat surveys were taking place. Searcher-efficiency and carcass-removal rates were then used to adjust the annual count of fatalities to arrive at a site-wide fatality estimate.

Results and Discussion

Mean time to scavenging for all placed carcasses was 3.3 days and ranged from as little as 7 minutes to as long as 53 days. The carcass that persisted for 53 days was an outlier by 31 days; after removing this outlier from the analysis the mean time to scavenging was 2.8 days. Within 24 hours of placement, 54.4% of carcasses had been scavenged and 26.3% had been removed entirely (with no trace evidence). Within 7 days of placement, 86.9% of the carcasses had been scavenged, and 38.4% had been removed entirely. Ravens were the most common scavenger, and scavenged more than half of the carcasses placed. Ravens also scavenged carcasses the fastest, with a mean time to scavenging of 2.5 days (and a mean time of 1.5 days with the 53-day outlier dropped). Ravens scavenged three carcasses less than 1 hour after placement, and 72.5% of carcasses within 24 hours. San Joaquin kit foxes scavenged 20 carcasses, and had the second fastest scavenging time, with a mean time to scavenging of 3.6 days.

Of the carcasses placed, small carcasses were scavenged more quickly than large carcasses and more likely to be completely removed (80.6% of small birds scavenged were completely removed compared to 22.2% for large birds); consequently, only 19.5% of the small carcasses removed left evidence (partial carcass or feather spot) of the fatality, whereas, 77.7% of the large carcasses scavenged left evidence of the fatality. A logical extension of this finding is that the creation of a feather spot when a bird is preyed upon by an avian or mammalian predator is likely to occur at least as often as the creation of a feather spot during a scavenging event and feather spots created by depredated birds are likely to persist and be detected during searches at rates equal to feather spots created from scavenged carcasses.

The persistence of carcasses in the environment varied by season and Project element; carcasses placed in the control plots were scavenged more quickly than those along the Gen-tie Line, and carcasses placed in the arrays had the longest persistence time prior to being scavenged.

During the reporting period, searchers detected 94 of 177 (53%) of the fatality plants that were randomly placed in operational arrays, control plots, underneath overhead lines, and along fence lines across the CVSR Project site. Overall, searcher detection rates were higher below overhead lines and along fencelines (56%) than rates in the solar panel arrays (50%). Furthermore, the detection rate in surveyed rows within the arrays was slightly higher than in un-surveyed rows, which is expected as detectability generally declines with distance from the observer. Searcher efficiency was greatest during winter months (63%) and for large–sized carcasses (61% efficiency as opposed to 43% for small sized sparrows). Carcass size and visibility class, based on vegetation height and cover, were the most important indicators of how well searchers located fatalities. Scent detection dogs could be used to increase searcher efficiency rates, particularly where dense vegetation obscures fatalities, to improve the precision of the fatality estimates. If scent dogs prove significantly better during bias trials, we recommend considering the use of scent dogs to conduct fatality searches.

Causes of death were often difficult or impossible to determine from feather spots and carcasses found in the arrays. In a few cases, carcasses were found with no apparent injuries; in other cases, injuries (e.g., broken necks) indicated that a collision was the cause of death. Determining the cause of death from feather spots was even more difficult. We found feather spots on the ground near panels and on panels themselves. Fatalities may have occurred as a direct or indirect result of the presence of solar panels (e.g., a bird stunned by a collision with a panel can then be more easily predated), or they may indicate direct mammalian or avian predation. Solar panels likely contribute to direct and indirect causes of death for birds, but in many cases, it was not possible to determine cause of death. Because the ratio of feather spots to found carcasses was 20:3 during the reporting period, the inability to partition feather spots associated with collisions and feather spots stemming from predation has important implications regarding inferences that can be drawn from the fatality estimate.

Accounting for the spatial organization of avian fatalities is an important aspect of designing surveys and making decisions about future sampling, monitoring, and avoidance and minimization strategies. The geostatistical analysis of the dispersion of avian fatalities in Array 1 and Array 2 separately sampled at 100%, as well as in both arrays combined, indicates that the dispersion of fatalities is not significantly different from a random distribution. Knowing that fatalities are randomly distributed within arrays at the Project site is important for designing future sampling because there are no observable high concentrations (clumping) of avian fatalities that need to be taken into consideration. Moreover, a random dispersion pattern indicates that the probability of detecting an avian fatality should not change as a function of the amount of area (or number of tracker units) searched.

We used the fatality values from Arrays 1 and 2, which were searched in their entirety during the reporting period, to determine how the proportion of each array surveyed affects the accuracy of fatality estimates and confidence intervals.. Given the random dispersion of avian fatalities seen during the study period, and the error analysis for a given area searched, we recommend reducing monitoring to 20% of the total area in each array or array group. Also, each surveyed sample should comprise 30–35 tracker units; to meet this requirement, small arrays (e.g., Array 5) should be grouped with other small, neighboring arrays so that 20% of a given set comprises at least 30 tracker units.

On this Project site, fatalities rates were not high enough to obtain accurate samples during 1-day and 5-day repeat surveys from such small survey areas. As a result, we recommend discontinuing the 1-day and 5-day repeat surveys. We recommend that daily searches generally not be conducted to obtain a fatality estimate because they are labor intensive and labor is generally offset by surveying smaller areas. Given the tradeoff between area covered and frequency of searches, it is better to conduct regular weekly searches of a larger proportion of the site. Daily searches would be most useful if they are necessary to answer specific research questions, for example linking fatalities to weather patterns or to test a deterrent method or some other form of mitigation where knowing more precise timing of fatalities is important, but data gathered for answering these questions should not be used to obtain a site-wide estimate.

We recommend avoiding multiple searches of the same area at different time intervals. If surveys are conducted at various search intervals on the same area to answer research questions, we recommend that the different search strategies be designed to avoid interfering with each other. For example, daily searchers would not collect fatalities so they will still be present for weekly searchers to find.

A total of 357 fatalities were found during surveys of Project elements between 16 August 2012 and 15 August 2013; and an additional 11 fatalities were observed during surveys of control plots within conservation lands. It is important to note that this total comprises observations obtained during clearance surveys, weekly surveys, and 1-day and 5-day repeat surveys. The total number of fatalities observed at various Project Elements, consequently, may be larger than the sample sizes used to conduct overall fatality estimates for Project Elements because fatalities older than the search interval and fatalities found during clearance surveys and 5-day repeat surveys are not used to calculate the overall fatality estimates. Fatality estimates based on weekly searches and 5-day repeat searches were calculated separately.

The majority of fatality species represented year-round avian residents. In total, we found fatalities of 31 different avian species. Nearly all of the species utilize a terrestrial foraging zone; the two exceptions were a single American coot (*Fulica americana*) found along the Gen-tie and a single tree swallow (*Tachycineta bicolor*) found within a control plot. Horned larks, house finches (*Carpodacus mexicanus*), and mourning doves accounted for the greatest proportion of fatalities. Horned larks and mourning doves commonly roost and nest under the solar panels, and the two species combined represent 63% of the total number of fatalities found within the arrays. Documented special-status species fatalities comprised burrowing owl (*Athene cunicularia*), short-eared owl (*Asio flammeus*), long-eared owl (*Asio otus*), and loggerhead shrike (*Lanius ludovicianus*) fatalities. The total count of special-status species fatalities was small compared to the overall count.

In general, we estimated fatalities to be more abundant in the spring and less in the summer. This pattern is likely associated with the peak avian activity in the spring and the subsequent decline in activity in the summer, both documented through onsite avian point counts (HTH 2013). Because birds were more active on the Project site in spring, predation rates and collision rates are likely to be higher.

The Gen-tie Line was the only Project element that was searched for a full year during this reporting period because Project construction was completed during 2012. Eighty-three fatalities were found along the Gen-tie line and, based upon scavenging rates and searcher efficiency, we estimated that 446 fatalities occurred along the Gen-tie during this reporting period. We recommend that linear controls should be used to evaluate fatality rates along both the Gen-tie and MVOH Lines. Point counts targeting both raptors and passerines should be conducted in arrays and along linear features, allowing comparisons to data on activity on the Conservation Lands. These counts and comparisons would indicate whether fatality rates are associated with species abundance.

Project elements became operational and began to be searched at different times of the year, and the number of tracker units surveyed differed among arrays. Therefore, direct comparisons of fatality rates among and between Project elements are not made in this first year's fatality report. At the conclusion of all fatality searches next year, HTH will have collected enough data to report on seasonal differences in fatality rates, differences among arrays, and estimated fatalities per megawatt (a measure of avian and bat impacts that can be used to compare effects among various energy generation facilities).

We estimated that 231 fatalities occurred over a full year in Array 1 (90% confidence intervals: 162, 382) based on 47 fatalities found, and 187 fatalities in the control plots (90% confidence intervals: 107, 367) based on 11 fatalities found. This resulted in an adjusted fatality range 90% confidence interval of 55-275 attributable to the array, or 0.83 to 4.167 fatalities per tracker per year. This corresponds to a mean rate of 7.34 (90% Confidence interval: 3.24 to 16.27 fatalities per MW per year, assuming 0.256MW per tracker).

There are several caveats to keep in mind when interpreting these estimates. As we reanalyze data with full years of surveys for the remaining arrays and control plots these estimates will likely change. Our sample area of control plots in this calculation was based on surveys of 22 tracker sized control plots, which we now know from resampling is a low sample size to calculate fatality rates from, especially for an area as large as the on-site conservation land at the CVSR Project. This is also a conservative adjustment, using only the lower bound of the confidence interval or minimum estimated number of background fatalities.

As we complete full years of surveys for the remaining arrays, this estimate will likely change. Furthermore, because the ratio of feather spots to found carcasses was 20:3 during the reporting period, the inability to partition feather spots associated with collisions and feather spots stemming from predation has important implications regarding inferences that can be drawn from the fatality estimate. We are examining relationships within the existing data set in an attempt to quantify the relative contribution of predation events to the overall fatality estimates.

Table of Contents

Figures

Tables

Photo

Appendices

List of Contributors

Brian B. Boroski, Ph.D., Vice President and Principal-in-Charge, Wildlife Ecology

Scott B. Terrill, Ph.D., Vice President, Ornithology

David Johnston, Ph.D., Project Manager, Associate Wildlife Ecologist

Jarrod Santora, Ph.D., Senior Quantitative Ecologist

Kim M. Briones, M.S., Wildlife Ecologist

Meredith K. Jantzen, M.S., Field Biologist

Elizabeth L. Porzig, Ph.D., Quantitative Ecologist

Gabe A. Reyes, M.A. Candidate., Wildlife Ecologist

Sara A. Snyder, M.S. Candidate., Wildlife Ecologist

Stephen L. Peterson, M.S., Wildlife Ecologist I

Section 1.0 Introduction

Through adoption of Resolution #2011-119, the Board of Supervisors of San Luis Obispo County (the County) approved the California Valley Solar Ranch Project (CVSR Project) Conditional Use Permit (DRC 2008-00097) on 19 April 2011. The Conditional Use Permit is subject to the Conditions of Approval (COAs) set forth in Exhibit 6 attached to the Resolution.

The Conditional Use Permit allows High Plains Ranch II, LLC (and any successor in interest for the life of the CVSR Project) to construct and operate a 250-megawatt photovoltaic solar power plant within an approximately 4685-acre site (Project site), located mostly south of State Route (SR) 58, about 6.4 kilometers (km) east of Soda Lake Road, immediately north of the California Valley subdivision, in the Shandon-Carrizo planning area of San Luis Obispo County (Figure 1).

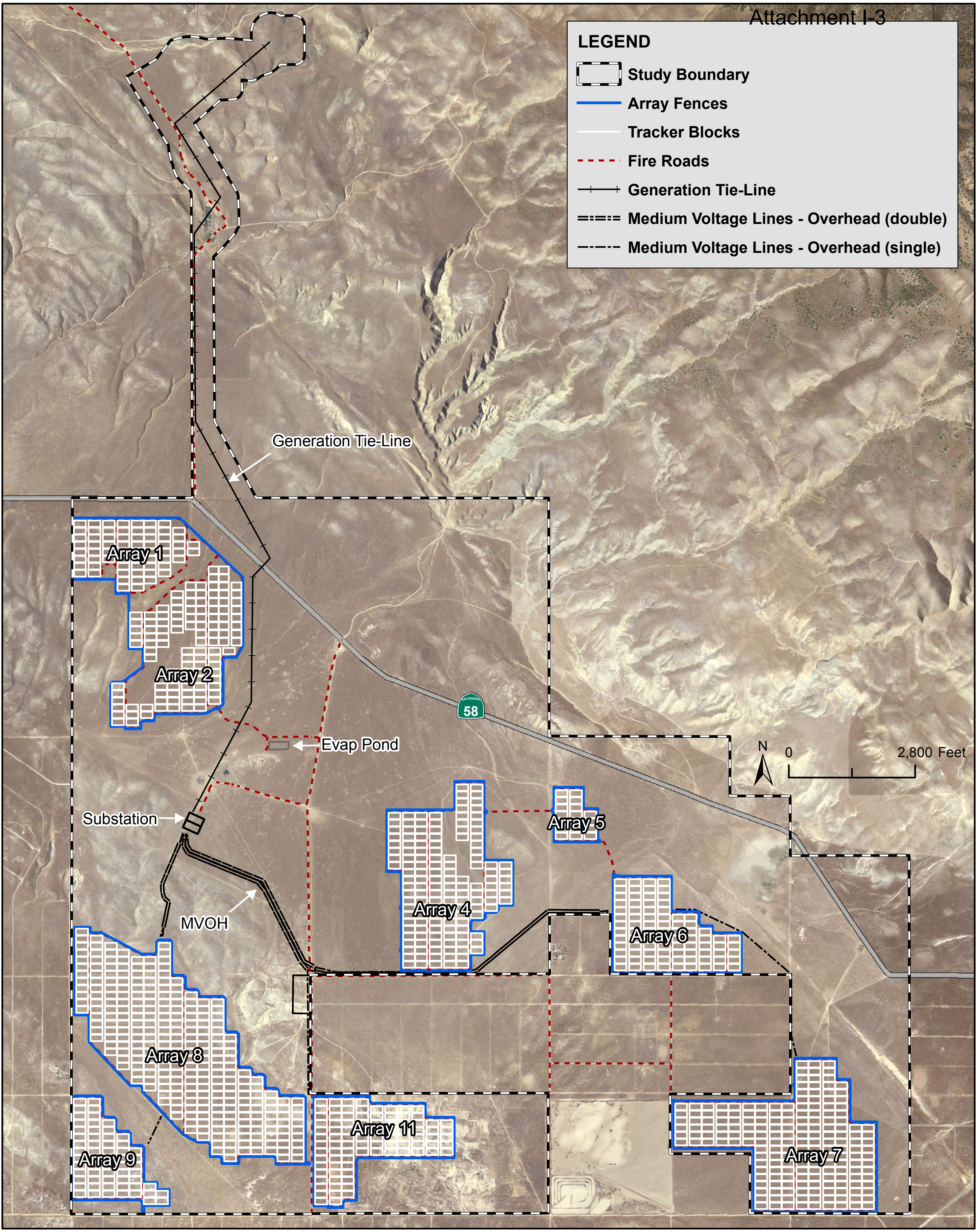
COA #58 of the Conditional Use Permit requires an Avian and Bat Protection Plan (ABPP) and an annual report detailing any Project-related bird or bat deaths or injuries detected during the monitoring study defined in COA #58c. To satisfy COA #58c, H. T. Harvey & Associates (HTH), on behalf of High Plains Ranch II, LLC, has prepared this postconstruction fatality report, which documents the number of avian and bat fatalities counted during Project postconstruction monitoring between 16 August 2012 and 15 August 2013.

One of the primary goals of this report is to provide estimates of the numbers of fatalities associated with different Project elements. To meet this objective, we used the Fatality Estimator (Huso 2010). In addition to performing regular weekly searches, we conducted searcher-efficiency trials to estimate the percentage of fatalities of different sizes found by searchers in both short and tall vegetation. To calculate the persistence of fatalities in the environment, we also conducted carcass-removal trials. The values we derived from both carcass-removal trials and searcher-efficiency trials were used in tandem with the results of our regular weekly searches to calculate estimated ranges of fatalities associated with different Project elements. Additionally, to obtain an estimate of background mortality levels, we conducted controlled searches in control plots located in onsite Conservation Lands. Finally, as a secondary, independent measure of fatalities, we conducted a series of repeat searches with more highly concentrated search intervals. This annual report presents methods, results, and a discussion of the searcher-efficiency trials, carcass-removal trials, regular weekly fatality searches, and all repeat fatality searches. Project elements searched during the reporting period were the Generation-tie (Gen-tie) Line; the Medium-voltage Overhead (MVOH) Line; Arrays 1, 2, 4, 5, and 8; the perimeter fences; and control plots associated with Arrays 1, 2, 4, and 8.

To determine the appropriate amount of sample area in which to conduct fatality searches for estimating total fatalities per year, we considered whether the spatial distribution of detected fatalities, as well as their temporal persistence, may vary according to the amount of area searched (or total number of tracker units searched). (Each tracker unit comprises 18 rows of solar panels, with 40 panels to a row.) Because of the complete survey effort (100% coverage) focused on Arrays 1 and 2 over the course of an entire year, we were able to provide a statistical assessment of how reduced area covered influences the uncertainty around our estimates, and recommend a level of survey coverage that would provide reasonable estimates).

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Annual 2013 Report\Figure 1 Project Site.mxd

HPR II

H.T. HARVEY & ASSOCIATES

Ecological Consultants

California Valley Solar Ranch

ABPP Annual Postconstruction Fatality Report

Figure 1: Project Site with Gen-tie Line, MVOH Line, and Nine Arrays

Section 2.0 Methods

2.1 Field Methods

2.1.1 Weekly Fatality Searches

To estimate the total number of fatalities associated with different Project elements during the reporting period, we conducted a series of weekly fatality searches on different Project elements. Because the construction of different Project elements was completed at different times, fatality searches began at varying times in the year, depending on the Project element searched (Table 1). We documented a fatality event each time a carcass or a feather spot was found. We considered a feather spot a fatality if it had at least two or more primary flight feathers, five or more tail feathers, or ten or more feathers of any type concentrated together in an area 1 square meter (m^2) or smaller (Smallwood 2007).

Preening spots often have fewer feathers and are more spread out than feather spots associated with fatalities. Roosting areas rarely contain primary or secondary feathers, but are often dotted with droppings. In the solar arrays, we regularly observed flocks of mourning doves (*Zenaida macroura)*, and horned larks (*Eremophila alpestris*) roosting. Mourning doves exhibit a complex molt strategy, which can occur year round and includes preformative, prealternate, and definitive prebasic molts (Otis et al. 2008). Likewise, horned lark adults and first-year birds undergo a definitive prebasic molt at the end of the breeding season (typically the end of July) (Beason 1995). Searchers used their biological knowledge to determine whether or not feathers from mourning doves, horned larks, or other species known to be in a molt period should be recorded as a fatality. When feathers were determined to be part of a molt or roost spot, no data were taken.

We gave each fatality a unique incident number. Incident numbers were written as follows: YYYYMMDD-#. Each searcher recorded a unique set of numbers, so data can be traced back to individual searchers. To further verify species identifications, we took photos of each fatality, and when necessary, we consulted Scott and McFarland's Bird Feathers identification book (2010). For each fatality, we recorded location (using Universal Transverse Mercator [UTM] coordinates), time found, taxon, common name, four-letter alpha code, carcass condition, parts found, number and types of feathers, and estimated time since death. Whenever possible, we recorded information about the age and sex of the fatality, as well as scavenger type. Additionally, we gathered information on the size and spread of the feather spot and the surrounding substrate, vegetation height, and percent vegetation cover, as well as whether the fatality occurred in a searcher or non-searcher row (for fatalities found in the arrays). All carcasses and feather spots discovered by regular weekly searchers were removed.

Table 1. Fatality Search Commencement Dates by Project Element

Project Element	Date Fatality Searches Began	Survey Period (Days)
Gen-tie Line	6 June 2012	435
Array 1	20 September 2012	329
Array 2 (Serengeti portion only)	25 September 2012	63
Array 1 control plot	1 November 2012	287
Array 1 and 2 fence	25 September 2012	324
Array 2 North (including Serengeti) and South	27 November 2012	261
Array 2 control plot	30 October 2012	289
Array 8 (20% sample)	7 January 2013	220
Array 4 (20% sample)	9 January 2013	218
Array 4 control plots	6 February 2013	190
Array 4 fence (20% sample)	16 January 2013	211
Array 5 and fence (20% sample)	9 January 2013	218
MVOH Line	30 January 2013	197
Array 8 control plots	4 February 2013	192
Array 8 fence (20% sample)	20 May 2013	87

Note: The Serengeti portion of Array 2 was searched separately only until 27 November 2012, so the Survey period reflects the time when the Serengeti portion was sampled separately from the rest of Array2.

Weekly fatality searches were performed along the Gen-tie Line; MVOH Line; Arrays 1, 2, 4, 5, and 8; and the associated control plots and fences for each array. The design comprised sampling 100% of Array 1 and 2, Gen-tie line, MVOH line, and fences for Array 1 and 2. Twenty percent of Array 4, 5, and 8 were sampled as were the fences for Array 4, 5, and 8. Each week, we selected random start locations for each Project element using a random number generator. Random selection was based on tower numbers (for the Gen-tie Line), line segment (for the MVOH Line), numbered array corners (for the solar arrays), and numbered fence corners (for the perimeter fence).

A team of two biologists searched a 30-meter (m)-wide transect centered under the complete length of the Gen-tie Line. Because of the relatively shorter height of the MVOH Line, it was assumed that carcasses would have less potential to distribute over a wide area (HTH 2011); therefore, the transect area along the entire length of the MVOH Line was only 18 m wide. Each person searched half the transect width and half the tower or pole radial areas for both the Gen-tie and MVOH Lines. On the Gen-tie Line, each person searched a 15-m-wide transect for large birds and a 6-m-wide transect for small birds and bats. On the MVOH Line, each person searched a 9-m-wide transect for small and large birds.

In the arrays, biologists searched tracker units in teams of two. In each tracker unit, biologists walked into every other row of panels and visually scanned both the row walked and each adjacent row. To avoid crossing the drive arms of the tracker units, searchers turned around upon reaching the drive arm, and continued to scan the next row as they proceeded out of the row. Thus, although searchers walked only every other row, they visually scanned adjacent rows to ensure full coverage.

To determine background rates of mortality, control plots were established on adjacent onsite Conservation Lands (plots were within 1 km of Arrays 1, 2, 4, and 8). Each control plot had the same dimensions as a tracker unit (i.e. equivalent to 18 rows of solar panels, with 40 panels to a row). We used pin flags or wooden stakes to delineate mock panel trackers on the control plots, and searchers followed the same pattern and procedure used for searching the arrays. Control plots were not established for the 20% sample of Array 5 because the 20% search area for this array contained too few trackers to meet the control plot establishment guidelines set forth in the Avian and Bat Fatality Monitoring Plan for the California Valley Solar Ranch (Appendix A *in* HTH 2011; one control plot for 16 tracker units searched).

Fence segments surveyed for Arrays 1, 2, 4, 5, and 8 (100% of Array 1 and 2 fences, and 20% of Array 4, 5, and 8 fences) were each searched by one biologist. Each week, the biologist walked the inside portion of the fence while scanning a 6-m-wide belt centered on the fence. In some cases, the fences were not completely built until after weekly searches had already commenced. In these instances, fences were included only as part of the regular search routine after they were completely installed.

Because searches were conducted only on designated days as a part of the search protocol, a “make-up” search was not conducted if the search day was missed because of inclement weather. For estimating the total number of fatalities, the fatality model accounted for search intervals of different lengths due to missed surveys (e.g., if a weekly search day was cancelled because of rain, the search effort would resume the following week and for that search, the interval was 14 days, not 7 days).

2.1.1 5-day Repeat Surveys

In addition to regular weekly searches, two types of repeat surveys were conducted. The 5-day repeat surveys were designed to serve several functions: (1) to identify a portion of the fatalities missed by regular weekly searchers, (2) to give limited estimates of the permanence of both feather spots and carcasses, (3) to provide an independent estimate of site-wide fatalities, and (4) to help estimate carcass deposition rates. Five-day repeat surveys were conducted on all Project elements subject to regular weekly searches, with the exception of the Gen-tie Line, which was not included in the 5-day repeat surveys because it was assumed that small birds and bats would be unlikely to strike high-tension powerlines. Each of the remaining sites was subjected to 5-day repeat surveys once every 4 weeks, and surveys were organized so that a 5-day repeat was conducted for a different site each week.

During each 5-day repeat survey period, searchers covered the same 25% (Array 1, Array 2, and MVOH Line) or 5% (Arrays 4, 5, and 8) portion of a given Project element for 5 consecutive days. Repeat searches of arrays also included searches of associated perimeter fences and control plots. However, because of the size of Array 2 and staffing limitations, conducting a 5-day survey of both Array 2 Serengeti and Array 2 North and South was not feasible. Therefore, these portions of Array 2 were treated as separate sites for the purposes of 5-day repeat surveys.

Five-day repeat surveys were originally conducted in the same areas as regular weekly searches for all arrays. However, in June 2013, this protocol was changed, and new, non-overlapping areas were established for 5-day repeat surveys in Arrays 4, 5, and 8, to keep the search interval at a constant span of 7 days for all weekly searches. In Arrays 1 and 2, however, overlapping search areas were unavoidable because weekly searches encompass 100% of the arrays. Under the revised protocol, feather spots and scavenged carcasses were still collected on the fifth day of each 5-day repeat survey, but any intact carcasses found were used in the carcass-removal trials, and camera traps were placed by the carcasses to record the activity of scavengers and monitor the persistence of the carcass past the 5-day span of the repeat survey. Then, the first day of each 5-day repeat survey was treated as a clearance search, and all fatalities found on the first day were removed from further analysis.

2.1.2 1-day Repeat Surveys

One-day repeats (carcass-detectability bias-correction surveys) represent a second type of repeat search, designed to identify a portion of the fatalities missed by weekly searchers. Every other week, a 1-day repeat survey was conducted on the day following regular weekly searches. One-day repeat searches were also conducted after each 5-day repeat survey on either the last day of the 5-day survey or 1 day after completion of the 5-day survey. These repeat searches were conducted to provide further estimates of the detectability of small bird and bat carcasses. Each 1-day repeat survey covered a randomly selected 25% of all elements searched in the weekly or 5-day repeat survey. For example, the 1-day repeat survey of Array 2 included a search of 25% of the array, 25% of the fence, and 25% of the associated control plots.

2.1.3 Searcher-efficiency Trials

To calculate searcher efficiency (i.e., searchers' rate of success in detecting fatalities), we conducted a total of 22 searcher-efficiency trials between 5 September 2012 and 25 September 2013 (Table 2). Although several of these trials fall outside of the current reporting period for fatalities, we include the trial result herein because these data were essential to our overall fatality estimates.

Season was assumed to be a potential influence on searcher efficiency. Within the reporting period, we defined four unique seasons as follows: fall (16 August to 15 November), winter (16 November to 15 February), spring (16 February to 15 May), and summer (16 May to 15 August). We were excluded from operational arrays of the Project site between 26 June and 17 July 2013 for maintenance reasons; therefore, no searcher-efficiency trials were conducted during this period.

Table 2. Searcher-efficiency Trial Date, Associated Season, and Location

Date	Season	Location(s)
5 September 2012	Fall	Gen-tie Line
26 September 2012	Fall	Gen-tie Line
18 December 2012	Winter	Array 2
29 January 2013	Winter	Array 2
28 February 2013	Spring	Array 1
17 March 2013	Spring	MVOH Line
15 May 2013	Spring	Arrays 2 and 4; control plots
23 May 2013	Summer	Array 1; control plots; Gen-tie Line
31 May 2013	Summer	Arrays 4, 5, and 8; control plots; Gen-tie Line
5 June 2013	Summer	MVOH Line
11 June 2013	Summer	Array 2
20 June 2013	Summer	Array 1
8 August 2013	Summer	Arrays 1 and 2
22 August 2013	Fall	Arrays 1, 4, and 5
26 August 2013	Fall	Array 8
11 September 2013	Fall	Arrays 4 and 5; control plots; Gen-tie Line; MVOH Line
16 September 2013	Fall	Arrays 4, 5, and 8; control plots
17 September 2013	Fall	Arrays 2, 4, 5, and 8; control plots
18 September 2013	Fall	Arrays 4 and 5; Gen-tie Line; MVOH Line
19 September 2013	Fall	Arrays 1, 4, 5, and 8
20 September 2013	Fall	Arrays 4, 5, and 8
25 September 2013	Fall	Arrays 4 and 5; Gen-tie Line; MVOH Line

Each week during which searcher-efficiency trials were scheduled, we set out between two and eight "fatality plants" (i.e., carcasses or feather spots) in areas scheduled for searches. We arrived approximately 1 hour in advance of the searchers so that we could set out fatality plants without alerting the regular searchers they were being tested. We recorded a Global Positioning System (GPS) point for each fatality plant. We marked each fatality discreetly with tape or flagging so that searchers would know to report their finds as part of the controlled searcher-efficiency trial. We randomly selected locations for the fatality plants within the tracker units, control plots, and along the overhead lines and fences. Within the tracker units and control plots, we randomized placement between surveyed and un-surveyed rows, as well as with regard to distance and direction from structures.

During the week of 16–20 September 2013, we set out 10 to 40 fatality plants each day to capture missing combinations of explanatory variables (e.g., large feather spots in medium vegetation cover), which were needed to correctly assess our final fatality estimates for the Project site, but were not adequately sampled in previous searcher-efficiency trials. For this period, we used a stratified random sampling scheme: we purposefully selected predetermined habitat categories to increase the sample size for our overall parameter estimates in our final fatality model.

We used a total of 177 fatality plants (90 carcasses and 87 feather spots) throughout the course of all trials. The fatality plants were specimens of common species found on the CVSR Project site (Appendix A).

2.1.4 Carcass-removal Trials

To estimate how long carcasses persist in the environment (which influences their continued detectability over time), we conducted carcass-removal trials. We acquired avian carcasses from the onsite fatality searches and wildlife rehabilitation centers, and also collected them opportunistically (e.g., collected road-killed birds) under state and federal salvage permits. Whenever possible, we used species that naturally occurred on the site or in the surrounding area. Once a carcass was acquired, we limited its handling to reduce transfer of foreign scents to the carcass. We marked carcasses by attaching electrical tape or flagging to one leg, to differentiate them from naturally occurring fatalities. We varied the body sizes of carcasses to determine carcass-removal rates and scavenging outcomes for different sizes. Of the 99 carcasses that we placed, 62 were large (>100 grams [g]) and 37 were small (<100 g) (Appendix B).

Initially we placed carcasses at randomly chosen locations along the Gen-tie Line, in Arrays 1 and 2, and their associated control plots. After construction was completed for additional elements (i.e., arrays and the MVOH lines), carcass removal trials were also conducted in all those search area elements. We dropped carcasses from shoulder height and allowed them to fall naturally to the ground. We recorded each carcass location with a GPS unit, noted the direction and distance to the nearest tower (when carcasses were placed along the Gen-tie Line) or tracker number (when carcasses were placed in arrays). We took photos to document the position of the carcass. We placed Bushnell Trophy Cameras (Model 119436) within 1–1.5 m of the carcass on a t-post, facing north to avoid allowing sunlight to shine directly into the camera lens. To avoid "scavenger swamping" (saturating our study area with more carcasses than resident scavengers have the ability to remove) (Smallwood et al. 2010), we limited the number of carcasses in a search area at one time to four. We programmed cameras to take three pictures in quick succession after each trigger event; each camera had a 1-second refractory period. Each picture was stamped with the date and time.

We checked each carcass at least once per week, for up to 6 weeks, or until it was scavenged. If the carcass was scavenged, we collected all remaining feathers and signs of the carcass and removed the camera. We classified the carcass as removed if the carcass could not be located, and there were fewer than ten feathers of any type or fewer than two primary feathers remaining. To classify feather spots, we used the same criteria as regular weekly searchers. Therefore, we classified the scavenging outcome as "not removed" if there were ten or more feathers of any type, or two or more primary feathers or any flesh or bone remaining. If the carcass was no longer in front of the camera and was not readily apparent, we searched the surrounding area using a spiral search pattern. We started the search at the camera's location and spiraled out to 30 m from the camera. If the carcass had been moved to a new location within the search area, but was intact, we repositioned the camera on the carcass in its new location. At least once per week, we checked the camera batteries and Secure Digital (SD) memory storage cards. We replaced the batteries when there was less than half of the charge remaining, and we replaced the SD card when there were more than 2000 pictures.

For 22 of the carcasses that were removed, the time of scavenging was not captured by camera. For these carcasses, we recorded the time the carcass was last photographed and the first time a photograph was taken without the carcass present. For the purpose of our descriptive statistics, we then calculated the midpoint between these two times and used that as the time of scavenging.

2.2 Statistical Methods

Several issues must be considered when estimating fatalities. First, animals die at an unknown rate; the rate must be inferred from regular searches of a site. Second, fatalities persist for varying amounts of time. Third, fatalities are imperfectly detected by searchers. The need to accurately estimate fatalities given these variables has driven the development of several fatality estimation statistical methods (e.g., see Johnson et al. 2003, Smallwood 2007, and Huso 2010). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where the number of fatalities, F, is the quotient of the number of carcasses found, C, over the product of carcasses left unscavenged, r, and the proportion that an observer sees, p (Huso 2010).

The inputs for r and p are estimated in subgroups of covariates that will influence the detectability and persistence of each carcass, such as carcass size, vegetation height, and stage of decay or scavenging (i.e., feather spot versus carcass). Given the tendency for many fatality models to underestimate site-wide fatalities, we chose to use a fatality estimator written by Huso (2010), which was shown to outperform previous fatality estimation models by more accurately accounting for imperfect detectability. This model, the Fatality Estimator, was developed to estimate fatalities primarily for wind energy projects; however, it can be applied to other sources of fatalities, including powerlines and solar projects (Huso 2010). The estimator uses this conceptual framework of fatalities, combined with "bootstrapping" from models of r and p, to calculate variances and confidence intervals for estimates of fatalities. Bootstrapping is a statistical method used to create a distribution to assign measures of variance to estimates that use data for which the underlying distribution is either unknown or cannot be represented algebraically (Efron and Tibshirani 1986). Bootstrapping resamples the data with replacement, several thousand times, to create a distribution that may be used to infer information about the sample mean.

2.2.1 Estimating Carcass-removal Rates

We assessed carcass-removal rates using the following descriptive categories: seasonality, scavenger species, size of carcass, and search area.

Measurements of carcass-removal rates typically include one or more censoring values. A censoring value is used in statistics when a value is only partially known. For example, if a carcass was checked on day 7 and was present, and was checked again on day 10, and found to be missing, then the date of scavenging is unknown, and an interval censor would be used. Because we used camera traps, most scavenging times were known precisely, so data were not censored. However, for the 22 carcasses for which the moment of scavenging was not recorded, we applied interval censoring. Additionally, we applied right censoring to the carcasses that were removed but left feather spots behind, because the extended persistence time of the feather spots was unknown. Specifically, we assumed that all small feather spots (i.e., feather spots left from a small carcass) would last at least 15 days, and large feather spots would last at least 30 days, beyond scavenging.

There are four commonly used distributions of survival models that can be used in the Fatality Estimator for a value of *r*: exponential, Weibull, loglogistic, and lognormal. These four distributions have different rates and shapes of decay curves that attempt to model the survival of carcasses over a given search interval. We used Akaike's Information Criterion (AIC), corrected for finite sample size (AICc; Akaike 1973), to rank the fit of each survival model to our carcass-removal trial data. Because the time of death for found fatalities is unknown, the probability of persistence cannot be calculated exactly for each carcass, but it can be estimated from the selected survival model and bootstrapped to obtain a range of estimates of *r* for each carcass. Because of issues regarding our sample size of covariate combinations, we modeled carcass-removal time only as a function of carcass size.

2.2.2 Estimating Searcher Efficiency

The proportion of fatalities that an observer sees, *p*, is represented most simply by the following equation:

$$p = \frac{NumberObserved}{NumberAvailable}$$

The value of *p* may be affected by several covariates. Therefore, we calculated detection rates for the following descriptive categories and combinations thereof: seasonality, Project element type (i.e., arrays and lines), visibility (i.e., habitat characteristics), and the size of each carcass or feather spot that was planted.

To determine which of the above explanatory variables (or combinations of) best described detection rates, we compared multiple models within the Fatality Estimator statistical software (Huso 2010) using AICc. Beginning with a null model (no temporal or categorical variation), we used a bottom-up modeling approach to compare AIC values and find the most appropriate model structure by incorporating different combinations of explanatory variables.

We calculated detection as the proportion of found fatality plants over the total available number of plants. Any fatality plant removed by scavengers before biologists searched the area was not included in the analysis. We assessed detection rates temporally, spatially, and categorically.

Based on the search method used (i.e., line transects under overhead lines and along fencelines, versus patterned searches within rows in arrays), we grouped fatality plants together. Those in arrays and control plots were grouped together, and those along the overhead lines (i.e., the Gen-tie and MVOH Lines) and fence lines surrounding searched arrays were grouped together.

We analyzed the two fall periods (2012 and 2013) together. Only one period of data was available for each of the winter, spring, and summer seasons.

We assessed habitat characteristics (i.e., vegetation height and percent cover) within a 1-m^2 area surrounding each fatality plant to test detection rates based upon visibility. We initially categorized visibility into three classes, easy, moderate, or difficult visibility, based on vegetation height and percent cover (Table 3), however, once trials began, we realized that the abundance of difficult visibility classes on the site were very limited; therefore, for all analyses, we grouped moderate and difficult visibility classes together (Figure 2).

Table 3. Visibility Classifications Assigned to Categories of Vegetation Height and Cover

Vegetation Height	Vegetation Cover (%)	Classification
Low	0–50	Easy
Low	50–100	Moderate
Medium	0–25	Easy
Medium	25–100	Moderate
High	0–50	Moderate
High	50–100	Difficult

a) Easy Visibility **b) Medium Visibility**

Figure 2. Photographic Examples of Easy and Medium Visibility Classes, Based on Vegetation Height and Percent Cover.

We assigned each species of carcass to one of two size classes (small or large) based on weight (i.e., small = <100 g; large = >100 g). We also assigned a size class to each feather spot used as a fatality plant. A small feather spot was defined as feathers from a small to medium-sized bird, scattered sparsely in a ≤20 square centimeter (cm^2) area; a large feather spot was defined as feathers from a large bird in a small area (≤20 cm^2) or feathers from a small to medium-sized bird scattered densely in an area ≥20 cm^2.

2.2.3 Estimating Fatalities on the Project Site

The Fatality Estimator bootstrapping procedure calculates an adjusted fatality value for every fatality found based on search interval, searcher efficiency, and carcass persistence. These bootstrapped values are then summed, and a site total estimate and 90% confidence intervals are calculated for the site and each covariate combination assigned. The Fatality Estimator was developed for wind energy projects, and uses individual wind turbines as the sample unit of replication. To apply this tool to the CVSR Project, we used tracker units instead of turbines as the sample unit. For linear features (overhead lines and fences) where we sampled the entire length, we used the entire feature as the sample unit. For sites in which we searched less than 100% of the area, we divided these values by the proportion of area searched to extrapolate it to the whole array or linear feature.

2.2.3.1 Overall Fatality Estimates

We calculated weekly fatality estimates separately for each Project element. For the arrays, we set the tracker as the unit of replication, and for each array we calculated total estimates of fatalities, fatalities per tracker unit, and 90% confidence intervals. In Array 2, 36 tracker units within the Serengeti portion of the array were searched for 2 months before the rest of the array, so we calculated separate values for that period. For linear features on the site, such as the Gen-tie Line, MVOH Line, and fences, we estimated fatalities for the feature as a whole. Estimates are based on 5000 bootstrapped iterations. We calculated fatality estimates and confidence intervals for large and small birds and particular species, as well as calculating seasonal totals.

Owing to the constraints and assumptions of the Fatality Estimator; appropriately, we did not include every fatality found in our calculations. We did not include fatalities found during clearance surveys (the first survey of an area), or fatalities that we determined to be older than the search interval, because the correction for searcher efficiency does not take into account repeated chances of finding a fatality (Huso pers. comm.).

2.2.3.2 Fatality Estimates from 5-day Repeat Surveys

To calculate fatality estimates from our 5-day repeat surveys, we treated each 5-day period as an independent unit of replication. Because the first day of each search was a clearance survey, each repeat survey period effectively consisted of 4 consecutive search days. We used the Fatality Estimator to calculate fatality estimates and 90% confidence intervals for the search areas of the array covered during repeat surveys. We then divided these estimates and 90% confidence intervals by the proportion of the array searched to extrapolate to the entire array, and then divided this estimate by the proportion of days searched over the total number of days until next search period to extrapolate temporally to the whole month (Huso pers. comm.).

To calculate the rate of deposition of fatalities per tracker units per day, we divided the estimate for each 5-day repeat period by the number of tracker units searched, and by the number of days it was searched.

2.2.3.3 Error Assessment for Sampling Avian Fatalities

To guide future sampling at CVSR, an error assessment was conducted to determine what proportion of arrays should be monitored to determine a reasonable measure of avian fatality. This is the first study that we are aware of designed to estimate the number of avian fatalities at a large utility scale photovoltaic facility. One of the unknowns was what percentage of the entire facility needed to be surveyed to attain a given confidence level for determining an accurate fatality estimate. To collect data to determine this, we surveyed two large arrays, Arrays 1 and 2, with 100% coverage. We continued this level of effort for a full year in case the distribution of fatalities varied significantly by season.

Two steps were involved in developing the error assessment for the survey effort. The first step was to determine the spatial organization of avian fatalities across 100% of the area searched inside the two sample arrays, throughout the entire monitoring period (1 year). We estimated the mean and standard deviation of avian fatalities per tracker unit (each unit of tracking solar panels with 18 rows and 40 solar panels per row) for each array and for both arrays combined. Furthermore, using the individual fatality sampling points, we calculated the Global Moran's I index to characterize the spatial dispersion of avian fatalities within and among arrays. The Global Moran's I index is a direct assessment of the spatial autocorrelation of points in space and provides a statistical measurement indicating whether avian fatalities may be clumped, uniform, or not different from random. We conducted the geostatistical analysis of avian fatalities using ArcInfo version 10.0 and its geographic statistical toolbox.

The next step was to establish the relationship between percent area monitored and the variation in fatality estimates around a true value.. To accomplish this we focused on the coefficient of variation (i.e., "variance-to-mean ratio") as our metric of variation for describing the changes in the number of detected avian fatalities with increasing area searched. Because the coefficient of variation is a normalized measure of dispersion, this metric is well suited for assessing changes in the distribution of avian fatalities as a function of area searched. In other words, it accounts for the clumping of avian fatalities in space (among tracker units within an array) and is a better metric than the mean for describing changes in detection of avian fatalities.

Using the datasets of detected avian fatalities for Arrays 1 and 2, we constructed a statistical resampling function to understand the variation that would be introduced into the final avian fatality estimate by sampling less than the entire array. This function simulates a range of sample sizes (from one tracker unit to one fewer than the total number of tracker units); for each sample size, 3000 simulated data sets were generated from the original data. For each of these data sets, the total number of fatalities was summed. This number was then divided by the values determined to correct for searcher efficiency and carcass persistence time. This number was then scaled to the total number of tracker units per unit area tested (e.g., tracker units in Array 1). We calculated the coefficient of variation for each sample size by dividing the standard deviation of the sample by the mean. All resampling analyses were conducted in the statistical program R, Version 3.0.2 (R Development Core Team 2011).

Section 3.0 Results

3.1 Carcass-removal Trials

Between 15 October 2012 and 12 August 2013, we placed a total of 99 carcasses for carcass-removal trials. We placed camera traps on 95 of these carcasses, and were able to record the exact removal time and scavenger species for 77 (81.1%) of the carcasses placed that had a camera trap. Of the 99 carcasses placed, 43 (43.4%) were eventually removed either completely, or left insufficient evidence to be classified as a fatality in a regular weekly search. The remaining 56 (56.6%) carcasses were scavenged from the original location or within the search area, and left evidence behind in the form of feathers, skin, or a partial carcass.

Mean time to scavenging for all placed carcasses was 3.3 days and ranged from as little as 7 minutes to as long as 53 days (Table 4). The carcass that persisted for 53 days was an outlier by 31 days; the mean time to scavenging without it was 2.8 days. Within 24 hours of placement, 54.4% of carcasses had been scavenged and 26.3% had been removed entirely (with no trace evidence). Within 7 days of placement, 86.9% of the carcasses had been scavenged, and 38.4% had been removed entirely (Table 5).

Table 4. Mean Times and Range for Scavenging for Each of Five Categories: Total, Carcass Size, Season, Scavenger Species, and Search Area

	N	Mean Time to Scavenging (Days)[a]	Range[b]
Total	99	3.3 ± 6.7 (2.8 ± 1.7)[b]	7 min–53 days
Carcass Size			
Large	63	3.5 ± 5.0	7 min–22 days
Small	36	3.0 ± 9.3 (1.5 ± 3.1)	10 min–53 days
Season			
Fall	8	1.2 ± 1.7	2 hours–5.5 days
Winter	16	8.3 ± 12.8 (5.3 ± 5.6)	4 hours–53 days
Spring	40	2.7 ± 4.9	15 min–22 days
Summer	35	2.2 ± 3.0	7 min–12.5 days
Scavenger			
Common raven	51	2.5 ± 8.0 (1.5 ± 3.7)	7 min–53 days
San Joaquin kit fox	20	3.6 ± 4.3	11 hours–16.5 days
Coyote	5	4.5 ± 4.7	8.5 hours–13.5 days
Unknown	22	4.3 ± 5.2	30 min–18 days
Search Area			
Array	49	4.4 ± 8.5 (3.4 ± 4.7)	1.7 hours–53 days
Gen-tie Line	40	2.6 ± 4.4	10 min–18 days
Control plots	10	0.6 ± 0.7	7 min–2 days

Notes: Min = minutes.

[a] Mean time to scavenging is shown ± 1 standard deviation.

[b] Carcass that persisted for 53 days excluded.

[c] (Results) reflect values excluding the carcass that persisted for 53 days.

Table 5. Percentage of Carcasses Scavenged and Removed within 1 Day and 7 Days of Placement, by Body Size, Season, Scavenger, and Placement Area

	N	% Scavenged by 1 Day	% Removed by 1 Day	% Scavenged by 7 Days	% Removed by 7 Days
Total	99	54.4	26.3	86.9	38.8
Carcass size					
Large	63	47.6	7.9	82.5	15.9
Small	36	66.6	58.3	94.4	77.8
Season					
Fall	8	87.5	50.0	100.0	75.0
Winter	16	37.5	18.8	62.5	31.3
Spring	40	67.5	30.0	90.0	32.5
Summer	35	51.4	20.0	91.4	40.0
Scavenger					
Common raven	51	72.5	31.4	94.1	33.3
San Joaquin kit fox	20	35.0	15.0	80.0	50.0
Coyote	5	20.0	20.0	20.0	20.0
Unknown	22	40.9	27.3	77.3	45.5
Search area					
Array	49	42.9	18.4	83.7	32.7
Gen-tie	40	62.5	35.0	35.0	87.5
Control plot	10	80.0	30.0	100.0	40.0

3.1.1 Effect of Scavenger Type

With our remote cameras, we were able to document four species of vertebrate scavengers during the carcass-removal trials: San Joaquin kit fox (*Vulpes macrotis mutica)*, common raven (*Corvus corax*), coyote (*Canis latrans*) and turkey vulture (*Cathartes aura*) (Figure 3). Ravens were the most common scavenger, and scavenged more than half of the carcasses placed. Ravens also scavenged carcasses the fastest, with a mean time to scavenging of 2.5 days (and a mean time of 1.5 days with the 53-day outlier dropped). Ravens scavenged three carcasses less than 1 hour after placement, and 72.5% of carcasses within 24 hours. Ninety-four point one percent of raven-scavenging events occurred within 1 week. Of the 51 carcasses scavenged by ravens, 37.3% were removed entirely. In total, ravens scavenged 32 large carcasses and 19 small carcasses.

Figure 3. Scavengers Documented in Carcass-removal Trials

Figure panels are as follows: (top left) a common raven removing a ruby-crowned kinglet 53 days after it was placed in an array, (top right) a San Joaquin kit fox removing a Brewer's blackbird from a control plot 4 days after it was placed, (bottom left) a coyote removing a barn owl carcass after 3 days, and (bottom right) a turkey vulture scavenging a red-tailed hawk carcass 7 days after it was placed.

San Joaquin kit foxes scavenged 20 carcasses, and had the second fastest scavenging time, with a mean time to scavenging of 3.6 days. Within 24 hours, 35% of the San Joaquin kit fox scavenging events had occurred, and 80% had occurred within 7 days (Table 5). San Joaquin kit foxes were more likely than ravens to remove carcasses without leaving trace evidence. Of the 20 carcasses scavenged, 60% were removed entirely (Table 6), and 13 of these were large-bodied birds.

Coyotes had the longest mean time to scavenging: 4.5 days. They scavenged five carcasses in total, all of which were large. In all but one case, there was enough trace evidence left from the scavenged carcass to be considered a fatality.

Finally, our remote cameras captured a turkey vulture scavenging the carcass of a red-tailed hawk (*Buteo jamaicensis*) 7 days after it was originally placed.

For the remaining 22 carcasses, the scavenger responsible was not photographed, because of camera malfunctions.

Table 6. Outcomes of Carcass-removal Trials

	N	Carcasses Removed (%)[a]	Carcasses Leaving Feather Spots (%)	Partial Carcass (%)[b]
Total	99	41.4	35.4	23.2
Carcass Size				
Large	63	22.2	44.4	33.3
Small	36	80.6	13.9	5.6
Season				
Fall	8	75.0	12.5	12.5
Winter	16	56.3	37.5	6.3
Spring	40	32.5	37.5	30.0
Summer	35	42.9	31.4	25.7
Scavenger				
Common raven	51	37.3	33.3	29.4
San Joaquin kit fox	20	60.0	30.0	10.0
Coyote	5	20.0	60.0	20.0
Turkey vulture	1	0.0	0.0	100.0
Search Area				
Array	49	36.7	38.8	24.5
Gen-tie Line	40	52.5	27.5	20.0
Control plots	10	40.0	30.0	30.0

Notes:

[a] "Removed" refers to all carcasses that left no sign, or too few feathers to be classified as a fatality.

[b] "Partial carcasses" are classified as any fatality that was partially removed but left trace amounts of bone or flesh behind.

3.1.2 Effect of Carcass Size

Of the 63 large carcasses we placed, 22.2% were removed entirely or left insufficient evidence to be considered a fatality. The mean time to scavenging for large carcasses was 3.5 days, with 47.6% scavenged within 24 hours and 82.5% scavenged within 7 days. Small carcasses were more likely to be removed: 80.6% were removed. Mean time to scavenging for small carcasses was 3.0 days when the carcass in this size class that persisted for 53 days was included, and 1.5 days when it was excluded. Within 24 hours, 66.6% of small carcasses were scavenged, and within 7 days 94.4% were scavenged.

3.1.3 Effect of Season and Search Area

We put out carcasses for carcass-removal trials during all four seasons, but the coverage across seasons was not equal: eight carcasses were placed in fall, 16 in winter, 40 in spring, and 35 in summer. The mean time to scavenging was longest in fall, and shortest in winter. The carcass that persisted for 53 days was placed in winter, but even after dropping that carcass from the analysis, scavenging time was still longest in winter. Mean scavenging times in spring and summer were 2.7 days and 2.2 days, respectively.

Carcasses placed in the control plots were scavenged more quickly than those along the Gen-tie Line (Figure 3). Carcasses placed in the arrays had the longest time to scavenging: 4.4 days. The carcass that persisted for 53 days was in an array; however, even when this carcass was dropped from the analysis, mean time to scavenging in the arrays was still the longest: 3.4 days.

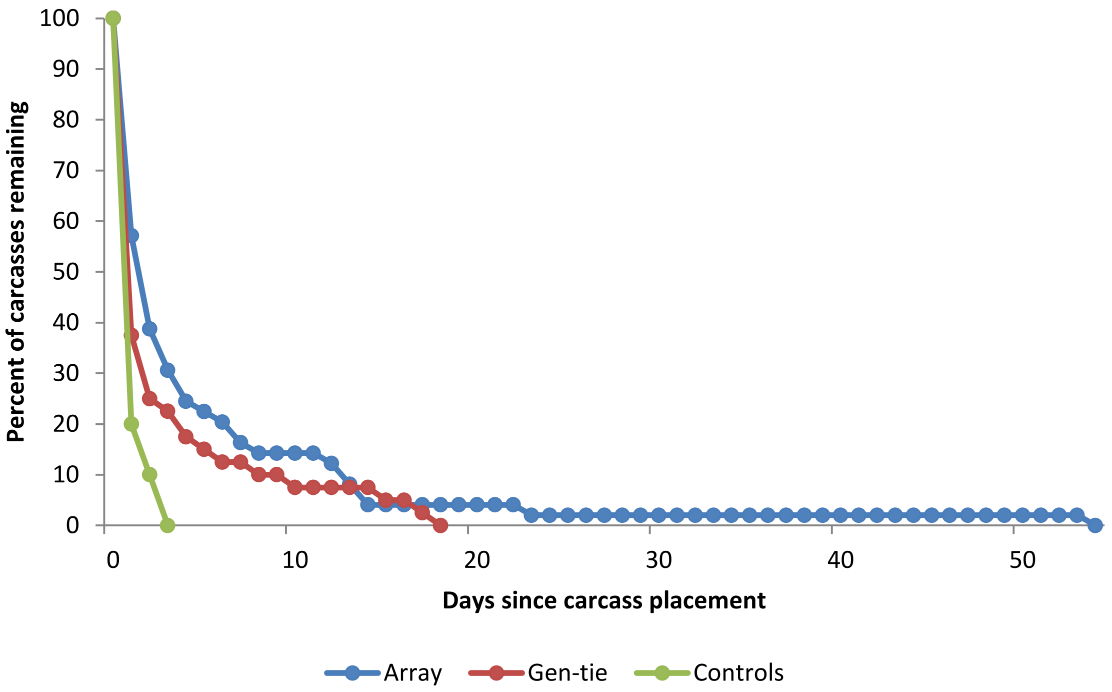


Figure 4. Percentage of Trial Carcasses Remaining Undisturbed by Scavengers per Day, Grouped by Search Area; N=99

3.1.4 Model Selection

Of the four selected survival models compared in the estimator, the lognormal model had the lowest AICc score (Table 7). For large carcasses, based on a search interval of 7 days, $r = 0.92$ (lower confidence interval =

0.86, upper confidence interval = 0.97). For small carcasses, $r = 0.42$ (lower confidence interval = 0.31, upper confidence interval = 0.55).

Table 7. AICc Values for Each of Four Distribution Models of Carcass Persistence

Survival Model for Carcass Persistence	AICc
Lognormal	253.00
Loglogistic	253.44
Weibull	259.44
Exponential	337.72

Because the difference in AICc values for the lognormal and loglogistic models was less than 2, these models were considered statistically equivalent (Akaike 1973), but we chose to use the lognormal model because it had a slightly lower AICc value.

3.2 Searcher-efficiency Rates

3.2.1 Overall Project Site Detection Rates

Over the course of 22 searcher-efficiency trials between September 2012 and September 2013, searchers detected 94 of 177 (53%) of the fatality plants that were randomly placed in operational arrays, control plots, underneath overhead lines, and along fence lines across the CVSR Project site. Small sample sizes in certain seasons prohibited us from using seasons as an explanatory variable for searcher efficiency. Nonetheless, we did see a sharp decrease (23%) in searcher efficiency between winter (N = 8) and spring (N = 10); efficiency then increased by 13% in summer (N = 17).

The detection rate of fatality plants in all areas with easy visibility was slightly higher (56%) than in those areas with medium visibility (51%). Searchers were slightly more efficient at detecting carcasses (56%) than feather spots (51%), and a greater proportion of large-sized fatality plants (61%) were detected by searchers compared to 43% of small-sized fatality plants in all areas (Table 8).

3.2.2 Detection Rates by Area and Explanatory Variables

Searcher detection rates were higher below overhead lines and along fencelines (56%) than rates in the solar panel arrays (50%). The detection rate in surveyed rows was slightly higher than in un-surveyed rows. Detection of fatality plants found in “easy” visibility areas along lines was higher (63%) than in “moderate” visibility areas (49%), but we found the opposite to be true in the arrays, where detectability in moderate areas was 8% greater than in easy areas. The detection rates of large fatality plants in arrays and along lines were essentially the same (approximately 62%), and large fatalities were easier to detect than small fatalities in both arrays (34%) and along lines (47%).

Detection rates within arrays, of large and small fatality plants in easy visibility areas, were 56% and 36%, respectively; these rates were lower than comparable rates along lines. In moderate visibility areas along lines, the detection rate of large fatality plants (48%) was lower than in easy visibility areas (76%), but we found that the detection of small fatality plants in moderate visibility areas along lines was slightly higher (6%) than in easy visibility areas. The detection rate of large fatality plants in moderate visibility areas in arrays (68%) was 20% higher than along lines, but the detection rate of small fatality plants in moderate visibility array areas (31%) was lower than the comparable rate along lines.

Detection rates were consistently higher for both large carcasses and feather spots in easy visibility areas than in moderate visibility areas, with the exception of the detection of small feather spots in medium visibility areas, which was 23% higher than in easy visibility areas.

Table 8. Overall Detection Rates from Searcher-efficiency Trials, September 2012 to September 2013

Category	Detection Rate	95% Confidence Intervals (lower, upper)	N
Overall	0.53	(0.46, 0.60)	177
Fall	0.54	(0.45, 0.62)	142
Winter	0.63	(0.31, 0.86)	8
Spring	0.40	(0.17, 0.69)	10
Summer	0.53	(0.31, 0.74)	17
Arrays/control plots	0.50	(0.40, 0.60)	90
Overhead/fence lines	0.56	(0.46, 0.66)	87
Surveyed row	0.51	(0.37, 0.65)	45
Unsurveyed row	0.45	(0.30, 0.62)	33
Large fatality size	0.61	(0.51, 0.70)	96
Small fatality size	0.43	(0.33, 0.54)	81
Carcass	0.55	(0.45, 0.65)	90
Feather spot	0.52	(0.40, 0.61)	87
Easy visibility	0.56	(0.45, 0.65)	90
Medium visibility	0.51	(0.40, 0.61)	87

Our top model in the Fatality Estimator had an AICc value of 238.55; this model indicated that carcass size best explains searcher-efficiency rates. However, the second best model, which differed by less than 2 (AICc

= 239.98), showed equal support for an additive effect between visibility class and fatality size (Table 9). We therefore adopted the additive effect structure for our detection rate in estimating fatalities, because visibility was shown in our descriptive statistics (see above) to be an important indicator of how well searchers did in locating fatalities.

Table 9. AICc Ranking of Searcher-efficiency Models

Searcher-efficiency Model	Explanatory Variables	AICc
size	Carcass size	238.55
size + visibility	Carcass size and visibility class	239.98
element + size + visibility	Project element, carcass size, and visibility	241.49
size x visibility	Carcass size and visibility class interaction	244.32
size x visibility + element	Carcass size and visibility interaction, and Project element	246
null	Null model	246.71
element	Project element	248.05
visibility	Visibility	248.32

3.3 Summary of Annual Fatalities

3.3.1 Results of Weekly Searches

A total of 357 fatalities were found during surveys of Project elements between 16 August 2012 and 15 August 2013; and an additional 11 fatalities were observed during surveys of control plots (each plot equivalent in size to a tracker unit: 18 rows of solar panels, with 40 panels to a row) within conservation lands (Table 10; Figures 5-9; Appendices C and D). It is important to note that this total comprises observations obtained during clearance surveys, weekly surveys, and 1-day and 5-day repeat surveys. The total number of fatalities observed at various Project Elements, consequently, may be larger than the sample sizes used to conduct overall fatality estimates for Project Elements because fatalities older than the search interval and fatalities found during clearance surveys and 5-day repeat surveys are not used to calculate the overall fatality estimates. Fatality estimates based on weekly searches and 5-day repeat searches were calculated separately.

The majority of fatality species represented year-round avian residents (Figure 10, Appendix D). In total, we found fatalities of 31 different avian species (Figure 11). Nearly all of the species utilize a terrestrial foraging zone; the two exceptions were a single American coot (*Fulica americana*) found along the Gen-tie and a single tree swallow (*Tachycineta bicolor*) found within a control plot (Appendix D). Horned larks, house finches (*Carpodacus mexicanus*), and mourning doves accounted for the greatest proportion of fatalities. Documented special-status species fatalities comprised burrowing owl (*Athene cunicularia*), short-eared owl (*Asio flammeus*), long-eared owl (*Asio otus*), and loggerhead shrike (*Lanius ludovicianus*) fatalities. The total count of special-status species fatalities was small compared to the overall count. One fatality was identified to genus, but not to species. Seven fatalities were not identified because partial skeletons and entrails or covert feathers were all that remained. These seven fatalities were placed into two "unknown" categories (unknown small passerine [6] and unknown [1]). Feather spots accounted for the vast majority of fatalities observed with a ratio of feather spots to carcasses (including partial carcasses) of 20:3.

Table 10. Summary of Avian Fatality Searches Conducted between 16 August 2012 and 15 August 2013; N= 357 for Project Elements, N = 11 for Control Plots

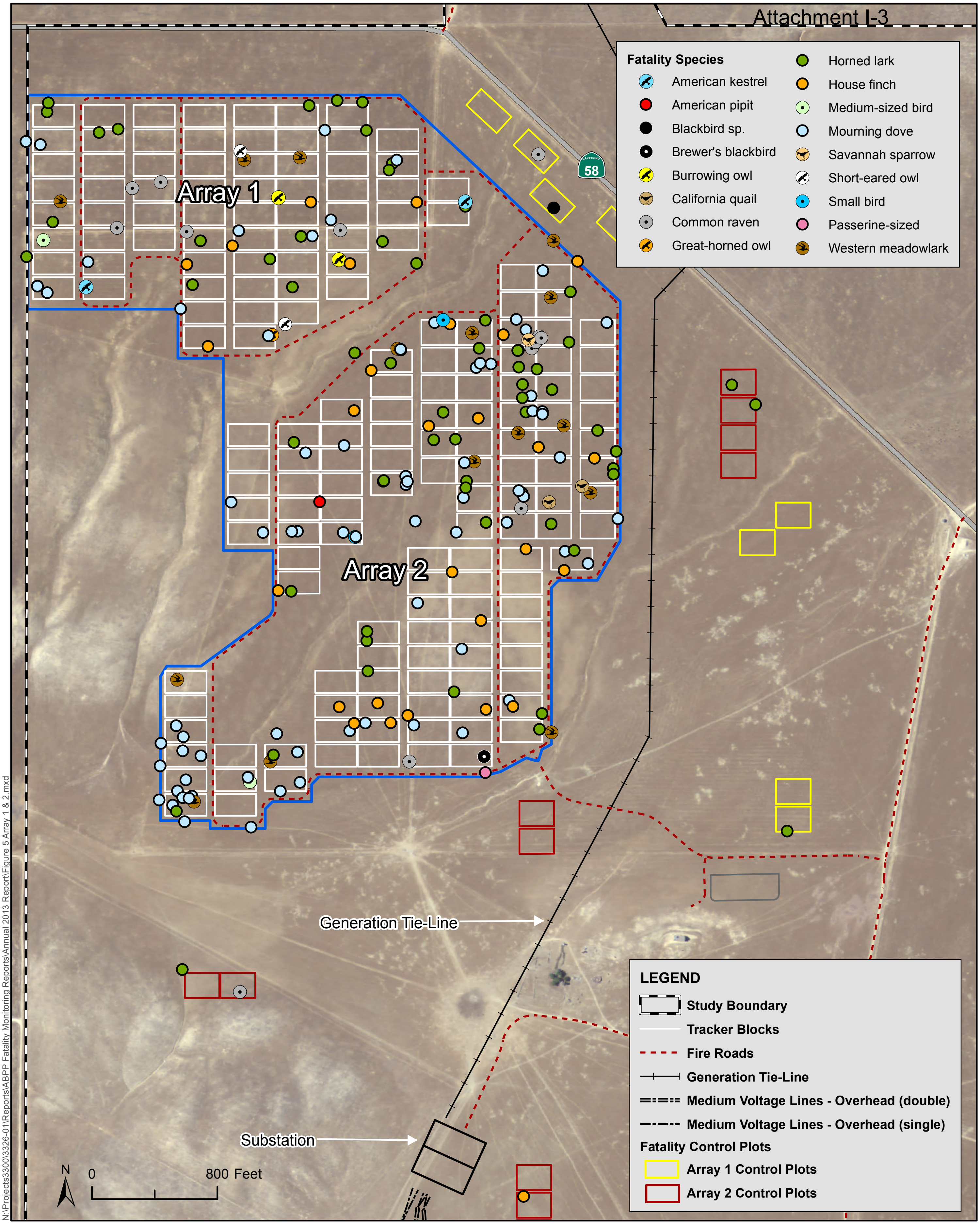
Project Element	Date of First Search	Number of Tracker Units[a] or Distance of Straight Line Search	Total Number of Fatalities Found Across all Survey Methods
Array 1	20 September 2012	66 trackers	52
Serengeti (only)[b]	25 September 2012	36 trackers	8
Array 1 control plots	30 October 2012	8 trackers	3
Array 1–2 fence	25 September 2012	5300 m	11
Array 2 North (including Serengeti) and South	27 November 2012	114 trackers	137
Array 2 control plots	1 November 2012	14 trackers	6
Array 4	9 January 2013	29 trackers	23
Array 4 control plots and fence	6 February 2013	4 trackers; 225-m fence	1 in control plot, 1 on fence
Array 5 and fence	9 January 2013	4 trackers; 56-m fence	5 in array, 0 on fence
Array 8	7 January 2013	54 trackers	13
Array 8 control plots	4 February 2013	6 trackers	1
Array 8 fence	20 May 2013	1600 m	0
Gen-tie Line	6 June 2012	4000 m	90
MVOH Line	30 January 2013	6800 m	17

[a] Tracker unit equals 18 rows of solar panels, with 40 panels to a row.

[b] The Serengeti portion of Array 2 was searched separately only until 27 November 2012, so the number of fatalities reported for the Serengeti reflects this initial period.

Additional Documentation Attachment to Comment 2-F1

Attachment I-3

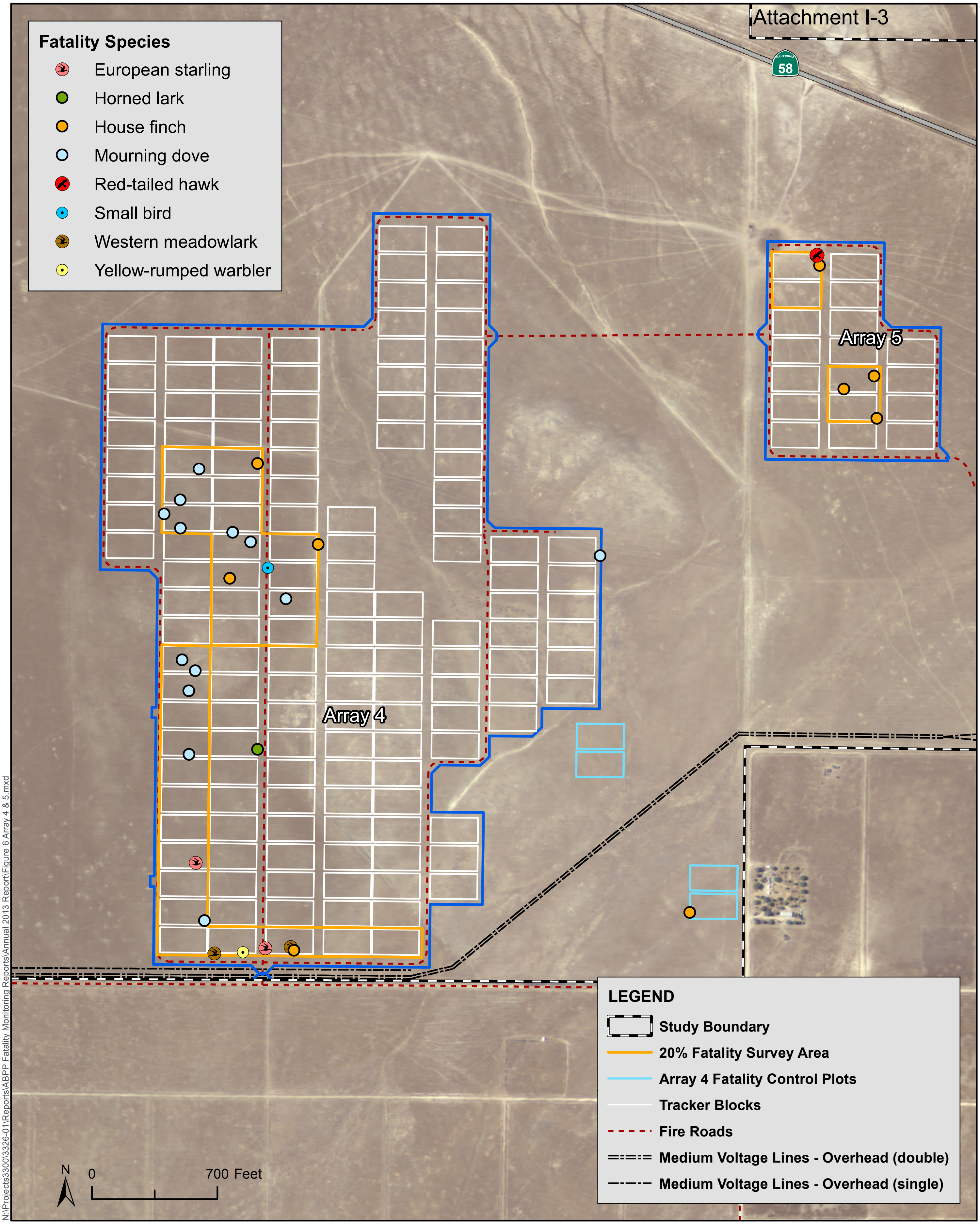


N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Annual 2013 Report\Figure 5 Array 1 & 2.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Annual Postconstruction Fatality Report
Figure 5: Locations and Species of Postconstruction Fatalities Observed at Arrays 1 and 2



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Annual 2013 Report\Figure 6 Array 4 & 5.mxd

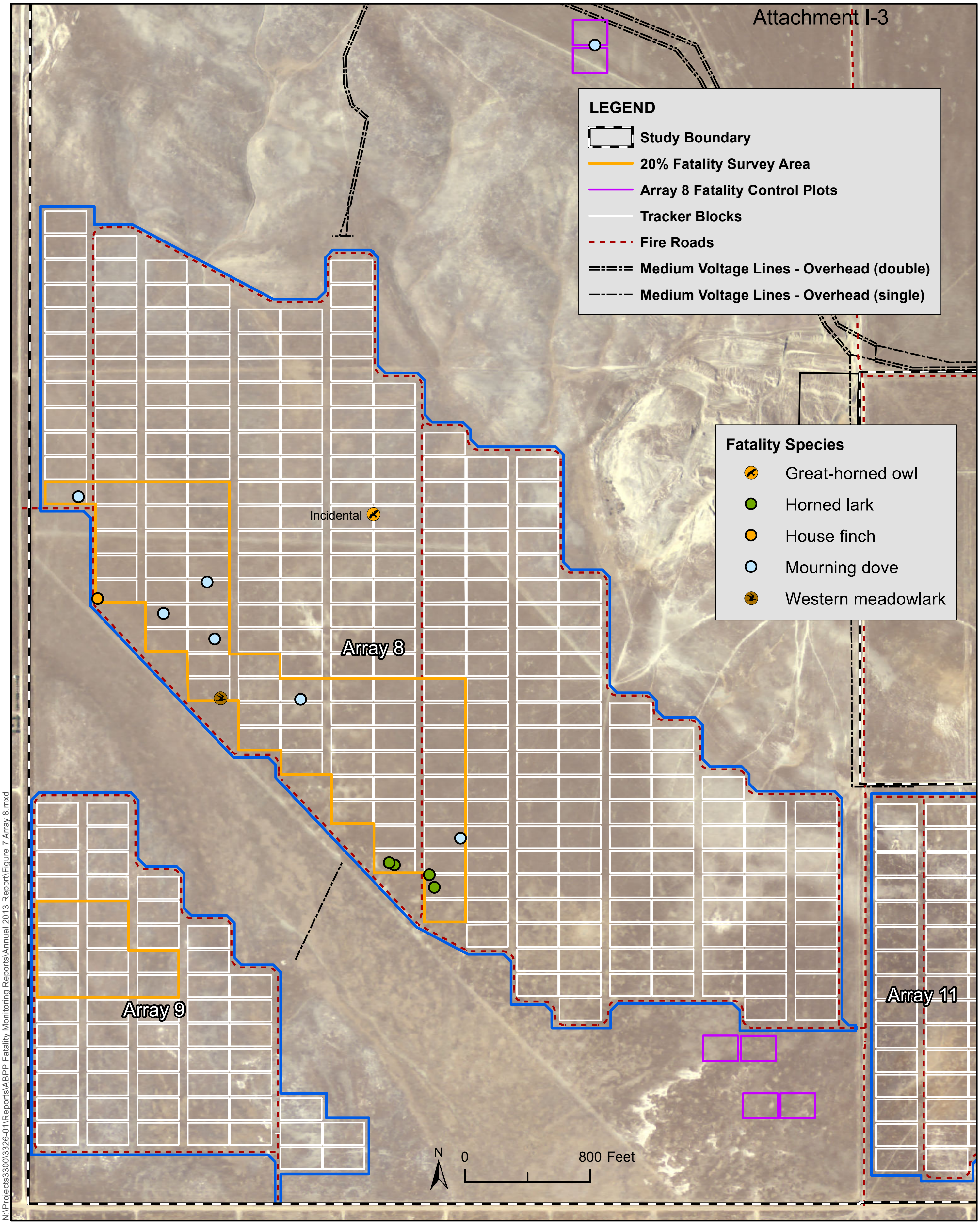
HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Annual Postconstruction Fatality Report
Figure 6: Locations and Species of Postconstruction Fatalities Observed at Arrays 4 and 5

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Annual 2013 Report\Figure 7 Array 8.mxd

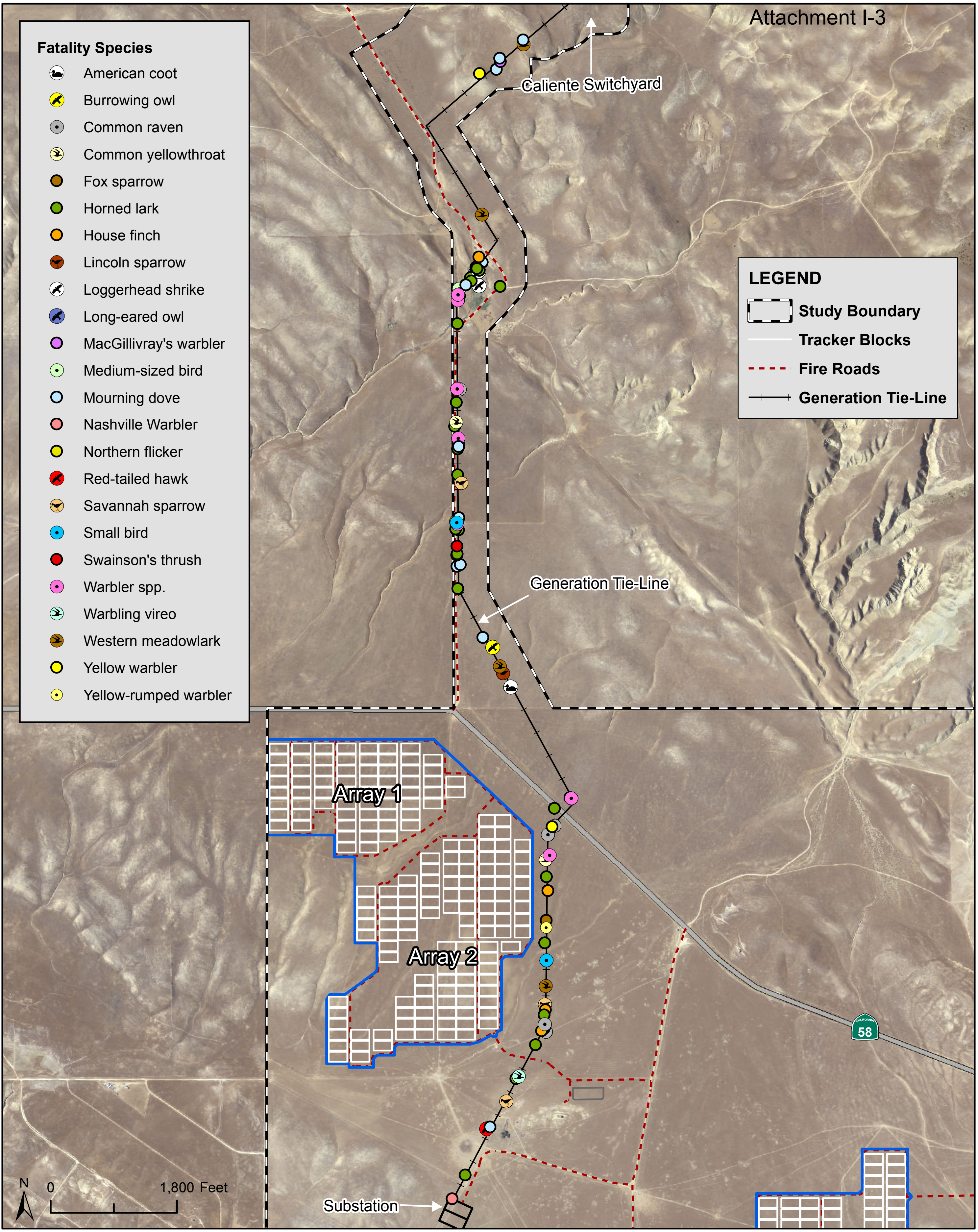
HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Annual Postconstruction Fatality Report

Figure 7: Locations and Species of Postconstruction Fatalities Observed at Array 8

Additional Documentation Attachment to Comment 2-F1
Attachment I-3



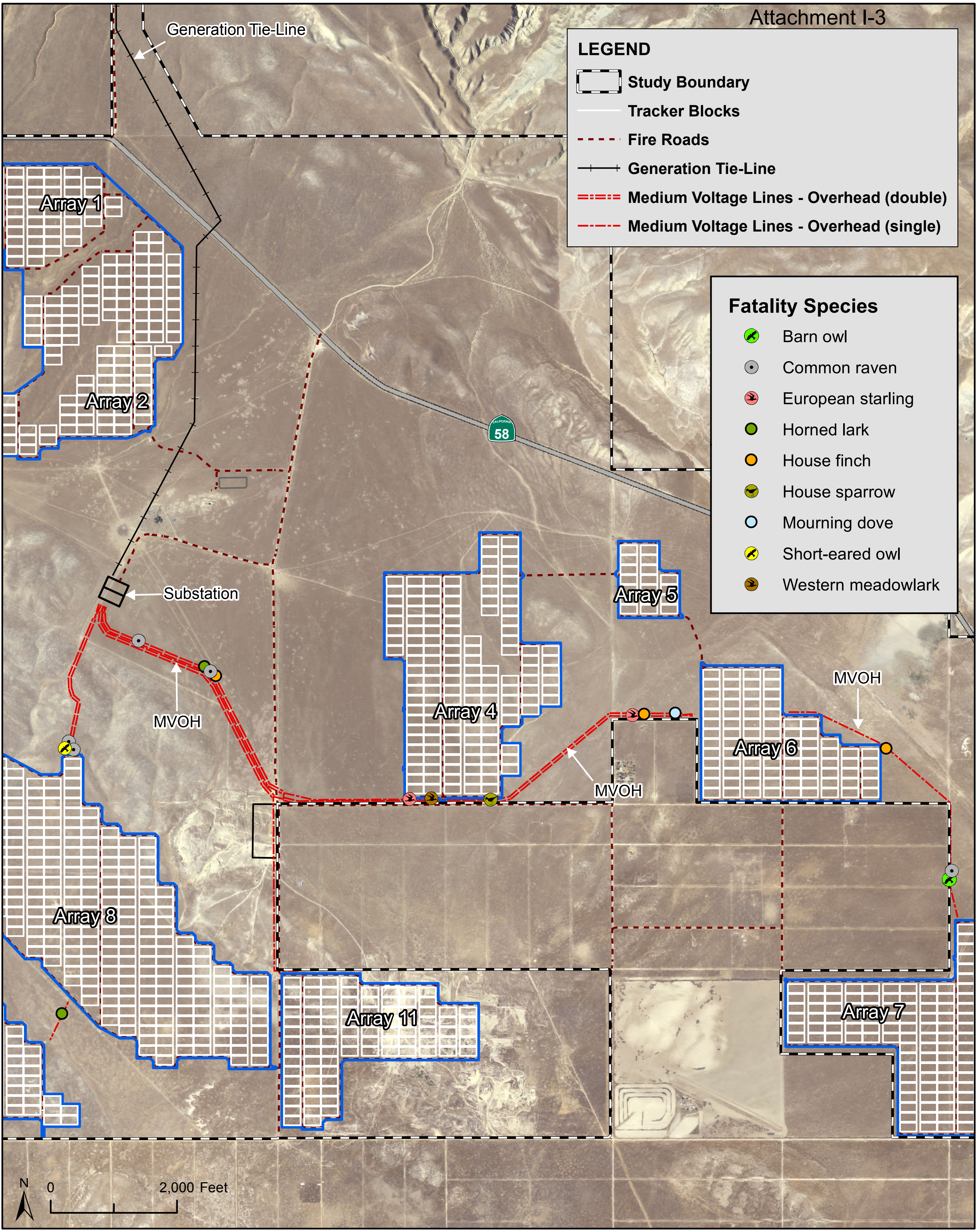
HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Annual Postconstruction Fatality Report
Figure 8: Locations and Species of Postconstruction Fatalities Observed along Gen-tie Line

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Annual 2013 Report\Figure 9 MVOH Area.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Annual Postconstruction Fatality Report
Figure 9: Locations and Species of Postconstruction Fatalities Observed along MVOH Line

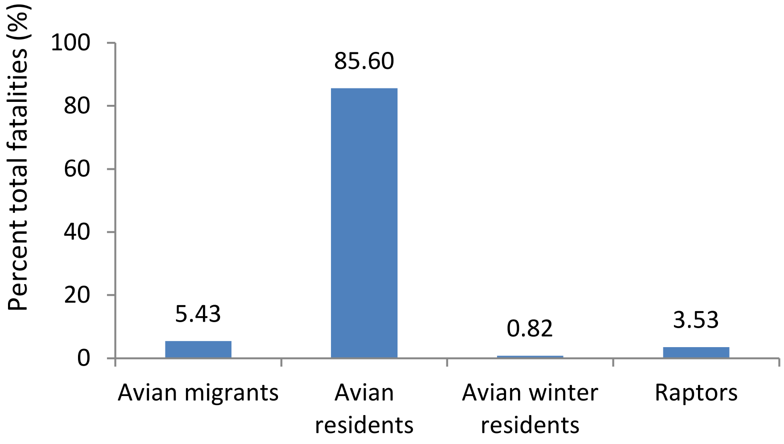


Figure 10. Percent of Total Fatalities in Each of Four Taxonomic Groups; N= 357

Groups were created based on knowledge of species typically found on the Project site at different times of the year.

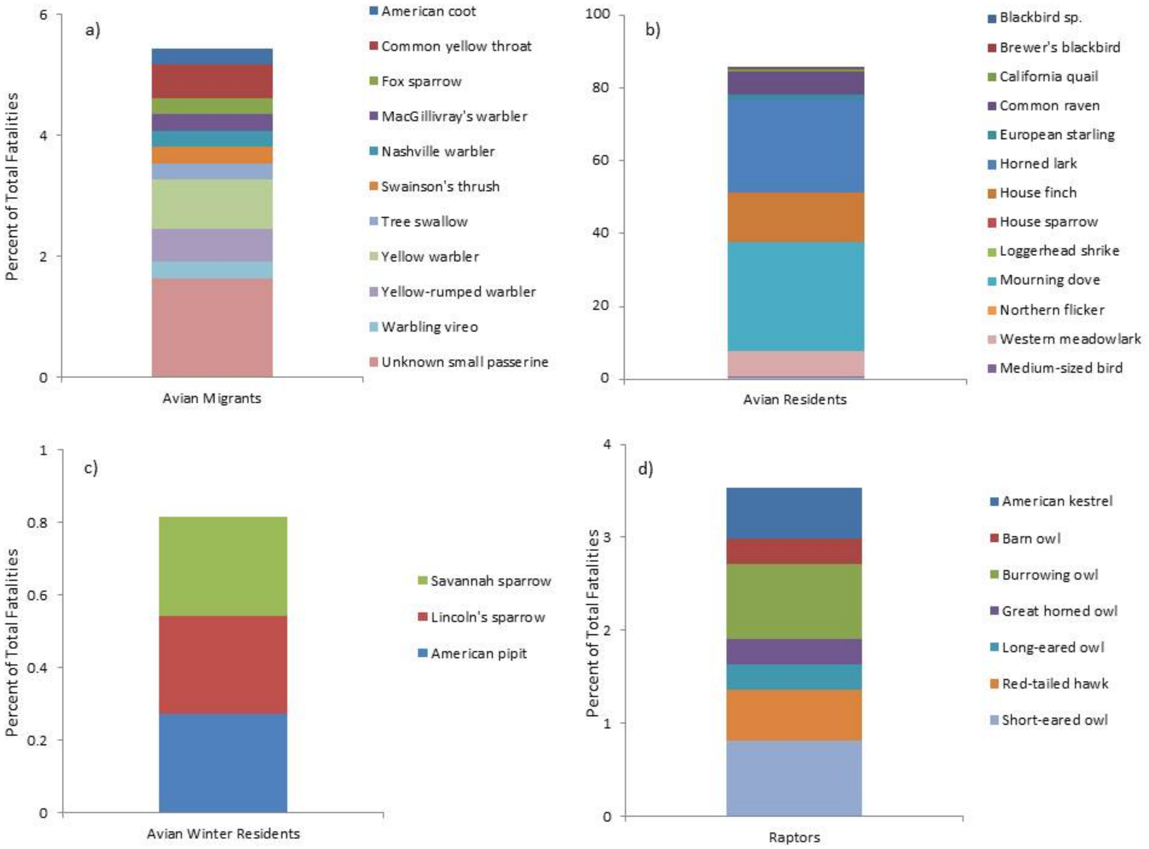


Figure 11. Percentage of Fatalities Belonging to Different Species, by Group; N= 357

Panels show: (a) fatalities by species of avian migrants, (b) fatalities by species of avian residents, (c) fatalities by species of avian winter residents, and (d) fatalities by species of raptors. Groups were created based on knowledge of species typically found on the Project site at different times of the year.

3.3.2 Results of 5-day Repeat Surveys

The first 5-day repeat surveys occurred on 29 October 2012. For the period of 29 October 2012 to 15 August 2013, 45 fatalities were found by repeat searchers. Thirty-six percent of all fatalities found by 5-day repeat searchers were mourning doves (Figure 12).

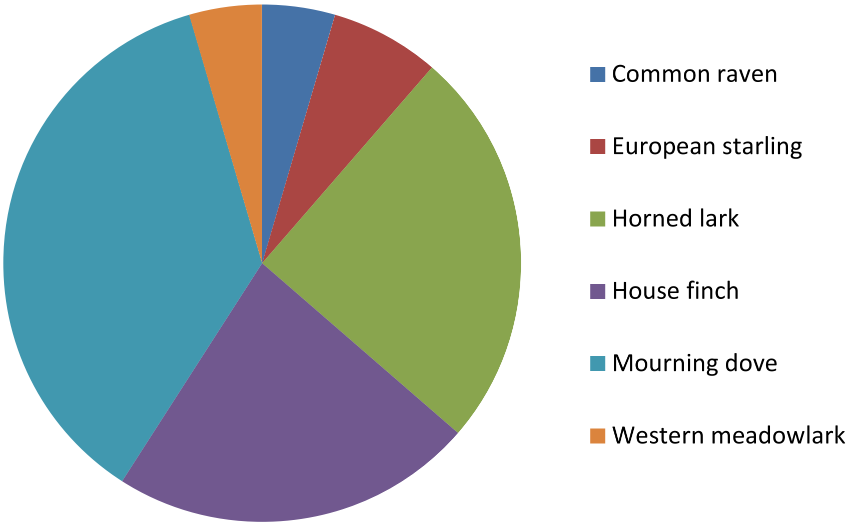


Figure 12. Total Fatalities Found during 5-Day Repeat Surveys, by Species; N= 45

3.3.3 Results of 1-day Repeat Surveys

3.3.3.1 1-Day Repeat Surveys of Weekly Search Areas

One-day (twice monthly) repeat surveys of weekly search areas began in the third quarter of the reporting period (i.e., in March 2013). In total, 16 fatalities were found by 1-day repeat searchers. Of these 16 fatalities, 25% were horned larks (Figure 13).

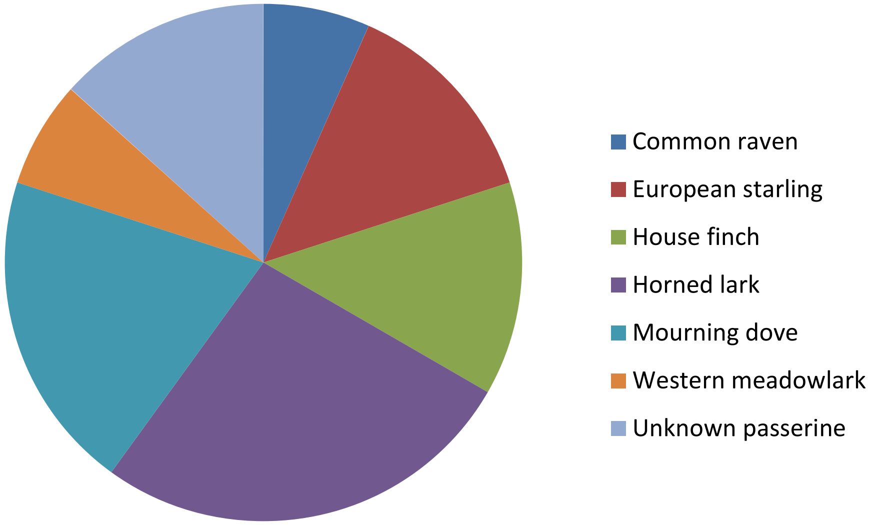


Figure 13. Total Fatalities Found during 1-day Repeat Surveys of Regular Weekly Search Areas, by Species; N= 16

3.3.3.2 1-Day Repeat Surveys of 5-Day Repeat Survey Areas

One-day repeat surveys of 5-day repeat areas also began in the third quarter of the reporting period. Between the third and fourth quarters, only one fatality was found during 1-day repeat surveys of these areas. This fatality was the feather spot of a common raven, found in Array 4.

3.3.4 Electrocutions

Although the cause of death is often difficult to determine, there were four clear cases of electrocution found during the reporting period. An additional two cases of electrocution were found the day before the period began, 15 August 2012. Although outside the official reporting period and excluded from all other analyses, we include mention of these deaths. All six electrocuted animals were ravens, and all electrocutions occurred on overhead lines, rather than in energized arrays. These cases are described in more detail below.

At Tower 7 along the Gen-tie Line, four common ravens were clearly electrocuted in two separate events on August 15 2012 and on 11 December 2012, as evidenced by scorch marks on their feet, and leg scales that were detached and curled. Tower 7 was evaluated and retrofitted during a plant outage on 22 January 2013 to prevent avian electrocutions. Changes to the tower conductor design to prevent electrocution included insulation of exposed conductors in configurations that could potentially create a ground-to-phase connection through a bird. No avian mortalities caused by electrocution related to Tower 7 have been observed since the correcting retrofit.

In April 2013, two ravens were found electrocuted along the MVOH Line. One bird had a clear exit burn through its neck, and singed feathers. The riser poles were temporarily modified to reduce the potential for further electrocutions until long-term remediation could be performed. NRG, SunPower, and Bechtel each consulted with experts on Avian Power Line Interaction Committee (APLIC) guidelines. Based on the consultations, perch diverters, squirrel guards, insulation, and covers were installed, and ground wires were relocated to minimize the potential for ravens or raptors to make contact between two energized phases or an energized phase and the ground at all potential contact points on the riser poles. These improvements were made to all Project MVOH Line riser poles. No further fatalities have occurred as a result of electrocution since these changes were made to the MVOH Line.

3.3.5 Tamarisk Pond

An 80-m section of the Gen-tie Line runs directly over a wetland consisting of a pond lined with saltcedar (*Tamarix ramosissima*). Because a large colony of red-winged blackbirds (*Agelaius phoeniceus*) and other species, such as tricolored blackbirds (*Agelaius tricolor*), a California species of special concern, nest in the wetland during the breeding season, we were unable to search this wetland at times during the reporting period. We stopped searching the pond on 15 March 2013, at the start of the breeding season. Also, because of stark differences in both bird activity and searcher efficiency in this area, we excluded the wetland from fatality estimates. Ten fatalities were found in this area: one long-eared owl, eight horned larks, and one lark sparrow.

3.4 Fatality Estimates from Weekly Searches

For the arrays and control plots, our estimates of the number of fatalities found per tracker unit during the search interval range from 5.68 in Array 2 to 0.95 in Array 8 (Table 11). For Project elements that were linearly searched (i.e., fences and overhead lines), our estimates of fatalities vary from 47 total fatalities along the fence around Arrays 1 and 2 to 446 along the Gen-tie Line (Table 12).

The Gen-tie Line was the only Project element that was searched for a whole year during this reporting period; therefore, this Project element is the only one for which we can accurately estimate seasonal fatality effects for the entire year. Contrary to our initial predictions, the number of small passerine carcasses found along the Gen-tie Line was much greater than the number of large birds and raptors found along the line (Table 13).

Table 11. Overall Fatality Estimates from Weekly Searches and 1-Day Repeat Searches of Nonlinear Areas, Using Wildlife Fatality Estimator, 16 August 2012 to 15 August 2013.

Site	Survey Period (Days)	Number of Fatalities Found in Sample Area	Estimated Number of Fatalities per Tracker Unit	90% Confidence Intervals (No. fatalities per tracker unit)	Estimated Number of Fatalities for Project Element	90% Confidence Intervals (Total no. fatalities)
Array 1	324	41	3.21	2.26, 5.35	212	150, 354
Array 2	261	125	5.68	4.17, 9.10	648	476, 1038
Array 2 Serengeti	63	8	1.02	0.69, 1.74	37	25, 63
Arrays 4 and 5	218	26	2.77	2.03, 4.25	449	329, 689
Array 8	220	11	0.95	0.55, 1.72	258	150, 464
Arrays 1 and 2 control plots	289 and 287	9	2.69	1.54, 5.35	60	34, 118
Arrays 4 and 8 control plots	190 and 192	2	0.73	0.55, 1.12	8	6, 12

Notes: Number of fatalities found in sample area does not include fatalities found during 5-day repeat searches or clearance searches, or carcasses older than the search interval. The size of the array and number of searches conducted vary by array, so results are not directly comparable. Survey Period (days) is the number of days from the onset of surveys at each site until 15 August 2013. Refer to Table 10 for a full list of the number of tracker units per array and dates searched. The numbers of estimated fatalities are rounded up to the nearest whole number. Estimates made based on fewer than five fatalities should be interpreted with caution.

Table 12. Overall Fatality Estimates from Weekly Searches and 1-Day Repeat Searches of Linear Areas, Using Wildlife Fatality Estimator, 16 August 2012 to 15 August 2013

Site	Number of Fatalities Found in Sample Area	Estimated Total Number of Fatalities	90% Confidence Intervals
Array 1–2 fence	11	47	35, 74
Array 4 fence	1	NA	NA
Array 5 fence	0	NA	NA
Array 8 fence	0	NA	NA
Gen-tie Line	83	446	343, 682
MVOH Line	14	71	51, 114

Notes: Number of fatalities found does not include fatalities found during 5-day repeat searches or clearance searches, or carcasses older than the search interval. The length of the line or fence and the number of searches conducted vary by Project element, so results are not directly comparable. The numbers of estimated fatalities are rounded up to the nearest whole number. Refer to Table 1 for full list of dates and survey lengths.

Table 13. Fatality Estimates from the Gen-tie Line by Season and Fatality Class

	Number of Fatalities Found	Estimated Total Number of Fatalities	90% Confidence Intervals
Fatality Class			
Large	21	44	38, 58
Small	69	403	303, 629
Season			
Fall	18	87	68, 128
Winter	17	69	54, 100
Spring	37	214	160, 339
Summer	18	78	60, 119

Note: Numbers of estimated fatalities are rounded up to the nearest whole number.

Finally, although we do not have a full year's worth of data to report for the remainder of the Project elements, both of the overhead lines and Arrays 1, 2, 4, 5, and 8 were all searched in spring and summer, so we were able to compare estimates from these two periods among different Project elements. The estimated number of fatalities per kilometer was much higher for the Gen-tie Line than the MVOH Line in both spring and summer (Table 14). The highest estimated number of fatalities for arrays was 2.65 per tracker unit (Array 2 in spring), and the lowest estimated number of fatalities was 0.11 per tracker unit (Arrays 4 and 5 in summer).

Table 14. Fatality Estimates from the Arrays and Overhead Lines by Season, per Tracker Unit or Kilometer

Project Element	Season[a]	Number of Fatalities Found in Sample Area	Estimated Number of Fatalities (per tracker unit or km)[b]	90% Confidence Intervals (per tracker unit or km)	Estimated Total Number of Fatalities for Project Element	90% Confidence Intervals (Total no. fatalities)
Array 1	Spring	10	0.9	0.46, 1.75	60	31, 116
	Summer	9	0.67	0.32, 1.35	45	21, 89
Array 2	Spring	57	2.65	1.87, 4.37	303	213, 498
	Summer	12	0.69	0.34, 1.38	79	40, 158
Arrays 4 and 5	Spring	6	0.87	0.33, 1.77	141	53, 287
	Summer	1	0.11	0.09, 0.37	18	14, 60
Array 8	Spring	3	0.26	0.08, 0.55	70	23, 150
	Summer	3	0.46	0.17, 1.22	124	48, 329
Array 1 and 2 control plots	Spring	4	0.97	0.27, 2.19	22	7, 49
	Summer	1	0.59	0.4, 2.45	13	9, 54
Array 4 and 8 control plots	Spring	2	0.73	0.55, 1.12	8	6, 12
	Summer	0	0	NA	NA	NA
Gen-tie Line	Spring	37	54	40, 85	214	160, 339
	Summer	18	20	15, 30	78	60, 119
MVOH Line	Spring	9	7	5, 10	41	31, 65
	Summer	5	5	4, 8	30	21, 50

Notes:

[a] Summer estimates may be artificially low because searches were not conducted during July due to maintenance work in the arrays.

[b] Estimates are given per tracker unit for arrays and control plots, and per kilometer for overhead lines.

3.5 Fatality Estimates from 5-day Repeat Surveys

After removing from the analysis all fatalities that had been missed by previous searchers or were cleared on the first day of the 5-day repeat survey, there were 22 fatalities remaining in the repeat-survey fatality analysis (20 in arrays, one along the MVOH Line, and one along the Array 1–2 fence).

Three additional fatalities had been found in control plots during 5-day repeat surveys, but two were found during clearance activities, and the third was judged to be older than the search interval, so fatality estimates could not be calculated for control plots from data collected during the 5-day repeat surveys.

For the arrays, estimates of fatalities ranged from 405 in Array 8 to 1995 in Arrays 4 and 5 (Table 15). Because the 5-day repeat surveys were started during different seasons in different arrays, the estimates shown in Table 15 are not directly comparable.

Table 15. Number of Surveys, Number of Fatalities Found, and Estimates of Total Fatalities per Element, Based on 5-Day Repeat Searches

Project Element	Number of Surveys	Number of Fatalities Found in Sample Area	Estimated Number of Fatalities for Project Element	90% Confidence Interval
Array 1	10	5	489	191, 1005
Array 2	7	6	628	464, 982
Array 2 Serengeti	11	3	336	224, 532
Arrays 4 and 5	7	4	1995	1283, 3420
Array 8	7	2	405	405, 539
Array 1–2 fence	11	1	84	84, 140
MVOH Line	4	1	111	84, 168

Note: Estimates for elements in which fewer than five fatalities were found should be interpreted with caution.

The rate of deposition of fatalities per day per tracker unit varied among arrays, from 0.007 fatalities per day per tracker unit in Array 8 to 0.063 fatalities per day per tracker unit in Arrays 4 and 5 (Table 16).

Table 16. Fatality Deposition Rates for Arrays and Linear Features

Project Element	Fatalities per Day (per tracker unit or per km)[a]	90% Confidence Interval
Array 1	0.026	0.01, 0.053
Array 2	0.041	0.029, 0.064
Array 2 Serengeti	0.028	0.02, 0.046
Array 4 and 5	0.063	0.039, 0.103
Array 8	0.007	0.006, 0.009
Array 1–2 fence	0.052	0.04, 0.073
MVOH Line	0.131	0.088, 0.219

Note:

[a] Fatality estimates are given per tracker unit for arrays, and per kilometer for fences and overhead lines. Estimates for Array 4, 5, and 8 fences are not included because of insufficient sample sizes (i.e. 0 or 1 observed fatalities).

3.6 Error Assessment Results

The geostatistical analysis of the dispersion of avian fatalities in Array 1 and Array 2 separately, as well as in both arrays combined, indicates that the dispersion of fatalities is not significantly different from a random distribution (Table 17). Knowing that fatalities are randomly distributed within arrays at the Project site is important for designing future sampling because there are no observable high concentrations (clumping) of avian fatalities that need to be taken into consideration. Moreover, a random dispersion pattern indicates that the probability of detecting an avian fatality should not change as a function of the amount of area (or number of tracker units) searched.

Table 17. Descriptive Statistics for Avian Fatalities per Tracker Unit and Results of a Point-pattern Analysis for Detecting Spatial Autocorrelation: Moran's I Test for Assessing the Dispersion of Avian Fatalities

Project Element	Number of Tracker Units	Sum	Mean ± SD	Moran's I (I, Z, *P*[1])	Spatial Dispersion
Array 1	66	52	0.79±0.81	-0.12, -0.81, 0.42	Random
Array 2	114	147	1.29±1.45	0.09, 1.14, 0.25	Random
Arrays 1 and 2	180	199	1.11±1.62	0.09, 1.29, 0.19	Random

Notes: SD = standard deviation, I = statistical measure of spatial autocorrelation, Z = number of standard deviations away from the mean

[1] *P* values indicate no significant difference from a clumped distribution.

Figure 9 illustrates the change in variation in fatality estimate as a function of the number of tracker units sampled. The only source of variation in this plot is the difference in number of tracker units sampled (which indicates carcasses occurred with a random dispersion with a mean and standard deviation of 1.11±1.62 fatalities per tracker unit); the plot does not include any variation generated by other processes (e.g., carcass persistence). The resampling analysis suggests that sampling 20% of the total area (represented by "Number of Trackers Sampled" in the figure) is sufficient to provide a reasonably precise estimate of the Project site fatality rate, with sampling equitably spread throughout the site to ensure a spatially representative overall sample. This analysis suggests that sampling 30–35 tracker units within an array would be sufficient to capture an index of avian fatality.

In sum, given the significant random dispersion of avian fatalities derived from the study period, and the resampling analysis of the coefficient of variation as a function of area searched, we consider it acceptable to monitor 20% of the total area of an array, or collective groups of small arrays at the CVSR Project. Additionally, each sample of an array should comprise 30–35 tracker units, so small arrays (e.g., Array 5) should be combined with other small neighboring arrays, so that 20% of a given set comprises at least 30 tracker units.

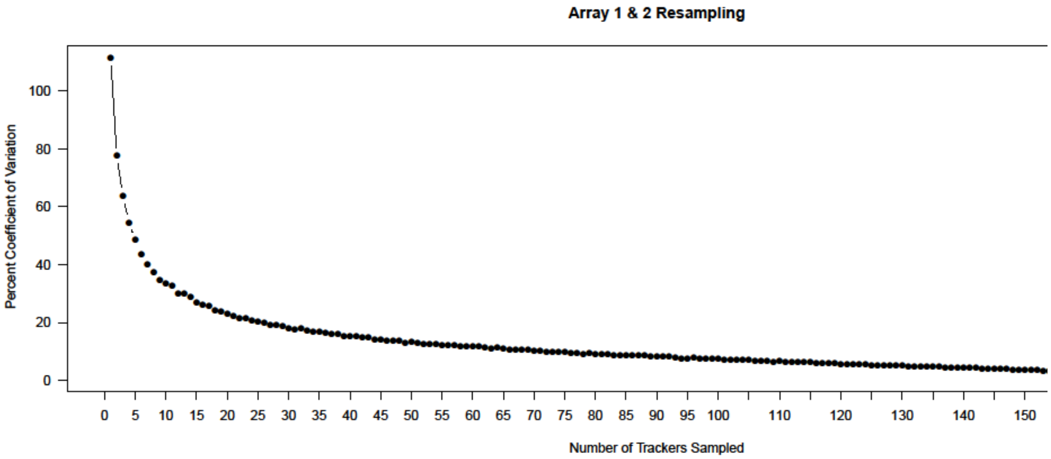


Figure 14. **Coefficient of Variation in Fatality Estimate Attributable to Sampling Variation for All Sample Sizes, Arrays 1 and 2 Combined**

Section 4.0 Discussion

4.1 Carcass-removal Rates

Almost half of placed carcasses were removed completely by scavengers or left insufficient evidence to be documented as a fatality during standardized carcass surveys. More than a third of these carcasses were removed within 7 days of placement, and would not have been detected during weekly fatality searches. The remaining carcasses persisted longer than the search interval, or were scavenged but left sufficient evidence to be considered a fatality by searchers. Only two carcasses left evidence insufficient to be considered a fatality, implying that if a carcass is scavenged in place, its remains will likely be detected during searches. A logical extension of this finding is that the creation of a feather spot when a bird is preyed upon by a raptor or mammalian predator is likely to occur at least as often as the creation of a feather spot during a scavenging event and feather spots created by depredated birds are likely to persist and be detected during searches at rates equal to feather spots created from scavenged carcasses.

The mean time to scavenging was 3.3 days, which is comparable to the mean times identified by carcass-removal studies at other sites. For example, Derby et al. (2007) found an average removal time of 5.1 days for small carcasses, and Smallwood et al. (2010) found an average removal time of 4.45 days for all carcass types. We found that the initial rate of scavenging was very rapid, followed by an exponential decrease; this pattern mirrors the findings of other studies. For example, Ponce et al. (2010) found that 32% of all carcasses were gone by the second day, and 52% of all carcasses were gone within a week. Our study's scavenging times may be somewhat shorter because we avoided scavenger swamping and used cameras. Wagner et al. (1983), Ponce et al. (2010), and Derby et al. (2007) likely overloaded the capacity of local scavengers to effectively dispose of placed carcasses (Smallwood 2010), whereas we placed smaller numbers of carcasses for removal trials. Our use of cameras allowed us to more accurately pinpoint the time of scavenging, whereas other studies (e.g., Derby et al. 2007 and Ponce et al. 2010) were limited by personnel availability; carcasses were often checked only weekly, rather than daily.

Our finding that the majority of small carcasses were removed within 7 days without leaving trace evidence suggests that the majority of small carcasses deposited on the site would be removed with no trace in between our weekly search intervals. Only rarely in our study did small-bodied carcasses leave remains behind after they were scavenged. Also, we found that large carcasses were more likely to leave evidence behind, and are therefore more likely to be detected during routine weekly searches.

The two most common scavengers, ravens and San Joaquin kit foxes, nest or den on the Project site, and coyotes (*Canis latrans*) regularly visit the site. In contrast, turkey vultures (*Cathartes aura*) are rarely seen on site and scavenged only one carcass. Although two other potential scavengers, American badgers (*Taxidea taxus*) and California ground squirrels (*Otospermophilus beecheyi*), occur on site, we did not document them at any of the carcasses that we placed. Likewise, Smallwood et al. (2010) documented red-tailed hawks scavenging carcasses, but we did not record any instances of scavenging by raptors, other than a turkey vulture, or owls in our study.

Although we did not place equal numbers of carcasses during the different seasons, our results do suggest that the time to scavenging was longest in winter and shortest in fall. This is a well-documented trend in carcass-removal trials (e.g., Prosser et al. 2008 and Smallwood et al. 2010). Many of the carcasses placed in winter froze at night, which may have made them less palatable to scavengers, or more difficult to detect by smell. In fall, there is less food available for scavengers because many of the nesting birds have left the area and insects such as grasshoppers are less common. This drop in food availability likely explains the shorter time to scavenging that we observed during this period.

Carcasses placed in the control plots were scavenged more quickly than carcasses placed in the solar arrays or along the Gen-tie Line. Carcasses were likely easier for scavengers to spot visually in the control plots, because there were lower levels of structural and vegetative cover on the control plots than along the Gen-tie Line and in the solar arrays.

Using remote cameras for the carcass-removal trials allowed a more accurate determination of carcass-removal time, reduced personnel time, and helped to document the scavenger species involved in carcass removals. In several instances, ravens removed carcasses within 15 minutes of placement. We could not have documented these quick removal rates without the use of the remote cameras. When cameras malfunctioned or failed to record scavenging, they were still able to narrow the time frame during which the carcass was removed, and so still yielded an advantage over daily or weekly checks by field personnel.

Among the scavenger species documented, ravens, in particular, are known for their high level of intelligence (Emery 2006). It is possible that ravens may have noticed the camera traps, and thus been alerted to the presence of new carcasses. However, Smallwood et al. (2010) explored this possibility by setting out camera traps with decoy carcasses, and found that none of the decoy carcasses were investigated by any scavenger species.

4.2 Searcher-efficiency Rates

Our overall searcher-efficiency rate of 53% is comparable to the results of searcher-efficiency trials conducted at wind energy facilities, where rates have ranged from 32% to 67% (Nicholson et al. 2005; Derby et al. 2007; Leslie et al. 2012; Johnston et al. 2013; Martin et al. 2013).

Although we were not able to make statistical inferences about the influence of season on searcher efficiency, there may be seasonal effects. For example, natural and artificial precipitation events (the solar panels are washed once a year) and the run off of condensed moisture, create patches of grass along the driplines of panels; vegetation changes in color from green to golden-brown and could either blend with or create a sharp contrast with the color of a fatality; and mean daily temperatures (e.g., extreme heat) could affect not only plant growth, but searchers' effectiveness. We observed a significant decrease in our detection rate between winter and spring, likely because in spring the high annual vegetation obscured planted carcasses.

Searcher efficiency in the surveyed rows of the arrays was slightly higher than in unsurveyed rows, as expected given that visibility is often reduced in adjacent tracker rows in the morning and the evening, when the solar panels are tilted the most.

Along the overhead lines, we found that searchers were more efficient at detecting fatality plants in easy visibility areas compared to moderate visibility areas. In many of the arrays and along the MVOH Line, construction-related activities disturbed the ground below the lines and along fence lines; however, vegetation height and density increased with increasing distance from array edges and overhead lines, resulting in reduced fatality detectability. Therefore, the ease of finding fatalities below powerlines and along fences may be magnified by the combined effects of the short distance from the searchers' paths to the fatalities and the relatively lower vegetation.

We found that the opposite was true in the arrays, where detectability was 8% higher in moderate visibility areas than in easy visibility areas. Many searchers focus their attention on the rows of clumped vegetation on either side of a searched row, where vegetation height and density is greater than in the middle of the row. (The vegetation is low to absent in the middle of rows because of continuous foot traffic and conditions that are drier than underneath the panels). This searcher behavior could explain the higher rate of detections in areas characterized as having moderate visibility.

Overall detection rates, explained by type of carcass planted, indicate that carcasses were somewhat easier to find than feather spots as a group, but that the detection of large or small carcasses differed by only 2%, in sharp contrast to a 38% difference in detectability between small and large feather spots. Understandably, feather spots are more detectable when more feathers are scattered over a larger area.

4.3 Weekly Fatality Searches

Causes of death were often difficult or impossible to determine from feather spots and carcasses found in the arrays. In a few cases, carcasses were found with no apparent injuries; in other cases, injuries (e.g., broken necks) indicated that a collision was the cause of death. Determining the cause of death from feather spots was even more difficult. We found feather spots on the ground near panels and on panels themselves. Fatalities may have occurred as a direct or indirect result of the presence of solar panels (e.g., a bird stunned by a collision with a panel can then be more easily predated), or they may indicate direct mammalian or avian predation. Solar panels likely contribute to direct and indirect causes of death for birds, but in many cases, it was not possible to determine cause of death. Because the ratio of feather spots to found carcasses was 20:3 during the reporting period, the inability to partition feather spots associated with collisions and feather spots stemming from predation has important implications regarding inferences that can be drawn from the fatality estimate.

In contrast to the uncertainty regarding causes of death within solar arrays, most fatalities found along the Gen-tie and MVOH Lines were located directly or nearly directly under these lines. This pattern suggests that many of these fatalities were caused by powerline collisions, and that the remains were indicative of scavenging, rather than predation. It is well documented that high-tension powerlines contribute to avian mortality, and especially to the mortality of larger birds such as waterfowl (Brown and Drewien 1995). However, very few large carcasses were detected during fatality searches of the Gen-tie and MVOH Lines. Instead, the majority of fatalities found were passerines, possibly reflecting the greater proportion of passerines that occur on the site. Nevertheless, these results suggest that the avian flight diverters installed on the Gen-tie Line may be successful in preventing collisions with larger birds, but are not effective at diverting smaller birds. Also, Gen-tie Line fatalities included migrant passerines not typically observed on the Project site or expected in the area. It seems likely that most of the migrant passerine fatalities are from nocturnally migrating birds, and the avian flight diverters on the Gen-tie lines appear to be ineffective in deterring these birds at night.

It is difficult to study how the mortality of large and small birds along the overhead lines compares with background mortality rates without having a linear control in the landscape. We know of no studies that control for background mortality rates along a linear corridor without an actual linear structure. Instead, most avian mortality studies of high-tension powerlines typically compare fatality rates of powerlines with or without avian flight-diverting structures (Brown et al. 1995; Janss and Ferrer 1998). Given that more passerine fatalities were documented along the lines than expected, and very few raptor fatalities were documented, a linear control would be useful in understanding how these fatality rates compare with background fatality rates for large and small avian groups in the Project area.

In addition to searching arrays and overhead lines, we conducted fatality searches along perimeter fences. Although these fences may represent a collision hazard for birds (Allen and Ramirez 1990), they also provide artificial hunting-perch habitat for predatory birds, such as loggerhead shrikes and kestrels (*Falco sparverius*) (Bohall-Wood 1987; Sheffield et al. 2001). Both species frequently occur in the arrays, and other studies suggest that they increase in abundance when artificial perches are introduced (Wolff et al. 1999; Yosef and Grubb 1999; Sheffield et al. 2001; Lynn et al. 2006). If perimeter array fences increase hunting opportunities for predatory birds, they may thereby contribute to fatality rates by creating feather spots from predation events along the fence lines and within the adjacent arrays. Flocks of birds, mostly passerines, were commonly seen roosting under the solar panels. Although we do not have data to quantitatively compare this activity in the arrays with roosting in surrounding Conservation Lands, it is plausible that the solar panels attract roosting birds, and thus increase the prey base for predatory birds, which have been documented hunting within the arrays (Refer to Photo 1: a 1-second photo sequence captured on remote camera).

Photo 1. **One-second photo sequence captured on remote camera depicting a red-tailed hawk foraging within a solar array.**

Horned larks and mourning doves commonly roost and nest under the solar panels, and the two species combined represent 63% of the total number of fatalities found within the arrays (Appendix D). When they were flushed, we observed these birds quickly navigating through the panels; in this high-clutter environment, some birds may fly into structural elements of the array. Species that fly in flocks seem to be at a greater risk of collision; it has been posited that birds flying in the rear of flocks are more likely to be unaware of upcoming obstacles (Janss 2000). Additionally, the relatively high densities of these species may provide greater opportunities for avian and mammalian predators to prey on these birds, resulting in feather spots that are recorded as fatalities.

In general, we estimated fatalities to be more abundant in the spring and less in the summer. This pattern is likely associated with the peak avian activity in the spring and the subsequent decline in activity in the summer, both documented through onsite avian point counts (HTH 2013). Because birds were more active on the Project site in spring, predation rates and collision rates are likely to be higher.

Accounting for the spatial organization of avian fatalities is an important aspect of designing surveys and making decisions about future sampling, monitoring, and avoidance and minimization strategies. The spatial organization of avian fatalities may be thought of in terms of the manner in which fatalities are connected with each other in space, and whether they exhibit apparent clumping, uniform or random distribution. This is a key aspect for future design of sampling and monitoring schemes for detecting avian fatalities, because if fatalities are clustered in space, then additional sampling to account for their clumping may be warranted. In this case, significant clumping of fatalities was not found.

4.4 Repeat Surveys

The fatality estimates we calculated from our 5-day and 1-day repeat surveys were all much higher than the estimates obtained from our weekly searches. This is because we extrapolated from the low amount of temporal and spatial coverage in these searches, which can cause high sample bias. The statistical methods we used in the Fatality Estimator are not appropriate for rare events, and caution is recommended when interpreting groups with a sample size lower than five. In all but one area (Array 2), there were fewer than 5 total fatalities found per survey area, included in the 5-day repeat search estimates. The inadequacy of the sample sizes for the repeat surveys (comprising usually only a few tracker units per array) is underscored by the power analysis, which, based on the year of empirical data collected from Arrays 1 and 2, suggests that each sample should comprise 30–35 tracker units (i.e., far more than were actually covered in the past year's repeat surveys).

4.4.1 5-day Repeat Surveys

Because detailed fatality searches have not been conducted previously at a large photovoltaic facility, we did not know at the start of our study whether the fatalities found would be predominately birds or bats. Similarly, there was little basis for projecting what the carcass scavenging rates might be, because scavenging rates often vary widely from location to location, as well as across years and seasons. In situations where carcasses of bats or other animals that are scavenged without leaving a trace occur more commonly, it is advantageous to conduct more intensive daily searches to increase the chances of detecting carcasses. However, after proceeding with the diverse elements of this study for more than a year, it became apparent that avian fatalities, particularly long-lasting feather spots, accounted for the bulk of the findings, and that most small and large carcasses and feather spots persisted for more than 7 days. These facts suggest that daily searches are not necessary at this site to accurately detect and quantify fatalities.

Owing to issues cited in the previous third quarterly report, the protocol for 5-day and regular weekly searchers working in overlapping areas changed at the beginning of June 2013. Therefore, during the fourth quarter, it was possible to determine the short-term permanence (within the 5-day period) of all feather spots and carcasses, whether they were detected during regular weekly searches or not. Although this quarter offered a relatively small sample size (7), data from weekly searches suggested that the relative permanence of feather spots was much greater than that of carcasses. This finding is supported by the overall ratio (20:3) of carcasses to feather spots found in the arrays during regular weekly searches

A general assumption of fatality searches is that searchers detect less than 100% of fatalities, owing to both environmental and individual constraints (e.g., vegetation height, visual obstacles such as support poles for the arrays, and worker fatigue) (Huso 2010). The results of both the 1-day and the 5-day repeat surveys support this premise, because more than half of the finds of repeat searches were missed by weekly searchers. Although the number of fatalities found by weekly searchers but missed by repeat searchers was not examined, we did record cases of weekly searchers finding fatalities that repeat searchers did not find, and it is likely that searcher misses go in both directions. The low rates of consistency between the findings of regular weekly searchers and repeat searchers also suggest that both random differences and differences that vary by individual searcher may affect search outcomes. For example, a taller searcher has a reduced field of vision into adjacent rows compared to a shorter searcher, and is unlikely to be able to fully compensate for this disadvantage, even with conscious efforts to look under the panels. Likewise, there are trade-offs based on where searchers focus their field of vision: if a searcher focuses on tufts of tall grass on the sides of array rows, he or she may overlook fatalities directly underfoot, and vice versa. Estimates of individual searcher efficiencies would provide useful information for model estimation of overall fatality rates. However, identifying individual efficiencies in a field team of our size (around 20 individuals) would require a prohibitively large number of searcher-efficiency trials (more than 1600 per year, excluding the explanatory variables of season and Project element).

Because of the high labor costs and time involved in 5-day repeat searches, the areas searched were very small, covering only 5% of most arrays and 5% of the fences. The small survey area covered and the infrequency of these searches (once a month at each site) resulted in a large sampling bias when extrapolating to entire Project elements. If fatality rates are low or not evenly distributed throughout the site, searching 5% of the area may be insufficient to accurately estimate fatalities, but increasing the search area is nevertheless very expensive and labor intensive. In addition, comparing two different methods for estimating fatalities is difficult when the true number of fatalities in not known, as is the case. Computer simulations may provide a method to test whether 5-day repeat surveys can accurately estimate fatalities on a site. However, the methods for estimating fatalities at wind energy facilities, which we adapted for this study, still represent a tested, reliable, and cost-effective way to estimate fatalities over a large site such as CVSR.

4.4.2 1-day Repeat Surveys

The 1-day repeat surveys were designed to increase understanding of searcher efficiency by providing an independent index of carcasses missed by the weekly searchers. However, 1-day repeat surveys did not provide a full measure of searcher efficiency because the efficiency of the 1-day repeat surveyor was not known. Although the searcher-efficiency trials involved dividing the number of found fatalities by a known number of fatality plants, 1-day repeat surveys counted found fatalities representing some proportion of an unknown total number of fatalities in the area. On this Project site, fatalities rates were not high enough to get an accurate sample from such small survey areas. We found very few fatalities in 1-day repeat surveys. As with the 5-day repeat surveys, the area covered by the 1-day repeat surveys was so small (5% of the array) that it was rare to encounter fatalities. Because our sample size from these searches was too small to make a reliable, independent estimate of searcher efficiency, data from these surveys were incorporated into regular weekly search data. Had fatality rates been higher, we may have been able to use these data in an independent detection probability analysis of searcher efficiency. Using data on the few fatalities actually detected, the results of such an analysis would have been inaccurate.

4.5 Fatality Estimator

This is the first study of its kind to be conducted on a photovoltaic solar project. In a review paper titled "Environmental impacts from the installation and operation of large-scale solar power plants," Turney and Fthenakis predicted that negative impacts on wildlife would occur because of fencing installed in wildlife corridors and changes in food availability and preying strategy, but posited that the number of direct fatalities caused by solar panels was likely to be low compared to other anthropogenic sources of fatalities (Turney and Fthenakis 2011). The only previous study of fatalities at a solar farm took place at a concentrating solar farm in 1983. The primary concern at that facility was singed feathers of birds flying through flux near a central tower generated by heliostats, or panels of reflective mirrors (Wagner et. al 1983). Fatalities in this report were reported over a time period, rather than over a given area, so we were unable to directly compare fatality rates calculated by our study to those previously reported. Likewise, Wagner et al. (1983) did not account for searcher-efficiency rates, and disregarded carcass-removal rates after a preliminary experiment. Failure to account for these issues can severely affect overall fatality estimates.

To give an initial estimate of fatality rates attributable to solar arrays beyond the background fatality rate, we estimated fatality rates for Array 1 using time periods beyond the time period this report covers. We estimated fatalities and confidence intervals for Array 1 based on a full year of data (20 September 2012 to 19 September 2013), and for the control plots for Array 1 and 2 from 15 November 2012 to 14 November 2013. We adjusted the control plot area estimate to cover an area the same size as Array 1 (66 trackers). We then subtracted the lower bound of the confidence interval for the control plot estimate from the Array 1 estimate to obtain an adjusted fatality estimate for Array 1 beyond the background fatality rate.

We estimated that 231 fatalities occurred over a full year in Array 1 (90% confidence intervals: 162, 382) based on 47 fatalities found, and 187 fatalities in the control plots (90% confidence intervals: 107, 367) based on 11 fatalities found. This resulted in an adjusted fatality range 90% confidence interval of 55-275 attributable to the array, or 0.83 to 4.167 fatalities per tracker per year This corresponds to a mean rate of 7.34, or (90% Confidence interval: 3.24 to 16.27 fatalities per MW per year, assuming 0.256MW per tracker).

There are several caveats to keep in mind when interpreting these estimates. As we reanalyze data with full years of surveys for the remaining arrays and control plots these estimates will likely change. Our sample area of control plots in this calculation was based on surveys of 22 tracker sized control plots, which we now know from resampling is a low sample size to calculate fatality rates from, especially for an area as large as the on-site conservation land at the CVSR Project. This is also a conservative adjustment, using only the lower bound of the confidence interval or minimum estimated number of background fatalities.

As we complete full years of surveys for the remaining arrays, this estimate will likely change. However, fatalities per megawatt of installed capacity are a useful metric to compare fatality rates across sites and methods of energy production (Arnett et al. 2008; Smallwood 2013). For example, at regional scales in North America, birds collide with wind turbines at similar rates (National Research Council 2007; Erickson et al. 2008; National Wind Coordinating Collaborative 2010; Smallwood 2013).

In terms of both vegetation and landscape features, the CVSR Project site is fairly homogeneous, particularly in and among arrays, mostly because of the geomorphology of the site but also partly due to the grading and ground disturbance that occurred during construction. Although during the two seasons in which we sampled all arrays, the overall estimates from each array varied by less than one fatality per tracker unit per season, fatality rates for different arrays may vary by season; therefore, a full year of sampling in all arrays is needed before it is known whether or not the number of fatalities is spatially even across arrays.

In contrast to the relatively homogeneous distribution of fatalities in the array areas, the difference between the Gen-tie Line fatalities and the MVOH Line fatalities is striking. The height and size of the Gen-tie and MVOH Lines are considerably different. Much of the linear area along the MVOH Line has been disturbed by construction-related activities, whereas nearly all of the grassland habitat along the Gen-tie Line is intact, and disturbance was limited to the tower pads and access roads to the pads. A natural wetland that provides many avian species with important resources also occurs along the Gen-tie Line. Furthermore, construction of the Gen-tie Line was completed in June 2012, whereas construction close to the MVOH Line was just coming to a close in fall 2013; therefore, noise and ground disturbance likely contributed to overall lower avian activity along the MVOH Line and consequently lower mortality rates.

At all Project elements, we found relatively few owls and diurnal raptors. However, the long-term effects on these birds of collision hazards such as solar arrays are unclear. For species that are K-strategists (i.e., larger animals that have relatively fewer offspring and live long), such as diurnal raptors and owls, even small numbers of fatalities may lead to long-term impacts. Other species that are r-strategists (i.e., smaller animals that have many offspring and are short-lived) may be better able to compensate for lowered population densities by increasing their clutch sizes and fledgling survival rates in response to an increased relative abundance of resources (Drewitt et al. 2008).

4.6 Conclusion and Recommendations

This annual fatality report offers insights into the under-studied effects of large solar photovoltaic installations on avian mortality. In the next annual fatality report, we will be able to report a site-wide estimate of fatalities for all seasons. Likewise, ongoing fatality searches, searcher-efficiency trials, and carcass-removal trials will help to increase the accuracy of our fatality estimates.

Based on our findings to date, we recommend the following:

- **Establish a Linear Control:** To better assess the fatality rates of passerines and raptors across the landscape, fatality searches along a linear control should be conducted, and fatality searches along the Gen-tie Line should continue for another year. Linear controls should be used to evaluate fatality rates along both the Gen-tie and MVOH Lines.

- **Measure Abundance of Passerines as Well as Raptors:** Point counts targeting both raptors and passerines should be conducted in arrays and along linear features, allowing comparisons to data on activity on the Conservation Lands. These counts and comparisons would indicate whether fatality rates are associated with species abundance. The current avian point counts are biased toward raptors and large birds.
- **Examine Ways to Partition Feathers Spots:** Because the ratio of feather spots to found carcasses was 20:3 during the reporting period, the inability to partition feather spots associated with collisions and feather spots stemming from predation has important implications regarding inferences that can be drawn from the fatality estimate. We are examining relationships within the existing data set in an attempt to quantify the relative contribution of predation events to the overall fatality estimates.

Discontinue Repeat Surveys: Given the low fatality rates on the site and the expense and labor involved in repeat surveys, 5-day and 1-day repeat surveys should be discontinued. We recommend focusing efforts on weekly fatality surveys. We recommend that daily searches generally not be conducted to obtain a fatality estimate because they are labor intensive and labor is generally offset by surveying smaller areas. Given the tradeoff between area covered and frequency of searches, it is better to conduct regular weekly searches of a larger proportion of the site. Daily searches would be most useful if they are necessary to answer specific research questions, for example linking fatalities to weather patterns or to test a deterrent method or some other form of mitigation where knowing more precise timing of fatalities is important, but data gathered for answering these questions should not be used to obtain a site-wide estimate.

We recommend avoiding multiple searches of the same area at different time intervals. If surveys are conducted at various search intervals on the same area to answer research questions, we recommend that the different search strategies be designed to avoid interfering with each other. For example, daily searchers would not collect fatalities so they will still be present for weekly searchers to find.

- **Modify Weekly Fatality Search Areas to Improve Sample Size:** We recommend discontinuing 100% searches of Arrays 1 and 2, reducing the coverage of these arrays to 20% based on the results of the subsampling error assessment (power analysis) of the first year of data. All other arrays should also be searched at the 20% level. Further, the smaller arrays close to each other should be combined so that a 20% sample comprises 30–35 tracker units.

- **Conduct Scent Dog Survey Trials:** Scent detection dogs could be used to increase searcher efficiency rates, particularly where grasses and forbs obscure fatalities. If scent dogs prove significantly better during bias trials, we recommend considering the use of scent dogs to conduct fatality searches, most likely in combination with human searchers, at least initially.

Section 5.0 References

5.1 Literature Cited

Akaike, H. 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in B. N. Petran and F. Csaki (Editors), 2nd International Symposium on Information Theory. Akademiai Kiado, Budapest, Hungary.

Allen, G. T., and P. Ramirez. 1990. A review of bird deaths on barbed-wire fences. The Wilson Bulletin 102(3):553–558.

Arnett, E. B., W. K. Brown, W. P. Erickson, J. K. Fiedler, B. L. Hamilton, T. H. Henry, A. Jain, G. D. Johnson, J. Kerns, R. R. Koford, C. P. Nicholson, T. J. O'Connell, M. D. Piorkowski, and R. D. Tankersley, 2008. Patterns of bat fatalities at wind energy facilities in North America. The Journal of Wildlife Management 72(1): 61-78.

Beason, R. C. 1995. Horned lark (*Eremophila alpestris*). No. 195 i*n* A. Poole (Editor), The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York. [online]: http://bna.birds.cornell.edu/bna/species/195. Doi:10.2173/bna.195

Bohall-Wood, P. 1987. Abundance, habitat use, and perch use of loggerhead shrikes in North-Central Florida. The Wilson Bulletin 99(1):82–86.

Brown, W. M., and R. C. Drewien. 1995. Evaluation of two power line markers to reduce crane and waterfowl collision mortality. Wildlife Society Bulletin 23(2):217–227.

Derby, C., A. Dahl, W. Erickson, K. Bay, and J. Hoban. 2007. Postconstruction Monitoring Report for Avian and Bat Mortality at the NPPD Ainsworth Wind Farm. February 27. Prepared for Nebraska Public Power District. Prepared by Western Ecosystems Technology, Inc.

Drewitt, A. L., and R. H. W. Langston. 2008. Collision effects of wind-power generators and other obstacles on birds. Annals of the New York Academy of Sciences 1134:233–266.

Efron, B., and R. Tibshirani. 1986. Bootstrap methods for standard errors, confidence intervals and other measures of statistical accuracy. Statistical Science 1:54–77.

Emery, N. J. 2006. Cognitive ornithology: The evolution of avian intelligence. Philosophical Transactions of the Royal Society 361(1465):23-43.

Erickson, W. P., D. Strickland, D. Young, and G. Johnson. 2008. A Summary of Avian and Bat Fatalities at Wind Facilities in the U.S. November. Presentation at the National Wind Coordinating Collaborative Research Meeting VII, Milwaukee, Wisconsin.

[HTH] H. T. Harvey & Associates. 2011. Avian and Bat Protection Plan for the California Valley Solar Ranch Project. Fresno, California.

[HTH] H. T. Harvey & Associates. 2013. California Valley Solar Ranch Avian Activity Surveys: October 2011 –October 2012. Fresno, CA.

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. Doi: 10.1002/env.1052

Janss, G. F. E. 2000. Avian mortality from power lines: A morphological approach of a species-specific mortality. Biological Conservation 95:353–359.

Janss, G. F. E., and M. Ferrer. 1998. Rate of bird collision with power lines: effects of conductor –marking and static wire-marking. Journal of Field Ornithology 69: 8-17.

Johnson, G. D., W. P. Erickson, M. D. Strickland, M. F. Sheperd, D. A. Sheperd, and S. A. Sarappo. 2003. Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota. American Midland Naturalist 150:332–342.

Johnston, D. S., J. A. Howell, S. B. Terrill, N. Thorngate, J. Castle, J. P. Smith, T. J. Mabee, J. H. Plissner, N. A. Schwab, P. M. Sanzenbacher, and C. M. Grinnell. 2013. Bird and Bat Movement Patterns and Mortality at the Montezuma Hills Wind Resource Area. California Energy Commission. CEC-500-2013-015.

Leslie, D., J. Schwartz, and B. Karas. 2012. Altamont Pass Wind Resource Area Bird Fatality Study, Bird Years 2005–2010. November. M87. ICF 00904.08. Prepared for Alameda County Community Development Agency, Hayward, California. Prepared by ICF International, Sacramento, California.

Lynn, S., J.A. Martin, and D. K. Garcelon, 2006. Can supplemental foraging perches enhance habitat for endangered San Clemente Loggerhead Shrikes? Wilson Journal of Ornithology, 118: 333-341.

Martin, C., E. Arnett, and M. Wallace. 2013. Evaluating Bird and Bat Postconstruction Impacts at the Sheffield Wind Facility, Vermont: 2012 Annual Report. March 25. Prepared for Bat Conservation International and First Wind.

National Research Council. 2007. Environmental Impacts of Wind-energy Projects. The National Academies Press, Washington, D.C.

National Wind Coordinating Collaborative. 2010. Wind Turbine Interactions with Birds, Bats, and Their Habitat: A Summary of Research Results and Priority Questions. Fact Sheet: Spring 2010. Washington, D.C.

Nicholson, C. P., R. D. Tankersley Jr., J. K. Fiedler, and N. S. Nicholas. 2005. Assessment and Prediction of Bird and Bat Mortality at Wind Energy Facilities in the Southeastern United States: Final Report, 2005. Tennessee Valley Authority, Knoxville, Tennessee.

Otis, D. L., J. H. Schulz, D. Miller, R. E. Mirarchi, and T. S. Baskett. 2008. Mourning dove (*Zenaida macroura*). No. 117 i*n* A. Poole (Editor), The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York. [online]: http://bna.birds.cornell.edu/bna/species/117.

Ponce, C., J. C. Alonso, G. Argandoña, and M. Carrasco. 2010. Carcass removal by scavengers and search accuracy affect bird mortality estimates at power lines. Animal Conservation 13:603–612.

Prosser, P., C. Nattrass, and C. Prosser. 2008. Rate of removal of bird carcasses in arable farmland by predators and scavengers. Ecotoxicology and Environmental Safety 71(2):601–608.

R Development Core Team. 2011. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.

Scott, S. D., and C. McFarland. 2010. Bird Feathers: A Guide to North American Species. Stackpole Books, Mechanicsburg, Pennsylvania.

Sheffield, L. M., J. R. Crait, W. D. Edge, and G. Wang, 2001. Response of American kestrels and gray-tailed voles to vegetation height and supplemental perches. Canadian Journal of Zoology, 79(3): 380-385.

Smallwood, K. S., D. A. Bell, S. A. Snyder, and J. E. Didonato. 2010. Novel scavenger removal trials increase wind turbine-caused avian fatality estimates. Journal of Wildlife Management 74(5):1089–1097.

Smallwood, K. S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781–2791.

Smallwood, K. S. 2013. Comparing bird and bat fatality rates among North American wind-energy projects. Wildlife Society Bulletin 37:19–33.

Turney, D. and V. Fthenakis. 2011. Environmental impacts from the installation and operation of large-scale solar power plants. Renewable and Sustainable Energy Reviews 15:3261–3270.

Wagner, W. D., R. L. McKernan, P. A. Flanagan, and R. W. Schreiber. 1983. Wildlife Interactions at Solar One Facility, Daggett, California: Fall 1982 Interim Report.

Wolff, J. O., T. Fox, R. R. Skillen, and G. Wang, 1999. The effect of supplemental perch sites on avian predation and demography of vole populations. Canadian Journal of Zoology 77(4): 535-541.

Yosef, R., and T. C. Grubb 1994. Resource dependency and territory size in Loggerhead Shrikes (*Lanius ludovicianus*). Auk 111:465-469.

5.2 Personal Communication

Huso, Manuela M. Supervisory Research Biological Statistician. USGS. 30 August 2013—Conversation with Gabriel Reyes of H.T. Harvey & Associates, regarding how to apply the fatality estimator to linear features and repeat fatality surveys.

Appendix A. Avian Species Used in Searcher-efficiency Trials, September 2012 to September 2013

Species	Carcass Size
American coot (*Fulica americana*)	Large
American crow (*Corvus brachyrhynchos*)	Large
American kestrel (*Falco sparverius*)	Large
Band-tailed pigeon (*Patagioenas fasciata*)	Large
Barn owl (*Tyto alba*)	Large
Black-crowned night heron (*Nycticorax nycticorax*)	Large
Black-headed grosbeak (*Pheucticus melanocephalus*)	Small
Brewer's blackbird (*Euphagus cyanocephalus*)	Small
California towhee (*Melozone crissalis*)	Small
Cedar waxwing (*Bombycilla cedrorum*)	Small
Chestnut-backed chickadee (*Poecile rufescens*)	Small
Common raven (*Corvus corax*)	Large
Common yellowthroat (*Geothylpis trichas*)	Small
Cooper's hawk (*Accipiter cooperii*)	Large
Eurasian collared-dove (*Streptopelia decaocto*)	Large
European starling (*Sturnus vulgaris*)	Small
Greater roadrunner (*Geococcyx californianus*)	Large
Great horned owl (*Bubo virginianus*)	Large
Green heron (*Butorides virescens*)	Large
Horned lark (*Eremophila alpestris*)	Small
House finch (*Carpodacus mexicanus*)	Small
Lesser goldfinch (*Spinus psaltria*)	Small
Long-eared owl (*Asio otus*)	Large
Mourning dove (*Zenaida macroura*)	Large
Rock pigeon (*Columba livia*)	Large
Red-shouldered hawk (*Buteo lineatus*)	Large
Savannah sparrow (*Passerculus sandwichensis*)	Small
Swainson's thrush (*Catharus ustulatus*)	Small
Varied thrush (*Ixoreus naevius*)	Large
Warbling vireo (*Vireo gilvus*)	Small
Western meadowlark (*Sturnella neglecta*)	Small
Western scrub-jay (*Aphelocoma californica*)	Small
White-tailed kite (*Elanus leucurus*)	Large
Yellow-billed magpie (*Pica nuttalli*)	Large
Yellow warbler (*Setophaga petechia*)	Small

Appendix B. Avian Species Used in Carcass-removal Trials

Species	Carcass Size	Number Placed
Acorn woodpecker (*Melanerpes formicivorus*)	Small	1
American coot (*Fulica americana*)	Large	1
American crow (*Corvus brachyrhynchos*)	Large	7
American goldfinch (*Spinus tristis*)	Small	1
American kestrel (*Falco sparverius*)	Large	1
American robin (*Turdus migratorius*)	Large	2
Anna's hummingbird (*Calypte anna*)	Small	1
Band-tailed pigeon (*Patagioenas fasciata*)	Large	2
Barn owl (*Tyto alba*)	Large	4
Black turnstone (*Arenaria melanocephala*)	Large	1
Brewer's blackbird (*Euphagus cyanocephalus*)	Small	2
California gull (*Larus californicus*)	Large	1
California quail (*Callipepla californica*)	Large	1
California towhee (*Melozone crissalis*)	Small	2
Cerulean warbler (*Setophaga cerulean*)	Small	2
Cliff swallow (*Petrochelidon pyrrhonota)*	Small	1
Common raven (*Corvus corax*)	Large	2
Eurasian collared-dove (*Streptopelia decaocto*)	Large	6
European starling (*Sturnus vulgaris*)	Small	2
Great horned owl (*Bubo virginianus*)	Large	6
Greater roadrunner (*Geococcyx californianus*)	Large	1
Hermit thrush (*Catharus guttatus*)	Small	1
Horned grebe (*Podiceps auritus*)	Large	2
Horned lark (*Eremophila alpestris*)	Small	3
House finch (*Haemorhous mexicanus*)	Small	3
House sparrow (*Passer domesticus*)	Small	1
Lesser goldfinch (*Spinus psaltria*)	Small	2
Lincoln's sparrow (*Melospiza lincolnii*)	Small	1
Mourning dove (*Zenaida macroura*)	Large	4
Northern flicker (*Colaptes auratus*)	Large	1
Northern mockingbird (*Mimus polyglottos*)	Small	1
Peregrine falcon (*Falco peregrinus*)	Large	1
Pine siskin (*Spinus pinus*)	Small	1
Red-shouldered hawk (*Buteo lineatus*)	Large	4
Red-tailed hawk (*Buteo jamaicensis)*	Large	8
Red-winged blackbird (*Agelaius phoeniceus*)	Small	1
Rock dove/pigeon (*Columba livia*)	Large	4
Ruby-crowned kinglet (*Regulus calendulai*)	Small	1
Sharp-shinned hawk (*Accipiter striatus*)	Large	1

Species	Carcass Size	Number Placed
Western meadowlark (*Sturnella neglecta*)	Medium	1
Western screech-owl (*Megascops kennicottii*)	Medium	1
Western scrub-jay (*Aphelocoma californica*)	Medium	4
White-crowned sparrow (*Zonotrichia leucophrys*)	Small	2
White-tailed kite (*Elanus leucurus*)	Large	2
Yellow-rumped warbler (*Setophaga coronata*)	Small	2

Appendix C. Weekly Fatality Search Results: 16 August 2012 to 15 August 2013

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 1	9/27/2012	Mourning dove	11S	233981	3915723	Feather spot.
Array 1	9/27/2012	Mourning dove	11S	233987	3915548	Feather spot. Suspected roosting/preening site.
Array 1	9/27/2012	Common raven	11S	233705	3915535	Feather spot.
Array 1	9/27/2012	Common raven	11S	234004	3915528	Feather spot.
Array 1	10/4/2012	Mourning dove	11S	233512	3915482	Feather spot. Suspected roosting/preening site.
Array 1	10/18/2012	Horned lark	11S	233542	3915733	Feather spot.
Array 1	10/18/2012	Burrowing owl	11S	233886	3915595	Feather spot.
Array 1	10/18/2012	Horned lark	11S	233579	3915738	Feather spot.
Array 1	10/18/2012	Horned lark	11S	233928	3915518	Feather spot.
Array 1	10/18/2012	Burrowing owl	11S	234000	3915471	Feather spot.
Array 1	10/25/2012	Horned lark	11S	233714	3915431	Feather spot.
Array 1	11/1/2012	Horned lark	11S	233442	3915776	Partial carcass with wings, legs, and bill. Bill impaled on tumbleweed. Cause of death possible predation by loggerhead shrike (LOSH).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 1	11/1/2012	Horned lark	11S	234110	3915654	Feather spot.
Array 1	11/8/2012	Horned lark	11S	234103	3915641	Feather spot.
Array 1	11/8/2012	Mourning dove	11S	233950	3915518	Feather spot. Suspected roosting/preening site.
Array 1	11/8/2012	Western meadowlark	11S	233822	3915671	Breast feathers. Some skin attached.
Array 1	11/8/2012	Medium-sized bird	11S	233426	3915528	Medium-sized bird based on articulated knee or elbow and fibula/tibia.
Array 1	11/8/2012	Mourning dove	11S	233807	3915533	Feather spot (body feathers). Suspected roosting/preening site.
Array 1	11/8/2012	Short-eared owl	11S	233815	3915688	Feather spot. Feathers on panel. Cause of death possible panel strike.
Array 1	11/8/2012	Short-eared owl	11S	233891	3915349	Feather spot. Feathers, possible organs, whitewash, spot with dirt absent on panel. Cause of death possible panel strike.
Array 1	12/20/2012	Mourning dove	11S	233412	3915438	Feather spot (>50 body feathers). Feathers scattered over 2x2-m area.
Array 1	1/10/2013	House finch	11S	234021	3915462	Head impaled on tumbleweed. Cause of death possible predation by LOSH.
Array 1	1/10/2013	Horned lark	11S	234056	3915775	Feather spot (several primaries and body feathers). Smudge marks and four body feathers stuck to the bottom right corner of panel. Feathers found at the array edge. Cause of death likely a panel strike.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 1	1/17/2013	Horned lark	11S	233952	3915772	Feather spot.
Array 1	1/17/2013	Western meadowlark	11S	233462	3915602	Feather spot (primaries, body, and contour feathers). Spread across 2x2-m area, likely wind-blown.
Array 1	1/31/2013	Horned lark	11S	233446	3915562	Feather spot (downy feathers).
Array 1	1/31/2013	House finch	11S	233740	3915310	Feather spot. Flesh on some feather tips.
Array 1	1/31/2013	Western meadowlark	11S	233930	3915672	Feather spot.
Array 1	1/31/2013	Mourning dove	11S	234119	3915660	Feather spot (13 body feathers). Suspected roosting/preening site.
Array 1	2/14/2013	Western meadowlark	11S	231009	3915719	Feather spot.
Array 1	3/21/2013	Horned lark	11S	234249	3915566	Feather spot (≥25 back and breast feathers). Several feathers found on the bare ground under the panels.
Array 1	3/28/2013	Horned lark	11S	234151	3915458	Feather spot. Near acoustic station near Array 1.
Array 1	4/18/2013	Horned lark	11S	234062	3915720	Feather spot (two secondaries with coverts attached, one secondary, and more than ten body feathers).
Array 1	5/9/2013	House finch	11S	234155	3915577	Feather spot (four primaries, ≥20 contour feathers).
Array 1	5/9/2013	Horned lark	11S	233866	3915476	Feather spot (~15 breast feathers in a clump).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 1	5/16/2013	Horned lark	11S	233445	3915794	Feather spot (≥15 flight feathers and ≥50 body feathers).
Array 1	5/23/2013	House finch	11S	233794	3915504	Feather spot (~40 breast feathers).
Array 1	5/23/2013	Mourning dove	11S	233689	3915385	Feather spot (approximately ten body feathers tightly clumped).
Array 1	5/23/2013	Horned lark	11S	234007	3915780	Feather spot (seven tail feathers, ten primaries attached by tissue, ≥20 contour feathers, and four secondaries).
Array 1	5/30/2013	Horned lark	11S	233732	3915516	Feather spot. Wing parts and contour feathers. Nest with eggs ~30 cm away. Bird may have been predated.
Array 1	6/13/2013	American kestrel	11S	233506	3915434	Feather spot (five feathers, including three primaries).
Array 1	6/20/2013	American kestrel	11S	234249	3915575	Feather spot (one secondary, five wing coverts, and 15 breast feathers).
Array 1	7/18/2013	Mourning dove	11S	233427	3915713	Feather spot (~15 body feathers tightly clustered).
Array 1	7/18/2013	House finch	11S	233949	3915584	Feather spot (~15 body feathers).
Array 1	7/25/2013	Mourning dove	11S	233858	3915327	Feather spot (~25 contour feathers and coverts).
Array 1	7/25/2013	Great horned owl	11S	233865	3915329	Feather spot (11 contour feathers). Feathers worn and older than search interval.
Array 1	8/1/2013	House finch	11S	233704	3915471	Feather spot (~15 feathers of a wing). Feathers barely attached.
Array 1	8/1/2013	Common raven	11S	233570	3915547	Feather spot (~20 breast feathers attached in a clump to dried flesh).
Array 1	8/1/2013	Horned lark	11S	233908	3915420	Feather spot (12 secondaries and contour feathers). Feathers worn and older than search interval.
Array 1	8/8/2013	Mourning dove	11S	233431	3915425	Feather spot (17 contour feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 1	8/8/2013	Common raven	11S	233602	3915623	Feather spot (ten primaries, 15 body feathers, and small amount of flesh dried to feathers).
Array 1	8/15/2013	Common raven	11S	233658	3915633	Partial carcass (wing).
Array 1 control plot	11/15/2012	Blackbird sp.	11S	234421	3915557	Feather spot.
Array 1 control plot	4/18/2013	Horned lark	11S	234835	3914331	Feather spot (two secondaries and three tail feathers).
Array 1 control plot	5/23/2013	Common raven	11S	234394	3915663	Feather spot (~20 contour feathers).
Array 1–2 fence	2/19/2013	Horned lark	11S	233393	3915496	Feather spot (≥15 body, one primary, and three secondary feathers).
Array 1–2 fence	3/5/2013	Mourning dove	11S	233616	3914432	Feather spot (≥20 body and breast feathers). Could be preening spot, but feathers were scattered in 1-m radius. Some feathers stuck together. Found 30 m north of fence point 17.
Array 1–2 fence	3/12/2013	Mourning dove	11S	233623	3914542	Feather spot (~50 breast feathers). Approx. 0.5 m east of fence.
Array 1–2 fence	5/7/2013	Unknown small bird	11S	234252	3914464	Feather spot (~20 body feathers, dark grey in color). Clearly rained upon.
Array 2 control plot	12/4/2012	Horned lark	11S	234801	3915162	Feather spot.
Array 2 control plot	2/5/2013	Tree swallow	11S	234303	3913572	Feather spot.
Array 2 control plot	2/5/2013	House finch	11S	234299	3913638	Whole carcass. No obvious injuries or signs of ill health.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 control plot	4/16/2013	Common raven	11S	233760	3914054	Feather spot (mixture of ~25 secondaries and contour feathers). Feathers scattered across 5 m.
Array 2 control plot	5/21/2013	Horned lark	11S	234756	3915202	Feather spot (15 flight feathers and ≥50 body feathers).
Array 2 control plot	7/23/2013	Horned lark	11S	233650	3914101	Feather spot (one tail feather and 14 contour feathers).
Array 2 North	12/4/2012	Western meadowlark	11S	234107	3915294	Feather spot. Wing (with some flesh) under panel at edge of tracker. Feather spot 4.6 m east, on top of panel (≥10 feathers stuck on panel with large smear marks).
Array 2 North	12/11/2012	Mourning dove	11S	234417	3915072	Feather spot. Body feathers and mourning dove (MODO) fecal droppings present. Suspected roosting/preening site.
Array 2 North	12/11/2012	Mourning dove	11S	233923	3915097	Feather spot. Body feathers and MODO fecal droppings present. Suspected roosting/preening site.
Array 2 North	12/11/2012	Horned lark	11S	234354	3915162	Feather spot.
Array 2 North	1/8/2013	Horned lark	11S	234492	3915122	Feather spot.
Array 2 North	1/8/2013	Horned lark	11S	234281	3915343	Feather spot (ten or more primaries and >50 downy feathers).
Array 2 North	1/8/2013	Horned lark	11S	234349	3915216	Whole carcass. Bird apparently died just prior to survey. Very good condition and weight. Possible head trauma. Seizure before death. No definitive evidence of panel strike. Cause of death potential panel strike.
Array 2 North	1/8/2013	Unknown small bird	11S	234013	3914931	Feather spot.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 North	1/8/2013	Mourning dove	11S	233775	3915006	Feather spot. Two feathers have blood on the ends.
Array 2 North	1/8/2013	Mourning dove	11S	233998	3915109	Feather spot.
Array 2 North	1/8/2013	Western meadowlark	11S	234474	3915002	Feather spot (clump of feathers).
Array 2 North	1/8/2013	California quail	11S	234458	3915015	Feather spot (clump of breast feathers).
Array 2 North	1/8/2013	American pipit	11S	233947	3915001	Whole carcass. No evidence of panel strike.
Array 2 North	1/15/2013	Mourning dove	11S	234116	3915029	Feather spot (primaries, secondaries, and body feathers).
Array 2 North	1/15/2013	Mourning dove	11S	234116	3915045	Feather spot (several downy and flight feathers). Found in same row as MODO feather spot from same day. Probably same fatality.
Array 2 North	1/15/2013	Common raven	11S	234369	3915286	Feather spot (contour feathers).
Array 2 North	1/15/2013	Western meadowlark	11S	234254	3915320	Feather spot (body feathers in small clump).
Array 2 North	1/15/2013	Common raven	11S	234384	3915309	Feather spot (body feathers).
Array 2 North	1/22/2013	Common raven	11S	234377	3915298	Feather spot (contour feathers). Potentially remnants from a previously collected common raven (CORA) fatality (1/15/13).
Array 2 North	1/22/2013	Mourning dove	11S	233835	3914945	Feather spot (clump of body feathers).
Array 2 North	1/22/2013	Mourning dove	11S	233902	3914945	Feather spot (downy feathers). Suspected preening site.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 North	1/22/2013	Mourning dove	11S	234359	3915322	Feather spot. Suspected preening site above cable tray.
Array 2 North	1/22/2013	Mourning dove	11S	234119	3915035	Feather spot (scattered feathers and one clump).
Array 2 North	1/22/2013	Horned lark	11S	234173	3915114	Feather spot.
Array 2 North	1/22/2013	California quail	11S	234393	3914986	Feather spot (clump of feathers).
Array 2 North	1/29/2013	Mourning dove	11S	233891	3914945	Feather spot (mostly breast feathers). Not under panel like most MODO preening areas.
Array 2 North	1/29/2013	Mourning dove	11S	234015	3914931	Feather spot (one clump of body feathers).
Array 2 North	1/29/2013	Mourning dove	11S	234365	3915193	Feather spot.
Array 2 North	1/29/2013	Mourning dove	11S	234367	3915164	Feather spot. Body feathers spread down row.
Array 2 North	2/5/2013	House finch	11S	234212	3915338	Whole carcass (broken neck). Cause of death potential panel strike.
Array 2 North	2/5/2013	Mourning dove	11S	233991	3914940	Feather spot. Skin attached to feathers.
Array 2 North	2/12/2013	Mourning dove	11S	234182	3915342	Feather spot (body and flight feathers). Some feathers with dried flesh attached at shaft base. Five body feathers stuck to solar panel, but no evidence of strike. Spread across entire tracker unit row.
Array 2 North	2/12/2013	Unknown small bird	11S	234198	3915347	Skeletal remains of wing and keel bones. Bones picked clean. Dried muscle fibers still attached but

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
						stringy.
Array 2 North	2/12/2013	Western meadowlark	11S	234409	3915384	Feather spot (~20 contour feathers).
Array 2 North	2/12/2013	House finch	11S	234464	3915452	Feather spot. Wing feather clumps. A few body and flight feathers on panel, but no evidence of panel strike. Many body feathers on ground under panel on outside face of tracker.
Array 2 North	2/12/2013	Mourning dove	11S	234386	3915162	Feather spot (~20 scattered downy feathers).
Array 2 North	2/12/2013	Mourning dove	11S	234386	3915157	Feather spot (two downy feathers on panel, two flight feathers on ground). No evidence of panel strike.
Array 2 North	2/12/2013	Mourning dove	11S	234260	3915252	Feather spot (>100 body and >10 flight feathers). Approximately 11 body feathers on panel, but no evidence of panel strike.
Array 2 North	2/19/2013	House finch	11S	233861	3914831	Feather spot (a few primaries and a few body feathers).
Array 2 North	2/19/2013	Mourning dove	11S	234396	3915436	Feather spot (≥50 feathers—ten or more secondaries and tertials and ≥40 body feathers). Feathers found stuck on panel. Possible panel strike or prey possibly eaten on panel.
Array 2 North	2/19/2013	Mourning dove	11S	234115	3915291	Feather spot (seven primaries with skin attached). Some feathers found stuck to panel. Possible panel strike or prey possibly eaten on panel.
Array 2 North	2/19/2013	Mourning dove	11S	234114	3915292	Feather spot (four or more secondaries, ≥15 body feathers, one tail feather, and one larger body feather). Absence of droppings and wide scatter of feathers indicate fatality and not preening station.

Area	**Date**	**Species**	**UTM**	**Easting**	**Northing**	**Observation Details[1]**
Array 2 North	2/19/2013	House finch	11S	234484	3915068	Feather spot (ten primaries and ≥50 body feathers). All feathers there—plucked.
Array 2 North	2/19/2013	Horned lark	11S	234442	3915295	Feather spot (≥15 body feathers and five or more primaries). Found directly under a panel.
Array 2 North	2/19/2013	House finch	11S	234164	3915141	Feather spot (≥30 body feathers).
Array 2 North	2/19/2013	House finch	11S	234261	3915153	Feather spot (ten primaries and ≥30 body feathers).
Array 2 North	2/26/2013	Western meadowlark	11S	234337	3915123	Feather spot (≥15 body feathers). All contour feathers. Isolated spot (not scattered).
Array 2 North	3/5/2013	Horned lark	11S	233901	3915118	Feather spot (five or more secondaries and ≥15 body feathers).
Array 2 North	3/5/2013	Horned lark	11S	234406	3915204	Whole carcass. Eyes gone but still fresh. Body warm but could be from intense sun. No visible signs of injury.
Array 2 North	3/5/2013	Horned lark	11S	234348	3915190	Feather spot (≥15 body feathers). White tips on body feathers.
Array 2 North	3/5/2013	Mourning dove	11S	234341	3915343	Feather spot (two flight feathers).
Array 2 North	3/12/2013	Mourning dove	11S	234227	3915000	Feather spot (≥50 body feathers and five or more flight feathers—mostly secondaries). Grey/white feathers. Spread over four rows. Some clumped feathers. Not a preening site.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 North	3/12/2013	Western meadowlark	11S	234250	3915070	Feather spot (one wing of ~20 primaries, five or more coverts, and yellow breast feathers).
Array 2 North	3/19/2013	House finch	11S	234341	3915005	Feather spot. Wings, foot, and feathers present (two wing partials; ≥20 primaries, secondaries, and coverts; and ≥50 body feathers). Bright red breast feathers present.
Array 2 North	3/26/2013	Horned lark	11S	234343	3915283	Whole carcass. Ants found in head and eye sockets. Found about 1 m from another horned lark (HOLA) fatality on same day. No signs of injury.
Array 2 North	3/26/2013	Horned lark	11S	234342	3915282	Feather spot. (partial wing, ten or more primaries and secondaries, five or more coverts, and ≥20 body feathers). Found about 1 m south of full HOLA carcass.
Array 2 North	4/2/2013	Horned lark	11S	234269	3914950	Feather spot. One clump of feathers on the cable tray (five primaries, six secondaries, two coverts, and one tail feather).
Array 2 North	4/2/2013	Horned lark	11S	234234	3915032	Feather spot. Clump of feathers (≥30 body feathers).
Array 2 North	4/2/2013	Horned lark	11S	234232	3915019	Feather spot (four primaries, eight secondaries, five tertials, and 12 contour feathers).
Array 2 North	4/16/2013	Horned lark	11S	234267	3915289	Whole carcass. No signs of injury.
Array 2 North	4/23/2013	Mourning dove	11S	234517	3915331	Feather spot (~15 primaries, 35 secondaries, ten tail feathers, 20 mantle feathers, and several hundred body feathers).
Array 2 North	4/30/2013	Mourning dove	11S	234268	3915260	Feather spot (one flight feather, ≥10 body feathers, and five body feathers in a clump).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 North	4/30/2013	Horned lark	11S	234215	3915114	Feather spot. Most feathers, including more than ten remiges, more than five retrices, and >75 contour feathers.
Array 2 North	4/30/2013	Horned lark	11S	234396	3914943	Feather spot (15 flight feathers, six tail feathers and 15 body feathers). Shafts of feathers broken. Possible juvenile, judging by sheaths. Probably not molting at this time of year. Feathers stuck to panel and cable tray. Possible panel strike or prey possibly eaten on panel.
Array 2 North	5/7/2013	Common raven	11S	234388	3915306	Feather spot (~30 body feathers). Some clumps of body feathers.
Array 2 North	5/7/2013	Horned lark	11S	234094	3915266	Feather spot (three tail feathers).
Array 2 North	5/14/2013	Horned lark	11S	234086	3915503	Whole carcass. Urea present on bird—most likely died minutes before discovered. Broken neck. Possible panel strike.
Array 2 North	5/21/2013	Horned lark	11S	234025	3915288	Feather spot (15 flight and five tail feathers). Found outside of tracker, off the side of the access road.
Array 2 North	5/28/2013	Horned lark	11S	234378	3915245	Whole carcass. Bird appeared emaciated, had excrement on cloaca.
Array 2 North	5/28/2013	Horned lark	11S	234072	3915037	Feather spot (one primary feather, ~40 body feathers, and five coverts).
Array 2 North	5/28/2013	Horned lark	11S	234343	3915250	Feather spot (six contour feathers and one tail feather). Two predated HOLA nests within 3–5 m of feathers.
Array 2 North	5/28/2013	Horned lark	11S	234073	3915038	Feather spot (~15 flight feathers, including some wing feathers still attached, and five body feathers).
Array 2 North	5/28/2013	House finch	11S	234020	3915176	Feather spot (feathers, wing, leg, and feathers with dried flesh).
Array 2 North	6/4/2013	House finch	11S	234338	3914975	Feather spot (11 body feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 North	6/4/2013	Common raven	11S	234338	3914976	Feather spot (~15 body feathers on road, close to panels).
Array 2 North	6/4/2013	House finch	11S	234315	3915314	Feather spot (seven flight feathers, ten body feathers, and five attached wing feathers).
Array 2 North	6/11/2013	Horned lark	11S	234520	3915047	Feather spot (two primaries and one contour feather). May not be a fatality because HOLAs were molting heavily at this time.
Array 2 North	6/11/2013	House finch	11S	234376	3915093	Feather spot (20 breast feathers, some clumped). Some feathers appeared to be plucked.
Array 2 North	6/11/2013	House finch	11S	234056	3915253	Feather spot (parts of wing, body feathers, and bone fragments).
Array 2 North	6/18/2013	Horned lark	11S	234193	3915167	Feather spot (partial wing and body feathers).
Array 2 North	6/25/2013	Mourning dove	11S	234211	3914933	Feather spot (two clumps, each with approximately eight contour feathers). Found on outside end of the tracker.
Array 2 North	6/25/2013	Horned lark	11S	234448	3915393	Feather spot (~15 body feathers, one contour feather, and one primary).
Array 2 North	7/23/2013	Horned lark	11S	233886	3914829	Feather spot (~50 body feathers and 20 flight feathers).
Array 2 North	7/30/2013	Mourning dove	11S	234289	3915258	Feather spot (several contour feathers).
Array 2 Serengeti	10/16/2012	Horned lark	11S	234520	3915036	Feather spot. Blood on some feathers.
Array 2 Serengeti	10/23/2012	Mourning dove	11S	234310	3914949	Feather spot (body feathers). Suspected roosting/preening site.
Array 2 Serengeti	10/23/2012	Mourning dove	11S	234344	3914998	Feather spot (body feathers). Suspected roosting/preening site.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 Serengeti	10/23/2012	Savannah sparrow	11S	234363	3915303	Whole carcass. No obvious injuries.
Array 2 Serengeti	10/30/2012	Mourning dove	11S	234231	3915068	Feather spot.
Array 2 Serengeti	10/30/2012	Mourning dove	11S	234526	3914949	Feather spot.
Array 2 Serengeti	11/13/2012	Western meadowlark	11S	234426	3915134	Feather spot.
Array 2 Serengeti	11/13/2012	Mourning dove	11S	234335	3915010	Feather spot.
Array 2 South	12/4/2012	Mourning dove	11S	233991	3914554	Feather spot (several flight feathers).
Array 2 South	12/4/2012	House finch	11S	234257	3914587	Decapitated carcass.
Array 2 South	12/4/2012	Mourning dove	11S	233680	3914437	Feather spot (≥20 body downy feathers and two flight feathers). Many MODO fecal droppings scattered in area. Suspected preening site.
Array 2 South	12/4/2012	Mourning dove	11S	233652	3914448	Feather spot (two feathers, possibly secondaries). Found at outer edge of tracker.
Array 2 South	12/4/2012	Unknown medium-sized bird	11S	233793	3914462	Feather spot (three feathers, including two primaries). Possible rock dove.
Array 2 South	12/11/2012	Western meadowlark	11S	233834	3914500	Feather spot (approximately ten secondaries).
Array 2 South	12/11/2012	Mourning dove	11S	233700	3914515	Feather spot (numerous downy feathers). Suspected preening site.
Array 2 South	12/18/2012	Mourning dove	11S	234132	3914957	Feather spot. In middle of row.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 South	1/8/2013	Mourning dove	11S	234116	3914561	Feather spot. Clump of feathers stuck to panel. Possible panel strike.
Array 2 South	1/8/2013	Mourning dove	11S	233790	3914470	Feather spot.
Array 2 South	1/8/2013	House finch	11S	234000	3914568	Feather spot. Carcass appears to have been plucked close to impact site. Impact smudge on the panel. Cause of death likely panel strike.
Array 2 South	1/8/2013	House finch	11S	234071	3914567	Feather spot.
Array 2 South	1/8/2013	Mourning dove	11S	233667	3914553	Feather spot (contour and flight feathers).
Array 2 South	1/8/2013	Mourning dove	11S	233888	3914516	Feather spot (approximately ten flight feathers).
Array 2 South	1/8/2013	Mourning dove	11S	233665	3914526	Feather spot (flight, body, and tail feathers). Spot widely scattered over two rows of panels.
Array 2 South	1/15/2013	Mourning dove	11S	234131	3914798	Feather spot (seven feathers: primaries, tail, and body feathers). Some primaries were a little muddy but it had not rained in the previous 24 hours.
Array 2 South	1/15/2013	House finch	11S	234345	3914896	Whole carcass. Odd growth above bill, possible avian pox. No apparent injury. Body still warm and limp, eyes not visible.
Array 2 South	1/15/2013	Mourning dove	11S	233664	3914388	Feather spot. Dried blood on ground. Many MODO roost here. Probably predated while roosting.
Array 2 South	1/22/2013	Mourning dove	11S	233669	3914469	Feather spot. Many (20–30) body feathers scattered throughout tracker, but remained clumped.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 South	1/22/2013	Mourning dove	11S	233642	3914421	Feather spot (four primaries and 20–30 body feathers).
Array 2 South	1/22/2013	House finch	11S	233654	3914575	Whole carcass. Ants on carcass. No broken vertebrae or broken wings found.
Array 2 South	1/22/2013	Mourning dove	11S	233849	3914553	Feather spot. Suspected roosting site.
Array 2 South	1/22/2013	Western meadowlark	11S	233683	3914427	Feather spot (>100 flight, body, and tail feathers). San Joaquin kit fox (SJKF) scat found on some feathers.
Array 2 South	1/22/2013	House finch	11S	234047	3914606	Partial carcass. Two wings, lower body, and feet found under cable tray and panel.
Array 2 South	1/22/2013	Mourning dove	11S	233654	3914575	Feather spot. Several distinct clumps of feathers.
Array 2 South	1/29/2013	Mourning dove	11S	234303	3914603	Feather spot (two flight feathers and spiral of breast feathers).
Array 2 South	1/29/2013	Mourning dove	11S	234022	3914568	Feather spot.
Array 2 South	2/5/2013	Western meadowlark	11S	233658	3914665	Feather spot. Single body feather and smudge marks on the lower left edge of panel. Large feather spot (body and flight feathers) scattered across tracker row. Some clumps of feathers with dried blood. Cause of death likely a panel strike.
Array 2 South	2/5/2013	House finch	11S	234200	3914856	Partial carcass and large feather spot (rump, two legs, and flight and body feathers). Found between trackers along road. Top portion of bill with orange tuft of feathers present. Breast feathers tinged with orange/red.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 South	2/12/2013	Mourning dove	11S	233891	3914457	Feather spot (15–20 downy and secondary feathers). No evidence of panel strike.
Array 2 South	2/19/2013	House finch	11S	234105	3914580	Feather spot (five or more primaries, a few secondaries, and ≥30 body feathers). At edge of tracker.
Array 2 South	3/5/2013	Horned lark	11S	234030	3914669	Whole carcass. Bill appears broken. Possible panel strike.
Array 2 South	3/5/2013	House finch	11S	234418	3914852	Feather spot (≥50 body feathers and ten flight feathers—mostly secondaries).
Array 2 South	3/19/2013	Mourning dove	11S	233662	3914435	Feather spot. Two primary feathers found under panel in area of abundant preening activity (fecal matter). Suspected preening site.
Array 2 South	4/2/2013	House finch	11S	234253	3914760	Feather spot (clump of >36 breast feathers, six primaries, and beak). Might have been plucked by avian predator.
Array 2 South	4/2/2013	Mourning dove	11S	233674	3914433	Feather spot (one secondary and 12 contour feathers). Suspected preening site.
Array 2 South	4/23/2013	Horned lark	11S	234030	3914728	Feather spot (~20 body feathers). Possible that more feathers blew away with high wind.
Array 2 South	4/23/2013	Mourning dove	11S	234214	3914706	Feather spot (20 contour feathers).
Array 2 South	4/30/2013	Horned lark	11S	233841	3914512	Feather spot (clump of ten body feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 South	4/30/2013	Brewer's blackbird	11S	234250	3914496	Feather spot (tip of left wing with flight feathers, coverts and alula, clump of tail feathers, body feathers with some skin, and one leg). More feathers two rows over (body feathers, flight feathers, and leg).
Array 2 South	4/30/2013	Mourning dove	11S	234465	3914864	Feather spot (≥15 body feathers in a few clumps with skin and dried intestine).
Array 2 South	4/30/2013	Common raven	11S	234104	3914491	Feather spot (~15 contour feathers).
Array 2 South	5/14/2013	House finch	11S	234310	3914591	Feather spot (one wing with flight feathers and coverts attached).
Array 2 South	5/14/2013	Unknown	11S	233830	3914497	Intestines of an unknown small animal.
Array 2 South	5/21/2013	Mourning dove	11S	234210	3914543	Feather spot (~20 feathers; three clumps with skin).
Array 2 South	5/21/2013	Horned lark	11S	234031	3914746	Feather spot (approximately six primaries and 35 body feathers).
Array 2 South	7/23/2013	Mourning dove	11S	234421	3914889	Feather spot (25 flight feathers).
Array 2 South	7/23/2013	Horned lark	11S	234439	3914890	Feather spot (five flight feathers).
Array 2 South	7/23/2013	Horned lark	11S	234196	3914623	Feather spot (two tail feathers and 15 body feathers).
Array 2 South	7/30/2013	Horned lark	11S	233649	3914409	Feather spot (~15 contour feathers).
Array 2 South	7/30/2013	Horned lark	11S	234366	3914575	Feather spot (three primaries, three tail feathers, two secondaries, two coverts, and ~35 contour feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 South	8/6/2013	House finch	11S	233972	3914601	Feather spot (~20 feathers, mostly primaries, and a few body feathers).
Array 2 South	8/13/2013	Horned lark	11S	234360	3914545	Feather spot (five flight feathers and ≥15 body feathers).
Array 4	1/9/2013	Mourning dove	11S	235596	3913032	Feather spot. Feathers in bunches, stuck together in clumps. Contour and wing feathers present, but no primaries or tail feathers.
Array 4	1/9/2013	Mourning dove	11S	235598	3913140	Feather spot. Contour and tail feathers only—no flight feathers present.
Array 4	1/16/2013	Mourning dove	11S	235591	3913465	Feather spot (≥100 body feathers). Feathers mainly in one central area, but some up to 4 m away.
Array 4	1/16/2013	House finch	11S	235672	3913330	Feather spot (14 flight feathers and numerous body feathers) and mandible.
Array 4	1/16/2013	Mourning dove	11S	235679	3913408	Feather spot. Feathers scattered. A second group of feathers, likely from the same bird but collected in a separate bag, found approximately 6 m north-northwest of this main feather group; both feather concentrations were fairly dispersed.
Array 4	1/16/2013	Mourning dove	11S	235610	3913174	Feather spot.
Array 4	1/16/2013	Mourning dove	11S	235588	3913193	Feather spot.
Array 4	1/16/2013	Mourning dove	11S	235616	3912749	Feather spot. Several hundred of feathers found.
Array 4	1/23/2013	Mourning dove	11S	235590	3913417	Feather spot. Only a few feathers, but one tail feather that was still mostly in the sheath; not a feather that would come from a live bird.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 4	1/23/2013	Mourning dove	11S	235624	3913517	Feather spot (>30 feathers).
Array 4	1/23/2013	Mourning dove	11S	235563	3913442	Older feather spot.
Array 4	1/23/2013	European starling	11S	235603	3912848	Feather spot (>50 body feathers).
Array 4	1/23/2013	Western meadowlark	11S	235761	3912701	Feather spot.
Array 4	2/13/2013	Western meadowlark	11S	235631	3912693	Feather spot at edge of row.
Array 4	2/13/2013	Mourning dove	11S	235767	3913293	Feather spot.
Array 4	2/13/2013	House finch	11S	235824	3913384	Feather spot (~15 body feathers).
Array 4	2/13/2013	Unknown small bird	11S	235737	3913347	Whole carcass. Fatality searcher informed of small dead bird on solar panel during weekly search. Bird was gone when searcher went to retrieve it 35 minutes later. Presumed to be removed by scavenger, potentially a CORA, which was seen in the area. Cause of death potential panel strike.
Array 4	4/24/2013	Horned lark	11S	235713	3913038	Feather spot (clump of ≥30 body feathers held together with dried skin).
Array 4	5/8/2013	House finch	11S	235724	3913524	Partial carcass (seven wing feathers still attached and one secondary).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 4	5/15/2013	Mourning dove	11S	235709	3913391	Feather spot (approximately ten primaries, six secondaries, and ≥30 wing and body feathers). Likely predated or scavenged by a mammal. Several feathers sheared off part way, as if bitten. Three clumps of feathers.
Array 4	6/12/2013	European starling	11S	235718	3912700	Feather spot (15 flight feathers).
Array 4	6/12/2013	House finch	11S	235767	3912695	Feather spot (23 flight feathers and ~50 contour feathers).
Array 4	6/19/2013	Yellow-rumped warbler	11S	235680	3912694	Feather spot (≥100 rump, contour, and wing covert feathers).
Array 4 control plot	4/17/2013	House finch	11S	236442	3912744	Feather spot (18 primaries, six other remiges, and ≥60 contour feathers).
Array 4 fence	2/13/2013	Mourning dove	11S	236303	3913354	Feather spot. Found outside of fence.
Array 5	1/16/2013	House finch	11S	236687	3913839[1]	Feather spot.
Array 5	2/6/2013	House finch	11S	236724	3913628	Feather spot.
Array 5	2/6/2013	Red-tailed hawk	11S	236683	3913857	Bones found (right leg and pelvis).
Array 5	3/27/2013	House finch	11S	236776	3913649	Feather spot (six primaries, two secondaries, and 20 breast feathers). Feathers sparsely spread across 3 m.

---

[1] Northing coordinate has been amended since the 2nd quarterly report was submitted, because this coordinate had been mislabeled.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 5	6/5/2013	House finch	11S	236779	3913577	Feather spot (three distinct clumps of feathers; ~40 breast and body feathers).
Array 8 Circuit 2	1/14/2013	Mourning dove	11S	233804	3912068	Feather spot.
Array 8 Circuit 2	1/21/2013	Mourning dove	11S	233641	3912191	Feather spot (four primaries and several body feathers).
Array 8 Circuit 2	1/21/2013	Mourning dove	11S	233630	3912302	Feather spot (several secondaries, coverts, and body feathers).
Array 8 Circuit 2	1/28/2013	Mourning dove	11S	234106	3911788	Feather spot (five primaries and >30 downy feathers).
Array 8 Circuit 2	1/28/2013	Mourning dove	11S	233543	3912244	Whole carcass. Found at preening site.
Array 8 Circuit 2	2/11/2013	Mourning dove	11S	233385	3912476	Feather spot (>20 body feathers, several flight feathers, and one clump of body feathers).
Array 8 Circuit 2	3/4/2013	House finch	11S	233416	3912277	Feather spot of partially intact whole wing, with five or more primary and secondary feathers each, and five or more body feathers.
Array 8 Circuit 2	4/15/2013	Western meadowlark	11S	233648	3912076	Partial carcass (wings and body, but no head). Could be red-tailed hawk (RTHA) kill. Two western kingbirds (WEKI) and one RTHA were observed earlier in day. RTHA was directly beside fence.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 8 Circuit 2	4/15/2013	Horned lark	11S	234052	3911694	Feather spot (one full wing, one partial wing, three breast feather clumps, and ≥50 loose body feathers). Feathers appear weathered.
Array 8 Circuit 2	7/17/2013	Great horned owl	11S	233957	3912424	Feather spot (two wings and >100 body feathers). Incidental fatality.[2]
Array 8 Circuit 2	7/22/2013	Horned lark	11S	234043	3911719	Feather spot (one primary and ~15 contour feathers).
Array 8 Circuit 2	8/5/2013	Horned lark	11S	233966	3911745	Feather spot (25–50 body feathers and several primaries). Found in charred substrate under panels and scattered throughout the tracker.
Array 8 Circuit 2	8/12/2013	Horned lark	11S	233976	3911740	Feather spot (~30 contour and flight feathers).
Array 8 control plot	3/4/2013	Mourning dove	11S	234418	3913321	Feather spot (two primaries together).
Array 1–2 fence	10/16/2012	Horned lark	11S	234527	3915080	Feathers and flesh hanging from fence, approximately 0.5 m off ground. One flight feather and flesh on ground right along fence.
Array 1–2 fence	10/30/2012	Mourning dove	11S	233399	3915720	Feather spot.
Array 1–2 fence	11/13/2012	Western meadowlark	11S	234418	3915494	Feather spot with beak and skull fragments.
Array 1–2 fence	12/4/2012	Mourning dove	11S	233852	3914441	Feather spot (≥20 body feathers).

---

[2] In the 4th quarterly report, this incidental fatality was reported as a long-eared owl on Figure 4, but was not included in the Appendix A summary of the weekly fatality search results. This species was later identified as a great horned owl.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 1–2 fence	12/11/2012	Mourning dove	11S	233793	3914373	Feather spot.
Array 1–2 fence	1/15/2013	Western meadowlark	11S	234383	3914539	Feather spot.
Array 1–2 fence	1/22/2013	Mourning dove	11S	233620	3914498	Feather spot. Two feather spots separated by 23 m, but feathers appear to be from same individual. Largely contour and down feathers, with a single primary found. Feathers spread on either side of the fenceline.
Gen-tie Line	8/29/2012	Burrowing owl	11S	234398	3916178	Feather spot at base of Tower 11. Feathers possibly from burrowing owl fatality previously found on 7/18/2012.
Gen-tie Line	8/29/2012	Horned lark	11S	234255	3916437	Feather spot scattered to the west of the tower 12.
Gen-tie Line	9/5/2012	Horned lark	11S	234266	3916692	Feather spot at base of Tower 13, directly below powerline.
Gen-tie Line	9/26/2012	Horned lark	11S	234527	3914444	Feather spot between Towers 3 and 4, directly below powerline.
Gen-tie Line	9/26/2012	Red-tailed hawk	11S	234302	3914086	Feathers with flesh attached, found between Towers 2 and 3, directly below powerline.
Gen-tie Line	10/3/2012	Horned lark	11S	234357	3917785	Feather spot at a feeding perch with droppings at the edge of the tamarisk wetland.
Gen-tie Line	10/3/2012	Long-eared owl	11S	234376	3917802	Feather spot in tamarisk wetland.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-tie Line	10/10/2012	Medium-sized bird	11S	234303	3917740	Feather spot of unknown medium-sized species found between tamarisk wetland and Tower 17, directly below powerline.
Gen-tie Line	10/10/2012	Horned lark	11S	234274	3917044	Whole specimen between Towers 14 and 15. Directly below powerline, but no sign of injury. Cause of death possible line collision.
Gen-tie Line	10/17/2012	Horned lark	11S	234271	3916931	Feather spot near Tower 14. Directly below powerline.
Gen-tie Line	10/17/2012	Lincoln's sparrow	11S	234439	3916064	Whole carcass between Towers 10 and 11, directly below powerline. Cause of death possible line collision.
Gen-tie Line	10/17/2012	Common raven	11S	234573	3914500	Feathers with flesh near Tower 4.
Gen-tie Line	10/17/2012	Savannah sparrow	11S	234573	3914618	Whole carcass between Towers 4 and 5, directly below powerline. Unidentified injury, but blood present on carcass. Cause of death possible line collision.
Gen-tie Line	10/17/2012	Mourning dove	11S	234358	3917786	Feather spot in tamarisk wetland. Found under perch where other feathers were found before.
Gen-tie Line	10/24/2012	Horned lark	11S	234203	3913888	Whole carcass between Towers 1 and 2, directly below powerline. Right wing broken. Cause of death possible line collision.
Gen-tie Line	10/24/2012	Savannah sparrow	11S	234391	3914203	Whole carcass between Towers 2 and 3, directly below powerline. No obvious injuries. Cause of death possible line collision.
Gen-tie Line	10/31/2012	American coot	11S	234470	3916002	Whole carcass between Towers 10 and 11, directly under powerline. Decapitated, but head found near body. Cause of death possible line collision.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-tie Line	10/31/2012	Fox sparrow	11S	234592	3914983	Feather spot between Towers 5 and 6, directly under powerline.
Gen-tie Line	10/31/2012	Mourning dove	11S	234408	3917851	Feather spot in tamarisk wetland. Suspected roosting/preening site.
Gen-tie Line	10/31/2012	Northern flicker	11S	234304	3917708	Feather spot between tamarisk wetland and Tower 17, directly below powerline.
Gen-tie Line	11/14/2012	Western meadowlark	11S	234580	3914699	Whole carcass between Towers 4 and 5, directly below powerline. Head dislocated at the neck. Some neck feathers plucked. No other obvious injuries. Cause of death possible line collision.
Gen-tie Line	11/28/2012	Horned lark	11S	234255	3916696	Feather spot (≥20 downy feathers).
Gen-tie Line	12/11/2012	Common raven	11S	234610	3915356	Whole carcass. Electrical burns on feet. Found ~5 m from base of Tower 7. Cause of death electrocution.
Gen-tie Line	12/11/2012	Common raven	11S	234640	3915393	Whole carcass. Head scavenged. Scales peeled back on legs. Found ~15 m east of Tower 7. Cause of death electrocution.
Gen-tie Line	12/12/2012	Mourning dove	11S	234382	3917819	Feather spot (≥200 feathers—downy, body, and flight feathers).
Gen-tie Line	12/19/2012	Mourning dove	11S	234255	3916534	Feather spot (flight, tail, and body feathers).
Gen-tie Line	12/19/2012	Western meadowlark	11S	234426	3916094	Whole carcass. Neck intact. Wings not broken but bones exposed on upper left wing. No sign of external injuries. Fresh. Cause of death likely line collision.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-tie Line	1/9/2013	Horned lark	11S	234374	3917774	Feather spot (body feathers and several secondaries and primaries).
Gen-tie Line	1/9/2013	Western meadowlark	11S	234256	3916730	Old feather spot along fence line east of main road.
Gen-tie Line	1/9/2013	Mourning dove	11S	234270	3916541	Feather spot (several tail and body feathers, and some secondaries and primaries).
Gen-tie Line	1/16/2013	Horned lark	11S	234355	3917785	Feather spot (breast feathers).
Gen-tie Line	1/16/2013	House finch	11S	234603	3915112	Feather spot (two primaries).
Gen-tie Line	1/23/2013	Common raven	11S	234291	3917304	Feather spot (primaries, secondaries, and a few contour feathers). Found about 4.6 m from the Gen-tie Line. Feathers appear sheared off (feather shaft cut at an angle). Feathers are weathered.
Gen-tie Line	1/23/2013	Mourning dove	11S	234357	3916221	Feather spot (tail, body, and primary feathers). Fresh MODO scat at feather spot. Found <3 m from Gen-tie Line.
Gen-tie Line	1/23/2013	Horned lark	11S	234381	3917831	Feather spot (body, tail, primary, and secondary feathers). Found in wetland area directly under Gen-tie Line.
Gen-tie Line	1/23/2013	Horned lark	11S	234390	3917811	Feather spot (body, tail, primary, and secondary feathers). Relatively fresh. Found in wetland area.
Gen-tie Line	1/23/2013	Loggerhead shrike	11S	234390	3917750	Feather spot (mostly primaries with some body feathers). Very old kill. Discovered buried under litter in wetland area while searcher was cleaning up a fresh feather spot from a HOLA.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-tie Line	1/23/2013	Loggerhead shrike	11S	234390	3917813	Feather spot (two fresh primaries). Found in wetland area.
Gen-tie Line	1/23/2013	Horned lark	11S	234394	3917816	Mixed feather spot of fresh and old feathers, potentially indicating other HOLA kills at same location. Blood found on branch near spot. Found near three previously documented fatalities.
Gen-tie Line	1/23/2013	Horned lark	11S	234358	3917772	Feather spot (body, tail, and flight feathers). Found just outside wetland area, under shrub.
Gen-tie Line	1/30/2013	Horned lark	11S	234384	3917825	Feather spot (>20 flight feathers and >40 body feathers). Found in tamarisk wetland.
Gen-tie Line	1/30/2013	Horned lark	11S	234482	3917744	Feather spot. Found in tamarisk wetland.
Gen-tie Line	1/30/2013	House finch	11S	234575	3914595	Feather spot (>20 flight feathers and >50 body feathers).
Gen-tie Line	1/30/2013	Horned lark	11S	234569	3914573	Feather spot (>20 body feathers).
Gen-tie Line	1/30/2013	House finch	11S	234568	3914514	Feather spot.
Gen-tie Line	1/30/2013	Horned lark	11S	234482	3917744	Feather spot.
Gen-tie Line	1/30/2013	House finch	11S	234394	3917875	Feather spot.
Gen-tie Line	1/30/2013	House finch	11S	234572	3914523	Feather spot (many tail and wing feathers, some body feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-tie Line	1/30/2013	House finch	11S	234556	3914504	Feather spot (>10 flight feathers and >20 body feathers).
Gen-tie Line	2/6/2013	Mourning dove	11S	234318	3914093	Feather spot. West of old farm house. Very likely a heavily used preening site.
Gen-tie Line	2/13/2013	Mourning dove	11S	234255	3916582	Feather spot (several hundred feathers—flight and body feathers). Possibly scavenged by SJKF—SJKF scat found at spot. Feathers found in two piles about 5 m apart. A "trail" of feathers connected the two piles. Scat from two animals (SJKF and pig or coyote) present.
Gen-tie Line	2/13/2013	Western meadowlark	11S	234413	3918059	Feathers spot. Feathers scattered across 10 m.
Gen-tie Line	2/20/2013	Savannah sparrow	11S	234285	3916896	Whole carcass. No visible signs of injury, but found directly under powerline. Cause of death possible line collision.
Gen-tie Line	3/20/2013	Horned lark	11S	234279	3917067	Feather spot (≥15 primaries and secondaries and ≥30 body feathers). Found directly under the powerline. SJKF scat present near spot.
Gen-tie Line	3/25/2013	Common yellowthroat	11S	234598	3915248	Whole carcass. Fresh blood on carcass. Tail broken. No other major injuries observed. Cause of death possible line collision.
Gen-tie Line	3/27/2013	Mourning dove	11S	234333	3917755	Feather spot (five or more secondaries and ten or more body feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-tie Line	4/3/2013	Mourning dove	11S	234270	3916745	Feather spot (four coverts and ten or more contour feathers). Spread across 5-m diameter.
Gen-tie Line	4/17/2013	Horned lark	11S	234291	3917588	Feather spot (20 flight feathers and 50 body feathers). Found directly under the powerline.
Gen-tie Line	4/17/2013	Horned lark	11S	234599	3915172	Feather spot (~20 primaries). Found directly under the powerline.
Gen-tie Line	4/23/2013	Nashville warbler	11S	234143	3913787	Whole carcass. Tip of beak broken, indicating likely collision. Cause of death possible line collision.
Gen-tie Line	4/24/2013	Warbler sp.	11S	234279	3917306	Feather spot (20 flight feathers, ≥30 body/breast feathers—all downy). Found at fenceline parallel to road.
Gen-tie Line	5/1/2013	Horned lark	11S	234437	3914300	Feather spot (partial wing, ≥20 flight feathers, and ≥50 body feathers—mostly downy). Found directly under the powerline.
Gen-tie Line	5/8/2013	Warbling vireo	11S	234450	3914310	Whole carcass, very fresh. Possible broken neck. Found directly under powerline. Cause of death possible line collision.
Gen-tie Line	5/22/2013	MacGillivray's warbler	11S	234515	3918720	Feather spot (11 primaries and part of wing).
Gen-tie Line	5/22/2013	Mourning dove	11S	234513	3918735	Feather spot (~100 body feathers and one primary).
Gen-tie Line	5/22/2013	Warbler sp.	11S	234277	3917091	Feather spot (~30 contour feathers).
Gen-tie Line	5/22/2013	Yellow warbler	11S	234631	3915389	Feather spot (eight flight feathers and ~50 contour feathers).
Gen-tie Line	5/22/2013	Swainson's thrush	11S	234258	3916622	Feather spot (~25 flight and 50 contour feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-Tie Line	5/29/2013	Horned lark	11S	234275	3917246	Feather spot (~100 body and 12 flight feathers). Found directly under the powerline.
Gen-tie Line	5/29/2013	Yellow-rumped warbler	11S	234265	3917142	Feather spot (~100 body and 15 flight feathers).
Gen-tie Line	5/29/2013	Horned lark	11S	234265	3917142	Feather spot (12 body and six flight feathers). Pig scat present.
Gen-tie Line	5/29/2013	Warbler sp.	11S	234296	3917715	Feather spot (12 flight and 30 body feathers). Found directly under the powerline.
Gen-tie Line	5/29/2013	Horned lark	11S	234713	3915513	Feather spot (15 flight feathers, some attached by tissue, and ~100 body feathers).
Gen-tie Line	5/29/2013	Western meadowlark	11S	234618	3918793	Feather spot (15 primaries and secondaries and 15 body feathers). One clump of wing feathers attached by flesh.
Gen-tie Line	5/29/2013	Warbler sp.	11S	234717	3915511	Feather spot (25 flight and 50 body feathers, some held together by tissue).
Gen-tie Line	5/29/2013	Common raven	11S	234570	3914533	Feather spot (three flight and ten body feathers).
Gen-tie Line	5/29/2013	Horned lark	11S	234582	3914885	Feather spot (~50 body feathers).
Gen-tie Line	5/29/2013	Mourning dove	11S	234497	3918687	Feather spot (eight flight and ten body feathers).
Gen-tie Line	5/29/2013	Yellow warbler	11S	234423	3918671	Whole carcass. Found directly under the powerline.
Gen-tie Line	6/5/2013	Unknown small bird	11S	234586	3914810	Feather spot. A small number of body feathers connected by tissue at base of Tower 5.
Gen-tie Line	6/5/2013	Horned lark	11S	234257	3916588	Feather spot (four flight feathers, one tail feather, and 15 body feathers).
Gen-tie Line	6/5/2013	Yellow-rumped warbler	11S	234589	3914953	Feather spot (16 flight feathers and ~100 body feathers). Found directly under the powerline.
Gen-tie Line	6/5/2013	Warbler sp.	11S	234295	3917690	Feather spot (13 flight feathers and 30 contour feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-tie Line	6/5/2013	Warbler sp.	11S	234261	3916718	Feather spot (small clump of approximately ten body feathers stuck together with skin).
Gen-tie Line	6/5/2013	Unknown small bird	11S	234258	3916725	Feather spot (two tail feathers and one body feather). Found 5 m west of powerline.
Gen-tie Line	6/7/2013	Warbler sp.	11S	234615	3915267	Whole carcass. Found directly under the powerline.
Gen-tie Line	6/19/2013	Horned lark	11S	234643	3915468	Feather spot (~20 body feathers). Found ~90 m from the powerline. May not be associated with line.
Gen-tie Line	7/3/2013	Common yellowthroat	11S	234271	3917162	Feather spot (20 primaries and secondaries and ~70 body feathers). Nearly directly underneath the powerline.
Gen-tie Line	7/3/2013	Mourning dove	11S	234617	3918811	Feather spot (~20 primaries and secondaries, four tail feathers, and ~100 body feathers). Found scattered on hill southwest of Tower 22.
Gen-tie Line	7/31/2013	Mourning dove	11S	234279	3917054	Feather spot (numerous feathers from entire body).
Medium-voltage Overhead (MVOH) Line	1/30/2013	House finch	11S	234625	3913324	Decapitated carcass. Found outside fenced GKR site. Cause of death possible predation by LOSH.
MVOH Line	2/27/2013	Mourning dove	11S	236848	3913043	Feather spot (seven tail, a few primary, a few secondary, and ≥15 body feathers). Found ~250 m west of Array 6 edge, between second and third pole from start of MVOH Line west of Array 6. Multiple feathers found within a 2-m radius.
MVOH Line	3/13/2013	Barn owl	11S	238143	3912198	Feather spot (~12 wing feathers and two or three breast/body feathers). Mixed in and under Russian thistle piled against barbed wire.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
MVOH Line	4/1/2013	Common raven	11S	233898	3912970	Whole carcass. More than likely electrocuted on 3/28/2013, when a breaker blew out at the Substation. Electrocuted on/above coupler on the MVOH Line. May have arced across the lines.
MVOH Line	4/11/2013	Common raven	11S	233909	3912966	Whole carcass. Electrocuted at 8:30 AM at second tower to west, directly north of Array 8. Exit burn through neck, burn on belly. Singed feathers along left wing.
MVOH Line	4/17/2013	Horned lark	11S	234603	3913329	Feather spot (approximately nine primaries). Found under CORA nest on MVOH Line—nest is on powerline straight-away near Substation to the east.
MVOH Line	4/17/2013	Common raven	11S	234615	3913319	Feather spot (more than ten feathers). Difficult to collect because of wind. Located under CORA nest. Adults were lining the nest with white material. Found 100 m from the Operations and Maintenance facility.
MVOH Line	4/24/2013	House finch	11S	237860	3912838	Feather spot (ten contour and 15 flight feathers). Located directly under the powerline, ~20 m southwest of power pole.
MVOH Line	5/22/2013	European starling	11S	235550	3912671	Feather spot (part of right wing with primary and covert feathers).
MVOH Line	6/5/2013	Common raven	11S	234268	3913479	Feather spot (two flight feathers and one body feather). Found on road adjacent to tracker. Raven footprints present in the dust on the ground.
MVOH Line	6/5/2013	Common raven	11S	238155	3912221	Whole carcass. Dead juvenile seen hanging from nest, with pin and body feathers on ground.
MVOH Line	6/12/2013	European starling	11S	236683	3913043	Feather spot (approximately ten primaries and ten body feathers).
MVOH Line	6/19/2013	House sparrow	11S	233773	3915437	Feather spot (five flight and 15 contour feathers). Found directly under the powerline.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
MVOH Line	7/10/2013	Western meadowlark	11S	235656	3912671	Feather spot (~100 breast, tail, and flight feathers).
MVOH Line	7/10/2013	House finch	11S	236680	3913043	Feather spot (six flight and tail feathers and ~30 body feathers).
MVOH Line	7/10/2013	Short-eared owl	11S	233895	3912971	Partial carcass (lower foot and small part of tibia).
MVOH Line	7/31/2013	Horned lark	11S	233839	3911689	Feather spot (~30 contour feathers). Found directly under the powerline.

Appendix D. Foraging Zone and Taxonomic Group of Species Observed Within Project Elements During Weekly Fatality Searches: 16 August 2012 to 15 August 2013

Species		**Foraging Zone**	**Taxonomic Group**	**Number Recorded**
Arrays				***238***
California Quail	*Callipepla californica*	terrestrial	avian resident	2
Red-tailed hawk	*Buteo jamaicensis*	terrestrial	raptor	1
Mourning Dove	*Zenaida macroura*	terrestrial	avian resident	88
Great Horned Owl	*Bubo virginianus*	terrestrial	raptor	2
Burrowing Owl	*Athene cunicularia*	terrestrial	raptor	2
Short-eared Owl	*Asio flammeus*	terrestrial	raptor	2
American Kestrel	*Falco sparverius*	terrestrial	raptor	2
Common Raven	*Corvus corax*	terrestrial	avian resident	11
Horned Lark	*Eremophila alpestris*	terrestrial	avian resident	61
European Starling	*Sturnus vulgaris*	terrestrial	avian resident	2
American Pipit	*Anthus rubescens*	terrestrial	avian winter resident	1
Savannah Sparrow	*Passerculus sandwichensis*	terrestrial	avian winter resident	1
Brewer's Blackbird	*Brewer's Blackbird*	terrestrial	avian resident	1
Western Meadowlark	*Sturnella neglecta*	terrestrial	avian resident	17
House Finch	*Haemorhous mexicanus*	terrestrial	avian resident	39
Unknown Small Passerine		terrestrial	avian migrant	3
Unknown Medium-sized Bird		terrestrial	avian resident	2
Unknown (intestines only)		unknown	unknown	1
Gen-tie Line				***90***
Red-tailed hawk	*Buteo jamaicensis*	terrestrial	raptor	1
American Coot	*Fulica americana*	water	avian migrant	1
Mourning Dove	*Zenaida macroura*	terrestrial	avian resident	14
Burrowing Owl	*Athene cunicularia*	terrestrial	raptor	1
Long-eared Owl	*Asio otus*	terrestrial	raptor	1
Northern Flicker	*Colaptes auratus*	terrestrial	avian resident	1
Loggerhead Shrike	*Lanius ludovicianus*	terrestrial	avian resident	2
Warbling Vireo	*Vireo gilvus*	terrestrial	avian migrant	1
Common Raven	*Corvus corax*	terrestrial	avian resident	5
Horned Lark	*Eremophila alpestris*	terrestrial	avian resident	28
Swainson's Thrush	*Catharus ustulatus*	terrestrial	avian migrant	1
Nashville Warbler	*Oreothlypis ruficapilla*	terrestrial	avian migrant	1
MacGillivray's Warbler	*Geothlypis tolmiei*	terrestrial	avian migrant	1
Common Yellowthroat	*Geothlypis trichas*	terrestrial	avian migrant	2
Yellow Warbler	*Setophaga petechia*	terrestrial	avian migrant	2
Yellow-rumped Warbler	*Setophaga coronata*	terrestrial	avian migrant	2
Unknown Warbler		terrestrial	avian migrant	7
Savannah Sparrow	*Passerculus sandwichensis*	terrestrial	avian winter resident	3
Fox Sparrow	*Passerella iliaca*	terrestrial	avian migrant	1
Lincoln's Sparrow	*Melospiza lincolnii*	terrestrial	avian winter resident	1
Western Meadowlark	*Sturnella neglecta*	terrestrial	avian resident	5
House Finch	*Haemorhous mexicanus*	terrestrial	avian resident	6

Species		**Foraging Zone**	**Taxonomic Group**	**Number Recorded**
Unknown Small Passerine		terrestrial	avian migrant	2
Unknown Medium-sized Bird		terrestrial	avian resident	1
Medium-voltage Overhead (MVOH) Line				***17***
Mourning Dove	*Zenaida macroura*	terrestrial	avian resident	1
Barn Owl	*Tyto alba*	terrestrial	raptor	1
Short-eared Owl	*Asio flammeus*	terrestrial	raptor	1
Common Raven	*Corvus corax*	terrestrial	avian resident	5
Horned Lark	*Eremophila alpestris*	terrestrial	avian resident	2
European Starling	*Sturnus vulgaris*	terrestrial	avian resident	2
Western Meadowlark	*Sturnella neglecta*	terrestrial	avian resident	1
House Finch	*Haemorhous mexicanus*	terrestrial	avian resident	3
House Sparrow	*Passer domesticus*	terrestrial	avian resident	1
Fence Lines				***12***
Mourning Dove	*Zenaida macroura*	terrestrial	avian resident	7
Horned Lark	*Eremophila alpestris*	terrestrial	avian resident	2
Western Meadowlark	*Sturnella neglecta*	terrestrial	avian resident	2
Unknown Small Passerine		terrestrial	avian migrant	1
Project Related Fatalities				***357***
Control Plots				***11***
Mourning Dove	*Zenaida macroura*	terrestrial	avian resident	1
Common Raven	*Corvus corax*	terrestrial	avian resident	2
Horned Lark	*Eremophila alpestris*	terrestrial	avian resident	4
Tree Swallow	*Tachycineta bicolor*	air	avian migrant	1
Unknown Blackbird		terrestrial	avian resident	1
House Finch	*Haemorhous mexicanus*	terrestrial	avian resident	2

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch Project Avian and Bat Protection Plan Annual Postconstruction Fatality Report

16 August 2012 – 15 August 2013

Prepared for:

HPR II, LLC
California Valley Solar Ranch
13505 Carissa Highway, Highway 58
Santa Margarita, CA 93453
Attn: Bill Cotton

Prepared by:

H. T. Harvey & Associates
Project # 3326-03

Prepared per:

Avian And Bat Protection Plan for the California Valley Solar Ranch Project

U.S. Fish and Wildlife Service
Biological Opinion (81420-2011-F-0511)
San Luis Obispo County
Conditional Use Permit (DRC2008-00097)

28 March 2014

Executive Summary

Background

The California Valley Solar Ranch Project (CVSR Project) is a 250-megawatt photovoltaic solar power plant recently constructed within an approximately 4685-acre site (Project site), located mostly south of State Route (SR) 58, about 6.4 kilometers (km) east of Soda Lake Road, immediately north of the California Valley subdivision, in the Shandon-Carrizo planning area of San Luis Obispo County (Figure 1). The Conditional Use Permit for the CVSR Project required that an Avian and Bat Protection Plan be prepared and implemented to monitor the impacts of the CVSR Project on birds and bats after construction. In compliance with the resultant Avian and Bat Protection Plan, this Annual Postconstruction Fatality Report documents the number of avian and bat fatalities counted during postconstruction monitoring of the Project between 16 August 2012 and 15 August 2013.

Methods

H. T. Harvey & Associates (HTH) biologists conducted weekly surveys in the following CVSR Project elements: Array 1, Array 2, Array 2 Serengeti, Array 4, Array 5, Array 8, the Medium-voltage Overhead (MVOH) Line, and the Generation-tie (Gen-Tie) Line. During the reporting period, all arrays were surveyed each week at 20% of their total area, with the exception of Arrays 1 and 2, which were surveyed with 100% coverage to inform and strengthen our sampling methods. By collecting data at 100%coverage of these arrays, we were able to determine the spatial pattern of fatalities within the arrays and determine how much of the arrays would need to be surveyed to attain a given confidence level for developing an accurate fatality estimate for increasing our understanding of impacts to avian species from operating solar energy facilities. Further, these arrays were surveyed at 100% for a full year to detect whether or not the distribution of fatalities varied by season. For each of the arrays listed, biologists also surveyed portions of the surrounding fence. Additionally, to help identify the proportion of fatalities found that could be attributed to natural mortality rates, we surveyed control plots, located in Conservation Lands surrounding the CVSR Project site.

In addition to performing weekly surveys, HTH biologists conducted a series of repeat surveys: 5-day repeat surveys, in which biologists searched the same subset of a Project element for 5 consecutive days, and 1-day repeat surveys, in which biologists searched a subset of an area that was searched 1 day previously by either 5-day repeat searchers or weekly searchers. The purpose of these repeat surveys was to check the efficiency of searchers and evaluate the consistency of results; however, as reported herein, not all of the repeat surveys proved necessary.

To estimate the rate of avian and bat fatalities occurring on the site, we used Huso's Fatality Estimator (2010). In formulating a fatality estimate, it was necessary to determine 1) the rate of scavenging that occurs on the site, and 2) how well searchers find different-size carcasses in different amounts of vegetation cover. These determinations were made by 1) planting fresh carcasses of birds of various sizes and placing camera traps on them to identify scavenger species and the exact time of carcass removal, and 2) planting both carcasses and feather spots of different sizes in different vegetation classes while regular weekly and repeat surveys were taking place. Searcher-efficiency and carcass-removal rates were then used to adjust the annual count of fatalities to arrive at a site-wide fatality estimate.

Results and Discussion

Mean time to scavenging for all placed carcasses was 3.3 days and ranged from as little as 7 minutes to as long as 53 days. The carcass that persisted for 53 days was an outlier by 31 days; after removing this outlier from the analysis the mean time to scavenging was 2.8 days. Within 24 hours of placement, 54.4% of carcasses had been scavenged and 26.3% had been removed entirely (with no trace evidence). Within 7 days of placement, 86.9% of the carcasses had been scavenged, and 38.4% had been removed entirely. Ravens were the most common scavenger, and scavenged more than half of the carcasses placed. Ravens also scavenged carcasses the fastest, with a mean time to scavenging of 2.5 days (and a mean time of 1.5 days with the 53-day outlier dropped). Ravens scavenged three carcasses less than 1 hour after placement, and 72.5% of carcasses within 24 hours. San Joaquin kit foxes scavenged 20 carcasses, and had the second fastest scavenging time, with a mean time to scavenging of 3.6 days.

Of the carcasses placed, small carcasses were scavenged more quickly than large carcasses and more likely to be completely removed (80.6% of small birds scavenged were completely removed compared to 22.2% for large birds); consequently, only 19.5% of the small carcasses removed left evidence (partial carcass or feather spot) of the fatality, whereas, 77.7% of the large carcasses scavenged left evidence of the fatality. A logical extension of this finding is that the creation of a feather spot when a bird is preyed upon by an avian or mammalian predator is likely to occur at least as often as the creation of a feather spot during a scavenging event and feather spots created by depredated birds are likely to persist and be detected during searches at rates equal to feather spots created from scavenged carcasses.

The persistence of carcasses in the environment varied by season and Project element; carcasses placed in the control plots were scavenged more quickly than those along the Gen-tie Line, and carcasses placed in the arrays had the longest persistence time prior to being scavenged.

During the reporting period, searchers detected 94 of 177 (53%) of the fatality plants that were randomly placed in operational arrays, control plots, underneath overhead lines, and along fence lines across the CVSR Project site. Overall, searcher detection rates were higher below overhead lines and along fencelines (56%) than rates in the solar panel arrays (50%). Furthermore, the detection rate in surveyed rows within the arrays was slightly higher than in un-surveyed rows, which is expected as detectability generally declines with distance from the observer. Searcher efficiency was greatest during winter months (63%) and for large–sized carcasses (61% efficiency as opposed to 43% for small sized sparrows). Carcass size and visibility class, based on vegetation height and cover, were the most important indicators of how well searchers located fatalities. Scent detection dogs could be used to increase searcher efficiency rates, particularly where dense vegetation obscures fatalities, to improve the precision of the fatality estimates. If scent dogs prove significantly better during bias trials, we recommend considering the use of scent dogs to conduct fatality searches.

Causes of death were often difficult or impossible to determine from feather spots and carcasses found in the arrays. In a few cases, carcasses were found with no apparent injuries; in other cases, injuries (e.g., broken necks) indicated that a collision was the cause of death. Determining the cause of death from feather spots was even more difficult. We found feather spots on the ground near panels and on panels themselves. Fatalities may have occurred as a direct or indirect result of the presence of solar panels (e.g., a bird stunned by a collision with a panel can then be more easily predated), or they may indicate direct mammalian or avian predation. Solar panels likely contribute to direct and indirect causes of death for birds, but in many cases, it was not possible to determine cause of death. Because the ratio of feather spots to found carcasses was 20:3 during the reporting period, the inability to partition feather spots associated with collisions and feather spots stemming from predation has important implications regarding inferences that can be drawn from the fatality estimate.

Accounting for the spatial organization of avian fatalities is an important aspect of designing surveys and making decisions about future sampling, monitoring, and avoidance and minimization strategies. The geostatistical analysis of the dispersion of avian fatalities in Array 1 and Array 2 separately sampled at 100%, as well as in both arrays combined, indicates that the dispersion of fatalities is not significantly different from a random distribution. Knowing that fatalities are randomly distributed within arrays at the Project site is important for designing future sampling because there are no observable high concentrations (clumping) of avian fatalities that need to be taken into consideration. Moreover, a random dispersion pattern indicates that the probability of detecting an avian fatality should not change as a function of the amount of area (or number of tracker units) searched.

We used the fatality values from Arrays 1 and 2, which were searched in their entirety during the reporting period, to determine how the proportion of each array surveyed affects the accuracy of fatality estimates and confidence intervals.. Given the random dispersion of avian fatalities seen during the study period, and the error analysis for a given area searched, we recommend reducing monitoring to 20% of the total area in each array or array group. Also, each surveyed sample should comprise 30–35 tracker units; to meet this requirement, small arrays (e.g., Array 5) should be grouped with other small, neighboring arrays so that 20% of a given set comprises at least 30 tracker units.

On this Project site, fatalities rates were not high enough to obtain accurate samples during 1-day and 5-day repeat surveys from such small survey areas. As a result, we recommend discontinuing the 1-day and 5-day repeat surveys. We recommend that daily searches generally not be conducted to obtain a fatality estimate because they are labor intensive and labor is generally offset by surveying smaller areas. Given the tradeoff between area covered and frequency of searches, it is better to conduct regular weekly searches of a larger proportion of the site. Daily searches would be most useful if they are necessary to answer specific research questions, for example linking fatalities to weather patterns or to test a deterrent method or some other form of mitigation where knowing more precise timing of fatalities is important, but data gathered for answering these questions should not be used to obtain a site-wide estimate.

We recommend avoiding multiple searches of the same area at different time intervals. If surveys are conducted at various search intervals on the same area to answer research questions, we recommend that the different search strategies be designed to avoid interfering with each other. For example, daily searchers would not collect fatalities so they will still be present for weekly searchers to find.

A total of 357 fatalities were found during surveys of Project elements between 16 August 2012 and 15 August 2013; and an additional 11 fatalities were observed during surveys of control plots within conservation lands. It is important to note that this total comprises observations obtained during clearance surveys, weekly surveys, and 1-day and 5-day repeat surveys. The total number of fatalities observed at various Project Elements, consequently, may be larger than the sample sizes used to conduct overall fatality estimates for Project Elements because fatalities older than the search interval and fatalities found during clearance surveys and 5-day repeat surveys are not used to calculate the overall fatality estimates. Fatality estimates based on weekly searches and 5-day repeat searches were calculated separately.

The majority of fatality species represented year-round avian residents. In total, we found fatalities of 31 different avian species. Nearly all of the species utilize a terrestrial foraging zone; the two exceptions were a single American coot (*Fulica americana*) found along the Gen-tie and a single tree swallow (*Tachycineta bicolor*) found within a control plot. Horned larks, house finches (*Carpodacus mexicanus*), and mourning doves accounted for the greatest proportion of fatalities. Horned larks and mourning doves commonly roost and nest under the solar panels, and the two species combined represent 63% of the total number of fatalities found within the arrays. Documented special-status species fatalities comprised burrowing owl (*Athene cunicularia*), short-eared owl (*Asio flammeus*), long-eared owl (*Asio otus*), and loggerhead shrike (*Lanius ludovicianus*) fatalities. The total count of special-status species fatalities was small compared to the overall count.

In general, we estimated fatalities to be more abundant in the spring and less in the summer. This pattern is likely associated with the peak avian activity in the spring and the subsequent decline in activity in the summer, both documented through onsite avian point counts (HTH 2013). Because birds were more active on the Project site in spring, predation rates and collision rates are likely to be higher.

The Gen-tie Line was the only Project element that was searched for a full year during this reporting period because Project construction was completed during 2012. Eighty-three fatalities were found along the Gen-tie line and, based upon scavenging rates and searcher efficiency, we estimated that 446 fatalities occurred along the Gen-tie during this reporting period. We recommend that linear controls should be used to evaluate fatality rates along both the Gen-tie and MVOH Lines. Point counts targeting both raptors and passerines should be conducted in arrays and along linear features, allowing comparisons to data on activity on the Conservation Lands. These counts and comparisons would indicate whether fatality rates are associated with species abundance.

Project elements became operational and began to be searched at different times of the year, and the number of tracker units surveyed differed among arrays. Therefore, direct comparisons of fatality rates among and between Project elements are not made in this first year's fatality report. At the conclusion of all fatality searches next year, HTH will have collected enough data to report on seasonal differences in fatality rates, differences among arrays, and estimated fatalities per megawatt (a measure of avian and bat impacts that can be used to compare effects among various energy generation facilities).

We estimated that 231 fatalities occurred over a full year in Array 1 (90% confidence intervals: 162, 382) based on 47 fatalities found, and 187 fatalities in the control plots (90% confidence intervals: 107, 367) based on 11 fatalities found. This resulted in an adjusted fatality range 90% confidence interval of 55-275 attributable to the array, or 0.83 to 4.167 fatalities per tracker per year. This corresponds to a mean rate of 7.34 (90% Confidence interval: 3.24 to 16.27 fatalities per MW per year, assuming 0.256MW per tracker).

There are several caveats to keep in mind when interpreting these estimates. As we reanalyze data with full years of surveys for the remaining arrays and control plots these estimates will likely change. Our sample area of control plots in this calculation was based on surveys of 22 tracker sized control plots, which we now know from resampling is a low sample size to calculate fatality rates from, especially for an area as large as the on-site conservation land at the CVSR Project. This is also a conservative adjustment, using only the lower bound of the confidence interval or minimum estimated number of background fatalities.

As we complete full years of surveys for the remaining arrays, this estimate will likely change. Furthermore, because the ratio of feather spots to found carcasses was 20:3 during the reporting period, the inability to partition feather spots associated with collisions and feather spots stemming from predation has important implications regarding inferences that can be drawn from the fatality estimate. We are examining relationships within the existing data set in an attempt to quantify the relative contribution of predation events to the overall fatality estimates.

Table of Contents

Figures

Tables

Photo

Appendices

List of Contributors

Brian B. Boroski, Ph.D., Vice President and Principal-in-Charge, Wildlife Ecology

Scott B. Terrill, Ph.D., Vice President, Ornithology

David Johnston, Ph.D., Project Manager, Associate Wildlife Ecologist

Jarrod Santora, Ph.D., Senior Quantitative Ecologist

Kim M. Briones, M.S., Wildlife Ecologist

Meredith K. Jantzen, M.S., Field Biologist

Elizabeth L. Porzig, Ph.D., Quantitative Ecologist

Gabe A. Reyes, M.A. Candidate., Wildlife Ecologist

Sara A. Snyder, M.S. Candidate., Wildlife Ecologist

Stephen L. Peterson, M.S., Wildlife Ecologist I

Section 1.0 Introduction

Through adoption of Resolution #2011-119, the Board of Supervisors of San Luis Obispo County (the County) approved the California Valley Solar Ranch Project (CVSR Project) Conditional Use Permit (DRC 2008-00097) on 19 April 2011. The Conditional Use Permit is subject to the Conditions of Approval (COAs) set forth in Exhibit 6 attached to the Resolution.

The Conditional Use Permit allows High Plains Ranch II, LLC (and any successor in interest for the life of the CVSR Project) to construct and operate a 250-megawatt photovoltaic solar power plant within an approximately 4685-acre site (Project site), located mostly south of State Route (SR) 58, about 6.4 kilometers (km) east of Soda Lake Road, immediately north of the California Valley subdivision, in the Shandon-Carrizo planning area of San Luis Obispo County (Figure 1).

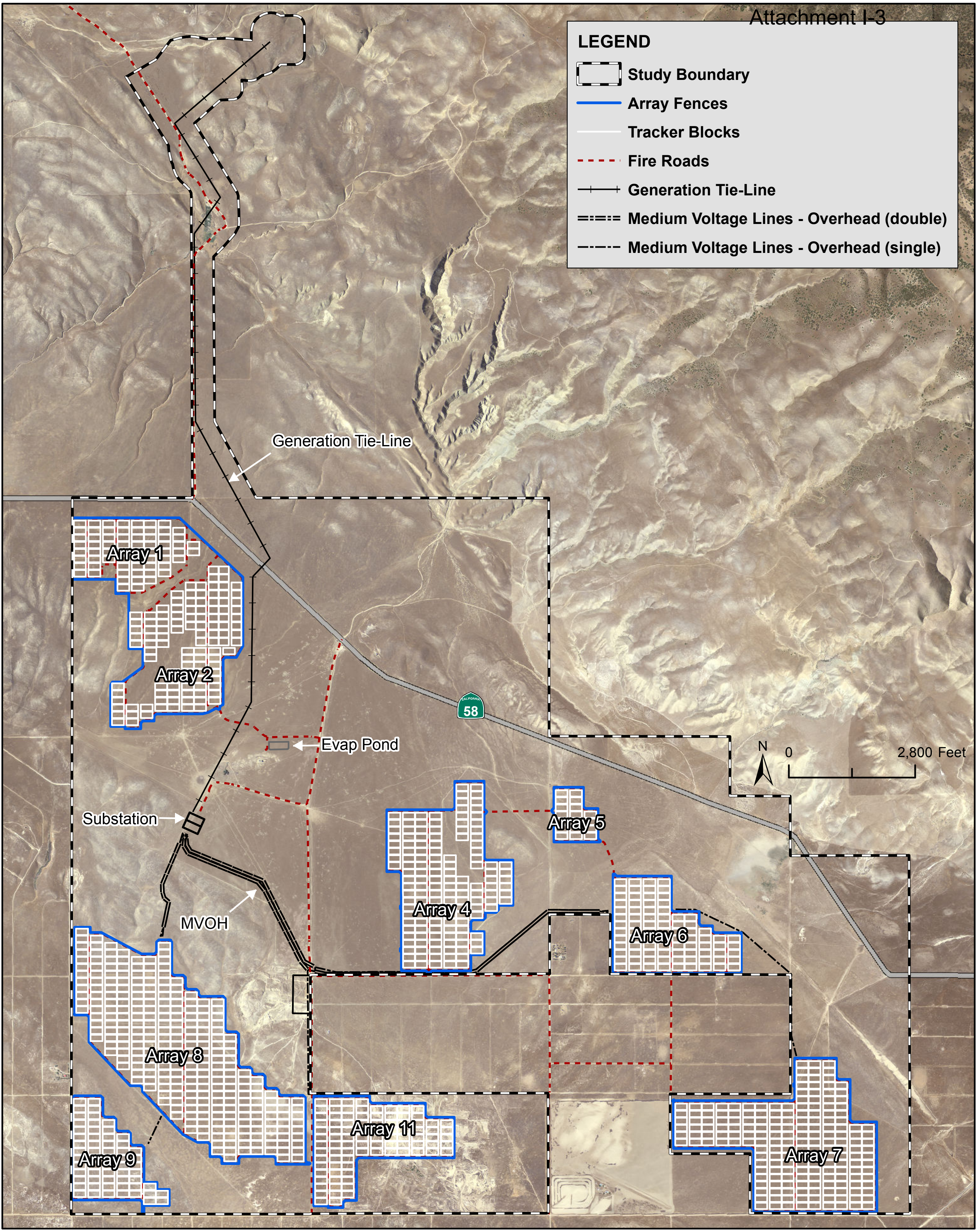
COA #58 of the Conditional Use Permit requires an Avian and Bat Protection Plan (ABPP) and an annual report detailing any Project-related bird or bat deaths or injuries detected during the monitoring study defined in COA #58c. To satisfy COA #58c, H. T. Harvey & Associates (HTH), on behalf of High Plains Ranch II, LLC, has prepared this postconstruction fatality report, which documents the number of avian and bat fatalities counted during Project postconstruction monitoring between 16 August 2012 and 15 August 2013.

One of the primary goals of this report is to provide estimates of the numbers of fatalities associated with different Project elements. To meet this objective, we used the Fatality Estimator (Huso 2010). In addition to performing regular weekly searches, we conducted searcher-efficiency trials to estimate the percentage of fatalities of different sizes found by searchers in both short and tall vegetation. To calculate the persistence of fatalities in the environment, we also conducted carcass-removal trials. The values we derived from both carcass-removal trials and searcher-efficiency trials were used in tandem with the results of our regular weekly searches to calculate estimated ranges of fatalities associated with different Project elements. Additionally, to obtain an estimate of background mortality levels, we conducted controlled searches in control plots located in onsite Conservation Lands. Finally, as a secondary, independent measure of fatalities, we conducted a series of repeat searches with more highly concentrated search intervals. This annual report presents methods, results, and a discussion of the searcher-efficiency trials, carcass-removal trials, regular weekly fatality searches, and all repeat fatality searches. Project elements searched during the reporting period were the Generation-tie (Gen-tie) Line; the Medium-voltage Overhead (MVOH) Line; Arrays 1, 2, 4, 5, and 8; the perimeter fences; and control plots associated with Arrays 1, 2, 4, and 8.

To determine the appropriate amount of sample area in which to conduct fatality searches for estimating total fatalities per year, we considered whether the spatial distribution of detected fatalities, as well as their temporal persistence, may vary according to the amount of area searched (or total number of tracker units searched). (Each tracker unit comprises 18 rows of solar panels, with 40 panels to a row.) Because of the complete survey effort (100% coverage) focused on Arrays 1 and 2 over the course of an entire year, we were able to provide a statistical assessment of how reduced area covered influences the uncertainty around our estimates, and recommend a level of survey coverage that would provide reasonable estimates).

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Annual 2013 Report\Figure 1 Project Site.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch

ABPP Annual Postconstruction Fatality Report

Figure 1: Project Site with Gen-tie Line, MVOH Line and Nine Arrays

Section 2.0 Methods

2.1 Field Methods

2.1.1 Weekly Fatality Searches

To estimate the total number of fatalities associated with different Project elements during the reporting period, we conducted a series of weekly fatality searches on different Project elements. Because the construction of different Project elements was completed at different times, fatality searches began at varying times in the year, depending on the Project element searched (Table 1). We documented a fatality event each time a carcass or a feather spot was found. We considered a feather spot a fatality if it had at least two or more primary flight feathers, five or more tail feathers, or ten or more feathers of any type concentrated together in an area 1 square meter (m^2) or smaller (Smallwood 2007).

Preening spots often have fewer feathers and are more spread out than feather spots associated with fatalities. Roosting areas rarely contain primary or secondary feathers, but are often dotted with droppings. In the solar arrays, we regularly observed flocks of mourning doves (*Zenaida macroura)*, and horned larks (*Eremophila alpestris*) roosting. Mourning doves exhibit a complex molt strategy, which can occur year round and includes preformative, prealternate, and definitive prebasic molts (Otis et al. 2008). Likewise, horned lark adults and first-year birds undergo a definitive prebasic molt at the end of the breeding season (typically the end of July) (Beason 1995). Searchers used their biological knowledge to determine whether or not feathers from mourning doves, horned larks, or other species known to be in a molt period should be recorded as a fatality. When feathers were determined to be part of a molt or roost spot, no data were taken.

We gave each fatality a unique incident number. Incident numbers were written as follows: YYYYMMDD-#. Each searcher recorded a unique set of numbers, so data can be traced back to individual searchers. To further verify species identifications, we took photos of each fatality, and when necessary, we consulted Scott and McFarland's Bird Feathers identification book (2010). For each fatality, we recorded location (using Universal Transverse Mercator [UTM] coordinates), time found, taxon, common name, four-letter alpha code, carcass condition, parts found, number and types of feathers, and estimated time since death. Whenever possible, we recorded information about the age and sex of the fatality, as well as scavenger type. Additionally, we gathered information on the size and spread of the feather spot and the surrounding substrate, vegetation height, and percent vegetation cover, as well as whether the fatality occurred in a searcher or non-searcher row (for fatalities found in the arrays). All carcasses and feather spots discovered by regular weekly searchers were removed.

Table 1. Fatality Search Commencement Dates by Project Element

Project Element	Date Fatality Searches Began	Survey Period (Days)
Gen-tie Line	6 June 2012	435
Array 1	20 September 2012	329
Array 2 (Serengeti portion only)	25 September 2012	63
Array 1 control plot	1 November 2012	287
Array 1 and 2 fence	25 September 2012	324
Array 2 North (including Serengeti) and South	27 November 2012	261
Array 2 control plot	30 October 2012	289
Array 8 (20% sample)	7 January 2013	220
Array 4 (20% sample)	9 January 2013	218
Array 4 control plots	6 February 2013	190
Array 4 fence (20% sample)	16 January 2013	211
Array 5 and fence (20% sample)	9 January 2013	218
MVOH Line	30 January 2013	197
Array 8 control plots	4 February 2013	192
Array 8 fence (20% sample)	20 May 2013	87

Note: The Serengeti portion of Array 2 was searched separately only until 27 November 2012, so the Survey period reflects the time when the Serengeti portion was sampled separately from the rest of Array2.

Weekly fatality searches were performed along the Gen-tie Line; MVOH Line; Arrays 1, 2, 4, 5, and 8; and the associated control plots and fences for each array. The design comprised sampling 100% of Array 1 and 2, Gen-tie line, MVOH line, and fences for Array 1 and 2. Twenty percent of Array 4, 5, and 8 were sampled as were the fences for Array 4, 5, and 8. Each week, we selected random start locations for each Project element using a random number generator. Random selection was based on tower numbers (for the Gen-tie Line), line segment (for the MVOH Line), numbered array corners (for the solar arrays), and numbered fence corners (for the perimeter fence).

A team of two biologists searched a 30-meter (m)-wide transect centered under the complete length of the Gen-tie Line. Because of the relatively shorter height of the MVOH Line, it was assumed that carcasses would have less potential to distribute over a wide area (HTH 2011); therefore, the transect area along the entire length of the MVOH Line was only 18 m wide. Each person searched half the transect width and half the tower or pole radial areas for both the Gen-tie and MVOH Lines. On the Gen-tie Line, each person searched a 15-m-wide transect for large birds and a 6-m-wide transect for small birds and bats. On the MVOH Line, each person searched a 9-m-wide transect for small and large birds.

In the arrays, biologists searched tracker units in teams of two. In each tracker unit, biologists walked into every other row of panels and visually scanned both the row walked and each adjacent row. To avoid crossing the drive arms of the tracker units, searchers turned around upon reaching the drive arm, and continued to scan the next row as they proceeded out of the row. Thus, although searchers walked only every other row, they visually scanned adjacent rows to ensure full coverage.

To determine background rates of mortality, control plots were established on adjacent onsite Conservation Lands (plots were within 1 km of Arrays 1, 2, 4, and 8). Each control plot had the same dimensions as a tracker unit (i.e. equivalent to 18 rows of solar panels, with 40 panels to a row). We used pin flags or wooden stakes to delineate mock panel trackers on the control plots, and searchers followed the same pattern and procedure used for searching the arrays. Control plots were not established for the 20% sample of Array 5 because the 20% search area for this array contained too few trackers to meet the control plot establishment guidelines set forth in the Avian and Bat Fatality Monitoring Plan for the California Valley Solar Ranch (Appendix A *in* HTH 2011; one control plot for 16 tracker units searched).

Fence segments surveyed for Arrays 1, 2, 4, 5, and 8 (100% of Array 1 and 2 fences, and 20% of Array 4, 5, and 8 fences) were each searched by one biologist. Each week, the biologist walked the inside portion of the fence while scanning a 6-m-wide belt centered on the fence. In some cases, the fences were not completely built until after weekly searches had already commenced. In these instances, fences were included only as part of the regular search routine after they were completely installed.

Because searches were conducted only on designated days as a part of the search protocol, a "make-up" search was not conducted if the search day was missed because of inclement weather. For estimating the total number of fatalities, the fatality model accounted for search intervals of different lengths due to missed surveys (e.g., if a weekly search day was cancelled because of rain, the search effort would resume the following week and for that search, the interval was 14 days, not 7 days).

2.1.1 5-day Repeat Surveys

In addition to regular weekly searches, two types of repeat surveys were conducted. The 5-day repeat surveys were designed to serve several functions: (1) to identify a portion of the fatalities missed by regular weekly searchers, (2) to give limited estimates of the permanence of both feather spots and carcasses, (3) to provide an independent estimate of site-wide fatalities, and (4) to help estimate carcass deposition rates. Five-day repeat surveys were conducted on all Project elements subject to regular weekly searches, with the exception of the Gen-tie Line, which was not included in the 5-day repeat surveys because it was assumed that small birds and bats would be unlikely to strike high-tension powerlines. Each of the remaining sites was subjected to 5-day repeat surveys once every 4 weeks, and surveys were organized so that a 5-day repeat was conducted for a different site each week.

During each 5-day repeat survey period, searchers covered the same 25% (Array 1, Array 2, and MVOH Line) or 5% (Arrays 4, 5, and 8) portion of a given Project element for 5 consecutive days. Repeat searches of arrays also included searches of associated perimeter fences and control plots. However, because of the size of Array 2 and staffing limitations, conducting a 5-day survey of both Array 2 Serengeti and Array 2 North and South was not feasible. Therefore, these portions of Array 2 were treated as separate sites for the purposes of 5-day repeat surveys.

Five-day repeat surveys were originally conducted in the same areas as regular weekly searches for all arrays. However, in June 2013, this protocol was changed, and new, non-overlapping areas were established for 5-day repeat surveys in Arrays 4, 5, and 8, to keep the search interval at a constant span of 7 days for all weekly searches. In Arrays 1 and 2, however, overlapping search areas were unavoidable because weekly searches encompass 100% of the arrays. Under the revised protocol, feather spots and scavenged carcasses were still collected on the fifth day of each 5-day repeat survey, but any intact carcasses found were used in the carcass-removal trials, and camera traps were placed by the carcasses to record the activity of scavengers and monitor the persistence of the carcass past the 5-day span of the repeat survey. Then, the first day of each 5-day repeat survey was treated as a clearance search, and all fatalities found on the first day were removed from further analysis.

2.1.2 1-day Repeat Surveys

One-day repeats (carcass-detectability bias-correction surveys) represent a second type of repeat search, designed to identify a portion of the fatalities missed by weekly searchers. Every other week, a 1-day repeat survey was conducted on the day following regular weekly searches. One-day repeat searches were also conducted after each 5-day repeat survey on either the last day of the 5-day survey or 1 day after completion of the 5-day survey. These repeat searches were conducted to provide further estimates of the detectability of small bird and bat carcasses. Each 1-day repeat survey covered a randomly selected 25% of all elements searched in the weekly or 5-day repeat survey. For example, the 1-day repeat survey of Array 2 included a search of 25% of the array, 25% of the fence, and 25% of the associated control plots.

2.1.3 Searcher-efficiency Trials

To calculate searcher efficiency (i.e., searchers' rate of success in detecting fatalities), we conducted a total of 22 searcher-efficiency trials between 5 September 2012 and 25 September 2013 (Table 2). Although several of these trials fall outside of the current reporting period for fatalities, we include the trial result herein because these data were essential to our overall fatality estimates.

Season was assumed to be a potential influence on searcher efficiency. Within the reporting period, we defined four unique seasons as follows: fall (16 August to 15 November), winter (16 November to 15 February), spring (16 February to 15 May), and summer (16 May to 15 August). We were excluded from operational arrays of the Project site between 26 June and 17 July 2013 for maintenance reasons; therefore, no searcher-efficiency trials were conducted during this period.

Table 2. Searcher-efficiency Trial Date, Associated Season, and Location

Date	Season	Location(s)
5 September 2012	Fall	Gen-tie Line
26 September 2012	Fall	Gen-tie Line
18 December 2012	Winter	Array 2
29 January 2013	Winter	Array 2
28 February 2013	Spring	Array 1
17 March 2013	Spring	MVOH Line
15 May 2013	Spring	Arrays 2 and 4; control plots
23 May 2013	Summer	Array 1; control plots; Gen-tie Line
31 May 2013	Summer	Arrays 4, 5, and 8; control plots; Gen-tie Line
5 June 2013	Summer	MVOH Line
11 June 2013	Summer	Array 2
20 June 2013	Summer	Array 1
8 August 2013	Summer	Arrays 1 and 2
22 August 2013	Fall	Arrays 1, 4, and 5
26 August 2013	Fall	Array 8
11 September 2013	Fall	Arrays 4 and 5; control plots; Gen-tie Line; MVOH Line
16 September 2013	Fall	Arrays 4, 5, and 8; control plots
17 September 2013	Fall	Arrays 2, 4, 5, and 8; control plots
18 September 2013	Fall	Arrays 4 and 5; Gen-tie Line; MVOH Line
19 September 2013	Fall	Arrays 1, 4, 5, and 8
20 September 2013	Fall	Arrays 4, 5, and 8
25 September 2013	Fall	Arrays 4 and 5; Gen-tie Line; MVOH Line

Each week during which searcher-efficiency trials were scheduled, we set out between two and eight "fatality plants" (i.e., carcasses or feather spots) in areas scheduled for searches. We arrived approximately 1 hour in advance of the searchers so that we could set out fatality plants without alerting the regular searchers they were being tested. We recorded a Global Positioning System (GPS) point for each fatality plant. We marked each fatality discreetly with tape or flagging so that searchers would know to report their finds as part of the controlled searcher-efficiency trial. We randomly selected locations for the fatality plants within the tracker units, control plots, and along the overhead lines and fences. Within the tracker units and control plots, we randomized placement between surveyed and un-surveyed rows, as well as with regard to distance and direction from structures.

During the week of 16–20 September 2013, we set out 10 to 40 fatality plants each day to capture missing combinations of explanatory variables (e.g., large feather spots in medium vegetation cover), which were needed to correctly assess our final fatality estimates for the Project site, but were not adequately sampled in previous searcher-efficiency trials. For this period, we used a stratified random sampling scheme: we purposefully selected predetermined habitat categories to increase the sample size for our overall parameter estimates in our final fatality model.

We used a total of 177 fatality plants (90 carcasses and 87 feather spots) throughout the course of all trials. The fatality plants were specimens of common species found on the CVSR Project site (Appendix A).

2.1.4 Carcass-removal Trials

To estimate how long carcasses persist in the environment (which influences their continued detectability over time), we conducted carcass-removal trials. We acquired avian carcasses from the onsite fatality searches and wildlife rehabilitation centers, and also collected them opportunistically (e.g., collected road-killed birds) under state and federal salvage permits. Whenever possible, we used species that naturally occurred on the site or in the surrounding area. Once a carcass was acquired, we limited its handling to reduce transfer of foreign scents to the carcass. We marked carcasses by attaching electrical tape or flagging to one leg, to differentiate them from naturally occurring fatalities. We varied the body sizes of carcasses to determine carcass-removal rates and scavenging outcomes for different sizes. Of the 99 carcasses that we placed, 62 were large (>100 grams [g]) and 37 were small (<100 g) (Appendix B).

Initially we placed carcasses at randomly chosen locations along the Gen-tie Line, in Arrays 1 and 2, and their associated control plots. After construction was completed for additional elements (i.e., arrays and the MVOH lines), carcass removal trials were also conducted in all those search area elements. We dropped carcasses from shoulder height and allowed them to fall naturally to the ground. We recorded each carcass location with a GPS unit, noted the direction and distance to the nearest tower (when carcasses were placed along the Gen-tie Line) or tracker number (when carcasses were placed in arrays). We took photos to document the position of the carcass. We placed Bushnell Trophy Cameras (Model 119436) within 1–1.5 m of the carcass on a t-post, facing north to avoid allowing sunlight to shine directly into the camera lens. To avoid "scavenger swamping" (saturating our study area with more carcasses than resident scavengers have the ability to remove) (Smallwood et al. 2010), we limited the number of carcasses in a search area at one time to four. We programmed cameras to take three pictures in quick succession after each trigger event; each camera had a 1-second refractory period. Each picture was stamped with the date and time.

We checked each carcass at least once per week, for up to 6 weeks, or until it was scavenged. If the carcass was scavenged, we collected all remaining feathers and signs of the carcass and removed the camera. We classified the carcass as removed if the carcass could not be located, and there were fewer than ten feathers of any type or fewer than two primary feathers remaining. To classify feather spots, we used the same criteria as regular weekly searchers. Therefore, we classified the scavenging outcome as "not removed" if there were ten or more feathers of any type, or two or more primary feathers or any flesh or bone remaining. If the carcass was no longer in front of the camera and was not readily apparent, we searched the surrounding area using a spiral search pattern. We started the search at the camera's location and spiraled out to 30 m from the camera. If the carcass had been moved to a new location within the search area, but was intact, we repositioned the camera on the carcass in its new location. At least once per week, we checked the camera batteries and Secure Digital (SD) memory storage cards. We replaced the batteries when there was less than half of the charge remaining, and we replaced the SD card when there were more than 2000 pictures.

For 22 of the carcasses that were removed, the time of scavenging was not captured by camera. For these carcasses, we recorded the time the carcass was last photographed and the first time a photograph was taken without the carcass present. For the purpose of our descriptive statistics, we then calculated the midpoint between these two times and used that as the time of scavenging.

2.2 Statistical Methods

Several issues must be considered when estimating fatalities. First, animals die at an unknown rate; the rate must be inferred from regular searches of a site. Second, fatalities persist for varying amounts of time. Third, fatalities are imperfectly detected by searchers. The need to accurately estimate fatalities given these variables has driven the development of several fatality estimation statistical methods (e.g., see Johnson et al. 2003, Smallwood 2007, and Huso 2010). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where the number of fatalities, F, is the quotient of the number of carcasses found, C, over the product of carcasses left unscavenged, r, and the proportion that an observer sees, p (Huso 2010).

The inputs for r and p are estimated in subgroups of covariates that will influence the detectability and persistence of each carcass, such as carcass size, vegetation height, and stage of decay or scavenging (i.e., feather spot versus carcass). Given the tendency for many fatality models to underestimate site-wide fatalities, we chose to use a fatality estimator written by Huso (2010), which was shown to outperform previous fatality estimation models by more accurately accounting for imperfect detectability. This model, the Fatality Estimator, was developed to estimate fatalities primarily for wind energy projects; however, it can be applied to other sources of fatalities, including powerlines and solar projects (Huso 2010). The estimator uses this conceptual framework of fatalities, combined with "bootstrapping" from models of r and p, to calculate variances and confidence intervals for estimates of fatalities. Bootstrapping is a statistical method used to create a distribution to assign measures of variance to estimates that use data for which the underlying distribution is either unknown or cannot be represented algebraically (Efron and Tibshirani 1986). Bootstrapping resamples the data with replacement, several thousand times, to create a distribution that may be used to infer information about the sample mean.

2.2.1 Estimating Carcass-removal Rates

We assessed carcass-removal rates using the following descriptive categories: seasonality, scavenger species, size of carcass, and search area.

Measurements of carcass-removal rates typically include one or more censoring values. A censoring value is used in statistics when a value is only partially known. For example, if a carcass was checked on day 7 and was present, and was checked again on day 10, and found to be missing, then the date of scavenging is unknown, and an interval censor would be used. Because we used camera traps, most scavenging times were known precisely, so data were not censored. However, for the 22 carcasses for which the moment of scavenging was not recorded, we applied interval censoring. Additionally, we applied right censoring to the carcasses that were removed but left feather spots behind, because the extended persistence time of the feather spots was unknown. Specifically, we assumed that all small feather spots (i.e., feather spots left from a small carcass) would last at least 15 days, and large feather spots would last at least 30 days, beyond scavenging.

There are four commonly used distributions of survival models that can be used in the Fatality Estimator for a value of *r*: exponential, Weibull, loglogistic, and lognormal. These four distributions have different rates and shapes of decay curves that attempt to model the survival of carcasses over a given search interval. We used Akaike's Information Criterion (AIC), corrected for finite sample size (AICc; Akaike 1973), to rank the fit of each survival model to our carcass-removal trial data. Because the time of death for found fatalities is unknown, the probability of persistence cannot be calculated exactly for each carcass, but it can be estimated from the selected survival model and bootstrapped to obtain a range of estimates of *r* for each carcass. Because of issues regarding our sample size of covariate combinations, we modeled carcass-removal time only as a function of carcass size.

2.2.2 Estimating Searcher Efficiency

The proportion of fatalities that an observer sees, *p*, is represented most simply by the following equation:

$$p = \frac{NumberObserved}{NumberAvailable}$$

The value of *p* may be affected by several covariates. Therefore, we calculated detection rates for the following descriptive categories and combinations thereof: seasonality, Project element type (i.e., arrays and lines), visibility (i.e., habitat characteristics), and the size of each carcass or feather spot that was planted.

To determine which of the above explanatory variables (or combinations of) best described detection rates, we compared multiple models within the Fatality Estimator statistical software (Huso 2010) using AICc. Beginning with a null model (no temporal or categorical variation), we used a bottom-up modeling approach to compare AIC values and find the most appropriate model structure by incorporating different combinations of explanatory variables.

We calculated detection as the proportion of found fatality plants over the total available number of plants. Any fatality plant removed by scavengers before biologists searched the area was not included in the analysis. We assessed detection rates temporally, spatially, and categorically.

Based on the search method used (i.e., line transects under overhead lines and along fencelines, versus patterned searches within rows in arrays), we grouped fatality plants together. Those in arrays and control plots were grouped together, and those along the overhead lines (i.e., the Gen-tie and MVOH Lines) and fence lines surrounding searched arrays were grouped together.

We analyzed the two fall periods (2012 and 2013) together. Only one period of data was available for each of the winter, spring, and summer seasons.

We assessed habitat characteristics (i.e., vegetation height and percent cover) within a 1-m² area surrounding each fatality plant to test detection rates based upon visibility. We initially categorized visibility into three classes, easy, moderate, or difficult visibility, based on vegetation height and percent cover (Table 3), however, once trials began, we realized that the abundance of difficult visibility classes on the site were very limited; therefore, for all analyses, we grouped moderate and difficult visibility classes together (Figure 2).

Table 3. Visibility Classifications Assigned to Categories of Vegetation Height and Cover

Vegetation Height	Vegetation Cover (%)	Classification
Low	0–50	Easy
Low	50–100	Moderate
Medium	0–25	Easy
Medium	25–100	Moderate
High	0–50	Moderate
High	50–100	Difficult

a) Easy Visibility **b) Medium Visibility**

Figure 2. Photographic Examples of Easy and Medium Visibility Classes, Based on Vegetation Height and Percent Cover.

We assigned each species of carcass to one of two size classes (small or large) based on weight (i.e., small = <100 g; large = >100 g). We also assigned a size class to each feather spot used as a fatality plant. A small feather spot was defined as feathers from a small to medium-sized bird, scattered sparsely in a ≤20 square centimeter (cm^2) area; a large feather spot was defined as feathers from a large bird in a small area (≤20 cm^2) or feathers from a small to medium-sized bird scattered densely in an area ≥20 cm^2.

2.2.3 Estimating Fatalities on the Project Site

The Fatality Estimator bootstrapping procedure calculates an adjusted fatality value for every fatality found based on search interval, searcher efficiency, and carcass persistence. These bootstrapped values are then summed, and a site total estimate and 90% confidence intervals are calculated for the site and each covariate combination assigned. The Fatality Estimator was developed for wind energy projects, and uses individual wind turbines as the sample unit of replication. To apply this tool to the CVSR Project, we used tracker units instead of turbines as the sample unit. For linear features (overhead lines and fences) where we sampled the entire length, we used the entire feature as the sample unit. For sites in which we searched less than 100% of the area, we divided these values by the proportion of area searched to extrapolate it to the whole array or linear feature.

2.2.3.1 Overall Fatality Estimates

We calculated weekly fatality estimates separately for each Project element. For the arrays, we set the tracker as the unit of replication, and for each array we calculated total estimates of fatalities, fatalities per tracker unit, and 90% confidence intervals. In Array 2, 36 tracker units within the Serengeti portion of the array were searched for 2 months before the rest of the array, so we calculated separate values for that period. For linear features on the site, such as the Gen-tie Line, MVOH Line, and fences, we estimated fatalities for the feature as a whole. Estimates are based on 5000 bootstrapped iterations. We calculated fatality estimates and confidence intervals for large and small birds and particular species, as well as calculating seasonal totals.

Owing to the constraints and assumptions of the Fatality Estimator; appropriately, we did not include every fatality found in our calculations. We did not include fatalities found during clearance surveys (the first survey of an area), or fatalities that we determined to be older than the search interval, because the correction for searcher efficiency does not take into account repeated chances of finding a fatality (Huso pers. comm.).

2.2.3.2 Fatality Estimates from 5-day Repeat Surveys

To calculate fatality estimates from our 5-day repeat surveys, we treated each 5-day period as an independent unit of replication. Because the first day of each search was a clearance survey, each repeat survey period effectively consisted of 4 consecutive search days. We used the Fatality Estimator to calculate fatality estimates and 90% confidence intervals for the search areas of the array covered during repeat surveys. We then divided these estimates and 90% confidence intervals by the proportion of the array searched to extrapolate to the entire array, and then divided this estimate by the proportion of days searched over the total number of days until next search period to extrapolate temporally to the whole month (Huso pers. comm.).

To calculate the rate of deposition of fatalities per tracker units per day, we divided the estimate for each 5-day repeat period by the number of tracker units searched, and by the number of days it was searched.

2.2.3.3 Error Assessment for Sampling Avian Fatalities

To guide future sampling at CVSR, an error assessment was conducted to determine what proportion of arrays should be monitored to determine a reasonable measure of avian fatality. This is the first study that we are aware of designed to estimate the number of avian fatalities at a large utility scale photovoltaic facility. One of the unknowns was what percentage of the entire facility needed to be surveyed to attain a given confidence level for determining an accurate fatality estimate. To collect data to determine this, we surveyed two large arrays, Arrays 1 and 2, with 100% coverage. We continued this level of effort for a full year in case the distribution of fatalities varied significantly by season.

Two steps were involved in developing the error assessment for the survey effort. The first step was to determine the spatial organization of avian fatalities across 100% of the area searched inside the two sample arrays, throughout the entire monitoring period (1 year). We estimated the mean and standard deviation of avian fatalities per tracker unit (each unit of tracking solar panels with 18 rows and 40 solar panels per row) for each array and for both arrays combined. Furthermore, using the individual fatality sampling points, we calculated the Global Moran's I index to characterize the spatial dispersion of avian fatalities within and among arrays. The Global Moran's I index is a direct assessment of the spatial autocorrelation of points in space and provides a statistical measurement indicating whether avian fatalities may be clumped, uniform, or not different from random. We conducted the geostatistical analysis of avian fatalities using ArcInfo version 10.0 and its geographic statistical toolbox.

The next step was to establish the relationship between percent area monitored and the variation in fatality estimates around a true value.. To accomplish this we focused on the coefficient of variation (i.e., "variance-to-mean ratio") as our metric of variation for describing the changes in the number of detected avian fatalities with increasing area searched. Because the coefficient of variation is a normalized measure of dispersion, this metric is well suited for assessing changes in the distribution of avian fatalities as a function of area searched. In other words, it accounts for the clumping of avian fatalities in space (among tracker units within an array) and is a better metric than the mean for describing changes in detection of avian fatalities.

Using the datasets of detected avian fatalities for Arrays 1 and 2, we constructed a statistical resampling function to understand the variation that would be introduced into the final avian fatality estimate by sampling less than the entire array. This function simulates a range of sample sizes (from one tracker unit to one fewer than the total number of tracker units); for each sample size, 3000 simulated data sets were generated from the original data. For each of these data sets, the total number of fatalities was summed. This number was then divided by the values determined to correct for searcher efficiency and carcass persistence time. This number was then scaled to the total number of tracker units per unit area tested (e.g., tracker units in Array 1). We calculated the coefficient of variation for each sample size by dividing the standard deviation of the sample by the mean. All resampling analyses were conducted in the statistical program R, Version 3.0.2 (R Development Core Team 2011).

Section 3.0 Results

3.1 Carcass-removal Trials

Between 15 October 2012 and 12 August 2013, we placed a total of 99 carcasses for carcass-removal trials. We placed camera traps on 95 of these carcasses, and were able to record the exact removal time and scavenger species for 77 (81.1%) of the carcasses placed that had a camera trap. Of the 99 carcasses placed, 43 (43.4%) were eventually removed either completely, or left insufficient evidence to be classified as a fatality in a regular weekly search. The remaining 56 (56.6%) carcasses were scavenged from the original location or within the search area, and left evidence behind in the form of feathers, skin, or a partial carcass.

Mean time to scavenging for all placed carcasses was 3.3 days and ranged from as little as 7 minutes to as long as 53 days (Table 4). The carcass that persisted for 53 days was an outlier by 31 days; the mean time to scavenging without it was 2.8 days. Within 24 hours of placement, 54.4% of carcasses had been scavenged and 26.3% had been removed entirely (with no trace evidence). Within 7 days of placement, 86.9% of the carcasses had been scavenged, and 38.4% had been removed entirely (Table 5).

Table 4. Mean Times and Range for Scavenging for Each of Five Categories: Total, Carcass Size, Season, Scavenger Species, and Search Area

	N	Mean Time to Scavenging (Days)[a]	Range[b]
Total	99	3.3 ± 6.7 (2.8 ± 1.7)[b]	7 min–53 days
Carcass Size			
Large	63	3.5 ± 5.0	7 min–22 days
Small	36	3.0 ± 9.3 (1.5 ± 3.1)	10 min–53 days
Season			
Fall	8	1.2 ± 1.7	2 hours–5.5 days
Winter	16	8.3 ± 12.8 (5.3 ± 5.6)	4 hours–53 days
Spring	40	2.7 ± 4.9	15 min–22 days
Summer	35	2.2 ± 3.0	7 min–12.5 days
Scavenger			
Common raven	51	2.5 ± 8.0 (1.5 ± 3.7)	7 min–53 days
San Joaquin kit fox	20	3.6 ± 4.3	11 hours–16.5 days
Coyote	5	4.5 ± 4.7	8.5 hours–13.5 days
Unknown	22	4.3 ± 5.2	30 min–18 days
Search Area			
Array	49	4.4 ± 8.5 (3.4 ± 4.7)	1.7 hours–53 days
Gen-tie Line	40	2.6 ± 4.4	10 min–18 days
Control plots	10	0.6 ± 0.7	7 min–2 days

Notes: Min = minutes.

[a] Mean time to scavenging is shown ± 1 standard deviation.

[b] Carcass that persisted for 53 days excluded.

[C] (Results) reflect values excluding the carcass that persisted for 53 days.

Table 5. Percentage of Carcasses Scavenged and Removed within 1 Day and 7 Days of Placement, by Body Size, Season, Scavenger, and Placement Area

	N	% Scavenged by 1 Day	% Removed by 1 Day	% Scavenged by 7 Days	% Removed by 7 Days
Total	99	54.4	26.3	86.9	38.8
Carcass size					
Large	63	47.6	7.9	82.5	15.9
Small	36	66.6	58.3	94.4	77.8
Season					
Fall	8	87.5	50.0	100.0	75.0
Winter	16	37.5	18.8	62.5	31.3
Spring	40	67.5	30.0	90.0	32.5
Summer	35	51.4	20.0	91.4	40.0
Scavenger					
Common raven	51	72.5	31.4	94.1	33.3
San Joaquin kit fox	20	35.0	15.0	80.0	50.0
Coyote	5	20.0	20.0	20.0	20.0
Unknown	22	40.9	27.3	77.3	45.5
Search area					
Array	49	42.9	18.4	83.7	32.7
Gen-tie	40	62.5	35.0	35.0	87.5
Control plot	10	80.0	30.0	100.0	40.0

3.1.1 Effect of Scavenger Type

With our remote cameras, we were able to document four species of vertebrate scavengers during the carcass-removal trials: San Joaquin kit fox (*Vulpes macrotis mutica)*, common raven (*Corvus corax*), coyote (*Canis latrans*) and turkey vulture (*Cathartes aura*) (Figure 3). Ravens were the most common scavenger, and scavenged more than half of the carcasses placed. Ravens also scavenged carcasses the fastest, with a mean time to scavenging of 2.5 days (and a mean time of 1.5 days with the 53-day outlier dropped). Ravens scavenged three carcasses less than 1 hour after placement, and 72.5% of carcasses within 24 hours. Ninety-four point one percent of raven-scavenging events occurred within 1 week. Of the 51 carcasses scavenged by ravens, 37.3% were removed entirely. In total, ravens scavenged 32 large carcasses and 19 small carcasses.

Figure 3. Scavengers Documented in Carcass-removal Trials

Figure panels are as follows: (top left) a common raven removing a ruby-crowned kinglet 53 days after it was placed in an array, (top right) a San Joaquin kit fox removing a Brewer's blackbird from a control plot 4 days after it was placed, (bottom left) a coyote removing a barn owl carcass after 3 days, and (bottom right) a turkey vulture scavenging a red-tailed hawk carcass 7 days after it was placed.

San Joaquin kit foxes scavenged 20 carcasses, and had the second fastest scavenging time, with a mean time to scavenging of 3.6 days. Within 24 hours, 35% of the San Joaquin kit fox scavenging events had occurred, and 80% had occurred within 7 days (Table 5). San Joaquin kit foxes were more likely than ravens to remove carcasses without leaving trace evidence. Of the 20 carcasses scavenged, 60% were removed entirely (Table 6), and 13 of these were large-bodied birds.

Coyotes had the longest mean time to scavenging: 4.5 days. They scavenged five carcasses in total, all of which were large. In all but one case, there was enough trace evidence left from the scavenged carcass to be considered a fatality.

Finally, our remote cameras captured a turkey vulture scavenging the carcass of a red-tailed hawk (*Buteo jamaicensis*) 7 days after it was originally placed.

For the remaining 22 carcasses, the scavenger responsible was not photographed, because of camera malfunctions.

Table 6. Outcomes of Carcass-removal Trials

	N	Carcasses Removed (%)[a]	Carcasses Leaving Feather Spots (%)	Partial Carcass (%)[b]
Total	99	41.4	35.4	23.2
Carcass Size				
Large	63	22.2	44.4	33.3
Small	36	80.6	13.9	5.6
Season				
Fall	8	75.0	12.5	12.5
Winter	16	56.3	37.5	6.3
Spring	40	32.5	37.5	30.0
Summer	35	42.9	31.4	25.7
Scavenger				
Common raven	51	37.3	33.3	29.4
San Joaquin kit fox	20	60.0	30.0	10.0
Coyote	5	20.0	60.0	20.0
Turkey vulture	1	0.0	0.0	100.0
Search Area				
Array	49	36.7	38.8	24.5
Gen-tie Line	40	52.5	27.5	20.0
Control plots	10	40.0	30.0	30.0

Notes:

[a] “Removed” refers to all carcasses that left no sign, or too few feathers to be classified as a fatality.

[b] “Partial carcasses” are classified as any fatality that was partially removed but left trace amounts of bone or flesh behind.

3.1.2 Effect of Carcass Size

Of the 63 large carcasses we placed, 22.2% were removed entirely or left insufficient evidence to be considered a fatality. The mean time to scavenging for large carcasses was 3.5 days, with 47.6% scavenged within 24 hours and 82.5% scavenged within 7 days. Small carcasses were more likely to be removed: 80.6% were removed. Mean time to scavenging for small carcasses was 3.0 days when the carcass in this size class that persisted for 53 days was included, and 1.5 days when it was excluded. Within 24 hours, 66.6% of small carcasses were scavenged, and within 7 days 94.4% were scavenged.

3.1.3 Effect of Season and Search Area

We put out carcasses for carcass-removal trials during all four seasons, but the coverage across seasons was not equal: eight carcasses were placed in fall, 16 in winter, 40 in spring, and 35 in summer. The mean time to scavenging was longest in fall, and shortest in winter. The carcass that persisted for 53 days was placed in winter, but even after dropping that carcass from the analysis, scavenging time was still longest in winter. Mean scavenging times in spring and summer were 2.7 days and 2.2 days, respectively.

Carcasses placed in the control plots were scavenged more quickly than those along the Gen-tie Line (Figure 3). Carcasses placed in the arrays had the longest time to scavenging: 4.4 days. The carcass that persisted for 53 days was in an array; however, even when this carcass was dropped from the analysis, mean time to scavenging in the arrays was still the longest: 3.4 days.

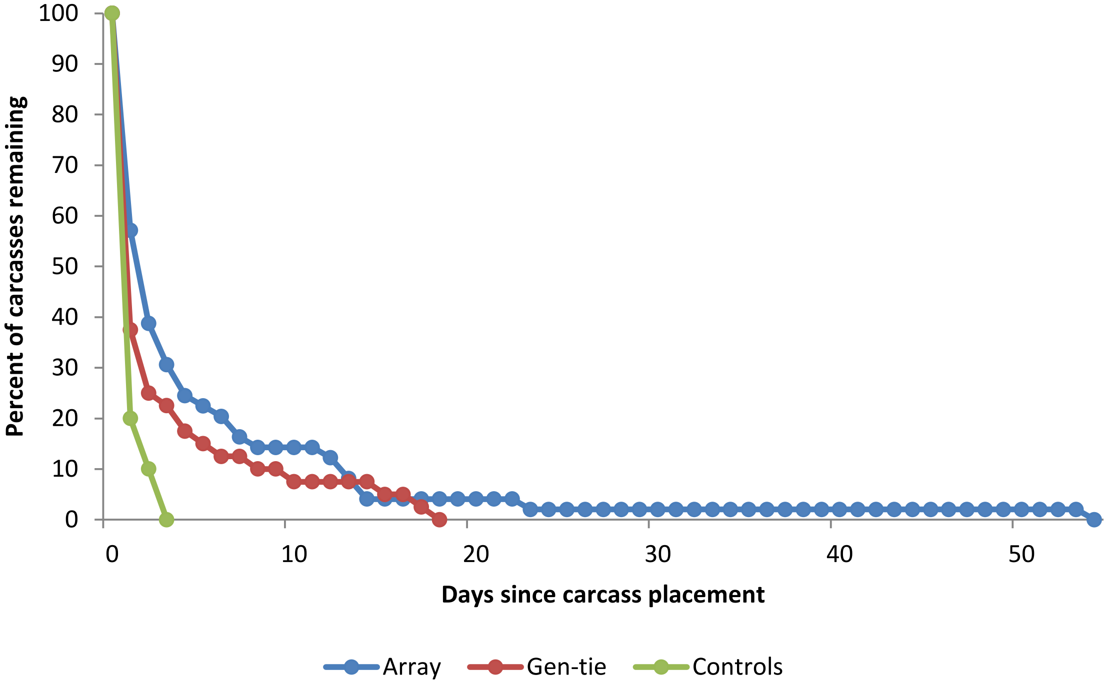


Figure 4. Percentage of Trial Carcasses Remaining Undisturbed by Scavengers per Day, Grouped by Search Area; N=99

3.1.4 Model Selection

Of the four selected survival models compared in the estimator, the lognormal model had the lowest AICc score (Table 7). For large carcasses, based on a search interval of 7 days, *r* = 0.92 (lower confidence interval =

0.86, upper confidence interval = 0.97). For small carcasses, $r = 0.42$ (lower confidence interval = 0.31, upper confidence interval = 0.55).

Table 7. AICc Values for Each of Four Distribution Models of Carcass Persistence

Survival Model for Carcass Persistence	AICc
Lognormal	253.00
Loglogistic	253.44
Weibull	259.44
Exponential	337.72

Because the difference in AICc values for the lognormal and loglogistic models was less than 2, these models were considered statistically equivalent (Akaike 1973), but we chose to use the lognormal model because it had a slightly lower AICc value.

3.2 Searcher-efficiency Rates

3.2.1 Overall Project Site Detection Rates

Over the course of 22 searcher-efficiency trials between September 2012 and September 2013, searchers detected 94 of 177 (53%) of the fatality plants that were randomly placed in operational arrays, control plots, underneath overhead lines, and along fence lines across the CVSR Project site. Small sample sizes in certain seasons prohibited us from using seasons as an explanatory variable for searcher efficiency. Nonetheless, we did see a sharp decrease (23%) in searcher efficiency between winter (N = 8) and spring (N = 10); efficiency then increased by 13% in summer (N = 17).

The detection rate of fatality plants in all areas with easy visibility was slightly higher (56%) than in those areas with medium visibility (51%). Searchers were slightly more efficient at detecting carcasses (56%) than feather spots (51%), and a greater proportion of large-sized fatality plants (61%) were detected by searchers compared to 43% of small-sized fatality plants in all areas (Table 8).

3.2.2 Detection Rates by Area and Explanatory Variables

Searcher detection rates were higher below overhead lines and along fencelines (56%) than rates in the solar panel arrays (50%). The detection rate in surveyed rows was slightly higher than in un-surveyed rows. Detection of fatality plants found in “easy” visibility areas along lines was higher (63%) than in “moderate” visibility areas (49%), but we found the opposite to be true in the arrays, where detectability in moderate areas was 8% greater than in easy areas. The detection rates of large fatality plants in arrays and along lines were essentially the same (approximately 62%), and large fatalities were easier to detect than small fatalities in both arrays (34%) and along lines (47%).

Detection rates within arrays, of large and small fatality plants in easy visibility areas, were 56% and 36%, respectively; these rates were lower than comparable rates along lines. In moderate visibility areas along lines, the detection rate of large fatality plants (48%) was lower than in easy visibility areas (76%), but we found that the detection of small fatality plants in moderate visibility areas along lines was slightly higher (6%) than in easy visibility areas. The detection rate of large fatality plants in moderate visibility areas in arrays (68%) was 20% higher than along lines, but the detection rate of small fatality plants in moderate visibility array areas (31%) was lower than the comparable rate along lines.

Detection rates were consistently higher for both large carcasses and feather spots in easy visibility areas than in moderate visibility areas, with the exception of the detection of small feather spots in medium visibility areas, which was 23% higher than in easy visibility areas.

Table 8. Overall Detection Rates from Searcher-efficiency Trials, September 2012 to September 2013

Category	Detection Rate	95% Confidence Intervals (lower, upper)	N
Overall	0.53	(0.46, 0.60)	177
Fall	0.54	(0.45, 0.62)	142
Winter	0.63	(0.31, 0.86)	8
Spring	0.40	(0.17, 0.69)	10
Summer	0.53	(0.31, 0.74)	17
Arrays/control plots	0.50	(0.40, 0.60)	90
Overhead/fence lines	0.56	(0.46, 0.66)	87
Surveyed row	0.51	(0.37, 0.65)	45
Unsurveyed row	0.45	(0.30, 0.62)	33
Large fatality size	0.61	(0.51, 0.70)	96
Small fatality size	0.43	(0.33, 0.54)	81
Carcass	0.55	(0.45, 0.65)	90
Feather spot	0.52	(0.40, 0.61)	87
Easy visibility	0.56	(0.45, 0.65)	90
Medium visibility	0.51	(0.40, 0.61)	87

Our top model in the Fatality Estimator had an AICc value of 238.55; this model indicated that carcass size best explains searcher-efficiency rates. However, the second best model, which differed by less than 2 (AICc

= 239.98), showed equal support for an additive effect between visibility class and fatality size (Table 9). We therefore adopted the additive effect structure for our detection rate in estimating fatalities, because visibility was shown in our descriptive statistics (see above) to be an important indicator of how well searchers did in locating fatalities.

Table 9. AICc Ranking of Searcher-efficiency Models

Searcher-efficiency Model	Explanatory Variables	AICc
size	Carcass size	238.55
size + visibility	Carcass size and visibility class	239.98
element + size + visibility	Project element, carcass size, and visibility	241.49
size x visibility	Carcass size and visibility class interaction	244.32
size x visibility + element	Carcass size and visibility interaction, and Project element	246
null	Null model	246.71
element	Project element	248.05
visibility	Visibility	248.32

3.3 Summary of Annual Fatalities

3.3.1 Results of Weekly Searches

A total of 357 fatalities were found during surveys of Project elements between 16 August 2012 and 15 August 2013; and an additional 11 fatalities were observed during surveys of control plots (each plot equivalent in size to a tracker unit: 18 rows of solar panels, with 40 panels to a row) within conservation lands (Table 10; Figures 5-9; Appendices C and D). It is important to note that this total comprises observations obtained during clearance surveys, weekly surveys, and 1-day and 5-day repeat surveys. The total number of fatalities observed at various Project Elements, consequently, may be larger than the sample sizes used to conduct overall fatality estimates for Project Elements because fatalities older than the search interval and fatalities found during clearance surveys and 5-day repeat surveys are not used to calculate the overall fatality estimates. Fatality estimates based on weekly searches and 5-day repeat searches were calculated separately.

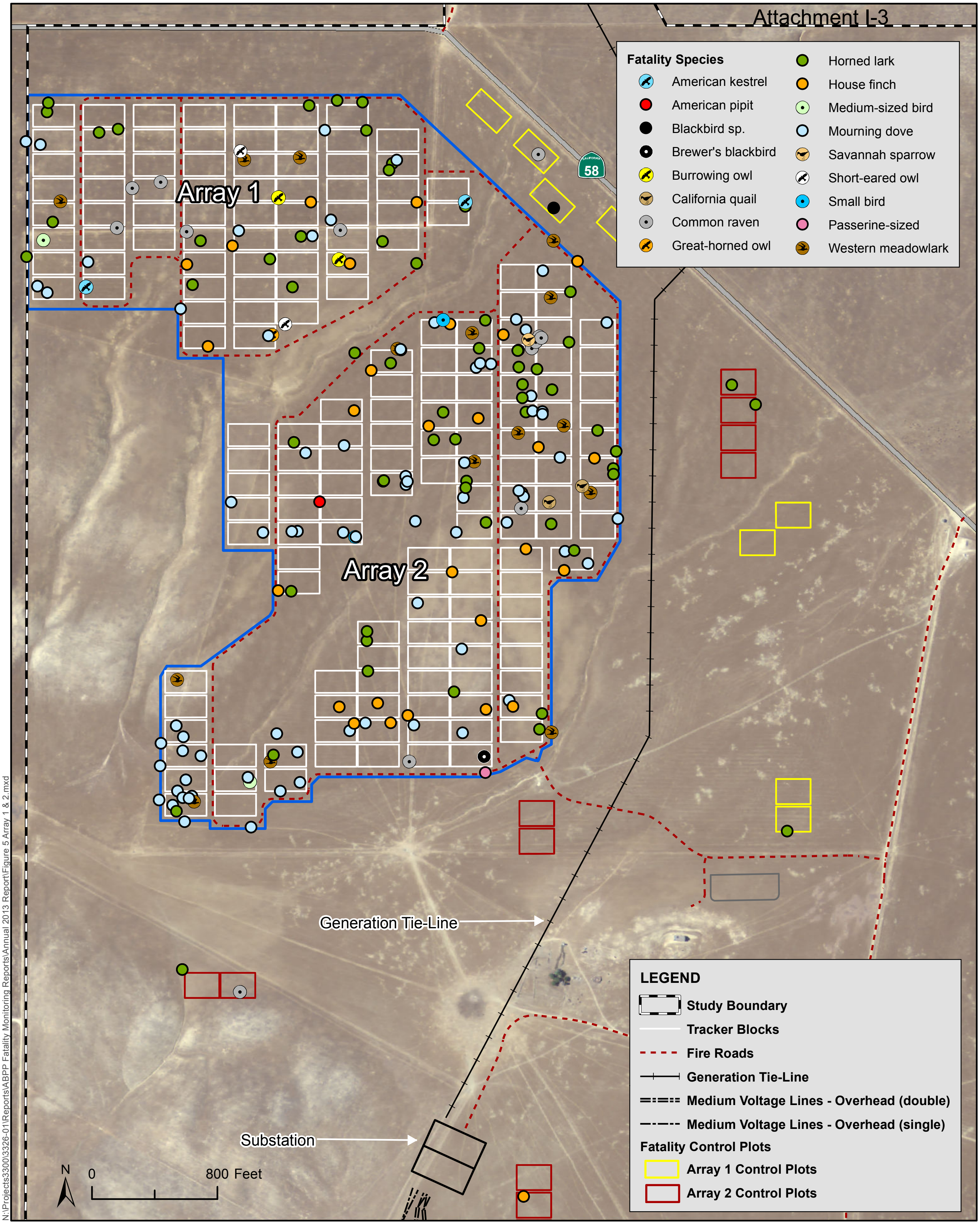
The majority of fatality species represented year-round avian residents (Figure 10, Appendix D). In total, we found fatalities of 31 different avian species (Figure 11). Nearly all of the species utilize a terrestrial foraging zone; the two exceptions were a single American coot (*Fulica americana*) found along the Gen-tie and a single tree swallow (*Tachycineta bicolor*) found within a control plot (Appendix D). Horned larks, house finches (*Carpodacus mexicanus*), and mourning doves accounted for the greatest proportion of fatalities. Documented special-status species fatalities comprised burrowing owl (*Athene cunicularia*), short-eared owl (*Asio flammeus*), long-eared owl (*Asio otus*), and loggerhead shrike (*Lanius ludovicianus*) fatalities. The total count of special-status species fatalities was small compared to the overall count. One fatality was identified to genus, but not to species. Seven fatalities were not identified because partial skeletons and entrails or covert feathers were all that remained. These seven fatalities were placed into two "unknown" categories (unknown small passerine [6] and unknown [1]). Feather spots accounted for the vast majority of fatalities observed with a ratio of feather spots to carcasses (including partial carcasses) of 20:3.

Table 10. Summary of Avian Fatality Searches Conducted between 16 August 2012 and 15 August 2013; N= 357 for Project Elements, N = 11 for Control Plots

Project Element	Date of First Search	Number of Tracker Units[a] or Distance of Straight Line Search	Total Number of Fatalities Found Across all Survey Methods
Array 1	20 September 2012	66 trackers	52
Serengeti (only)[b]	25 September 2012	36 trackers	8
Array 1 control plots	30 October 2012	8 trackers	3
Array 1–2 fence	25 September 2012	5300 m	11
Array 2 North (including Serengeti) and South	27 November 2012	114 trackers	137
Array 2 control plots	1 November 2012	14 trackers	6
Array 4	9 January 2013	29 trackers	23
Array 4 control plots and fence	6 February 2013	4 trackers; 225-m fence	1 in control plot, 1 on fence
Array 5 and fence	9 January 2013	4 trackers; 56-m fence	5 in array, 0 on fence
Array 8	7 January 2013	54 trackers	13
Array 8 control plots	4 February 2013	6 trackers	1
Array 8 fence	20 May 2013	1600 m	0
Gen-tie Line	6 June 2012	4000 m	90
MVOH Line	30 January 2013	6800 m	17

[a] Tracker unit equals 18 rows of solar panels, with 40 panels to a row.

[b] The Serengeti portion of Array 2 was searched separately only until 27 November 2012, so the number of fatalities reported for the Serengeti reflects this initial period.



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Annual 2013 Report\Figure 5 Array 1 & 2.mxd

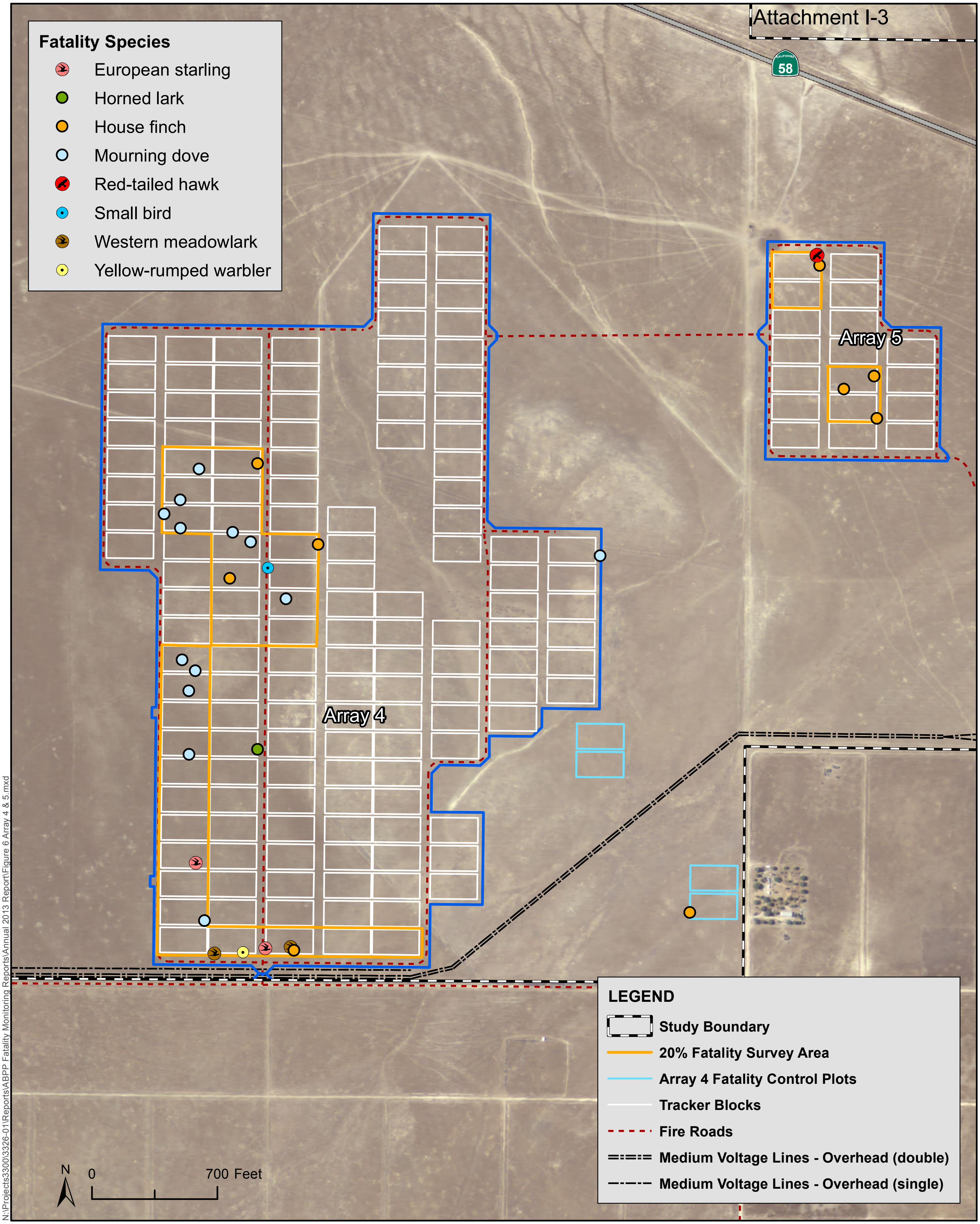
HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Annual Postconstruction Fatality Report
Figure 5: Locations and Species of Postconstruction Fatalities Observed at Arrays 1 and 2

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Annual 2013 Report\Figure 6 Array 4 & 5.mxd

HPR II

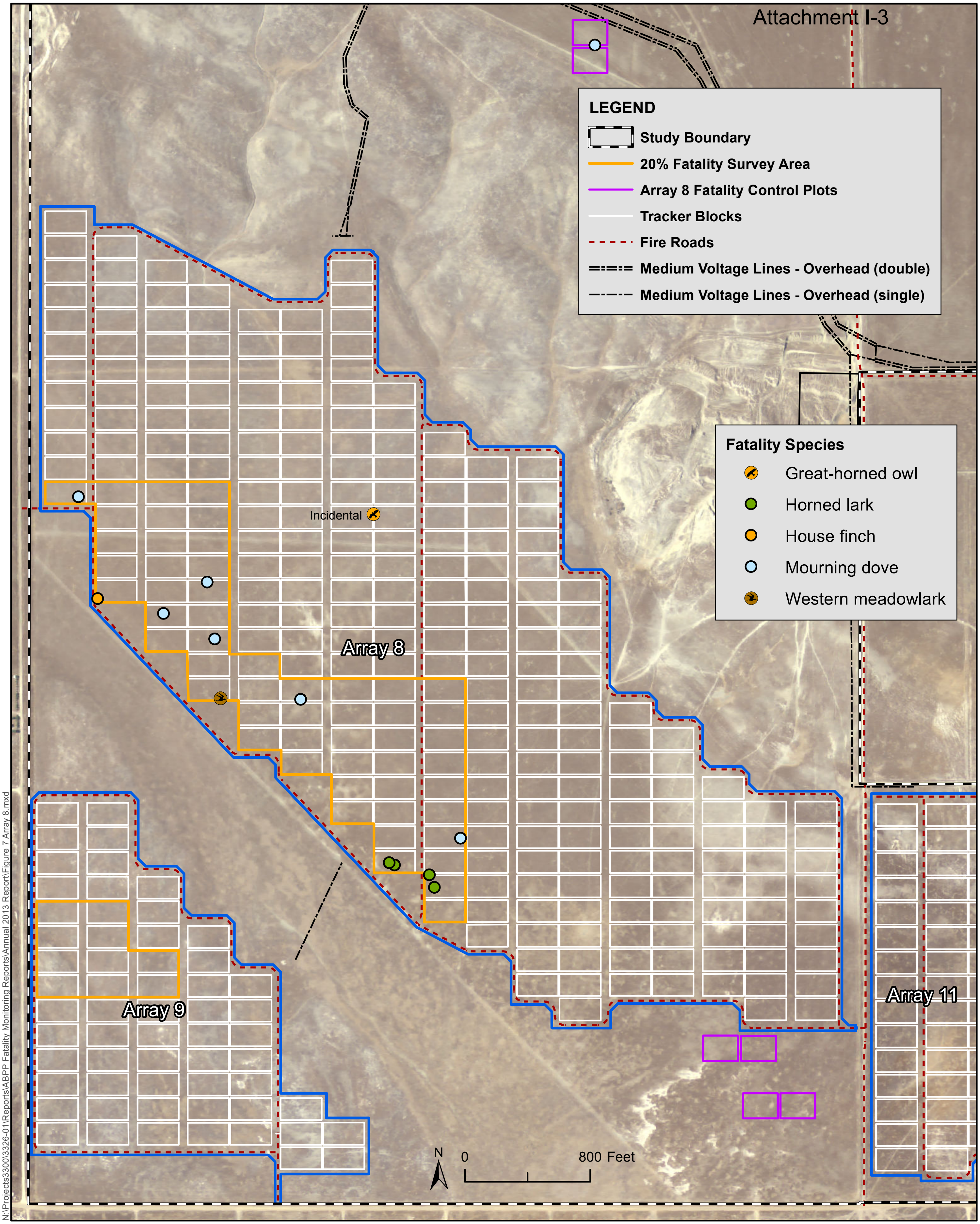
H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Annual Postconstruction Fatality Report

Figure 6: Locations and Species of Postconstruction Fatalities Observed at Arrays 4 and 5

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Annual 2013 Report\Figure 7 Array 8.mxd

HPR II

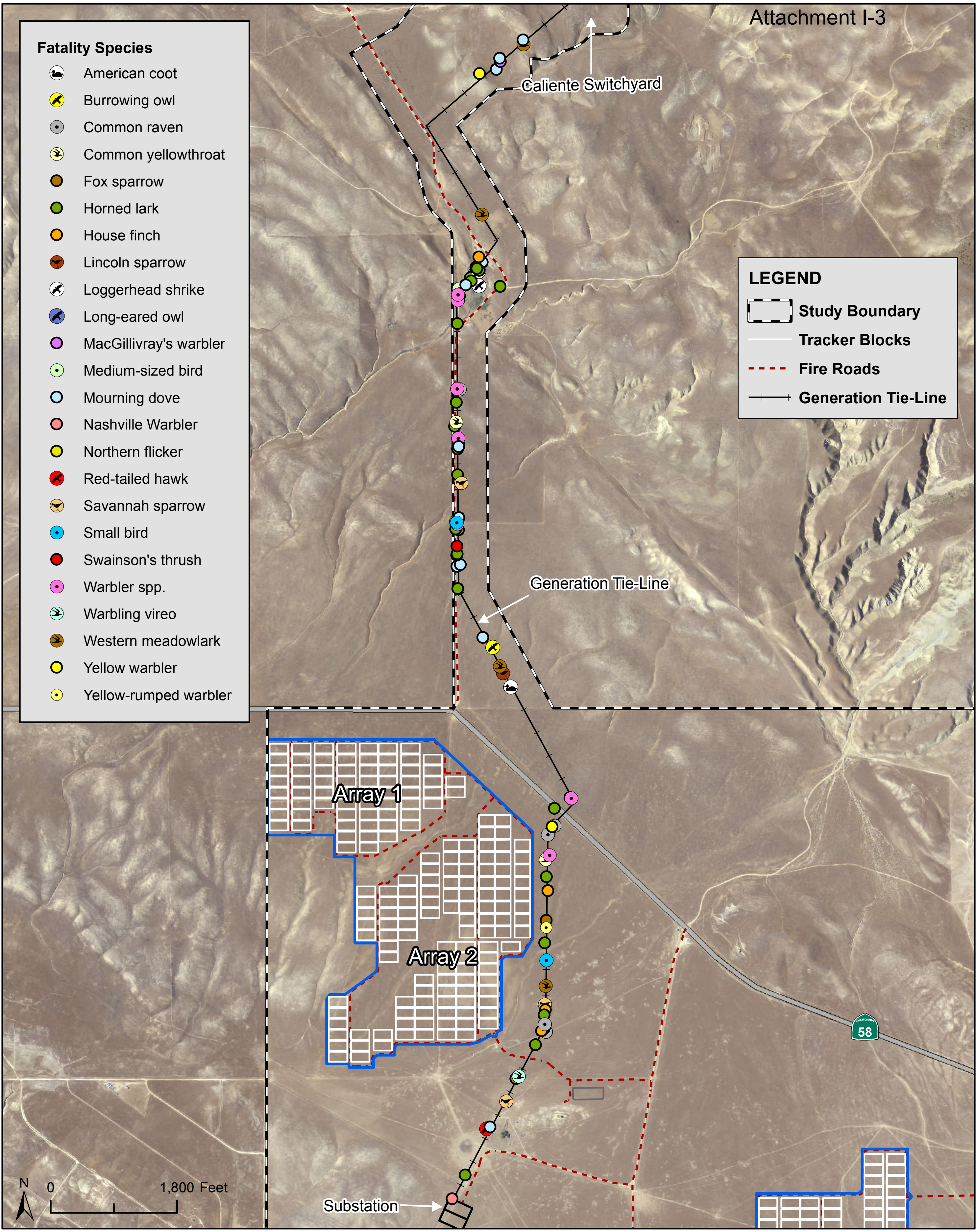
H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Annual Postconstruction Fatality Report

Figure 7: Locations and Species of Postconstruction Fatalities Observed at Array 8

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Annual 2013 Report\Figure 8 Gen-tie Area.mxd

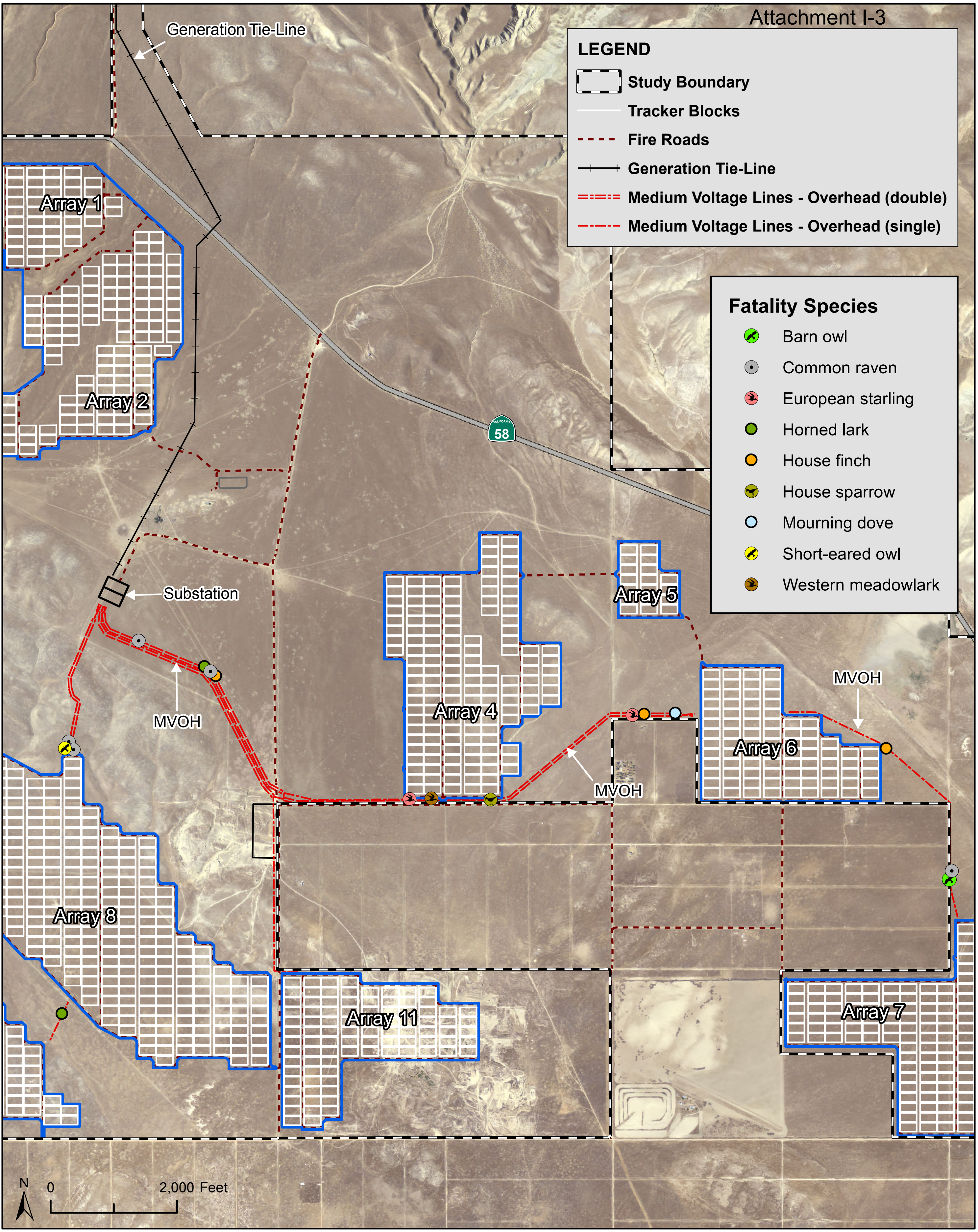
HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch

ABPP Annual Postconstruction Fatality Report

Figure 8: Locations and Species of Postconstruction Fatalities Observed along Gen-tie Line



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Annual 2013 Report\Figure 9 MVOH Area.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Annual Postconstruction Fatality Report
Figure 9: Locations and Species of Postconstruction Fatalities Observed along MVOH Line

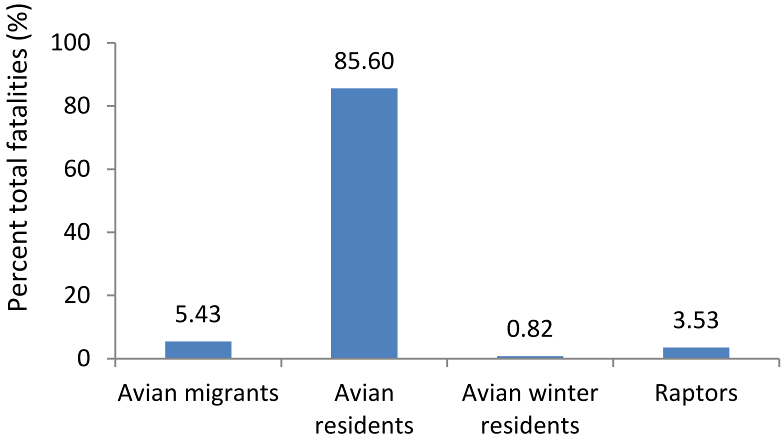


Figure 10. Percent of Total Fatalities in Each of Four Taxonomic Groups; N= 357

Groups were created based on knowledge of species typically found on the Project site at different times of the year.

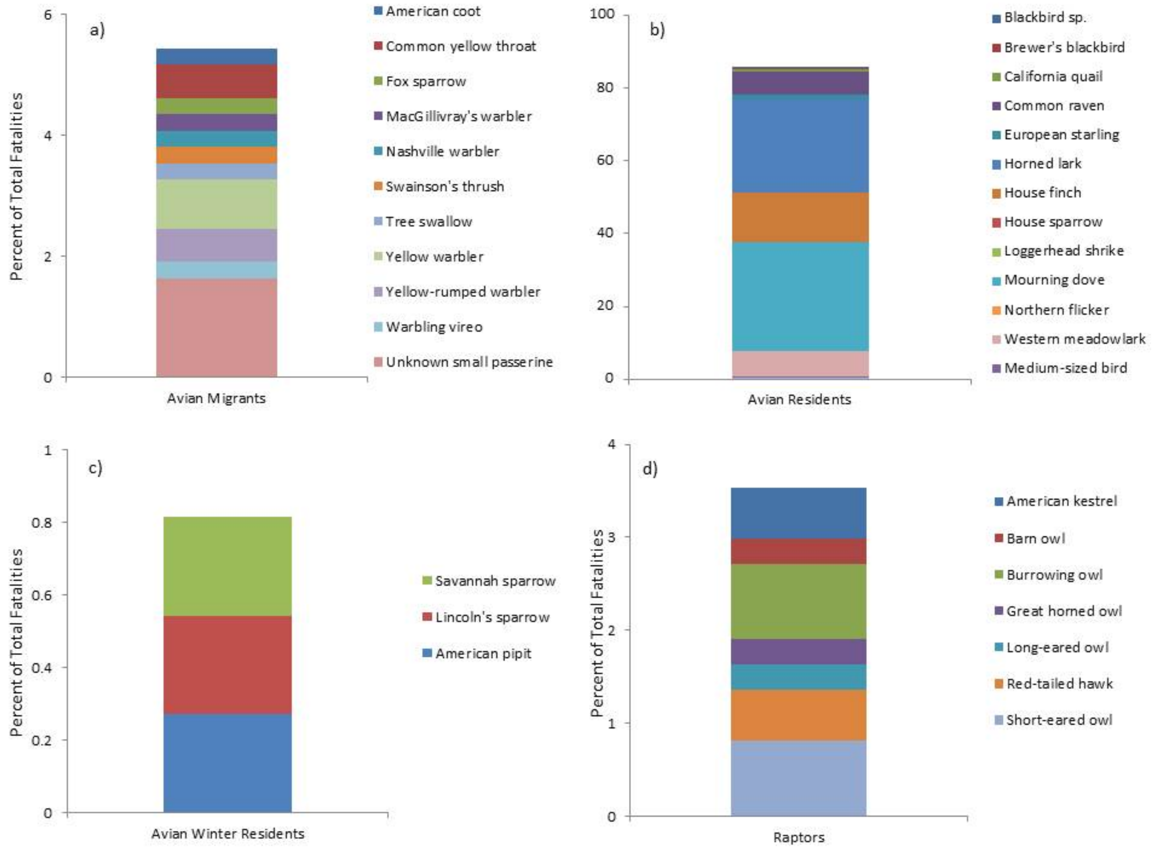


Figure 11. Percentage of Fatalities Belonging to Different Species, by Group; N= 357

Panels show: (a) fatalities by species of avian migrants, (b) fatalities by species of avian residents, (c) fatalities by species of avian winter residents, and (d) fatalities by species of raptors. Groups were created based on knowledge of species typically found on the Project site at different times of the year.

3.3.2 Results of 5-day Repeat Surveys

The first 5-day repeat surveys occurred on 29 October 2012. For the period of 29 October 2012 to 15 August 2013, 45 fatalities were found by repeat searchers. Thirty-six percent of all fatalities found by 5-day repeat searchers were mourning doves (Figure 12).

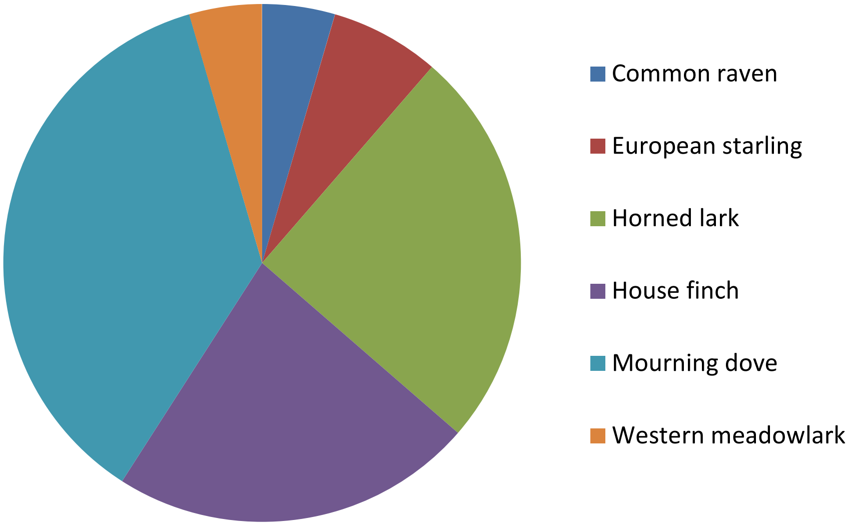


Figure 12. Total Fatalities Found during 5-Day Repeat Surveys, by Species; N= 45

3.3.3 Results of 1-day Repeat Surveys

3.3.3.1 1-Day Repeat Surveys of Weekly Search Areas

One-day (twice monthly) repeat surveys of weekly search areas began in the third quarter of the reporting period (i.e., in March 2013). In total, 16 fatalities were found by 1-day repeat searchers. Of these 16 fatalities, 25% were horned larks (Figure 13).

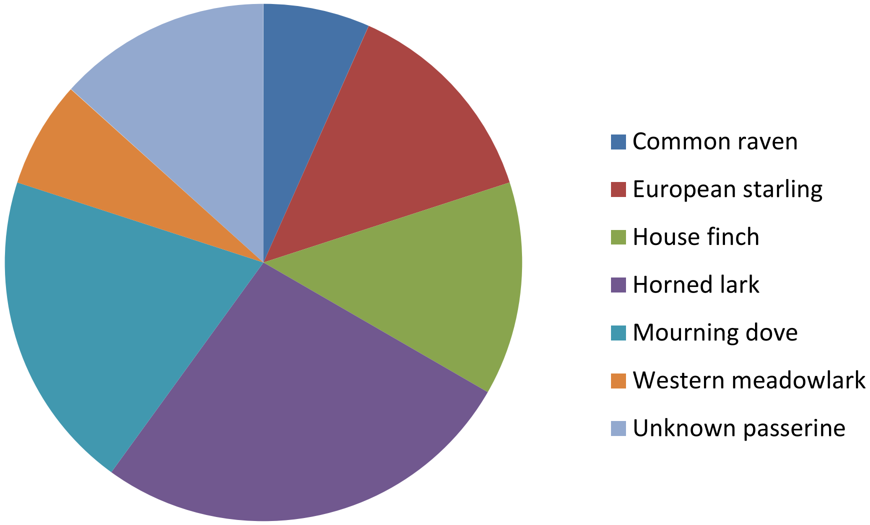


Figure 13. Total Fatalities Found during 1-day Repeat Surveys of Regular Weekly Search Areas, by Species; N= 16

3.3.3.2 1-Day Repeat Surveys of 5-Day Repeat Survey Areas

One-day repeat surveys of 5-day repeat areas also began in the third quarter of the reporting period. Between the third and fourth quarters, only one fatality was found during 1-day repeat surveys of these areas. This fatality was the feather spot of a common raven, found in Array 4.

3.3.4 Electrocutions

Although the cause of death is often difficult to determine, there were four clear cases of electrocution found during the reporting period. An additional two cases of electrocution were found the day before the period began, 15 August 2012. Although outside the official reporting period and excluded from all other analyses, we include mention of these deaths. All six electrocuted animals were ravens, and all electrocutions occurred on overhead lines, rather than in energized arrays. These cases are described in more detail below.

At Tower 7 along the Gen-tie Line, four common ravens were clearly electrocuted in two separate events on August 15 2012 and on 11 December 2012, as evidenced by scorch marks on their feet, and leg scales that were detached and curled. Tower 7 was evaluated and retrofitted during a plant outage on 22 January 2013 to prevent avian electrocutions. Changes to the tower conductor design to prevent electrocution included insulation of exposed conductors in configurations that could potentially create a ground-to-phase connection through a bird. No avian mortalities caused by electrocution related to Tower 7 have been observed since the correcting retrofit.

In April 2013, two ravens were found electrocuted along the MVOH Line. One bird had a clear exit burn through its neck, and singed feathers. The riser poles were temporarily modified to reduce the potential for further electrocutions until long-term remediation could be performed. NRG, SunPower, and Bechtel each consulted with experts on Avian Power Line Interaction Committee (APLIC) guidelines. Based on the consultations, perch diverters, squirrel guards, insulation, and covers were installed, and ground wires were relocated to minimize the potential for ravens or raptors to make contact between two energized phases or an energized phase and the ground at all potential contact points on the riser poles. These improvements were made to all Project MVOH Line riser poles. No further fatalities have occurred as a result of electrocution since these changes were made to the MVOH Line.

3.3.5 Tamarisk Pond

An 80-m section of the Gen-tie Line runs directly over a wetland consisting of a pond lined with saltcedar (*Tamarix ramosissima*). Because a large colony of red-winged blackbirds (*Agelaius phoeniceus*) and other species, such as tricolored blackbirds (*Agelaius tricolor*), a California species of special concern, nest in the wetland during the breeding season, we were unable to search this wetland at times during the reporting period. We stopped searching the pond on 15 March 2013, at the start of the breeding season. Also, because of stark differences in both bird activity and searcher efficiency in this area, we excluded the wetland from fatality estimates. Ten fatalities were found in this area: one long-eared owl, eight horned larks, and one lark sparrow.

3.4 Fatality Estimates from Weekly Searches

For the arrays and control plots, our estimates of the number of fatalities found per tracker unit during the search interval range from 5.68 in Array 2 to 0.95 in Array 8 (Table 11). For Project elements that were linearly searched (i.e., fences and overhead lines), our estimates of fatalities vary from 47 total fatalities along the fence around Arrays 1 and 2 to 446 along the Gen-tie Line (Table 12).

The Gen-tie Line was the only Project element that was searched for a whole year during this reporting period; therefore, this Project element is the only one for which we can accurately estimate seasonal fatality effects for the entire year. Contrary to our initial predictions, the number of small passerine carcasses found along the Gen-tie Line was much greater than the number of large birds and raptors found along the line (Table 13).

Table 11. Overall Fatality Estimates from Weekly Searches and 1-Day Repeat Searches of Nonlinear Areas, Using Wildlife Fatality Estimator, 16 August 2012 to 15 August 2013.

Site	Survey Period (Days)	Number of Fatalities Found in Sample Area	Estimated Number of Fatalities per Tracker Unit	90% Confidence Intervals (No. fatalities per tracker unit)	Estimated Number of Fatalities for Project Element	90% Confidence Intervals (Total no. fatalities)
Array 1	324	41	3.21	2.26, 5.35	212	150, 354
Array 2	261	125	5.68	4.17, 9.10	648	476, 1038
Array 2 Serengeti	63	8	1.02	0.69, 1.74	37	25, 63
Arrays 4 and 5	218	26	2.77	2.03, 4.25	449	329, 689
Array 8	220	11	0.95	0.55, 1.72	258	150, 464
Arrays 1 and 2 control plots	289 and 287	9	2.69	1.54, 5.35	60	34, 118
Arrays 4 and 8 control plots	190 and 192	2	0.73	0.55, 1.12	8	6, 12

Notes: Number of fatalities found in sample area does not include fatalities found during 5-day repeat searches or clearance searches, or carcasses older than the search interval. The size of the array and number of searches conducted vary by array, so results are not directly comparable. Survey Period (days) is the number of days from the onset of surveys at each site until 15 August 2013. Refer to Table 10 for a full list of the number of tracker units per array and dates searched. The numbers of estimated fatalities are rounded up to the nearest whole number. Estimates made based on fewer than five fatalities should be interpreted with caution.

Table 12. Overall Fatality Estimates from Weekly Searches and 1-Day Repeat Searches of Linear Areas, Using Wildlife Fatality Estimator, 16 August 2012 to 15 August 2013

Site	Number of Fatalities Found in Sample Area	Estimated Total Number of Fatalities	90% Confidence Intervals
Array 1–2 fence	11	47	35, 74
Array 4 fence	1	NA	NA
Array 5 fence	0	NA	NA
Array 8 fence	0	NA	NA
Gen-tie Line	83	446	343, 682
MVOH Line	14	71	51, 114

Notes: Number of fatalities found does not include fatalities found during 5-day repeat searches or clearance searches, or carcasses older than the search interval. The length of the line or fence and the number of searches conducted vary by Project element, so results are not directly comparable. The numbers of estimated fatalities are rounded up to the nearest whole number. Refer to Table 1 for full list of dates and survey lengths.

Table 13. Fatality Estimates from the Gen-tie Line by Season and Fatality Class

	Number of Fatalities Found	Estimated Total Number of Fatalities	90% Confidence Intervals
Fatality Class			
Large	21	44	38, 58
Small	69	403	303, 629
Season			
Fall	18	87	68, 128
Winter	17	69	54, 100
Spring	37	214	160, 339
Summer	18	78	60, 119

Note: Numbers of estimated fatalities are rounded up to the nearest whole number.

Finally, although we do not have a full year's worth of data to report for the remainder of the Project elements, both of the overhead lines and Arrays 1, 2, 4, 5, and 8 were all searched in spring and summer, so we were able to compare estimates from these two periods among different Project elements. The estimated number of fatalities per kilometer was much higher for the Gen-tie Line than the MVOH Line in both spring and summer (Table 14). The highest estimated number of fatalities for arrays was 2.65 per tracker unit (Array 2 in spring), and the lowest estimated number of fatalities was 0.11 per tracker unit (Arrays 4 and 5 in summer).

Table 14. Fatality Estimates from the Arrays and Overhead Lines by Season, per Tracker Unit or Kilometer

Project Element	Season[a]	Number of Fatalities Found in Sample Area	Estimated Number of Fatalities (per tracker unit or km)[b]	90% Confidence Intervals (per tracker unit or km)	Estimated Total Number of Fatalities for Project Element	90% Confidence Intervals (Total no. fatalities)
Array 1	Spring	10	0.9	0.46, 1.75	60	31, 116
	Summer	9	0.67	0.32, 1.35	45	21, 89
Array 2	Spring	57	2.65	1.87, 4.37	303	213, 498
	Summer	12	0.69	0.34, 1.38	79	40, 158
Arrays 4 and 5	Spring	6	0.87	0.33, 1.77	141	53, 287
	Summer	1	0.11	0.09, 0.37	18	14, 60
Array 8	Spring	3	0.26	0.08, 0.55	70	23, 150
	Summer	3	0.46	0.17, 1.22	124	48, 329
Array 1 and 2 control plots	Spring	4	0.97	0.27, 2.19	22	7, 49
	Summer	1	0.59	0.4, 2.45	13	9, 54
Array 4 and 8 control plots	Spring	2	0.73	0.55, 1.12	8	6, 12
	Summer	0	0	NA	NA	NA
Gen-tie Line	Spring	37	54	40, 85	214	160, 339
	Summer	18	20	15, 30	78	60, 119
MVOH Line	Spring	9	7	5, 10	41	31, 65
	Summer	5	5	4, 8	30	21, 50

Notes:

[a] Summer estimates may be artificially low because searches were not conducted during July due to maintenance work in the arrays.

[b] Estimates are given per tracker unit for arrays and control plots, and per kilometer for overhead lines.

3.5 Fatality Estimates from 5-day Repeat Surveys

After removing from the analysis all fatalities that had been missed by previous searchers or were cleared on the first day of the 5-day repeat survey, there were 22 fatalities remaining in the repeat-survey fatality analysis (20 in arrays, one along the MVOH Line, and one along the Array 1–2 fence).

Three additional fatalities had been found in control plots during 5-day repeat surveys, but two were found during clearance activities, and the third was judged to be older than the search interval, so fatality estimates could not be calculated for control plots from data collected during the 5-day repeat surveys.

For the arrays, estimates of fatalities ranged from 405 in Array 8 to 1995 in Arrays 4 and 5 (Table 15). Because the 5-day repeat surveys were started during different seasons in different arrays, the estimates shown in Table 15 are not directly comparable.

Table 15. Number of Surveys, Number of Fatalities Found, and Estimates of Total Fatalities per Element, Based on 5-Day Repeat Searches

Project Element	Number of Surveys	Number of Fatalities Found in Sample Area	Estimated Number of Fatalities for Project Element	90% Confidence Interval
Array 1	10	5	489	191, 1005
Array 2	7	6	628	464, 982
Array 2 Serengeti	11	3	336	224, 532
Arrays 4 and 5	7	4	1995	1283, 3420
Array 8	7	2	405	405, 539
Array 1–2 fence	11	1	84	84, 140
MVOH Line	4	1	111	84, 168

Note: Estimates for elements in which fewer than five fatalities were found should be interpreted with caution.

The rate of deposition of fatalities per day per tracker unit varied among arrays, from 0.007 fatalities per day per tracker unit in Array 8 to 0.063 fatalities per day per tracker unit in Arrays 4 and 5 (Table 16).

Table 16. Fatality Deposition Rates for Arrays and Linear Features

Project Element	Fatalities per Day (per tracker unit or per km)[a]	90% Confidence Interval
Array 1	0.026	0.01, 0.053
Array 2	0.041	0.029, 0.064
Array 2 Serengeti	0.028	0.02, 0.046
Array 4 and 5	0.063	0.039, 0.103
Array 8	0.007	0.006, 0.009
Array 1–2 fence	0.052	0.04, 0.073
MVOH Line	0.131	0.088, 0.219

Note:

[a] Fatality estimates are given per tracker unit for arrays, and per kilometer for fences and overhead lines. Estimates for Array 4, 5, and 8 fences are not included because of insufficient sample sizes (i.e. 0 or 1 observed fatalities).

3.6 Error Assessment Results

The geostatistical analysis of the dispersion of avian fatalities in Array 1 and Array 2 separately, as well as in both arrays combined, indicates that the dispersion of fatalities is not significantly different from a random distribution (Table 17). Knowing that fatalities are randomly distributed within arrays at the Project site is important for designing future sampling because there are no observable high concentrations (clumping) of avian fatalities that need to be taken into consideration. Moreover, a random dispersion pattern indicates that the probability of detecting an avian fatality should not change as a function of the amount of area (or number of tracker units) searched.

Table 17. Descriptive Statistics for Avian Fatalities per Tracker Unit and Results of a Point-pattern Analysis for Detecting Spatial Autocorrelation:
Moran's I Test for Assessing the Dispersion of Avian Fatalities

Project Element	Number of Tracker Units	Sum	Mean ± SD	Moran's I (I, Z, *P*[1])	Spatial Dispersion
Array 1	66	52	0.79±0.81	-0.12, -0.81, 0.42	Random
Array 2	114	147	1.29±1.45	0.09, 1.14, 0.25	Random
Arrays 1 and 2	180	199	1.11±1.62	0.09, 1.29, 0.19	Random

Notes: SD = standard deviation, I = statistical measure of spatial autocorrelation, Z = number of standard deviations away from the mean

[1] *P* values indicate no significant difference from a clumped distribution.

Figure 9 illustrates the change in variation in fatality estimate as a function of the number of tracker units sampled. The only source of variation in this plot is the difference in number of tracker units sampled (which indicates carcasses occurred with a random dispersion with a mean and standard deviation of 1.11±1.62 fatalities per tracker unit); the plot does not include any variation generated by other processes (e.g., carcass persistence). The resampling analysis suggests that sampling 20% of the total area (represented by "Number of Trackers Sampled" in the figure) is sufficient to provide a reasonably precise estimate of the Project site fatality rate, with sampling equitably spread throughout the site to ensure a spatially representative overall sample. This analysis suggests that sampling 30–35 tracker units within an array would be sufficient to capture an index of avian fatality.

In sum, given the significant random dispersion of avian fatalities derived from the study period, and the resampling analysis of the coefficient of variation as a function of area searched, we consider it acceptable to monitor 20% of the total area of an array, or collective groups of small arrays at the CVSR Project. Additionally, each sample of an array should comprise 30–35 tracker units, so small arrays (e.g., Array 5) should be combined with other small neighboring arrays, so that 20% of a given set comprises at least 30 tracker units.

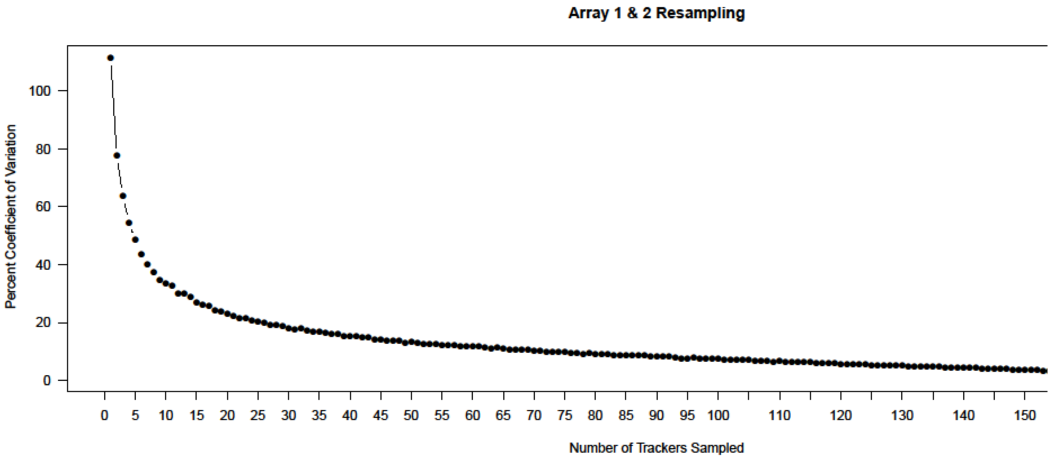


Figure 14. **Coefficient of Variation in Fatality Estimate Attributable to Sampling Variation for All Sample Sizes, Arrays 1 and 2 Combined**

Section 4.0 Discussion

4.1 Carcass-removal Rates

Almost half of placed carcasses were removed completely by scavengers or left insufficient evidence to be documented as a fatality during standardized carcass surveys. More than a third of these carcasses were removed within 7 days of placement, and would not have been detected during weekly fatality searches. The remaining carcasses persisted longer than the search interval, or were scavenged but left sufficient evidence to be considered a fatality by searchers. Only two carcasses left evidence insufficient to be considered a fatality, implying that if a carcass is scavenged in place, its remains will likely be detected during searches. A logical extension of this finding is that the creation of a feather spot when a bird is preyed upon by a raptor or mammalian predator is likely to occur at least as often as the creation of a feather spot during a scavenging event and feather spots created by depredated birds are likely to persist and be detected during searches at rates equal to feather spots created from scavenged carcasses.

The mean time to scavenging was 3.3 days, which is comparable to the mean times identified by carcass-removal studies at other sites. For example, Derby et al. (2007) found an average removal time of 5.1 days for small carcasses, and Smallwood et al. (2010) found an average removal time of 4.45 days for all carcass types. We found that the initial rate of scavenging was very rapid, followed by an exponential decrease; this pattern mirrors the findings of other studies. For example, Ponce et al. (2010) found that 32% of all carcasses were gone by the second day, and 52% of all carcasses were gone within a week. Our study's scavenging times may be somewhat shorter because we avoided scavenger swamping and used cameras. Wagner et al. (1983), Ponce et al. (2010), and Derby et al. (2007) likely overloaded the capacity of local scavengers to effectively dispose of placed carcasses (Smallwood 2010), whereas we placed smaller numbers of carcasses for removal trials. Our use of cameras allowed us to more accurately pinpoint the time of scavenging, whereas other studies (e.g., Derby et al. 2007 and Ponce et al. 2010) were limited by personnel availability; carcasses were often checked only weekly, rather than daily.

Our finding that the majority of small carcasses were removed within 7 days without leaving trace evidence suggests that the majority of small carcasses deposited on the site would be removed with no trace in between our weekly search intervals. Only rarely in our study did small-bodied carcasses leave remains behind after they were scavenged. Also, we found that large carcasses were more likely to leave evidence behind, and are therefore more likely to be detected during routine weekly searches.

The two most common scavengers, ravens and San Joaquin kit foxes, nest or den on the Project site, and coyotes (*Canis latrans*) regularly visit the site. In contrast, turkey vultures (*Cathartes aura*) are rarely seen on site and scavenged only one carcass. Although two other potential scavengers, American badgers (*Taxidea taxus*) and California ground squirrels (*Otospermophilus beecheyi*), occur on site, we did not document them at any of the carcasses that we placed. Likewise, Smallwood et al. (2010) documented red-tailed hawks scavenging carcasses, but we did not record any instances of scavenging by raptors, other than a turkey vulture, or owls in our study.

Although we did not place equal numbers of carcasses during the different seasons, our results do suggest that the time to scavenging was longest in winter and shortest in fall. This is a well-documented trend in carcass-removal trials (e.g., Prosser et al. 2008 and Smallwood et al. 2010). Many of the carcasses placed in winter froze at night, which may have made them less palatable to scavengers, or more difficult to detect by smell. In fall, there is less food available for scavengers because many of the nesting birds have left the area and insects such as grasshoppers are less common. This drop in food availability likely explains the shorter time to scavenging that we observed during this period.

Carcasses placed in the control plots were scavenged more quickly than carcasses placed in the solar arrays or along the Gen-tie Line. Carcasses were likely easier for scavengers to spot visually in the control plots, because there were lower levels of structural and vegetative cover on the control plots than along the Gen-tie Line and in the solar arrays.

Using remote cameras for the carcass-removal trials allowed a more accurate determination of carcass-removal time, reduced personnel time, and helped to document the scavenger species involved in carcass removals. In several instances, ravens removed carcasses within 15 minutes of placement. We could not have documented these quick removal rates without the use of the remote cameras. When cameras malfunctioned or failed to record scavenging, they were still able to narrow the time frame during which the carcass was removed, and so still yielded an advantage over daily or weekly checks by field personnel.

Among the scavenger species documented, ravens, in particular, are known for their high level of intelligence (Emery 2006). It is possible that ravens may have noticed the camera traps, and thus been alerted to the presence of new carcasses. However, Smallwood et al. (2010) explored this possibility by setting out camera traps with decoy carcasses, and found that none of the decoy carcasses were investigated by any scavenger species.

4.2 Searcher-efficiency Rates

Our overall searcher-efficiency rate of 53% is comparable to the results of searcher-efficiency trials conducted at wind energy facilities, where rates have ranged from 32% to 67% (Nicholson et al. 2005; Derby et al. 2007; Leslie et al. 2012; Johnston et al. 2013; Martin et al. 2013).

Although we were not able to make statistical inferences about the influence of season on searcher efficiency, there may be seasonal effects. For example, natural and artificial precipitation events (the solar panels are washed once a year) and the run off of condensed moisture, create patches of grass along the driplines of panels; vegetation changes in color from green to golden-brown and could either blend with or create a sharp contrast with the color of a fatality; and mean daily temperatures (e.g., extreme heat) could affect not only plant growth, but searchers' effectiveness. We observed a significant decrease in our detection rate between winter and spring, likely because in spring the high annual vegetation obscured planted carcasses.

Searcher efficiency in the surveyed rows of the arrays was slightly higher than in unsurveyed rows, as expected given that visibility is often reduced in adjacent tracker rows in the morning and the evening, when the solar panels are tilted the most.

Along the overhead lines, we found that searchers were more efficient at detecting fatality plants in easy visibility areas compared to moderate visibility areas. In many of the arrays and along the MVOH Line, construction-related activities disturbed the ground below the lines and along fence lines; however, vegetation height and density increased with increasing distance from array edges and overhead lines, resulting in reduced fatality detectability. Therefore, the ease of finding fatalities below powerlines and along fences may be magnified by the combined effects of the short distance from the searchers' paths to the fatalities and the relatively lower vegetation.

We found that the opposite was true in the arrays, where detectability was 8% higher in moderate visibility areas than in easy visibility areas. Many searchers focus their attention on the rows of clumped vegetation on either side of a searched row, where vegetation height and density is greater than in the middle of the row. (The vegetation is low to absent in the middle of rows because of continuous foot traffic and conditions that are drier than underneath the panels). This searcher behavior could explain the higher rate of detections in areas characterized as having moderate visibility.

Overall detection rates, explained by type of carcass planted, indicate that carcasses were somewhat easier to find than feather spots as a group, but that the detection of large or small carcasses differed by only 2%, in sharp contrast to a 38% difference in detectability between small and large feather spots. Understandably, feather spots are more detectable when more feathers are scattered over a larger area.

4.3 Weekly Fatality Searches

Causes of death were often difficult or impossible to determine from feather spots and carcasses found in the arrays. In a few cases, carcasses were found with no apparent injuries; in other cases, injuries (e.g., broken necks) indicated that a collision was the cause of death. Determining the cause of death from feather spots was even more difficult. We found feather spots on the ground near panels and on panels themselves. Fatalities may have occurred as a direct or indirect result of the presence of solar panels (e.g., a bird stunned by a collision with a panel can then be more easily predated), or they may indicate direct mammalian or avian predation. Solar panels likely contribute to direct and indirect causes of death for birds, but in many cases, it was not possible to determine cause of death. Because the ratio of feather spots to found carcasses was 20:3 during the reporting period, the inability to partition feather spots associated with collisions and feather spots stemming from predation has important implications regarding inferences that can be drawn from the fatality estimate.

In contrast to the uncertainty regarding causes of death within solar arrays, most fatalities found along the Gen-tie and MVOH Lines were located directly or nearly directly under these lines. This pattern suggests that many of these fatalities were caused by powerline collisions, and that the remains were indicative of scavenging, rather than predation. It is well documented that high-tension powerlines contribute to avian mortality, and especially to the mortality of larger birds such as waterfowl (Brown and Drewien 1995). However, very few large carcasses were detected during fatality searches of the Gen-tie and MVOH Lines. Instead, the majority of fatalities found were passerines, possibly reflecting the greater proportion of passerines that occur on the site. Nevertheless, these results suggest that the avian flight diverters installed on the Gen-tie Line may be successful in preventing collisions with larger birds, but are not effective at diverting smaller birds. Also, Gen-tie Line fatalities included migrant passerines not typically observed on the Project site or expected in the area. It seems likely that most of the migrant passerine fatalities are from nocturnally migrating birds, and the avian flight diverters on the Gen-tie lines appear to be ineffective in deterring these birds at night.

It is difficult to study how the mortality of large and small birds along the overhead lines compares with background mortality rates without having a linear control in the landscape. We know of no studies that control for background mortality rates along a linear corridor without an actual linear structure. Instead, most avian mortality studies of high-tension powerlines typically compare fatality rates of powerlines with or without avian flight-diverting structures (Brown et al. 1995; Janss and Ferrer 1998). Given that more passerine fatalities were documented along the lines than expected, and very few raptor fatalities were documented, a linear control would be useful in understanding how these fatality rates compare with background fatality rates for large and small avian groups in the Project area.

In addition to searching arrays and overhead lines, we conducted fatality searches along perimeter fences. Although these fences may represent a collision hazard for birds (Allen and Ramirez 1990), they also provide artificial hunting-perch habitat for predatory birds, such as loggerhead shrikes and kestrels (*Falco sparverius*) (Bohall-Wood 1987; Sheffield et al. 2001). Both species frequently occur in the arrays, and other studies suggest that they increase in abundance when artificial perches are introduced (Wolff et al. 1999; Yosef and Grubb 1999; Sheffield et al. 2001; Lynn et al. 2006). If perimeter array fences increase hunting opportunities for predatory birds, they may thereby contribute to fatality rates by creating feather spots from predation events along the fence lines and within the adjacent arrays. Flocks of birds, mostly passerines, were commonly seen roosting under the solar panels. Although we do not have data to quantitatively compare this activity in the arrays with roosting in surrounding Conservation Lands, it is plausible that the solar panels attract roosting birds, and thus increase the prey base for predatory birds, which have been documented hunting within the arrays (Refer to Photo 1: a 1-second photo sequence captured on remote camera).

Photo 1. **One-second photo sequence captured on remote camera depicting a red-tailed hawk foraging within a solar array.**

Horned larks and mourning doves commonly roost and nest under the solar panels, and the two species combined represent 63% of the total number of fatalities found within the arrays (Appendix D). When they were flushed, we observed these birds quickly navigating through the panels; in this high-clutter environment, some birds may fly into structural elements of the array. Species that fly in flocks seem to be at a greater risk of collision; it has been posited that birds flying in the rear of flocks are more likely to be unaware of upcoming obstacles (Janss 2000). Additionally, the relatively high densities of these species may provide greater opportunities for avian and mammalian predators to prey on these birds, resulting in feather spots that are recorded as fatalities.

In general, we estimated fatalities to be more abundant in the spring and less in the summer. This pattern is likely associated with the peak avian activity in the spring and the subsequent decline in activity in the summer, both documented through onsite avian point counts (HTH 2013). Because birds were more active on the Project site in spring, predation rates and collision rates are likely to be higher.

Accounting for the spatial organization of avian fatalities is an important aspect of designing surveys and making decisions about future sampling, monitoring, and avoidance and minimization strategies. The spatial organization of avian fatalities may be thought of in terms of the manner in which fatalities are connected with each other in space, and whether they exhibit apparent clumping, uniform or random distribution. This is a key aspect for future design of sampling and monitoring schemes for detecting avian fatalities, because if fatalities are clustered in space, then additional sampling to account for their clumping may be warranted. In this case, significant clumping of fatalities was not found.

4.4 Repeat Surveys

The fatality estimates we calculated from our 5-day and 1-day repeat surveys were all much higher than the estimates obtained from our weekly searches. This is because we extrapolated from the low amount of temporal and spatial coverage in these searches, which can cause high sample bias. The statistical methods we used in the Fatality Estimator are not appropriate for rare events, and caution is recommended when interpreting groups with a sample size lower than five. In all but one area (Array 2), there were fewer than 5 total fatalities found per survey area, included in the 5-day repeat search estimates. The inadequacy of the sample sizes for the repeat surveys (comprising usually only a few tracker units per array) is underscored by the power analysis, which, based on the year of empirical data collected from Arrays 1 and 2, suggests that each sample should comprise 30–35 tracker units (i.e., far more than were actually covered in the past year's repeat surveys).

4.4.1 5-day Repeat Surveys

Because detailed fatality searches have not been conducted previously at a large photovoltaic facility, we did not know at the start of our study whether the fatalities found would be predominately birds or bats. Similarly, there was little basis for projecting what the carcass scavenging rates might be, because scavenging rates often vary widely from location to location, as well as across years and seasons. In situations where carcasses of bats or other animals that are scavenged without leaving a trace occur more commonly, it is advantageous to conduct more intensive daily searches to increase the chances of detecting carcasses. However, after proceeding with the diverse elements of this study for more than a year, it became apparent that avian fatalities, particularly long-lasting feather spots, accounted for the bulk of the findings, and that most small and large carcasses and feather spots persisted for more than 7 days. These facts suggest that daily searches are not necessary at this site to accurately detect and quantify fatalities.

Owing to issues cited in the previous third quarterly report, the protocol for 5-day and regular weekly searchers working in overlapping areas changed at the beginning of June 2013. Therefore, during the fourth quarter, it was possible to determine the short-term permanence (within the 5-day period) of all feather spots and carcasses, whether they were detected during regular weekly searches or not. Although this quarter offered a relatively small sample size (7), data from weekly searches suggested that the relative permanence of feather spots was much greater than that of carcasses. This finding is supported by the overall ratio (20:3) of carcasses to feather spots found in the arrays during regular weekly searches

A general assumption of fatality searches is that searchers detect less than 100% of fatalities, owing to both environmental and individual constraints (e.g., vegetation height, visual obstacles such as support poles for the arrays, and worker fatigue) (Huso 2010). The results of both the 1-day and the 5-day repeat surveys support this premise, because more than half of the finds of repeat searches were missed by weekly searchers. Although the number of fatalities found by weekly searchers but missed by repeat searchers was not examined, we did record cases of weekly searchers finding fatalities that repeat searchers did not find, and it is likely that searcher misses go in both directions. The low rates of consistency between the findings of regular weekly searchers and repeat searchers also suggest that both random differences and differences that vary by individual searcher may affect search outcomes. For example, a taller searcher has a reduced field of vision into adjacent rows compared to a shorter searcher, and is unlikely to be able to fully compensate for this disadvantage, even with conscious efforts to look under the panels. Likewise, there are trade-offs based on where searchers focus their field of vision: if a searcher focuses on tufts of tall grass on the sides of array rows, he or she may overlook fatalities directly underfoot, and vice versa. Estimates of individual searcher efficiencies would provide useful information for model estimation of overall fatality rates. However, identifying individual efficiencies in a field team of our size (around 20 individuals) would require a prohibitively large number of searcher-efficiency trials (more than 1600 per year, excluding the explanatory variables of season and Project element).

Because of the high labor costs and time involved in 5-day repeat searches, the areas searched were very small, covering only 5% of most arrays and 5% of the fences. The small survey area covered and the infrequency of these searches (once a month at each site) resulted in a large sampling bias when extrapolating to entire Project elements. If fatality rates are low or not evenly distributed throughout the site, searching 5% of the area may be insufficient to accurately estimate fatalities, but increasing the search area is nevertheless very expensive and labor intensive. In addition, comparing two different methods for estimating fatalities is difficult when the true number of fatalities in not known, as is the case. Computer simulations may provide a method to test whether 5-day repeat surveys can accurately estimate fatalities on a site. However, the methods for estimating fatalities at wind energy facilities, which we adapted for this study, still represent a tested, reliable, and cost-effective way to estimate fatalities over a large site such as CVSR.

4.4.2 1-day Repeat Surveys

The 1-day repeat surveys were designed to increase understanding of searcher efficiency by providing an independent index of carcasses missed by the weekly searchers. However, 1-day repeat surveys did not provide a full measure of searcher efficiency because the efficiency of the 1-day repeat surveyor was not known. Although the searcher-efficiency trials involved dividing the number of found fatalities by a known number of fatality plants, 1-day repeat surveys counted found fatalities representing some proportion of an unknown total number of fatalities in the area. On this Project site, fatalities rates were not high enough to get an accurate sample from such small survey areas. We found very few fatalities in 1-day repeat surveys. As with the 5-day repeat surveys, the area covered by the 1-day repeat surveys was so small (5% of the array) that it was rare to encounter fatalities. Because our sample size from these searches was too small to make a reliable, independent estimate of searcher efficiency, data from these surveys were incorporated into regular weekly search data. Had fatality rates been higher, we may have been able to use these data in an independent detection probability analysis of searcher efficiency. Using data on the few fatalities actually detected, the results of such an analysis would have been inaccurate.

4.5 Fatality Estimator

This is the first study of its kind to be conducted on a photovoltaic solar project. In a review paper titled "Environmental impacts from the installation and operation of large-scale solar power plants," Turney and Fthenakis predicted that negative impacts on wildlife would occur because of fencing installed in wildlife corridors and changes in food availability and preying strategy, but posited that the number of direct fatalities caused by solar panels was likely to be low compared to other anthropogenic sources of fatalities (Turney and Fthenakis 2011). The only previous study of fatalities at a solar farm took place at a concentrating solar farm in 1983. The primary concern at that facility was singed feathers of birds flying through flux near a central tower generated by heliostats, or panels of reflective mirrors (Wagner et. al 1983). Fatalities in this report were reported over a time period, rather than over a given area, so we were unable to directly compare fatality rates calculated by our study to those previously reported. Likewise, Wagner et al. (1983) did not account for searcher-efficiency rates, and disregarded carcass-removal rates after a preliminary experiment. Failure to account for these issues can severely affect overall fatality estimates.

To give an initial estimate of fatality rates attributable to solar arrays beyond the background fatality rate, we estimated fatality rates for Array 1 using time periods beyond the time period this report covers. We estimated fatalities and confidence intervals for Array 1 based on a full year of data (20 September 2012 to 19 September 2013), and for the control plots for Array 1 and 2 from 15 November 2012 to 14 November 2013. We adjusted the control plot area estimate to cover an area the same size as Array 1 (66 trackers). We then subtracted the lower bound of the confidence interval for the control plot estimate from the Array 1 estimate to obtain an adjusted fatality estimate for Array 1 beyond the background fatality rate.

We estimated that 231 fatalities occurred over a full year in Array 1 (90% confidence intervals: 162, 382) based on 47 fatalities found, and 187 fatalities in the control plots (90% confidence intervals: 107, 367) based on 11 fatalities found. This resulted in an adjusted fatality range 90% confidence interval of 55-275 attributable to the array, or 0.83 to 4.167 fatalities per tracker per year This corresponds to a mean rate of 7.34, or (90% Confidence interval: 3.24 to 16.27 fatalities per MW per year, assuming 0.256MW per tracker).

There are several caveats to keep in mind when interpreting these estimates. As we reanalyze data with full years of surveys for the remaining arrays and control plots these estimates will likely change. Our sample area of control plots in this calculation was based on surveys of 22 tracker sized control plots, which we now know from resampling is a low sample size to calculate fatality rates from, especially for an area as large as the on-site conservation land at the CVSR Project. This is also a conservative adjustment, using only the lower bound of the confidence interval or minimum estimated number of background fatalities.

As we complete full years of surveys for the remaining arrays, this estimate will likely change. However, fatalities per megawatt of installed capacity are a useful metric to compare fatality rates across sites and methods of energy production (Arnett et al. 2008; Smallwood 2013). For example, at regional scales in North America, birds collide with wind turbines at similar rates (National Research Council 2007; Erickson et al. 2008; National Wind Coordinating Collaborative 2010; Smallwood 2013).

In terms of both vegetation and landscape features, the CVSR Project site is fairly homogeneous, particularly in and among arrays, mostly because of the geomorphology of the site but also partly due to the grading and ground disturbance that occurred during construction. Although during the two seasons in which we sampled all arrays, the overall estimates from each array varied by less than one fatality per tracker unit per season, fatality rates for different arrays may vary by season; therefore, a full year of sampling in all arrays is needed before it is known whether or not the number of fatalities is spatially even across arrays.

In contrast to the relatively homogeneous distribution of fatalities in the array areas, the difference between the Gen-tie Line fatalities and the MVOH Line fatalities is striking. The height and size of the Gen-tie and MVOH Lines are considerably different. Much of the linear area along the MVOH Line has been disturbed by construction-related activities, whereas nearly all of the grassland habitat along the Gen-tie Line is intact, and disturbance was limited to the tower pads and access roads to the pads. A natural wetland that provides many avian species with important resources also occurs along the Gen-tie Line. Furthermore, construction of the Gen-tie Line was completed in June 2012, whereas construction close to the MVOH Line was just coming to a close in fall 2013; therefore, noise and ground disturbance likely contributed to overall lower avian activity along the MVOH Line and consequently lower mortality rates.

At all Project elements, we found relatively few owls and diurnal raptors. However, the long-term effects on these birds of collision hazards such as solar arrays are unclear. For species that are K-strategists (i.e., larger animals that have relatively fewer offspring and live long), such as diurnal raptors and owls, even small numbers of fatalities may lead to long-term impacts. Other species that are r-strategists (i.e., smaller animals that have many offspring and are short-lived) may be better able to compensate for lowered population densities by increasing their clutch sizes and fledgling survival rates in response to an increased relative abundance of resources (Drewitt et al. 2008).

4.6 Conclusion and Recommendations

This annual fatality report offers insights into the under-studied effects of large solar photovoltaic installations on avian mortality. In the next annual fatality report, we will be able to report a site-wide estimate of fatalities for all seasons. Likewise, ongoing fatality searches, searcher-efficiency trials, and carcass-removal trials will help to increase the accuracy of our fatality estimates.

Based on our findings to date, we recommend the following:

- **Establish a Linear Control:** To better assess the fatality rates of passerines and raptors across the landscape, fatality searches along a linear control should be conducted, and fatality searches along the Gen-tie Line should continue for another year. Linear controls should be used to evaluate fatality rates along both the Gen-tie and MVOH Lines.

- **Measure Abundance of Passerines as Well as Raptors:** Point counts targeting both raptors and passerines should be conducted in arrays and along linear features, allowing comparisons to data on activity on the Conservation Lands. These counts and comparisons would indicate whether fatality rates are associated with species abundance. The current avian point counts are biased toward raptors and large birds.
- **Examine Ways to Partition Feathers Spots:** Because the ratio of feather spots to found carcasses was 20:3 during the reporting period, the inability to partition feather spots associated with collisions and feather spots stemming from predation has important implications regarding inferences that can be drawn from the fatality estimate. We are examining relationships within the existing data set in an attempt to quantify the relative contribution of predation events to the overall fatality estimates.

Discontinue Repeat Surveys: Given the low fatality rates on the site and the expense and labor involved in repeat surveys, 5-day and 1-day repeat surveys should be discontinued. We recommend focusing efforts on weekly fatality surveys. We recommend that daily searches generally not be conducted to obtain a fatality estimate because they are labor intensive and labor is generally offset by surveying smaller areas. Given the tradeoff between area covered and frequency of searches, it is better to conduct regular weekly searches of a larger proportion of the site. Daily searches would be most useful if they are necessary to answer specific research questions, for example linking fatalities to weather patterns or to test a deterrent method or some other form of mitigation where knowing more precise timing of fatalities is important, but data gathered for answering these questions should not be used to obtain a site-wide estimate.

We recommend avoiding multiple searches of the same area at different time intervals. If surveys are conducted at various search intervals on the same area to answer research questions, we recommend that the different search strategies be designed to avoid interfering with each other. For example, daily searchers would not collect fatalities so they will still be present for weekly searchers to find.

- **Modify Weekly Fatality Search Areas to Improve Sample Size:** We recommend discontinuing 100% searches of Arrays 1 and 2, reducing the coverage of these arrays to 20% based on the results of the subsampling error assessment (power analysis) of the first year of data. All other arrays should also be searched at the 20% level. Further, the smaller arrays close to each other should be combined so that a 20% sample comprises 30–35 tracker units.

- **Conduct Scent Dog Survey Trials:** Scent detection dogs could be used to increase searcher efficiency rates, particularly where grasses and forbs obscure fatalities. If scent dogs prove significantly better during bias trials, we recommend considering the use of scent dogs to conduct fatality searches, most likely in combination with human searchers, at least initially.

Section 5.0 References

5.1 Literature Cited

Akaike, H. 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in B. N. Petran and F. Csaki (Editors), 2nd International Symposium on Information Theory. Akademiai Kiado, Budapest, Hungary.

Allen, G. T., and P. Ramirez. 1990. A review of bird deaths on barbed-wire fences. The Wilson Bulletin 102(3):553–558.

Arnett, E. B., W. K. Brown, W. P. Erickson, J. K. Fiedler, B. L. Hamilton, T. H. Henry, A. Jain, G. D. Johnson, J. Kerns, R. R. Koford, C. P. Nicholson, T. J. O'Connell, M. D. Piorkowski, and R. D. Tankersley, 2008. Patterns of bat fatalities at wind energy facilities in North America. The Journal of Wildlife Management 72(1): 61-78.

Beason, R. C. 1995. Horned lark (*Eremophila alpestris*). No. 195 i*n* A. Poole (Editor), The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York. [online]: http://bna.birds.cornell.edu/bna/species/195. Doi:10.2173/bna.195

Bohall-Wood, P. 1987. Abundance, habitat use, and perch use of loggerhead shrikes in North-Central Florida. The Wilson Bulletin 99(1):82–86.

Brown, W. M., and R. C. Drewien. 1995. Evaluation of two power line markers to reduce crane and waterfowl collision mortality. Wildlife Society Bulletin 23(2):217–227.

Derby, C., A. Dahl, W. Erickson, K. Bay, and J. Hoban. 2007. Postconstruction Monitoring Report for Avian and Bat Mortality at the NPPD Ainsworth Wind Farm. February 27. Prepared for Nebraska Public Power District. Prepared by Western Ecosystems Technology, Inc.

Drewitt, A. L., and R. H. W. Langston. 2008. Collision effects of wind-power generators and other obstacles on birds. Annals of the New York Academy of Sciences 1134:233–266.

Efron, B., and R. Tibshirani. 1986. Bootstrap methods for standard errors, confidence intervals and other measures of statistical accuracy. Statistical Science 1:54–77.

Emery, N. J. 2006. Cognitive ornithology: The evolution of avian intelligence. Philosophical Transactions of the Royal Society 361(1465):23-43.

Erickson, W. P., D. Strickland, D. Young, and G. Johnson. 2008. A Summary of Avian and Bat Fatalities at Wind Facilities in the U.S. November. Presentation at the National Wind Coordinating Collaborative Research Meeting VII, Milwaukee, Wisconsin.

[HTH] H. T. Harvey & Associates. 2011. Avian and Bat Protection Plan for the California Valley Solar Ranch Project. Fresno, California.

[HTH] H. T. Harvey & Associates. 2013. California Valley Solar Ranch Avian Activity Surveys: October 2011 –October 2012. Fresno, CA.

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. Doi: 10.1002/env.1052

Janss, G. F. E. 2000. Avian mortality from power lines: A morphological approach of a species-specific mortality. Biological Conservation 95:353–359.

Janss, G. F. E., and M. Ferrer. 1998. Rate of bird collision with power lines: effects of conductor –marking and static wire-marking. Journal of Field Ornithology 69: 8-17.

Johnson, G. D., W. P. Erickson, M. D. Strickland, M. F. Sheperd, D. A. Sheperd, and S. A. Sarappo. 2003. Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota. American Midland Naturalist 150:332–342.

Johnston, D. S., J. A. Howell, S. B. Terrill, N. Thorngate, J. Castle, J. P. Smith, T. J. Mabee, J. H. Plissner, N. A. Schwab, P. M. Sanzenbacher, and C. M. Grinnell. 2013. Bird and Bat Movement Patterns and Mortality at the Montezuma Hills Wind Resource Area. California Energy Commission. CEC-500-2013-015.

Leslie, D., J. Schwartz, and B. Karas. 2012. Altamont Pass Wind Resource Area Bird Fatality Study, Bird Years 2005–2010. November. M87. ICF 00904.08. Prepared for Alameda County Community Development Agency, Hayward, California. Prepared by ICF International, Sacramento, California.

Lynn, S., J.A. Martin, and D. K. Garcelon, 2006. Can supplemental foraging perches enhance habitat for endangered San Clemente Loggerhead Shrikes? Wilson Journal of Ornithology, 118: 333-341.

Martin, C., E. Arnett, and M. Wallace. 2013. Evaluating Bird and Bat Postconstruction Impacts at the Sheffield Wind Facility, Vermont: 2012 Annual Report. March 25. Prepared for Bat Conservation International and First Wind.

National Research Council. 2007. Environmental Impacts of Wind-energy Projects. The National Academies Press, Washington, D.C.

National Wind Coordinating Collaborative. 2010. Wind Turbine Interactions with Birds, Bats, and Their Habitat: A Summary of Research Results and Priority Questions. Fact Sheet: Spring 2010. Washington, D.C.

Nicholson, C. P., R. D. Tankersley Jr., J. K. Fiedler, and N. S. Nicholas. 2005. Assessment and Prediction of Bird and Bat Mortality at Wind Energy Facilities in the Southeastern United States: Final Report, 2005. Tennessee Valley Authority, Knoxville, Tennessee.

Otis, D. L., J. H. Schulz, D. Miller, R. E. Mirarchi, and T. S. Baskett. 2008. Mourning dove (*Zenaida macroura*). No. 117 i*n* A. Poole (Editor), The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York. [online]: http://bna.birds.cornell.edu/bna/species/117.

Ponce, C., J. C. Alonso, G. Argandoña, and M. Carrasco. 2010. Carcass removal by scavengers and search accuracy affect bird mortality estimates at power lines. Animal Conservation 13:603–612.

Prosser, P., C. Nattrass, and C. Prosser. 2008. Rate of removal of bird carcasses in arable farmland by predators and scavengers. Ecotoxicology and Environmental Safety 71(2):601–608.

R Development Core Team. 2011. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.

Scott, S. D., and C. McFarland. 2010. Bird Feathers: A Guide to North American Species. Stackpole Books, Mechanicsburg, Pennsylvania.

Sheffield, L. M., J. R. Crait, W. D. Edge, and G. Wang, 2001. Response of American kestrels and gray-tailed voles to vegetation height and supplemental perches. Canadian Journal of Zoology, 79(3): 380-385.

Smallwood, K. S., D. A. Bell, S. A. Snyder, and J. E. Didonato. 2010. Novel scavenger removal trials increase wind turbine-caused avian fatality estimates. Journal of Wildlife Management 74(5):1089–1097.

Smallwood, K. S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781–2791.

Smallwood, K. S. 2013. Comparing bird and bat fatality rates among North American wind-energy projects. Wildlife Society Bulletin 37:19–33.

Turney, D. and V. Fthenakis. 2011. Environmental impacts from the installation and operation of large-scale solar power plants. Renewable and Sustainable Energy Reviews 15:3261–3270.

Wagner, W. D., R. L. McKernan, P. A. Flanagan, and R. W. Schreiber. 1983. Wildlife Interactions at Solar One Facility, Daggett, California: Fall 1982 Interim Report.

Wolff, J. O., T. Fox, R. R. Skillen, and G. Wang, 1999. The effect of supplemental perch sites on avian predation and demography of vole populations. Canadian Journal of Zoology 77(4): 535-541.

Yosef, R., and T. C. Grubb 1994. Resource dependency and territory size in Loggerhead Shrikes (*Lanius ludovicianus*). Auk 111:465-469.

5.2 Personal Communication

Huso, Manuela M. Supervisory Research Biological Statistician. USGS. 30 August 2013—Conversation with Gabriel Reyes of H.T. Harvey & Associates, regarding how to apply the fatality estimator to linear features and repeat fatality surveys.

Appendix A. Avian Species Used in Searcher-efficiency Trials, September 2012 to September 2013

Species	Carcass Size
American coot (*Fulica americana*)	Large
American crow (*Corvus brachyrhynchos*)	Large
American kestrel (*Falco sparverius*)	Large
Band-tailed pigeon (*Patagioenas fasciata*)	Large
Barn owl (*Tyto alba*)	Large
Black-crowned night heron (*Nycticorax nycticorax*)	Large
Black-headed grosbeak (*Pheucticus melanocephalus*)	Small
Brewer's blackbird (*Euphagus cyanocephalus*)	Small
California towhee (*Melozone crissalis*)	Small
Cedar waxwing (*Bombycilla cedrorum*)	Small
Chestnut-backed chickadee (*Poecile rufescens*)	Small
Common raven (*Corvus corax*)	Large
Common yellowthroat (*Geothylpis trichas*)	Small
Cooper's hawk (*Accipiter cooperii*)	Large
Eurasian collared-dove (*Streptopelia decaocto*)	Large
European starling (*Sturnus vulgaris*)	Small
Greater roadrunner (*Geococcyx californianus*)	Large
Great horned owl (*Bubo virginianus*)	Large
Green heron (*Butorides virescens*)	Large
Horned lark (*Eremophila alpestris*)	Small
House finch (*Carpodacus mexicanus*)	Small
Lesser goldfinch (*Spinus psaltria*)	Small
Long-eared owl (*Asio otus*)	Large
Mourning dove (*Zenaida macroura*)	Large
Rock pigeon (*Columba livia*)	Large
Red-shouldered hawk (*Buteo lineatus*)	Large
Savannah sparrow (*Passerculus sandwichensis*)	Small
Swainson's thrush (*Catharus ustulatus*)	Small
Varied thrush (*Ixoreus naevius*)	Large
Warbling vireo (*Vireo gilvus*)	Small
Western meadowlark (*Sturnella neglecta*)	Small
Western scrub-jay (*Aphelocoma californica*)	Small
White-tailed kite (*Elanus leucurus*)	Large
Yellow-billed magpie (*Pica nuttalli*)	Large
Yellow warbler (*Setophaga petechia*)	Small

Appendix B. Avian Species Used in Carcass-removal Trials

Species	Carcass Size	Number Placed
Acorn woodpecker (*Melanerpes formicivorus*)	Small	1
American coot (*Fulica americana*)	Large	1
American crow (*Corvus brachyrhynchos*)	Large	7
American goldfinch (*Spinus tristis*)	Small	1
American kestrel (*Falco sparverius*)	Large	1
American robin (*Turdus migratorius*)	Large	2
Anna's hummingbird (*Calypte anna*)	Small	1
Band-tailed pigeon (*Patagioenas fasciata*)	Large	2
Barn owl (*Tyto alba*)	Large	4
Black turnstone (*Arenaria melanocephala*)	Large	1
Brewer's blackbird (*Euphagus cyanocephalus*)	Small	2
California gull (*Larus californicus*)	Large	1
California quail (*Callipepla californica*)	Large	1
California towhee (*Melozone crissalis*)	Small	2
Cerulean warbler (*Setophaga cerulean*)	Small	2
Cliff swallow (*Petrochelidon pyrrhonota)*	Small	1
Common raven (*Corvus corax*)	Large	2
Eurasian collared-dove (*Streptopelia decaocto*)	Large	6
European starling (*Sturnus vulgaris*)	Small	2
Great horned owl (*Bubo virginianus*)	Large	6
Greater roadrunner (*Geococcyx californianus*)	Large	1
Hermit thrush (*Catharus guttatus*)	Small	1
Horned grebe (*Podiceps auritus*)	Large	2
Horned lark (*Eremophila alpestris*)	Small	3
House finch (*Haemorhous mexicanus*)	Small	3
House sparrow (*Passer domesticus*)	Small	1
Lesser goldfinch (*Spinus psaltria*)	Small	2
Lincoln's sparrow (*Melospiza lincolnii*)	Small	1
Mourning dove (*Zenaida macroura*)	Large	4
Northern flicker (*Colaptes auratus*)	Large	1
Northern mockingbird (*Mimus polyglottos*)	Small	1
Peregrine falcon (*Falco peregrinus*)	Large	1
Pine siskin (*Spinus pinus*)	Small	1
Red-shouldered hawk (*Buteo lineatus*)	Large	4
Red-tailed hawk (*Buteo jamaicensis)*	Large	8
Red-winged blackbird (*Agelaius phoeniceus*)	Small	1
Rock dove/pigeon (*Columba livia*)	Large	4
Ruby-crowned kinglet (*Regulus calendulai*)	Small	1
Sharp-shinned hawk (*Accipiter striatus*)	Large	1

Species	Carcass Size	Number Placed
Western meadowlark (*Sturnella neglecta*)	Medium	1
Western screech-owl (*Megascops kennicottii*)	Medium	1
Western scrub-jay (*Aphelocoma californica*)	Medium	4
White-crowned sparrow (*Zonotrichia leucophrys*)	Small	2
White-tailed kite (*Elanus leucurus*)	Large	2
Yellow-rumped warbler (*Setophaga coronata*)	Small	2

Appendix C. Weekly Fatality Search Results: 16 August 2012 to 15 August 2013

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 1	9/27/2012	Mourning dove	11S	233981	3915723	Feather spot.
Array 1	9/27/2012	Mourning dove	11S	233987	3915548	Feather spot. Suspected roosting/preening site.
Array 1	9/27/2012	Common raven	11S	233705	3915535	Feather spot.
Array 1	9/27/2012	Common raven	11S	234004	3915528	Feather spot.
Array 1	10/4/2012	Mourning dove	11S	233512	3915482	Feather spot. Suspected roosting/preening site.
Array 1	10/18/2012	Horned lark	11S	233542	3915733	Feather spot.
Array 1	10/18/2012	Burrowing owl	11S	233886	3915595	Feather spot.
Array 1	10/18/2012	Horned lark	11S	233579	3915738	Feather spot.
Array 1	10/18/2012	Horned lark	11S	233928	3915518	Feather spot.
Array 1	10/18/2012	Burrowing owl	11S	234000	3915471	Feather spot.
Array 1	10/25/2012	Horned lark	11S	233714	3915431	Feather spot.
Array 1	11/1/2012	Horned lark	11S	233442	3915776	Partial carcass with wings, legs, and bill. Bill impaled on tumbleweed. Cause of death possible predation by loggerhead shrike (LOSH).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 1	11/1/2012	Horned lark	11S	234110	3915654	Feather spot.
Array 1	11/8/2012	Horned lark	11S	234103	3915641	Feather spot.
Array 1	11/8/2012	Mourning dove	11S	233950	3915518	Feather spot. Suspected roosting/preening site.
Array 1	11/8/2012	Western meadowlark	11S	233822	3915671	Breast feathers. Some skin attached.
Array 1	11/8/2012	Medium-sized bird	11S	233426	3915528	Medium-sized bird based on articulated knee or elbow and fibula/tibia.
Array 1	11/8/2012	Mourning dove	11S	233807	3915533	Feather spot (body feathers). Suspected roosting/preening site.
Array 1	11/8/2012	Short-eared owl	11S	233815	3915688	Feather spot. Feathers on panel. Cause of death possible panel strike.
Array 1	11/8/2012	Short-eared owl	11S	233891	3915349	Feather spot. Feathers, possible organs, whitewash, spot with dirt absent on panel. Cause of death possible panel strike.
Array 1	12/20/2012	Mourning dove	11S	233412	3915438	Feather spot (>50 body feathers). Feathers scattered over 2x2-m area.
Array 1	1/10/2013	House finch	11S	234021	3915462	Head impaled on tumbleweed. Cause of death possible predation by LOSH.
Array 1	1/10/2013	Horned lark	11S	234056	3915775	Feather spot (several primaries and body feathers). Smudge marks and four body feathers stuck to the bottom right corner of panel. Feathers found at the array edge. Cause of death likely a panel strike.

Area	Date	Species	UTM	Easting	Northing	Observation Details¹
Array 1	1/17/2013	Horned lark	11S	233952	3915772	Feather spot.
Array 1	1/17/2013	Western meadowlark	11S	233462	3915602	Feather spot (primaries, body, and contour feathers). Spread across 2x2-m area, likely wind-blown.
Array 1	1/31/2013	Horned lark	11S	233446	3915562	Feather spot (downy feathers).
Array 1	1/31/2013	House finch	11S	233740	3915310	Feather spot. Flesh on some feather tips.
Array 1	1/31/2013	Western meadowlark	11S	233930	3915672	Feather spot.
Array 1	1/31/2013	Mourning dove	11S	234119	3915660	Feather spot (13 body feathers). Suspected roosting/preening site.
Array 1	2/14/2013	Western meadowlark	11S	231009	3915719	Feather spot.
Array 1	3/21/2013	Horned lark	11S	234249	3915566	Feather spot (≥25 back and breast feathers). Several feathers found on the bare ground under the panels.
Array 1	3/28/2013	Horned lark	11S	234151	3915458	Feather spot. Near acoustic station near Array 1.
Array 1	4/18/2013	Horned lark	11S	234062	3915720	Feather spot (two secondaries with coverts attached, one secondary, and more than ten body feathers).
Array 1	5/9/2013	House finch	11S	234155	3915577	Feather spot (four primaries, ≥20 contour feathers).
Array 1	5/9/2013	Horned lark	11S	233866	3915476	Feather spot (~15 breast feathers in a clump).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 1	5/16/2013	Horned lark	11S	233445	3915794	Feather spot (≥15 flight feathers and ≥50 body feathers).
Array 1	5/23/2013	House finch	11S	233794	3915504	Feather spot (~40 breast feathers).
Array 1	5/23/2013	Mourning dove	11S	233689	3915385	Feather spot (approximately ten body feathers tightly clumped).
Array 1	5/23/2013	Horned lark	11S	234007	3915780	Feather spot (seven tail feathers, ten primaries attached by tissue, ≥20 contour feathers, and four secondaries).
Array 1	5/30/2013	Horned lark	11S	233732	3915516	Feather spot. Wing parts and contour feathers. Nest with eggs ~30 cm away. Bird may have been predated.
Array 1	6/13/2013	American kestrel	11S	233506	3915434	Feather spot (five feathers, including three primaries).
Array 1	6/20/2013	American kestrel	11S	234249	3915575	Feather spot (one secondary, five wing coverts, and 15 breast feathers).
Array 1	7/18/2013	Mourning dove	11S	233427	3915713	Feather spot (~15 body feathers tightly clustered).
Array 1	7/18/2013	House finch	11S	233949	3915584	Feather spot (~15 body feathers).
Array 1	7/25/2013	Mourning dove	11S	233858	3915327	Feather spot (~25 contour feathers and coverts).
Array 1	7/25/2013	Great horned owl	11S	233865	3915329	Feather spot (11 contour feathers). Feathers worn and older than search interval.
Array 1	8/1/2013	House finch	11S	233704	3915471	Feather spot (~15 feathers of a wing). Feathers barely attached.
Array 1	8/1/2013	Common raven	11S	233570	3915547	Feather spot (~20 breast feathers attached in a clump to dried flesh).
Array 1	8/1/2013	Horned lark	11S	233908	3915420	Feather spot (12 secondaries and contour feathers). Feathers worn and older than search interval.
Array 1	8/8/2013	Mourning dove	11S	233431	3915425	Feather spot (17 contour feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 1	8/8/2013	Common raven	11S	233602	3915623	Feather spot (ten primaries, 15 body feathers, and small amount of flesh dried to feathers).
Array 1	8/15/2013	Common raven	11S	233658	3915633	Partial carcass (wing).
Array 1 control plot	11/15/2012	Blackbird sp.	11S	234421	3915557	Feather spot.
Array 1 control plot	4/18/2013	Horned lark	11S	234835	3914331	Feather spot (two secondaries and three tail feathers).
Array 1 control plot	5/23/2013	Common raven	11S	234394	3915663	Feather spot (~20 contour feathers).
Array 1–2 fence	2/19/2013	Horned lark	11S	233393	3915496	Feather spot (≥15 body, one primary, and three secondary feathers).
Array 1–2 fence	3/5/2013	Mourning dove	11S	233616	3914432	Feather spot (≥20 body and breast feathers). Could be preening spot, but feathers were scattered in 1-m radius. Some feathers stuck together. Found 30 m north of fence point 17.
Array 1–2 fence	3/12/2013	Mourning dove	11S	233623	3914542	Feather spot (~50 breast feathers). Approx. 0.5 m east of fence.
Array 1–2 fence	5/7/2013	Unknown small bird	11S	234252	3914464	Feather spot (~20 body feathers, dark grey in color). Clearly rained upon.
Array 2 control plot	12/4/2012	Horned lark	11S	234801	3915162	Feather spot.
Array 2 control plot	2/5/2013	Tree swallow	11S	234303	3913572	Feather spot.
Array 2 control plot	2/5/2013	House finch	11S	234299	3913638	Whole carcass. No obvious injuries or signs of ill health.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 control plot	4/16/2013	Common raven	11S	233760	3914054	Feather spot (mixture of ~25 secondaries and contour feathers). Feathers scattered across 5 m.
Array 2 control plot	5/21/2013	Horned lark	11S	234756	3915202	Feather spot (15 flight feathers and ≥50 body feathers).
Array 2 control plot	7/23/2013	Horned lark	11S	233650	3914101	Feather spot (one tail feather and 14 contour feathers).
Array 2 North	12/4/2012	Western meadowlark	11S	234107	3915294	Feather spot. Wing (with some flesh) under panel at edge of tracker. Feather spot 4.6 m east, on top of panel (≥10 feathers stuck on panel with large smear marks).
Array 2 North	12/11/2012	Mourning dove	11S	234417	3915072	Feather spot. Body feathers and mourning dove (MODO) fecal droppings present. Suspected roosting/preening site.
Array 2 North	12/11/2012	Mourning dove	11S	233923	3915097	Feather spot. Body feathers and MODO fecal droppings present. Suspected roosting/preening site.
Array 2 North	12/11/2012	Horned lark	11S	234354	3915162	Feather spot.
Array 2 North	1/8/2013	Horned lark	11S	234492	3915122	Feather spot.
Array 2 North	1/8/2013	Horned lark	11S	234281	3915343	Feather spot (ten or more primaries and >50 downy feathers).
Array 2 North	1/8/2013	Horned lark	11S	234349	3915216	Whole carcass. Bird apparently died just prior to survey. Very good condition and weight. Possible head trauma. Seizure before death. No definitive evidence of panel strike. Cause of death potential panel strike.
Array 2 North	1/8/2013	Unknown small bird	11S	234013	3914931	Feather spot.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 North	1/8/2013	Mourning dove	11S	233775	3915006	Feather spot. Two feathers have blood on the ends.
Array 2 North	1/8/2013	Mourning dove	11S	233998	3915109	Feather spot.
Array 2 North	1/8/2013	Western meadowlark	11S	234474	3915002	Feather spot (clump of feathers).
Array 2 North	1/8/2013	California quail	11S	234458	3915015	Feather spot (clump of breast feathers).
Array 2 North	1/8/2013	American pipit	11S	233947	3915001	Whole carcass. No evidence of panel strike.
Array 2 North	1/15/2013	Mourning dove	11S	234116	3915029	Feather spot (primaries, secondaries, and body feathers).
Array 2 North	1/15/2013	Mourning dove	11S	234116	3915045	Feather spot (several downy and flight feathers). Found in same row as MODO feather spot from same day. Probably same fatality.
Array 2 North	1/15/2013	Common raven	11S	234369	3915286	Feather spot (contour feathers).
Array 2 North	1/15/2013	Western meadowlark	11S	234254	3915320	Feather spot (body feathers in small clump).
Array 2 North	1/15/2013	Common raven	11S	234384	3915309	Feather spot (body feathers).
Array 2 North	1/22/2013	Common raven	11S	234377	3915298	Feather spot (contour feathers). Potentially remnants from a previously collected common raven (CORA) fatality (1/15/13).
Array 2 North	1/22/2013	Mourning dove	11S	233835	3914945	Feather spot (clump of body feathers).
Array 2 North	1/22/2013	Mourning dove	11S	233902	3914945	Feather spot (downy feathers). Suspected preening site.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 North	1/22/2013	Mourning dove	11S	234359	3915322	Feather spot. Suspected preening site above cable tray.
Array 2 North	1/22/2013	Mourning dove	11S	234119	3915035	Feather spot (scattered feathers and one clump).
Array 2 North	1/22/2013	Horned lark	11S	234173	3915114	Feather spot.
Array 2 North	1/22/2013	California quail	11S	234393	3914986	Feather spot (clump of feathers).
Array 2 North	1/29/2013	Mourning dove	11S	233891	3914945	Feather spot (mostly breast feathers). Not under panel like most MODO preening areas.
Array 2 North	1/29/2013	Mourning dove	11S	234015	3914931	Feather spot (one clump of body feathers).
Array 2 North	1/29/2013	Mourning dove	11S	234365	3915193	Feather spot.
Array 2 North	1/29/2013	Mourning dove	11S	234367	3915164	Feather spot. Body feathers spread down row.
Array 2 North	2/5/2013	House finch	11S	234212	3915338	Whole carcass (broken neck). Cause of death potential panel strike.
Array 2 North	2/5/2013	Mourning dove	11S	233991	3914940	Feather spot. Skin attached to feathers.
Array 2 North	2/12/2013	Mourning dove	11S	234182	3915342	Feather spot (body and flight feathers). Some feathers with dried flesh attached at shaft base. Five body feathers stuck to solar panel, but no evidence of strike. Spread across entire tracker unit row.
Array 2 North	2/12/2013	Unknown small bird	11S	234198	3915347	Skeletal remains of wing and keel bones. Bones picked clean. Dried muscle fibers still attached but

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
						stringy.
Array 2 North	2/12/2013	Western meadowlark	11S	234409	3915384	Feather spot (~20 contour feathers).
Array 2 North	2/12/2013	House finch	11S	234464	3915452	Feather spot. Wing feather clumps. A few body and flight feathers on panel, but no evidence of panel strike. Many body feathers on ground under panel on outside face of tracker.
Array 2 North	2/12/2013	Mourning dove	11S	234386	3915162	Feather spot (~20 scattered downy feathers).
Array 2 North	2/12/2013	Mourning dove	11S	234386	3915157	Feather spot (two downy feathers on panel, two flight feathers on ground). No evidence of panel strike.
Array 2 North	2/12/2013	Mourning dove	11S	234260	3915252	Feather spot (>100 body and >10 flight feathers). Approximately 11 body feathers on panel, but no evidence of panel strike.
Array 2 North	2/19/2013	House finch	11S	233861	3914831	Feather spot (a few primaries and a few body feathers).
Array 2 North	2/19/2013	Mourning dove	11S	234396	3915436	Feather spot (≥50 feathers—ten or more secondaries and tertials and ≥40 body feathers). Feathers found stuck on panel. Possible panel strike or prey possibly eaten on panel.
Array 2 North	2/19/2013	Mourning dove	11S	234115	3915291	Feather spot (seven primaries with skin attached). Some feathers found stuck to panel. Possible panel strike or prey possibly eaten on panel.
Array 2 North	2/19/2013	Mourning dove	11S	234114	3915292	Feather spot (four or more secondaries, ≥15 body feathers, one tail feather, and one larger body feather). Absence of droppings and wide scatter of feathers indicate fatality and not preening station.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 North	2/19/2013	House finch	11S	234484	3915068	Feather spot (ten primaries and ≥50 body feathers). All feathers there—plucked.
Array 2 North	2/19/2013	Horned lark	11S	234442	3915295	Feather spot (≥15 body feathers and five or more primaries). Found directly under a panel.
Array 2 North	2/19/2013	House finch	11S	234164	3915141	Feather spot (≥30 body feathers).
Array 2 North	2/19/2013	House finch	11S	234261	3915153	Feather spot (ten primaries and ≥30 body feathers).
Array 2 North	2/26/2013	Western meadowlark	11S	234337	3915123	Feather spot (≥15 body feathers). All contour feathers. Isolated spot (not scattered).
Array 2 North	3/5/2013	Horned lark	11S	233901	3915118	Feather spot (five or more secondaries and ≥15 body feathers).
Array 2 North	3/5/2013	Horned lark	11S	234406	3915204	Whole carcass. Eyes gone but still fresh. Body warm but could be from intense sun. No visible signs of injury.
Array 2 North	3/5/2013	Horned lark	11S	234348	3915190	Feather spot (≥15 body feathers). White tips on body feathers.
Array 2 North	3/5/2013	Mourning dove	11S	234341	3915343	Feather spot (two flight feathers).
Array 2 North	3/12/2013	Mourning dove	11S	234227	3915000	Feather spot (≥50 body feathers and five or more flight feathers—mostly secondaries). Grey/white feathers. Spread over four rows. Some clumped feathers. Not a preening site.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 North	3/12/2013	Western meadowlark	11S	234250	3915070	Feather spot (one wing of ~20 primaries, five or more coverts, and yellow breast feathers).
Array 2 North	3/19/2013	House finch	11S	234341	3915005	Feather spot. Wings, foot, and feathers present (two wing partials; ≥20 primaries, secondaries, and coverts; and ≥50 body feathers). Bright red breast feathers present.
Array 2 North	3/26/2013	Horned lark	11S	234343	3915283	Whole carcass. Ants found in head and eye sockets. Found about 1 m from another horned lark (HOLA) fatality on same day. No signs of injury.
Array 2 North	3/26/2013	Horned lark	11S	234342	3915282	Feather spot. (partial wing, ten or more primaries and secondaries, five or more coverts, and ≥20 body feathers). Found about 1 m south of full HOLA carcass.
Array 2 North	4/2/2013	Horned lark	11S	234269	3914950	Feather spot. One clump of feathers on the cable tray (five primaries, six secondaries, two coverts, and one tail feather).
Array 2 North	4/2/2013	Horned lark	11S	234234	3915032	Feather spot. Clump of feathers (≥30 body feathers).
Array 2 North	4/2/2013	Horned lark	11S	234232	3915019	Feather spot (four primaries, eight secondaries, five tertials, and 12 contour feathers).
Array 2 North	4/16/2013	Horned lark	11S	234267	3915289	Whole carcass. No signs of injury.
Array 2 North	4/23/2013	Mourning dove	11S	234517	3915331	Feather spot (~15 primaries, 35 secondaries, ten tail feathers, 20 mantle feathers, and several hundred body feathers).
Array 2 North	4/30/2013	Mourning dove	11S	234268	3915260	Feather spot (one flight feather, ≥10 body feathers, and five body feathers in a clump).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 North	4/30/2013	Horned lark	11S	234215	3915114	Feather spot. Most feathers, including more than ten remiges, more than five retrices, and >75 contour feathers.
Array 2 North	4/30/2013	Horned lark	11S	234396	3914943	Feather spot (15 flight feathers, six tail feathers and 15 body feathers). Shafts of feathers broken. Possible juvenile, judging by sheaths. Probably not molting at this time of year. Feathers stuck to panel and cable tray. Possible panel strike or prey possibly eaten on panel.
Array 2 North	5/7/2013	Common raven	11S	234388	3915306	Feather spot (~30 body feathers). Some clumps of body feathers.
Array 2 North	5/7/2013	Horned lark	11S	234094	3915266	Feather spot (three tail feathers).
Array 2 North	5/14/2013	Horned lark	11S	234086	3915503	Whole carcass. Urea present on bird—most likely died minutes before discovered. Broken neck. Possible panel strike.
Array 2 North	5/21/2013	Horned lark	11S	234025	3915288	Feather spot (15 flight and five tail feathers). Found outside of tracker, off the side of the access road.
Array 2 North	5/28/2013	Horned lark	11S	234378	3915245	Whole carcass. Bird appeared emaciated, had excrement on cloaca.
Array 2 North	5/28/2013	Horned lark	11S	234072	3915037	Feather spot (one primary feather, ~40 body feathers, and five coverts).
Array 2 North	5/28/2013	Horned lark	11S	234343	3915250	Feather spot (six contour feathers and one tail feather). Two predated HOLA nests within 3–5 m of feathers.
Array 2 North	5/28/2013	Horned lark	11S	234073	3915038	Feather spot (~15 flight feathers, including some wing feathers still attached, and five body feathers).
Array 2 North	5/28/2013	House finch	11S	234020	3915176	Feather spot (feathers, wing, leg, and feathers with dried flesh).
Array 2 North	6/4/2013	House finch	11S	234338	3914975	Feather spot (11 body feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 North	6/4/2013	Common raven	11S	234338	3914976	Feather spot (~15 body feathers on road, close to panels).
Array 2 North	6/4/2013	House finch	11S	234315	3915314	Feather spot (seven flight feathers, ten body feathers, and five attached wing feathers).
Array 2 North	6/11/2013	Horned lark	11S	234520	3915047	Feather spot (two primaries and one contour feather). May not be a fatality because HOLAs were molting heavily at this time.
Array 2 North	6/11/2013	House finch	11S	234376	3915093	Feather spot (20 breast feathers, some clumped). Some feathers appeared to be plucked.
Array 2 North	6/11/2013	House finch	11S	234056	3915253	Feather spot (parts of wing, body feathers, and bone fragments).
Array 2 North	6/18/2013	Horned lark	11S	234193	3915167	Feather spot (partial wing and body feathers).
Array 2 North	6/25/2013	Mourning dove	11S	234211	3914933	Feather spot (two clumps, each with approximately eight contour feathers). Found on outside end of the tracker.
Array 2 North	6/25/2013	Horned lark	11S	234448	3915393	Feather spot (~15 body feathers, one contour feather, and one primary).
Array 2 North	7/23/2013	Horned lark	11S	233886	3914829	Feather spot (~50 body feathers and 20 flight feathers).
Array 2 North	7/30/2013	Mourning dove	11S	234289	3915258	Feather spot (several contour feathers).
Array 2 Serengeti	10/16/2012	Horned lark	11S	234520	3915036	Feather spot. Blood on some feathers.
Array 2 Serengeti	10/23/2012	Mourning dove	11S	234310	3914949	Feather spot (body feathers). Suspected roosting/preening site.
Array 2 Serengeti	10/23/2012	Mourning dove	11S	234344	3914998	Feather spot (body feathers). Suspected roosting/preening site.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 Serengeti	10/23/2012	Savannah sparrow	11S	234363	3915303	Whole carcass. No obvious injuries.
Array 2 Serengeti	10/30/2012	Mourning dove	11S	234231	3915068	Feather spot.
Array 2 Serengeti	10/30/2012	Mourning dove	11S	234526	3914949	Feather spot.
Array 2 Serengeti	11/13/2012	Western meadowlark	11S	234426	3915134	Feather spot.
Array 2 Serengeti	11/13/2012	Mourning dove	11S	234335	3915010	Feather spot.
Array 2 South	12/4/2012	Mourning dove	11S	233991	3914554	Feather spot (several flight feathers).
Array 2 South	12/4/2012	House finch	11S	234257	3914587	Decapitated carcass.
Array 2 South	12/4/2012	Mourning dove	11S	233680	3914437	Feather spot (≥20 body downy feathers and two flight feathers). Many MODO fecal droppings scattered in area. Suspected preening site.
Array 2 South	12/4/2012	Mourning dove	11S	233652	3914448	Feather spot (two feathers, possibly secondaries). Found at outer edge of tracker.
Array 2 South	12/4/2012	Unknown medium-sized bird	11S	233793	3914462	Feather spot (three feathers, including two primaries). Possible rock dove.
Array 2 South	12/11/2012	Western meadowlark	11S	233834	3914500	Feather spot (approximately ten secondaries).
Array 2 South	12/11/2012	Mourning dove	11S	233700	3914515	Feather spot (numerous downy feathers). Suspected preening site.
Array 2 South	12/18/2012	Mourning dove	11S	234132	3914957	Feather spot. In middle of row.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 South	1/8/2013	Mourning dove	11S	234116	3914561	Feather spot. Clump of feathers stuck to panel. Possible panel strike.
Array 2 South	1/8/2013	Mourning dove	11S	233790	3914470	Feather spot.
Array 2 South	1/8/2013	House finch	11S	234000	3914568	Feather spot. Carcass appears to have been plucked close to impact site. Impact smudge on the panel. Cause of death likely panel strike.
Array 2 South	1/8/2013	House finch	11S	234071	3914567	Feather spot.
Array 2 South	1/8/2013	Mourning dove	11S	233667	3914553	Feather spot (contour and flight feathers).
Array 2 South	1/8/2013	Mourning dove	11S	233888	3914516	Feather spot (approximately ten flight feathers).
Array 2 South	1/8/2013	Mourning dove	11S	233665	3914526	Feather spot (flight, body, and tail feathers). Spot widely scattered over two rows of panels.
Array 2 South	1/15/2013	Mourning dove	11S	234131	3914798	Feather spot (seven feathers: primaries, tail, and body feathers). Some primaries were a little muddy but it had not rained in the previous 24 hours.
Array 2 South	1/15/2013	House finch	11S	234345	3914896	Whole carcass. Odd growth above bill, possible avian pox. No apparent injury. Body still warm and limp, eyes not visible.
Array 2 South	1/15/2013	Mourning dove	11S	233664	3914388	Feather spot. Dried blood on ground. Many MODO roost here. Probably predated while roosting.
Array 2 South	1/22/2013	Mourning dove	11S	233669	3914469	Feather spot. Many (20–30) body feathers scattered throughout tracker, but remained clumped.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 South	1/22/2013	Mourning dove	11S	233642	3914421	Feather spot (four primaries and 20–30 body feathers).
Array 2 South	1/22/2013	House finch	11S	233654	3914575	Whole carcass. Ants on carcass. No broken vertebrae or broken wings found.
Array 2 South	1/22/2013	Mourning dove	11S	233849	3914553	Feather spot. Suspected roosting site.
Array 2 South	1/22/2013	Western meadowlark	11S	233683	3914427	Feather spot (>100 flight, body, and tail feathers). San Joaquin kit fox (SJKF) scat found on some feathers.
Array 2 South	1/22/2013	House finch	11S	234047	3914606	Partial carcass. Two wings, lower body, and feet found under cable tray and panel.
Array 2 South	1/22/2013	Mourning dove	11S	233654	3914575	Feather spot. Several distinct clumps of feathers.
Array 2 South	1/29/2013	Mourning dove	11S	234303	3914603	Feather spot (two flight feathers and spiral of breast feathers).
Array 2 South	1/29/2013	Mourning dove	11S	234022	3914568	Feather spot.
Array 2 South	2/5/2013	Western meadowlark	11S	233658	3914665	Feather spot. Single body feather and smudge marks on the lower left edge of panel. Large feather spot (body and flight feathers) scattered across tracker row. Some clumps of feathers with dried blood. Cause of death likely a panel strike.
Array 2 South	2/5/2013	House finch	11S	234200	3914856	Partial carcass and large feather spot (rump, two legs, and flight and body feathers). Found between trackers along road. Top portion of bill with orange tuft of feathers present. Breast feathers tinged with orange/red.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 South	2/12/2013	Mourning dove	11S	233891	3914457	Feather spot (15–20 downy and secondary feathers). No evidence of panel strike.
Array 2 South	2/19/2013	House finch	11S	234105	3914580	Feather spot (five or more primaries, a few secondaries, and ≥30 body feathers). At edge of tracker.
Array 2 South	3/5/2013	Horned lark	11S	234030	3914669	Whole carcass. Bill appears broken. Possible panel strike.
Array 2 South	3/5/2013	House finch	11S	234418	3914852	Feather spot (≥50 body feathers and ten flight feathers—mostly secondaries).
Array 2 South	3/19/2013	Mourning dove	11S	233662	3914435	Feather spot. Two primary feathers found under panel in area of abundant preening activity (fecal matter). Suspected preening site.
Array 2 South	4/2/2013	House finch	11S	234253	3914760	Feather spot (clump of >36 breast feathers, six primaries, and beak). Might have been plucked by avian predator.
Array 2 South	4/2/2013	Mourning dove	11S	233674	3914433	Feather spot (one secondary and 12 contour feathers). Suspected preening site.
Array 2 South	4/23/2013	Horned lark	11S	234030	3914728	Feather spot (~20 body feathers). Possible that more feathers blew away with high wind.
Array 2 South	4/23/2013	Mourning dove	11S	234214	3914706	Feather spot (20 contour feathers).
Array 2 South	4/30/2013	Horned lark	11S	233841	3914512	Feather spot (clump of ten body feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 South	4/30/2013	Brewer's blackbird	11S	234250	3914496	Feather spot (tip of left wing with flight feathers, coverts and alula, clump of tail feathers, body feathers with some skin, and one leg). More feathers two rows over (body feathers, flight feathers, and leg).
Array 2 South	4/30/2013	Mourning dove	11S	234465	3914864	Feather spot (≥15 body feathers in a few clumps with skin and dried intestine).
Array 2 South	4/30/2013	Common raven	11S	234104	3914491	Feather spot (~15 contour feathers).
Array 2 South	5/14/2013	House finch	11S	234310	3914591	Feather spot (one wing with flight feathers and coverts attached).
Array 2 South	5/14/2013	Unknown	11S	233830	3914497	Intestines of an unknown small animal.
Array 2 South	5/21/2013	Mourning dove	11S	234210	3914543	Feather spot (~20 feathers; three clumps with skin).
Array 2 South	5/21/2013	Horned lark	11S	234031	3914746	Feather spot (approximately six primaries and 35 body feathers).
Array 2 South	7/23/2013	Mourning dove	11S	234421	3914889	Feather spot (25 flight feathers).
Array 2 South	7/23/2013	Horned lark	11S	234439	3914890	Feather spot (five flight feathers).
Array 2 South	7/23/2013	Horned lark	11S	234196	3914623	Feather spot (two tail feathers and 15 body feathers).
Array 2 South	7/30/2013	Horned lark	11S	233649	3914409	Feather spot (~15 contour feathers).
Array 2 South	7/30/2013	Horned lark	11S	234366	3914575	Feather spot (three primaries, three tail feathers, two secondaries, two coverts, and ~35 contour feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 2 South	8/6/2013	House finch	11S	233972	3914601	Feather spot (~20 feathers, mostly primaries, and a few body feathers).
Array 2 South	8/13/2013	Horned lark	11S	234360	3914545	Feather spot (five flight feathers and ≥15 body feathers).
Array 4	1/9/2013	Mourning dove	11S	235596	3913032	Feather spot. Feathers in bunches, stuck together in clumps. Contour and wing feathers present, but no primaries or tail feathers.
Array 4	1/9/2013	Mourning dove	11S	235598	3913140	Feather spot. Contour and tail feathers only—no flight feathers present.
Array 4	1/16/2013	Mourning dove	11S	235591	3913465	Feather spot (≥100 body feathers). Feathers mainly in one central area, but some up to 4 m away.
Array 4	1/16/2013	House finch	11S	235672	3913330	Feather spot (14 flight feathers and numerous body feathers) and mandible.
Array 4	1/16/2013	Mourning dove	11S	235679	3913408	Feather spot. Feathers scattered. A second group of feathers, likely from the same bird but collected in a separate bag, found approximately 6 m north-northwest of this main feather group; both feather concentrations were fairly dispersed.
Array 4	1/16/2013	Mourning dove	11S	235610	3913174	Feather spot.
Array 4	1/16/2013	Mourning dove	11S	235588	3913193	Feather spot.
Array 4	1/16/2013	Mourning dove	11S	235616	3912749	Feather spot. Several hundred of feathers found.
Array 4	1/23/2013	Mourning dove	11S	235590	3913417	Feather spot. Only a few feathers, but one tail feather that was still mostly in the sheath; not a feather that would come from a live bird.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 4	1/23/2013	Mourning dove	11S	235624	3913517	Feather spot (>30 feathers).
Array 4	1/23/2013	Mourning dove	11S	235563	3913442	Older feather spot.
Array 4	1/23/2013	European starling	11S	235603	3912848	Feather spot (>50 body feathers).
Array 4	1/23/2013	Western meadowlark	11S	235761	3912701	Feather spot.
Array 4	2/13/2013	Western meadowlark	11S	235631	3912693	Feather spot at edge of row.
Array 4	2/13/2013	Mourning dove	11S	235767	3913293	Feather spot.
Array 4	2/13/2013	House finch	11S	235824	3913384	Feather spot (~15 body feathers).
Array 4	2/13/2013	Unknown small bird	11S	235737	3913347	Whole carcass. Fatality searcher informed of small dead bird on solar panel during weekly search. Bird was gone when searcher went to retrieve it 35 minutes later. Presumed to be removed by scavenger, potentially a CORA, which was seen in the area. Cause of death potential panel strike.
Array 4	4/24/2013	Horned lark	11S	235713	3913038	Feather spot (clump of ≥30 body feathers held together with dried skin).
Array 4	5/8/2013	House finch	11S	235724	3913524	Partial carcass (seven wing feathers still attached and one secondary).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 4	5/15/2013	Mourning dove	11S	235709	3913391	Feather spot (approximately ten primaries, six secondaries, and ≥30 wing and body feathers). Likely predated or scavenged by a mammal. Several feathers sheared off part way, as if bitten. Three clumps of feathers.
Array 4	6/12/2013	European starling	11S	235718	3912700	Feather spot (15 flight feathers).
Array 4	6/12/2013	House finch	11S	235767	3912695	Feather spot (23 flight feathers and ~50 contour feathers).
Array 4	6/19/2013	Yellow-rumped warbler	11S	235680	3912694	Feather spot (≥100 rump, contour, and wing covert feathers).
Array 4 control plot	4/17/2013	House finch	11S	236442	3912744	Feather spot (18 primaries, six other remiges, and ≥60 contour feathers).
Array 4 fence	2/13/2013	Mourning dove	11S	236303	3913354	Feather spot. Found outside of fence.
Array 5	1/16/2013	House finch	11S	236687	3913839[1]	Feather spot.
Array 5	2/6/2013	House finch	11S	236724	3913628	Feather spot.
Array 5	2/6/2013	Red-tailed hawk	11S	236683	3913857	Bones found (right leg and pelvis).
Array 5	3/27/2013	House finch	11S	236776	3913649	Feather spot (six primaries, two secondaries, and 20 breast feathers). Feathers sparsely spread across 3 m.

---

[1] Northing coordinate has been amended since the 2nd quarterly report was submitted, because this coordinate had been mislabeled.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 5	6/5/2013	House finch	11S	236779	3913577	Feather spot (three distinct clumps of feathers; ~40 breast and body feathers).
Array 8 Circuit 2	1/14/2013	Mourning dove	11S	233804	3912068	Feather spot.
Array 8 Circuit 2	1/21/2013	Mourning dove	11S	233641	3912191	Feather spot (four primaries and several body feathers).
Array 8 Circuit 2	1/21/2013	Mourning dove	11S	233630	3912302	Feather spot (several secondaries, coverts, and body feathers).
Array 8 Circuit 2	1/28/2013	Mourning dove	11S	234106	3911788	Feather spot (five primaries and >30 downy feathers).
Array 8 Circuit 2	1/28/2013	Mourning dove	11S	233543	3912244	Whole carcass. Found at preening site.
Array 8 Circuit 2	2/11/2013	Mourning dove	11S	233385	3912476	Feather spot (>20 body feathers, several flight feathers, and one clump of body feathers).
Array 8 Circuit 2	3/4/2013	House finch	11S	233416	3912277	Feather spot of partially intact whole wing, with five or more primary and secondary feathers each, and five or more body feathers.
Array 8 Circuit 2	4/15/2013	Western meadowlark	11S	233648	3912076	Partial carcass (wings and body, but no head). Could be red-tailed hawk (RTHA) kill. Two western kingbirds (WEKI) and one RTHA were observed earlier in day. RTHA was directly beside fence.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 8 Circuit 2	4/15/2013	Horned lark	11S	234052	3911694	Feather spot (one full wing, one partial wing, three breast feather clumps, and ≥50 loose body feathers). Feathers appear weathered.
Array 8 Circuit 2	7/17/2013	Great horned owl	11S	233957	3912424	Feather spot (two wings and >100 body feathers). Incidental fatality.[2]
Array 8 Circuit 2	7/22/2013	Horned lark	11S	234043	3911719	Feather spot (one primary and ~15 contour feathers).
Array 8 Circuit 2	8/5/2013	Horned lark	11S	233966	3911745	Feather spot (25–50 body feathers and several primaries). Found in charred substrate under panels and scattered throughout the tracker.
Array 8 Circuit 2	8/12/2013	Horned lark	11S	233976	3911740	Feather spot (~30 contour and flight feathers).
Array 8 control plot	3/4/2013	Mourning dove	11S	234418	3913321	Feather spot (two primaries together).
Array 1–2 fence	10/16/2012	Horned lark	11S	234527	3915080	Feathers and flesh hanging from fence, approximately 0.5 m off ground. One flight feather and flesh on ground right along fence.
Array 1–2 fence	10/30/2012	Mourning dove	11S	233399	3915720	Feather spot.
Array 1–2 fence	11/13/2012	Western meadowlark	11S	234418	3915494	Feather spot with beak and skull fragments.
Array 1–2 fence	12/4/2012	Mourning dove	11S	233852	3914441	Feather spot (≥20 body feathers).

---

[2] In the 4th quarterly report, this incidental fatality was reported as a long-eared owl on Figure 4, but was not included in the Appendix A summary of the weekly fatality search results. This species was later identified as a great horned owl.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Array 1–2 fence	12/11/2012	Mourning dove	11S	233793	3914373	Feather spot.
Array 1–2 fence	1/15/2013	Western meadowlark	11S	234383	3914539	Feather spot.
Array 1–2 fence	1/22/2013	Mourning dove	11S	233620	3914498	Feather spot. Two feather spots separated by 23 m, but feathers appear to be from same individual. Largely contour and down feathers, with a single primary found. Feathers spread on either side of the fenceline.
Gen-tie Line	8/29/2012	Burrowing owl	11S	234398	3916178	Feather spot at base of Tower 11. Feathers possibly from burrowing owl fatality previously found on 7/18/2012.
Gen-tie Line	8/29/2012	Horned lark	11S	234255	3916437	Feather spot scattered to the west of the tower 12.
Gen-tie Line	9/5/2012	Horned lark	11S	234266	3916692	Feather spot at base of Tower 13, directly below powerline.
Gen-tie Line	9/26/2012	Horned lark	11S	234527	3914444	Feather spot between Towers 3 and 4, directly below powerline.
Gen-tie Line	9/26/2012	Red-tailed hawk	11S	234302	3914086	Feathers with flesh attached, found between Towers 2 and 3, directly below powerline.
Gen-tie Line	10/3/2012	Horned lark	11S	234357	3917785	Feather spot at a feeding perch with droppings at the edge of the tamarisk wetland.
Gen-tie Line	10/3/2012	Long-eared owl	11S	234376	3917802	Feather spot in tamarisk wetland.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-tie Line	10/10/2012	Medium-sized bird	11S	234303	3917740	Feather spot of unknown medium-sized species found between tamarisk wetland and Tower 17, directly below powerline.
Gen-tie Line	10/10/2012	Horned lark	11S	234274	3917044	Whole specimen between Towers 14 and 15. Directly below powerline, but no sign of injury. Cause of death possible line collision.
Gen-tie Line	10/17/2012	Horned lark	11S	234271	3916931	Feather spot near Tower 14. Directly below powerline.
Gen-tie Line	10/17/2012	Lincoln's sparrow	11S	234439	3916064	Whole carcass between Towers 10 and 11, directly below powerline. Cause of death possible line collision.
Gen-tie Line	10/17/2012	Common raven	11S	234573	3914500	Feathers with flesh near Tower 4.
Gen-tie Line	10/17/2012	Savannah sparrow	11S	234573	3914618	Whole carcass between Towers 4 and 5, directly below powerline. Unidentified injury, but blood present on carcass. Cause of death possible line collision.
Gen-tie Line	10/17/2012	Mourning dove	11S	234358	3917786	Feather spot in tamarisk wetland. Found under perch where other feathers were found before.
Gen-tie Line	10/24/2012	Horned lark	11S	234203	3913888	Whole carcass between Towers 1 and 2, directly below powerline. Right wing broken. Cause of death possible line collision.
Gen-tie Line	10/24/2012	Savannah sparrow	11S	234391	3914203	Whole carcass between Towers 2 and 3, directly below powerline. No obvious injuries. Cause of death possible line collision.
Gen-tie Line	10/31/2012	American coot	11S	234470	3916002	Whole carcass between Towers 10 and 11, directly under powerline. Decapitated, but head found near body. Cause of death possible line collision.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-tie Line	10/31/2012	Fox sparrow	11S	234592	3914983	Feather spot between Towers 5 and 6, directly under powerline.
Gen-tie Line	10/31/2012	Mourning dove	11S	234408	3917851	Feather spot in tamarisk wetland. Suspected roosting/preening site.
Gen-tie Line	10/31/2012	Northern flicker	11S	234304	3917708	Feather spot between tamarisk wetland and Tower 17, directly below powerline.
Gen-tie Line	11/14/2012	Western meadowlark	11S	234580	3914699	Whole carcass between Towers 4 and 5, directly below powerline. Head dislocated at the neck. Some neck feathers plucked. No other obvious injuries. Cause of death possible line collision.
Gen-tie Line	11/28/2012	Horned lark	11S	234255	3916696	Feather spot (≥20 downy feathers).
Gen-tie Line	12/11/2012	Common raven	11S	234610	3915356	Whole carcass. Electrical burns on feet. Found ~5 m from base of Tower 7. Cause of death electrocution.
Gen-tie Line	12/11/2012	Common raven	11S	234640	3915393	Whole carcass. Head scavenged. Scales peeled back on legs. Found ~15 m east of Tower 7. Cause of death electrocution.
Gen-tie Line	12/12/2012	Mourning dove	11S	234382	3917819	Feather spot (≥200 feathers—downy, body, and flight feathers).
Gen-tie Line	12/19/2012	Mourning dove	11S	234255	3916534	Feather spot (flight, tail, and body feathers).
Gen-tie Line	12/19/2012	Western meadowlark	11S	234426	3916094	Whole carcass. Neck intact. Wings not broken but bones exposed on upper left wing. No sign of external injuries. Fresh. Cause of death likely line collision.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-tie Line	1/9/2013	Horned lark	11S	234374	3917774	Feather spot (body feathers and several secondaries and primaries).
Gen-tie Line	1/9/2013	Western meadowlark	11S	234256	3916730	Old feather spot along fence line east of main road.
Gen-tie Line	1/9/2013	Mourning dove	11S	234270	3916541	Feather spot (several tail and body feathers, and some secondaries and primaries).
Gen-tie Line	1/16/2013	Horned lark	11S	234355	3917785	Feather spot (breast feathers).
Gen-tie Line	1/16/2013	House finch	11S	234603	3915112	Feather spot (two primaries).
Gen-tie Line	1/23/2013	Common raven	11S	234291	3917304	Feather spot (primaries, secondaries, and a few contour feathers). Found about 4.6 m from the Gen-tie Line. Feathers appear sheared off (feather shaft cut at an angle). Feathers are weathered.
Gen-tie Line	1/23/2013	Mourning dove	11S	234357	3916221	Feather spot (tail, body, and primary feathers). Fresh MODO scat at feather spot. Found <3 m from Gen-tie Line.
Gen-tie Line	1/23/2013	Horned lark	11S	234381	3917831	Feather spot (body, tail, primary, and secondary feathers). Found in wetland area directly under Gen-tie Line.
Gen-tie Line	1/23/2013	Horned lark	11S	234390	3917811	Feather spot (body, tail, primary, and secondary feathers). Relatively fresh. Found in wetland area.
Gen-tie Line	1/23/2013	Loggerhead shrike	11S	234390	3917750	Feather spot (mostly primaries with some body feathers). Very old kill. Discovered buried under litter in wetland area while searcher was cleaning up a fresh feather spot from a HOLA.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-tie Line	1/23/2013	Loggerhead shrike	11S	234390	3917813	Feather spot (two fresh primaries). Found in wetland area.
Gen-tie Line	1/23/2013	Horned lark	11S	234394	3917816	Mixed feather spot of fresh and old feathers, potentially indicating other HOLA kills at same location. Blood found on branch near spot. Found near three previously documented fatalities.
Gen-tie Line	1/23/2013	Horned lark	11S	234358	3917772	Feather spot (body, tail, and flight feathers). Found just outside wetland area, under shrub.
Gen-tie Line	1/30/2013	Horned lark	11S	234384	3917825	Feather spot (>20 flight feathers and >40 body feathers). Found in tamarisk wetland.
Gen-tie Line	1/30/2013	Horned lark	11S	234482	3917744	Feather spot. Found in tamarisk wetland.
Gen-tie Line	1/30/2013	House finch	11S	234575	3914595	Feather spot (>20 flight feathers and >50 body feathers).
Gen-tie Line	1/30/2013	Horned lark	11S	234569	3914573	Feather spot (>20 body feathers).
Gen-tie Line	1/30/2013	House finch	11S	234568	3914514	Feather spot.
Gen-tie Line	1/30/2013	Horned lark	11S	234482	3917744	Feather spot.
Gen-tie Line	1/30/2013	House finch	11S	234394	3917875	Feather spot.
Gen-tie Line	1/30/2013	House finch	11S	234572	3914523	Feather spot (many tail and wing feathers, some body feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-tie Line	1/30/2013	House finch	11S	234556	3914504	Feather spot (>10 flight feathers and >20 body feathers).
Gen-tie Line	2/6/2013	Mourning dove	11S	234318	3914093	Feather spot. West of old farm house. Very likely a heavily used preening site.
Gen-tie Line	2/13/2013	Mourning dove	11S	234255	3916582	Feather spot (several hundred feathers—flight and body feathers). Possibly scavenged by SJKF—SJKF scat found at spot. Feathers found in two piles about 5 m apart. A "trail" of feathers connected the two piles. Scat from two animals (SJKF and pig or coyote) present.
Gen-tie Line	2/13/2013	Western meadowlark	11S	234413	3918059	Feathers spot. Feathers scattered across 10 m.
Gen-tie Line	2/20/2013	Savannah sparrow	11S	234285	3916896	Whole carcass. No visible signs of injury, but found directly under powerline. Cause of death possible line collision.
Gen-tie Line	3/20/2013	Horned lark	11S	234279	3917067	Feather spot (≥15 primaries and secondaries and ≥30 body feathers). Found directly under the powerline. SJKF scat present near spot.
Gen-tie Line	3/25/2013	Common yellowthroat	11S	234598	3915248	Whole carcass. Fresh blood on carcass. Tail broken. No other major injuries observed. Cause of death possible line collision.
Gen-tie Line	3/27/2013	Mourning dove	11S	234333	3917755	Feather spot (five or more secondaries and ten or more body feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-tie Line	4/3/2013	Mourning dove	11S	234270	3916745	Feather spot (four coverts and ten or more contour feathers). Spread across 5-m diameter.
Gen-tie Line	4/17/2013	Horned lark	11S	234291	3917588	Feather spot (20 flight feathers and 50 body feathers). Found directly under the powerline.
Gen-tie Line	4/17/2013	Horned lark	11S	234599	3915172	Feather spot (~20 primaries). Found directly under the powerline.
Gen-tie Line	4/23/2013	Nashville warbler	11S	234143	3913787	Whole carcass. Tip of beak broken, indicating likely collision. Cause of death possible line collision.
Gen-tie Line	4/24/2013	Warbler sp.	11S	234279	3917306	Feather spot (20 flight feathers, ≥30 body/breast feathers—all downy). Found at fenceline parallel to road.
Gen-tie Line	5/1/2013	Horned lark	11S	234437	3914300	Feather spot (partial wing, ≥20 flight feathers, and ≥50 body feathers—mostly downy). Found directly under the powerline.
Gen-tie Line	5/8/2013	Warbling vireo	11S	234450	3914310	Whole carcass, very fresh. Possible broken neck. Found directly under powerline. Cause of death possible line collision.
Gen-tie Line	5/22/2013	MacGillivray's warbler	11S	234515	3918720	Feather spot (11 primaries and part of wing).
Gen-tie Line	5/22/2013	Mourning dove	11S	234513	3918735	Feather spot (~100 body feathers and one primary).
Gen-tie Line	5/22/2013	Warbler sp.	11S	234277	3917091	Feather spot (~30 contour feathers).
Gen-tie Line	5/22/2013	Yellow warbler	11S	234631	3915389	Feather spot (eight flight feathers and ~50 contour feathers).
Gen-tie Line	5/22/2013	Swainson's thrush	11S	234258	3916622	Feather spot (~25 flight and 50 contour feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-Tie Line	5/29/2013	Horned lark	11S	234275	3917246	Feather spot (~100 body and 12 flight feathers). Found directly under the powerline.
Gen-tie Line	5/29/2013	Yellow-rumped warbler	11S	234265	3917142	Feather spot (~100 body and 15 flight feathers).
Gen-tie Line	5/29/2013	Horned lark	11S	234265	3917142	Feather spot (12 body and six flight feathers). Pig scat present.
Gen-tie Line	5/29/2013	Warbler sp.	11S	234296	3917715	Feather spot (12 flight and 30 body feathers). Found directly under the powerline.
Gen-tie Line	5/29/2013	Horned lark	11S	234713	3915513	Feather spot (15 flight feathers, some attached by tissue, and ~100 body feathers).
Gen-tie Line	5/29/2013	Western meadowlark	11S	234618	3918793	Feather spot (15 primaries and secondaries and 15 body feathers). One clump of wing feathers attached by flesh.
Gen-tie Line	5/29/2013	Warbler sp.	11S	234717	3915511	Feather spot (25 flight and 50 body feathers, some held together by tissue).
Gen-tie Line	5/29/2013	Common raven	11S	234570	3914533	Feather spot (three flight and ten body feathers).
Gen-tie Line	5/29/2013	Horned lark	11S	234582	3914885	Feather spot (~50 body feathers).
Gen-tie Line	5/29/2013	Mourning dove	11S	234497	3918687	Feather spot (eight flight and ten body feathers).
Gen-tie Line	5/29/2013	Yellow warbler	11S	234423	3918671	Whole carcass. Found directly under the powerline.
Gen-tie Line	6/5/2013	Unknown small bird	11S	234586	3914810	Feather spot. A small number of body feathers connected by tissue at base of Tower 5.
Gen-tie Line	6/5/2013	Horned lark	11S	234257	3916588	Feather spot (four flight feathers, one tail feather, and 15 body feathers).
Gen-tie Line	6/5/2013	Yellow-rumped warbler	11S	234589	3914953	Feather spot (16 flight feathers and ~100 body feathers). Found directly under the powerline.
Gen-tie Line	6/5/2013	Warbler sp.	11S	234295	3917690	Feather spot (13 flight feathers and 30 contour feathers).

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
Gen-tie Line	6/5/2013	Warbler sp.	11S	234261	3916718	Feather spot (small clump of approximately ten body feathers stuck together with skin).
Gen-tie Line	6/5/2013	Unknown small bird	11S	234258	3916725	Feather spot (two tail feathers and one body feather). Found 5 m west of powerline.
Gen-tie Line	6/7/2013	Warbler sp.	11S	234615	3915267	Whole carcass. Found directly under the powerline.
Gen-tie Line	6/19/2013	Horned lark	11S	234643	3915468	Feather spot (~20 body feathers). Found ~90 m from the powerline. May not be associated with line.
Gen-tie Line	7/3/2013	Common yellowthroat	11S	234271	3917162	Feather spot (20 primaries and secondaries and ~70 body feathers). Nearly directly underneath the powerline.
Gen-tie Line	7/3/2013	Mourning dove	11S	234617	3918811	Feather spot (~20 primaries and secondaries, four tail feathers, and ~100 body feathers). Found scattered on hill southwest of Tower 22.
Gen-tie Line	7/31/2013	Mourning dove	11S	234279	3917054	Feather spot (numerous feathers from entire body).
Medium-voltage Overhead (MVOH) Line	1/30/2013	House finch	11S	234625	3913324	Decapitated carcass. Found outside fenced GKR site. Cause of death possible predation by LOSH.
MVOH Line	2/27/2013	Mourning dove	11S	236848	3913043	Feather spot (seven tail, a few primary, a few secondary, and ≥15 body feathers). Found ~250 m west of Array 6 edge, between second and third pole from start of MVOH Line west of Array 6. Multiple feathers found within a 2-m radius.
MVOH Line	3/13/2013	Barn owl	11S	238143	3912198	Feather spot (~12 wing feathers and two or three breast/body feathers). Mixed in and under Russian thistle piled against barbed wire.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
MVOH Line	4/1/2013	Common raven	11S	233898	3912970	Whole carcass. More than likely electrocuted on 3/28/2013, when a breaker blew out at the Substation. Electrocuted on/above coupler on the MVOH Line. May have arced across the lines.
MVOH Line	4/11/2013	Common raven	11S	233909	3912966	Whole carcass. Electrocuted at 8:30 AM at second tower to west, directly north of Array 8. Exit burn through neck, burn on belly. Singed feathers along left wing.
MVOH Line	4/17/2013	Horned lark	11S	234603	3913329	Feather spot (approximately nine primaries). Found under CORA nest on MVOH Line—nest is on powerline straight-away near Substation to the east.
MVOH Line	4/17/2013	Common raven	11S	234615	3913319	Feather spot (more than ten feathers). Difficult to collect because of wind. Located under CORA nest. Adults were lining the nest with white material. Found 100 m from the Operations and Maintenance facility.
MVOH Line	4/24/2013	House finch	11S	237860	3912838	Feather spot (ten contour and 15 flight feathers). Located directly under the powerline, ~20 m southwest of power pole.
MVOH Line	5/22/2013	European starling	11S	235550	3912671	Feather spot (part of right wing with primary and covert feathers).
MVOH Line	6/5/2013	Common raven	11S	234268	3913479	Feather spot (two flight feathers and one body feather). Found on road adjacent to tracker. Raven footprints present in the dust on the ground.
MVOH Line	6/5/2013	Common raven	11S	238155	3912221	Whole carcass. Dead juvenile seen hanging from nest, with pin and body feathers on ground.
MVOH Line	6/12/2013	European starling	11S	236683	3913043	Feather spot (approximately ten primaries and ten body feathers).
MVOH Line	6/19/2013	House sparrow	11S	233773	3915437	Feather spot (five flight and 15 contour feathers). Found directly under the powerline.

Area	Date	Species	UTM	Easting	Northing	Observation Details[1]
MVOH Line	7/10/2013	Western meadowlark	11S	235656	3912671	Feather spot (~100 breast, tail, and flight feathers).
MVOH Line	7/10/2013	House finch	11S	236680	3913043	Feather spot (six flight and tail feathers and ~30 body feathers).
MVOH Line	7/10/2013	Short-eared owl	11S	233895	3912971	Partial carcass (lower foot and small part of tibia).
MVOH Line	7/31/2013	Horned lark	11S	233839	3911689	Feather spot (~30 contour feathers). Found directly under the powerline.

Appendix D. Foraging Zone and Taxonomic Group of Species Observed Within Project Elements During Weekly Fatality Searches: 16 August 2012 to 15 August 2013

Species		**Foraging Zone**	**Taxonomic Group**	**Number Recorded**
Arrays				***238***
California Quail	*Callipepla californica*	terrestrial	avian resident	2
Red-tailed hawk	*Buteo jamaicensis*	terrestrial	raptor	1
Mourning Dove	*Zenaida macroura*	terrestrial	avian resident	88
Great Horned Owl	*Bubo virginianus*	terrestrial	raptor	2
Burrowing Owl	*Athene cunicularia*	terrestrial	raptor	2
Short-eared Owl	*Asio flammeus*	terrestrial	raptor	2
American Kestrel	*Falco sparverius*	terrestrial	raptor	2
Common Raven	*Corvus corax*	terrestrial	avian resident	11
Horned Lark	*Eremophila alpestris*	terrestrial	avian resident	61
European Starling	*Sturnus vulgaris*	terrestrial	avian resident	2
American Pipit	*Anthus rubescens*	terrestrial	avian winter resident	1
Savannah Sparrow	*Passerculus sandwichensis*	terrestrial	avian winter resident	1
Brewer's Blackbird	*Brewer's Blackbird*	terrestrial	avian resident	1
Western Meadowlark	*Sturnella neglecta*	terrestrial	avian resident	17
House Finch	*Haemorhous mexicanus*	terrestrial	avian resident	39
Unknown Small Passerine		terrestrial	avian migrant	3
Unknown Medium-sized Bird		terrestrial	avian resident	2
Unknown (intestines only)		unknown	unknown	1
Gen-tie Line				***90***
Red-tailed hawk	*Buteo jamaicensis*	terrestrial	raptor	1
American Coot	*Fulica americana*	water	avian migrant	1
Mourning Dove	*Zenaida macroura*	terrestrial	avian resident	14
Burrowing Owl	*Athene cunicularia*	terrestrial	raptor	1
Long-eared Owl	*Asio otus*	terrestrial	raptor	1
Northern Flicker	*Colaptes auratus*	terrestrial	avian resident	1
Loggerhead Shrike	*Lanius ludovicianus*	terrestrial	avian resident	2
Warbling Vireo	*Vireo gilvus*	terrestrial	avian migrant	1
Common Raven	*Corvus corax*	terrestrial	avian resident	5
Horned Lark	*Eremophila alpestris*	terrestrial	avian resident	28
Swainson's Thrush	*Catharus ustulatus*	terrestrial	avian migrant	1
Nashville Warbler	*Oreothlypis ruficapilla*	terrestrial	avian migrant	1
MacGillivray's Warbler	*Geothlypis tolmiei*	terrestrial	avian migrant	1
Common Yellowthroat	*Geothlypis trichas*	terrestrial	avian migrant	2
Yellow Warbler	*Setophaga petechia*	terrestrial	avian migrant	2
Yellow-rumped Warbler	*Setophaga coronata*	terrestrial	avian migrant	2
Unknown Warbler		terrestrial	avian migrant	7
Savannah Sparrow	*Passerculus sandwichensis*	terrestrial	avian winter resident	3
Fox Sparrow	*Passerella iliaca*	terrestrial	avian migrant	1
Lincoln's Sparrow	*Melospiza lincolnii*	terrestrial	avian winter resident	1
Western Meadowlark	*Sturnella neglecta*	terrestrial	avian resident	5
House Finch	*Haemorhous mexicanus*	terrestrial	avian resident	6

Species		**Foraging Zone**	**Taxonomic Group**	**Number Recorded**
Unknown Small Passerine		terrestrial	avian migrant	2
Unknown Medium-sized Bird		terrestrial	avian resident	1
Medium-voltage Overhead (MVOH) Line				***17***
Mourning Dove	*Zenaida macroura*	terrestrial	avian resident	1
Barn Owl	*Tyto alba*	terrestrial	raptor	1
Short-eared Owl	*Asio flammeus*	terrestrial	raptor	1
Common Raven	*Corvus corax*	terrestrial	avian resident	5
Horned Lark	*Eremophila alpestris*	terrestrial	avian resident	2
European Starling	*Sturnus vulgaris*	terrestrial	avian resident	2
Western Meadowlark	*Sturnella neglecta*	terrestrial	avian resident	1
House Finch	*Haemorhous mexicanus*	terrestrial	avian resident	3
House Sparrow	*Passer domesticus*	terrestrial	avian resident	1
Fence Lines				***12***
Mourning Dove	*Zenaida macroura*	terrestrial	avian resident	7
Horned Lark	*Eremophila alpestris*	terrestrial	avian resident	2
Western Meadowlark	*Sturnella neglecta*	terrestrial	avian resident	2
Unknown Small Passerine		terrestrial	avian migrant	1
Project Related Fatalities				***357***
Control Plots				***11***
Mourning Dove	*Zenaida macroura*	terrestrial	avian resident	1
Common Raven	*Corvus corax*	terrestrial	avian resident	2
Horned Lark	*Eremophila alpestris*	terrestrial	avian resident	4
Tree Swallow	*Tachycineta bicolor*	air	avian migrant	1
Unknown Blackbird		terrestrial	avian resident	1
House Finch	*Haemorhous mexicanus*	terrestrial	avian resident	2

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

California Valley Solar Ranch Project

Avian Fatality during Construction
First Annual Report
September 2011 – September 2012

Prepared By:

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
983 University Avenue, Building D
Los Gatos, CA 95032

Prepared for:

HPR II, LLC
5790 Fleet St., Suite 200
Carlsbad, CA 92008
Attention: Ray Kelly

18 March 2013

Table of Contents

Figures

Tables

Contributors

Brian B. Boroski, Ph.D., Vice President/Principal, Wildlife Ecologist
Julie L. Klingmann, M.S., Associate, Wildlife Ecologist
Amy Sparks, J.D., Associate, Regulatory Specialist

Section 1. Introduction

Through adoption of Resolution #2011-119, the Board of Supervisors of the County of San Luis Obispo (County) approved the California Valley Solar Ranch Project (CVSR Project) Conditional Use Permit (DRC2008-00097) on 19 April 2011. The Conditional Use Permit is subject to the Conditions of Approval set forth in Exhibit 6 attached to the Resolution.

The Conditional Use Permit allows the Applicant (High Plains Ranch II, LLC, and any successor in interest for the life of the CVSR Project) to construct and operate a 250-megawatt (MW) photovoltaic solar power plant on an approximately 4685 acre (ac) site, located mostly south of State Route (SR) 58, about 4 miles east of Soda Lake Road, immediately north of the California Valley subdivision, in the Shandon-Carrizo planning area in San Luis Obispo County (CVSR site).

Condition of Approval (COA) #58 of the CVSR Project Conditional Use Permit requires an Avian Fatality Monitoring Plan (Plan) for the CVSR Project and a quarterly report detailing any project-related bird deaths or injuries detected during the monitoring study or at any other time. To satisfy COA #58 of the CVSR Project Conditional Use Permit, the Applicant has prepared this *Avian Fatality during Construction First Annual Report,* which documents the number of avian mortalities detected during project construction from September 2011 through September 2012.

Avian fatality monitoring was conducted consistent with the Plan as construction was completed within arrays and they became operational. The Plan provides for systematic assessment of avian fatalities and, when sufficient data is available, can be analyzed to determine statistically significant effects. Because per the Plan, avian fatality monitoring is initiated in each array block as it becomes operational, there is a period of time during construction when the sampled area is not large enough to meet the requirements of the analysis of significant effects. Because these methodologies differ significantly and the analyses cannot be combined, in this report and in quarterly reports going forward, fatalities during construction and results of monitoring during operations will be reported separately. The results of studies detailed in the Plan for post-construction monitoring in operational portions of the Project site will be covered in additional, separate *Avian Fatality Monitoring Quarterly* and *Annual Reports* initially timed to coincide with seasonal patterns of avian occurrence on the site and the initial implementation of the monitoring protocols. In the *Avian Fatality Monitoring Annual Report*, adequate data will have been collected to conduct the scientifically rigorous analysis required by the Plan and an associated assessment of potential adaptive management measures. This report will include relevant base line information as requested by the County.

Section 2. Monitoring Methodology

COA #58 requires monitoring the death and injury of birds associated with facility features such as feeder/distribution lines, solar panels, fences, and evaporation ponds. This Report documents avian mortality detected during construction activities from September 2011 through September 2012.

Monitoring of avian mortalities occurred during standard pre-activity surveys and construction monitoring. In addition, nesting deterrence for burrowing owls and other birds was conducted from 1 February – 31 August 2012. During monitoring of burrowing owl, one-way doors and searches for nests in impact and buffer areas, evidence of avian mortality was noted. Avian mortality data is collected within daily construction monitoring data sheets and includes date, location, and details of each observation.

Section 3. Results

From September 2011 through September 2012, 30 avian fatalities were detected during construction on the Project site (Table 1, Figure 1). These included 3 birds found in the giant kangaroo rat (GKR; Dipodomys ingens) relocation enclosures during pre-construction activities in October 2011, which were identified as 2 savannah sparrows (*Passerculus sandwichensis*) and 1 European starling (*Sturnus vulgaris*).

Also included in the avian fatalities are 5 birds reported to have been found dead in vertical piles by the County Environmental Monitor (not included in Table 1 or Figure 1 due to lack of detailed information) and 4 birds found dead in vertical piles and identified by H. T. Harvey & Associates biologists in early February 2012. These birds were identified as 3 horned larks (*Eremophila alpestris*), 5 mountain bluebirds (*Sialia currucoides*), and one American pipit (*Anthus rubescens*). Mortality was a result of an open vertical shaft in which birds were trapped.

Of the 30 avian fatalities detected, 14 were due to entrapment, 3 to vehicle strikes, 5 to predation, and 8 due to unknown causes.

Of the 30 avian fatalities detected, there was one American pipit, one burrowing owl (*Athene cunicularia*), 4 common ravens (*Corvus corax*), one European starling, 5 horned larks, 3 house finches (*Carpodacus mexicanus*), one lark sparrow (*Chondestes grammacus*), 5 mountain bluebirds, 5 savannah sparrows, one Townsend's warbler (*Dendroica townsendi*), 2 white-crowned sparrows (*Zonotrichia leucophrys*), and one species that was unidentifiable because only a portion of a wing was found.

Table 1. Avian Fatalities Detected during Construction from September 2011 through September 2012[1].

Date	Species	No.	Location	Observation Details
~10/24/2011	Savannah sparrow	1	Conservation Area	A dead savannah sparrow was found in GKR relocation enclosure during pre-construction activities. Cause of death was entrapment. UTM 11S 0235027 3912839.
~10/24/2011	Savannah sparrow	1	Conservation Area	A dead savannah sparrow was found in GKR relocation enclosure during pre-construction activities. Cause of death was entrapment. UTM 11S 0233561 3914287.
~10/24/2011	European starling	1	Conservation Area	A dead European starling was found in GKR relocation enclosure R7 during pre-construction activities. Cause of death was entrapment. UTM 11S 0233604 3914277.

---

[1] Does not include fatalities previously reported as detected during "fatality searches", which are part of the operational monitoring Plan and will be included in the *Avian Fatality Monitoring Annual Report.*

Date	Species	No.	Location	Observation Details
12/21/2011	Horned lark	1	Array 2	A horned lark was found dead on the ground among piles. Cause of death unknown. UTM 11S 0234127 3914884.
01/14/2012	White-crowned sparrow	1	Temporary Construction Facility	A white-crowned sparrow found dead in the grill of a truck was probably killed during travel to the site. Cause of death likely vehicle strike.
01/19/2012	Burrowing owl	1	Array 1	Burrowing owl feathers (15 feathers) from a scavenged individual were found scattered underneath a solar panel pallet in the array. Cause of death was likely predation.
02/02/2012	Horned lark	1	Array 2	A horned lark was found dead inside a vertical pile in the southern portion of the array. Cause of death was entrapment.
02/03/2012	Horned lark	1	Array 2	A horned lark was found dead inside driven vertical piles in Array 2. Cause of death was entrapment.
02/03/2012	Mountain bluebird	2	Array 2	Two mountain bluebirds were found dead inside vertical piles. Cause of death was entrapment.
02/09/2012	House finch	1	Array 1	A female house finch was found dead adjacent to the water storage tent near the first aid trailer in Array 1. Cause of death unknown.
02/10/2012	Common raven	1	Operations & Maintenance	A dead, flattened common raven was found with one wing clipped and the bill flattened and broken in half. The bird was weathered in appearance with exposed bone primarily around breast. Cause of death unknown.
02/15/2012	Savannah sparrow	1	Array 1	A savannah sparrow was found dead between two rows of panels, in the SE corner of the array with no evidence of injury. Cause of death unknown.
02/22/2012	Savannah sparrow	1	Main entrance	A savannah sparrow was found dead near the car wash. Cause of death may have been vehicle strike.
03/08/2012	Lark sparrow	1	SR 58	A lark sparrow was found dead on the north shoulder of SR 58, south of Gen-Tie #8. Cause of death was likely vehicle strike.
03/08/2012	Common raven	1	Array 4	Common raven feathers were found in the array. The feathers appeared to be old. Cause of death unknown.
03/23/2012	White-crowned sparrow	1	Gen-tie #15	A white-crowned sparrow was found dead about 20 ft south-southeast of Gen-tie #15. The bird had a puncture wound on back of head/nape with feathers plucked immediately around the wound and no other visible signs of injury. Cause of death was predation. UTM: 11S 0234289 3916912.

Date	Species	No.	Location	Observation Details
03/29/2012	House finch	1	Array 2	A house finch was found dead in a box of solar panels. The box lid had been warped by rain so it likely flew in and became trapped. Cause of death was entrapment. UTM: 11S 0234459 3915235.
04/18/2012	Horned lark	1	Array 2	A male horned lark found was found dead between panel rows in north-central Array 2 with no external injuries. Cause of death unknown. UTM 11S 0234199, 3915174.
04/19/2012	Savannah sparrow	1	Gen-tie #3 to Gen-tie #4	Savannah sparrow was found dead on the access road between Gen-tie #3 and #4. Cause of death unknown.
05/10/2012	Unidentifiable	1	Gen-tie #1 to Gen-tie #2	A portion of a bird wing was found between Gen-tie #1 and #2. Cause of death unknown, but likely predated and scavenged. UTM: 11S 0234213 3913902.
05/11/2012	Townsend's warbler	1	Gen-tie #2 to Gen-tie #3	A Townsend's warbler was found dead by a laborer. Cause of death unknown.
06/12/2012	House finch	1	Temp Tap (North of SR 58)	A male house finch was found dead inside an AC panel inside the Temp Tap building. Cause of death was entrapment. UTM 11S 234836, 3919053.
07/19/2012	Common raven	1	Black Bear Road	Juvenile common raven feathers were found below a telephone line, about 30 ft from the base of the telephone pole, ~15 ft west of Black Bear Road, mid-way between the intersections with Brady Trail and Belmont Trail. Cause of death was likely predation. UTM: 11S 0236482 3911499.
08/8/2012	Common raven	1	Array 4	A common raven was observed as a golden eagle prey item. A large feather pile, both wings and a leg were subsequently found. Cause of death was predation. UTM: 11S 236003 3914204.

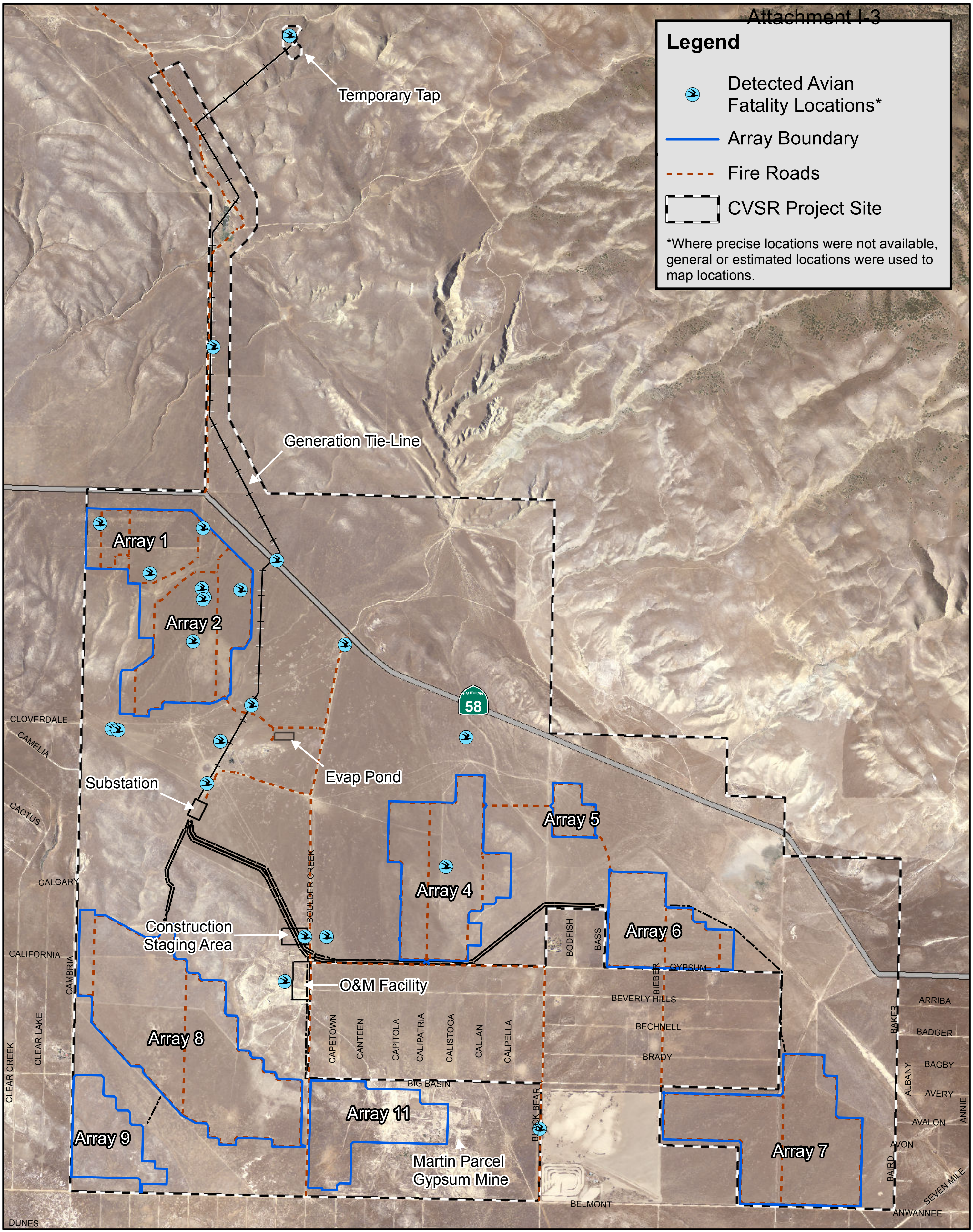
GKR = giant kangaroo rat.

3.1 Avian Mortality in Piles

One of the first activities of constructing a solar array is to drive piles into the ground to support the solar panels. These vertical piles remain open and in place until a fitting that holds the solar panel is welded on top. Because these vertical piles are similar to vertical pipe mining claim markers, inside which a recent popular article reported occurrences of avian mortality, the piles were inspected. The inspection of approximately 200 vertical piles by the County Environmental Monitor detected dead birds in 5 of the piles. The birds were identified as one horned lark, 3 mountain bluebirds, and one American pipit. Subsequently, during pre-activity surveys and monitoring of construction activities in early February 2012, H. T. Harvey & Associates biologists detected dead birds in piles in Array 2. The birds were identified as 2 horned larks and 2 mountain bluebirds. Mortality was a result of an open vertical shaft in which birds were trapped.

3.2 Avian Mortality in Giant Kangaroo Rat Enclosures

During the monitoring of giant kangaroo rat relocation enclosures, a pre-construction mitigation activity, H. T. Harvey and Associates biologists detected several avian entrapments resulting in 3 avian mortalities within the enclosures; the carcasses included two savannah sparrows and one European starling. During the week of 23 October 2011, a Loggerhead Shrike (*Lanius ludovicianus*) was found in one of the giant kangaroo rat relocation enclosures and was released unharmed. Four savannah sparrows (*Passerculus sandwichensis*) were found in a second enclosure. Three were released unharmed, but one was dead. A dead savannah sparrow was found in a third enclosure. The carcass of a European starling was found in the artificial burrow chamber in relocation enclosure R7.



HPR II

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

California Valley Solar Ranch
Avian Fatality During Construction - First Annual Report

Figure 1: Detected Avian Fatality Locations - September 2011 - September 2012

Section 4. Discussion/Conclusion

Of 30 detected avian fatalities during construction in the first year, 12 (40%) were the result of entrapment in vertical piles or giant kangaroo rat relocation enclosures; the cause of these mortalities was immediately resolved and no longer occurs (see below). Mortality of 2 house finches (6%) was also due to entrapment, one in construction materials and one in a structure under construction. Five fatalities (17%) were related to predation and are not likely construction-related. Three fatalities were related to vehicle strikes; these fatalities represent 10% of detected fatalities. However, one was on State Route 58 and could have resulted from any traveler on the highway and one was detected on the grill of a vehicle that had traveled to the site. The third fatality was on the access road near the entrance and could have been related to travel to or from the site or could have been related to a construction vehicle. For 8 fatalities (27%), the cause of the fatality is unknown.

4.1 Avian Mortality in Piles

To prevent avian mortality in vertical piles, the Applicant re-designed them as a solid C-channel pier, which does not present an open pipe. As a result, the redesigned C-channel piers, which were tested and implemented in August 2012, now permanently eliminate the possibility of bird entrainment from round vertical piles.

Prior to the C-channel redesign and following discovery that the round piles posed a risk of avian entrapment, to prevent continued mortality from entrapment within piles, the Applicant covered the exposed vertical piles with plastic caps until they were permanently closed or capped.

A letter describing the observed fatalities and additional preventative measures was provided to San Luis Obispo County, California Department of Fish and Wildlife (CDFW), and U.S. Fish and Wildlife Service on 10 February 2012. The caps were delivered on 10 February 2012, and all exposed vertical piles were capped on 11 February 2012.

Biological monitors on the Project continue to check any remaining round piles for the presence of the temporary plastic caps to further ensure that they remain in place until permanently capped. Caps may fall off the piles during wind and rain events. Those caps are replaced after the open piles are inspected for birds that may have become trapped.

4.2 Avian Mortality in Giant Kangaroo Rat Enclosures

Upon inspection of the giant kangaroo rat trapping and relocation enclosures, H. T .Harvey & Associates biologists found that birds likely entered the enclosures through small gaps between the nylon mesh that were stitched together with nylon ties. The top covers of the enclosures were originally constructed with heavy duty nylon mesh material (similar to standard construction environmental sensitive area fencing) with a mesh size of 0.5 to 1 inch; CDFW recommends a mesh size of 1.5 inches or less for avian enclosure material. Modifications to the relocation enclosures were implemented immediately after these observations. The modifications insured that future applications of avian exclosure material include no gaps larger than the mesh size to prevent the trapping of avian species. Additionally, the enclosure roofing material was altered to include a single-piece of shade cloth material, cut to fit the enclosure, resulting in fewer openings that can also be better secured. This material is expected to preclude smaller birds and avian predators from entering the enclosures and preclude giant kangaroo rats from jumping over the fence. A monitoring program has also been implemented to ensure that all enclosures are inspected daily for trapped birds.

During the monitoring of giant kangaroo rat relocation enclosures in subsequent months, H. T. Harvey and Associates biologists detected no trapped birds, indicating that modifications and repairs to the enclosure coverings have resolved the problem of birds entering the enclosure and becoming trapped.

4.3 Avian Mortality Due to Other Causes

Over the entire year, a total of 1670.77 ac was impacted by construction and only 12 fatalities were detected on the Project site during that period that could be attributed to construction activities. The causative factors have been addressed and no additional adaptive measures to minimize avian mortality are needed at this time.

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch Project Avian and Bat Protection Plan Final Postconstruction Fatality Report

Prepared for:

HPR II, LLC
California Valley Solar Ranch
13505 Carissa Highway, Highway 58
Santa Margarita, CA 93453

Prepared by:

H. T. Harvey & Associates
Project # 3326-03

Prepared per:

Avian and Bat Protection Plan for the California Valley Solar Ranch Project

U.S. Fish and Wildlife Service
Biological Opinion (81420-2011-F-0511)
San Luis Obispo County
Conditional Use Permit (DRC2008-00097)

4 March 2015

Executive Summary

Project Overview

The California Valley Solar Ranch Project (CVSR Project) is a 250-megawatt solar photovoltaic energy facility located within an approximately 4685-acre site (Project site) in eastern San Luis Obispo County, California (Figure 1). The facility is owned and operated by High Plains Ranch II, LLC (HPR II). The Conditional Use Permit for the CVSR Project required that an Avian and Bat Protection Plan be prepared and implemented to monitor the impacts of the CVSR Project on birds and bats after construction. In compliance with the resultant Avian and Bat Protection Plan, avian and bat fatality searches were conducted from 6 June 2012 through 17 November 2014. This report represents the final avian and bat fatality report, and covers the monitoring results of searcher-efficiency trials, carcass-persistence trials, repeat fatality searches, regular weekly fatality searches, and incidental observations of fatalities from 16 August 2013 to 17 November 2014.

Methods

H. T. Harvey & Associates (HTH) biologists conducted weekly surveys in the following CVSR Project elements: Arrays 1, 2, 4, 5, 6, 7, 8, 9, 11, and in 20% of all associated perimeter fence areas, the Medium-voltage Overhead (MVOH) Line, the Generation-tie (Gen-tie) Line, and the Evaporation Pond. During the reporting period, all arrays were surveyed each week at 20% of their total area, with the exception of Arrays 1 and 2, which were surveyed with 100% coverage through the end of December 2013, at which time they too were surveyed at 20% of their total area. Additionally, to help identify the proportion of fatalities found that could be attributed to natural mortality rates, we surveyed control plots, located in Conservation Lands surrounding the CVSR Project site.

All fatalities were classified as either carcasses or feather spots. Feather spots consisted of groups of feathers composed of at least two or more primary flight feathers, five or more tail feathers, or 10 or more feathers of any type concentrated together in an area 1 square meter (m^2) or smaller (Smallwood 2007); feathers with significant skin or flesh, or with any bone attached, were considered fatality detections but were not necessarily considered feather spots.

In addition to performing weekly searches, HTH biologists conducted a series of repeat searches: 5-day repeats, in which biologists searched the same subset of a Project element for 5 consecutive days, and 1-day repeat searches, in which biologists searched a subset of an area that was searched 1 day previously by either 5-day repeat searchers or weekly searchers. The purpose of these repeat searches was to check the efficiency of searchers and evaluate the consistency of results; however, as reported herein, not all of the repeat searches proved necessary, and they were discontinued at the end of December 2013.

To estimate the rate of avian and bat fatalities occurring on the site, we used Huso's Fatality Estimator (2011). In formulating a fatality estimate, it was necessary to determine (1) the rate of scavenging that occurs on the site, and (2) how well searchers find different-size carcasses in different amounts of vegetation cover. These determinations were made by (1) planting fresh carcasses of birds of various sizes and placing camera traps on them to identify scavenger species and the exact time of carcass removal, and (2) planting both carcasses and feather spots of different sizes in different vegetation classes while regular weekly and repeat searches were taking place. Searcher-efficiency and carcass-removal rates were then used to adjust the annual count of fatalities to arrive at a site-wide fatality estimate.

We used background fatality rates estimated from searches of control plots within onsite Conservation Lands to adjust fatality rates within arrays. This enabled us to estimate mean background-adjusted fatality rates for the CVSR Project that represent fatalities that cannot be explained by background fatalities alone. This estimate was substantially less than the total unadjusted fatality rates within arrays. Our method used bootstrap resampling of observed data to estimate the mean and 90% confidence intervals for background-adjusted per-tracker unit fatality rates.

Results and Discussion

During the period of 16 August 2013 to 17 November 2014, a total of 453 avian fatalities, of 36 identified species and 5 unknown species groups, were detected. A total of 364 fatalities were found during standardized weekly searches. This number includes four clearance fatalities (fatalities found on the initial search of an area, which cannot be reliably aged or attributed to Project-related causes). A total of 54 fatalities were found during standardized 5-day and 1-day repeat searches. This number includes 18 clearance fatalities. A total of 35 fatalities were found incidentally. Two of the incidental fatalities were found in onsite Conservation Lands, and these, along with the four weekly clearance and 18 repeat clearance fatalities, were not used in any analyses in this report. That left an effective sample size of 429 fatalities that were used for analyses in this report.

Of the 429 fatalities found in Project elements and control plots during this reporting period, the cause of death for the majority (80.9%) could not be reliably discerned. Seventy-three (17.0%) were believed to have died as a result of a collision (65 with powerlines, 7 with solar panels, and 1 with a perimeter fence). Two deaths were believed to be caused by electrocution (0.5%). Six (1.4%) were believed to have been caused by predation, and one (0.2%) was believed to have been caused by disease.

Across Project elements, the majority (85.3%) of all fatalities were of resident species. The highest number of fatalities of migrants was found along the Gen-tie Line, where migratory species accounted for 21.5% of all fatalities. Seasonal variation was apparent in the pattern of fatalities found in both the arrays and along the Gen-tie Line. Fatalities found in the arrays peaked in the winter, whereas Gen-tie Line fatalities peaked in the late summer and fall.

For both carcass-persistence and searcher-efficiency trials, data were grouped over the entire postconstruction period to create a more robust sample size for the purposes of using the Fatality Estimator. One specimen was placed for each persistence or searcher efficiency trial. Between 15 October 2012 and 11 March 2014, we conducted carcass-persistence trials with 206 specimens. Eleven trial carcasses were excluded because the persistence data collected were insufficient (i.e., carcasses were collected by staff after the initial scavenging event), leaving an effective sample size of 195 carcasses. The carcass-persistence trials included 96 small carcasses and 99 large carcasses. Assuming conservatively that carcasses would not persist past the 6-week trial period, mean carcass persistence over the entire year was 9.3 days for small carcasses and 22.2 days for large carcasses.

In total, we planted 434 fatalities for searcher-efficiency trials. Three fatality plants were removed by scavengers, leaving an effective sample size of 431 (113 small and 98 large feather spots and 113 small and 107 large carcasses). Overall searcher efficiency was 50.8%, but varied from 57.3% to 44.5% in easy and moderate-visibility areas, respectively. Searcher efficiency also varied by size and fatality type: 72.9% of all large carcasses were found and 41.6% of all small carcasses were found, whereas 65.3% of all large feather spots were found and only 26.5% of all small feather spots were found.

During the period of 7 November 2013 to 6 November 2014 (the period used in the Fatality Estimator, representing one full year where weekly fatality searches occurred across all Project elements), there were an estimated 126 fatalities from known causes that occurred on the Project site (90% confidence interval: 106–155). There were not enough fatalities with known or suspected causes of death in the arrays to run a fatality estimate reflecting cause of death (N=2), but the estimate of fatalities per tracker in the arrays, for fatalities with unknown or natural causes of death, was 2.24 (90% confidence interval: 1.83–2.87). In the control plots, this estimate was 1.72 (90% confidence interval: 1.05–2.68).

For this same period, we estimated the mean background-adjusted per-tracker fatality rate to be 0.51 (90% confidence interval:-0.83-1.81) for one full year. The mean annual background-adjusted fatality estimate within arrays encompassing approximately 1176 acres at the CVSR project containing 1032 tracker units for the period of 7 November 2013 to 6 November 2014 was 526 fatalities (0.51 fatalities per tracker unit x 1032 tracker units).

Recommendations

During the course of this fatality monitoring study, we have identified areas where further research is needed to guide the design of future fatality monitoring studies at utility-scale solar facilities. The following recommendations outline research areas and measures that we believe are important.

- Background mortality should be assessed using a spatially balanced study employing control plots similar in size, layout, and overall total area to the developed project site.
- Focused research on the causes of feather spots and the average number of feather spots created from a single fatality should be considered.

- If site-wide fatality monitoring is deemed necessary, monitoring should start once the full project becomes operational and for at least one year. Fatality monitoring survey design, including spatial coverage requirements and survey frequency can be optimized after the collection of preliminary data.
- Intensive daily repeat fatality surveys are not necessary to conduct fatality estimates and are only recommended when required to link timing of fatalities to specific events (e.g., weather patterns or operational changes).
- Avian use studies should consider bird census techniques that are potentially more effective in documenting species richness and relative abundance of birds in project areas that will be covered by arrays, such as line transect methods.
- Projects incorporating high-tension powerlines should assess whether the project site is located in an important route for migratory songbirds.
- To assess fatalities along linear project features such as powerlines, study designs should incorporate linear controls, to provide background mortality rates for such features.
- To the extent practicable, powerlines should not be placed over wetland features, where large numbers of birds may roost and nest.
- We recommend that necropsies be performed on a subsample of carcasses to provide confirmation of the cause of the fatality.
- The use of scent dogs should be considered to increase the likelihood of detecting rare events and increase the accuracy and narrow the confidence level of fatality estimates, especially in areas with high density vegetation.
- Feather spots should be incorporated into bias-trial protocols to produce more robust fatality estimates and to provide more comparable industry-wide fatality estimates, especially for studies with longer search intervals.

Table of Contents

Figures

Tables

Appendices

Contributors

Brian B. Boroski, Ph.D., Vice President and Principal in Charge, Wildlife Ecology

David Johnston, Ph.D., Project Manager, Associate Wildlife Ecologist

Doug Drynan, B.S., Project Manager, Senior Wildlife Ecologist

Kim M. Briones, M.S., Wildlife Ecologist

Meredith K. Jantzen, M.S., Wildlife Ecologist

Gabe A. Reyes, M.A. Candidate., Wildlife Ecologist

Ken Lindke, M.S., Quantitative Ecologist

Heather Ogston, B.A., Technical Editor

Section 1.0 Introduction

On 19 April 2011, through adoption of Resolution #2011-119, the Board of Supervisors of San Luis Obispo County (the County) approved the California Valley Solar Ranch Project (CVSR Project) Conditional Use Permit (DRC 2008-00097). The CVSR Project is a 250-megawatt solar photovoltaic energy facility located within an approximately 4685-acre site (Project site) in eastern San Luis Obispo County, California (Figure 1). The facility is owned and operated by High Plains Ranch II, LLC (HPR II).

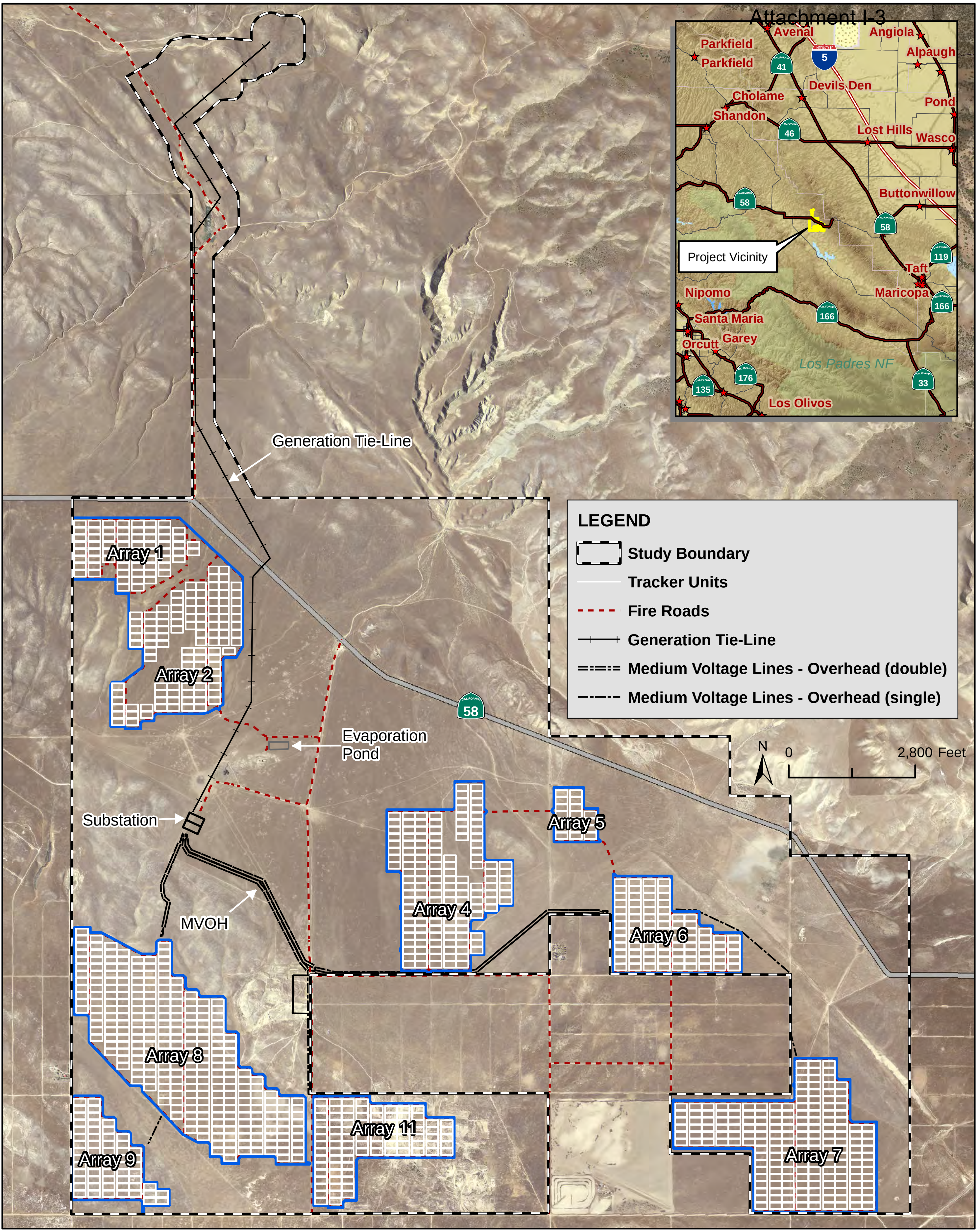
Before construction of the Project, there were concerns about the anticipated impacts that the Project might have on birds and bats. In particular, it was predicted that obligate waterbirds may mistake the panels for water and be attracted to the solar arrays; waterbirds are sometimes found in black-top parking lots or on roads, and some solar facilities have reported finding waterbird fatalities (Horvath et al. 2009; Grippo et al. 2014; Kagan et al. 2014). There was also concern that birds and bats could collide with panels (McCrary et al. 1986; Grippo et al. 2014). Although bird and bat mortality has been well documented at wind energy projects (Arnett et al. 2008; Baerwald and Barclay 2009), the level of CVSR's probable impacts was not certain. Therefore, H. T. Harvey & Associates (HTH) developed an Avian and Bat Protection Plan (ABPP) (HTH 2011) for the Project as required by the County as part of its Conditions of Approval (COAs), set forth in Exhibit 6 attached to the Resolution. As elements of the Project became operational, and continuing after the full completion of construction, HTH ecologists have implemented the *Avian and Bat Fatality Monitoring Plan for the California Valley Solar Ranch* (Fatality Monitoring Plan) (Appendix A in HTH 2011), conducting weekly fatality searches and additional searches to document impacts on birds and bats.

As required in COA #58, HTH, on behalf of HPR II, has submitted one annual report and eight quarterly reports detailing all Project-related bird or bat deaths or injuries detected during the monitoring study defined by the Fatality Monitoring Plan. This document represents the final fatality report for the Project. As required in the Fatality Monitoring Plan, this Final Postconstruction Fatality Report documents the results of postconstruction monitoring for 1 full year after completion of the Project. It summarizes the results of fatalities found since the end of the first annual reporting period (15 August 2013), integrating results from the most recent quarter of monitoring, and discusses the complete study period for the Project, where appropriate.

One of the main goals of the monitoring effort was to estimate the numbers of fatalities associated with different Project elements. In addition to performing regular weekly searches, we conducted searcher-efficiency trials to estimate the percentage of fatalities of different sizes found by searchers in both short and tall vegetation. To calculate the persistence of fatalities in the environment, we also conducted carcass-persistence trials. The values we derived from both types of trial were used in tandem with the results of the weekly searches to estimate ranges of fatalities associated with different Project elements. Additionally, to obtain an estimate of background mortality levels, we conducted controlled searches in control plots located on onsite Conservation Lands. We calculated levels of fatalities associated with various Project elements, using the Fatality Estimator (Huso 2011) to extrapolate from our survey data to the entire Project. The date range for all fatality estimates is based on one full year where weekly fatality searches occurred across all Project elements, from 7 November 2013 to 6 November 2014.

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 1 Project Site.mxd

HPR II

H.T. HARVEY & ASSOCIATES

Ecological Consultants

California Valley Solar Ranch

ABPP Final Postconstruction Fatality Report

Figure 1. Project Site with Gen-tie Line, MVOH Line, Evaporation Pond, Nine Arrays, and Control Plots

This Final Postconstruction Fatality Report is organized as follows:

- Section 2 describes our field and statistical methods.
- Section 3 presents the results of weekly and repeat fatality searches, describes trends and patterns in the monitoring results; and provides estimates of fatalities by Project element and cause of death.
- Section 4 draws comparisons between our results and the results of fatality searches conducted in other regions and industries.
- Section 5 lists recommendations for future studies.
- Section 6 lists the references cited in this report.
- Appendices A and B list avian species used in the searcher-efficiency and carcass-persistence trials.
- Appendix C presents data from weekly fatality searches for the period of 16 August 2013 to 17 November 2014.
- Appendices D and E present data from repeat searches for the period of 16 August 2013 to 31 December 2013 (after which repeat searches were discontinued).
- Appendix F lists fatalities that were incidentally observed in the period of 16 August 2013 to 17 November 2014.
- Appendix G includes errata for data reported in the first annual postconstruction fatality report (HTH 2014a); revisions were made to correct errors, erroneous omissions, or any other changes that were made to the dataset. Notes are included summarizing the reason for the change.

Section 2.0 Methods

This section presents the methods we used to conduct weekly and repeat fatality searches, collect data from incidental observations, and perform carcass-removal and searcher-efficiency trials. Project elements searched as part of this study were the Generation-tie (Gen-tie) Line; the Medium-voltage Overhead (MVOH) Line; Arrays 1, 2, 4, 5, 6, 7, 8, 9, and 11; the array perimeter fences; control plots; and the Evaporation Pond.

2.1 Field Methods

2.1.1 Weekly Fatality Searches

To estimate the total number of fatalities associated with different Project elements, we conducted a series of weekly fatality searches on different Project elements. Because the construction of different Project elements was completed at different times, fatality searches began at varying times of year, depending on the Project element searched (Table 1).

2.1.1.1 Field Search Methods

Weekly fatality searches were performed for the Gen-tie Line; MVOH Line; Evaporation Pond; Arrays 1, 2, 4, 5, 6, 7, 8, 9, and 11; and the associated control plots and fences for each array. The study design involved sampling 100% of the Gen-tie Line, MVOH Line, and Evaporation Pond. Twenty percent of Arrays 4, 5, 6, 7, 8, 9, and 11 were sampled, as was 20% of their respective fences. Arrays 1 and 2 and their associated fences were searched at 100% for the first year of fatality searches, after which (beginning in January 2014) they were searched at 20%, and four control plots were removed to reflect the decreased search effort in these areas. Each week, we selected random start locations for each Project element using a random number generator. Random selection was based on tower numbers (for the Gen-tie Line), line segment (for the MVOH Line), numbered array corners (for the solar arrays), and numbered fence corners (for the array perimeter fences).

A team of two biologists searched a 30-meter (m)-wide transect centered under the complete length of the Gen-tie Line. Because of the relatively shorter height of the MVOH Line, it was assumed that carcasses would have less potential to distribute over a wide area (HTH 2011); therefore, the transect area along the entire length of the MVOH Line was only 18 m wide. Each person searched half the transect width and half the tower or pole radial areas for both the Gen-tie and MVOH Lines. On the Gen-tie Line, each person searched a 15-m-wide transect for large birds and a 6-m-wide transect for small birds and bats. On the MVOH Line, each person searched a 9-m-wide transect for small and large birds.

Table 1. Fatality Search Commencement Dates by Project Element

Project Element	Date Fatality Searches Began
Gen-tie Line	6 June 2012
Array 1[1]	20 September 2012
Array 2 (Serengeti portion only)[2]	25 September 2012
Array 1 and 2 fence[1]	25 September 2012
Array 2 control plots	30 October 2012
Array 1 control plot	1 November 2012
Array 2 North (including Serengeti) and South[1, 2]	27 November 2012
Array 8 (20% sample)	7 January 2013
Array 4 (20% sample)	9 January 2013
Array 5 and fence (20% sample)	9 January 2013
Array 4 fence (20% sample)	16 January 2013
MVOH Line	30 January 2013
Array 8 control plots	4 February 2013
Array 4 control plots	6 February 2013
Array 8 fence (20% sample)	20 May 2013
Array 6 and fence (20% sample) and control plots	30 September 2013
Array 7 and fence (20% sample) and control plots	10 October 2013
Array 9 and fence (20% sample)	6 November 2013
Array 11 and fence (20% sample), and control plots	6 November 2013
Evaporation Pond	11 November 2013

Notes:
[1] Sampling reduced to 20% of total array area (starting 2 January and 7 January 2014 for Arrays 2 and 1, respectively).
[2] The Serengeti portion of Array 2 was searched separately only until 27 November 2012 (3 days).

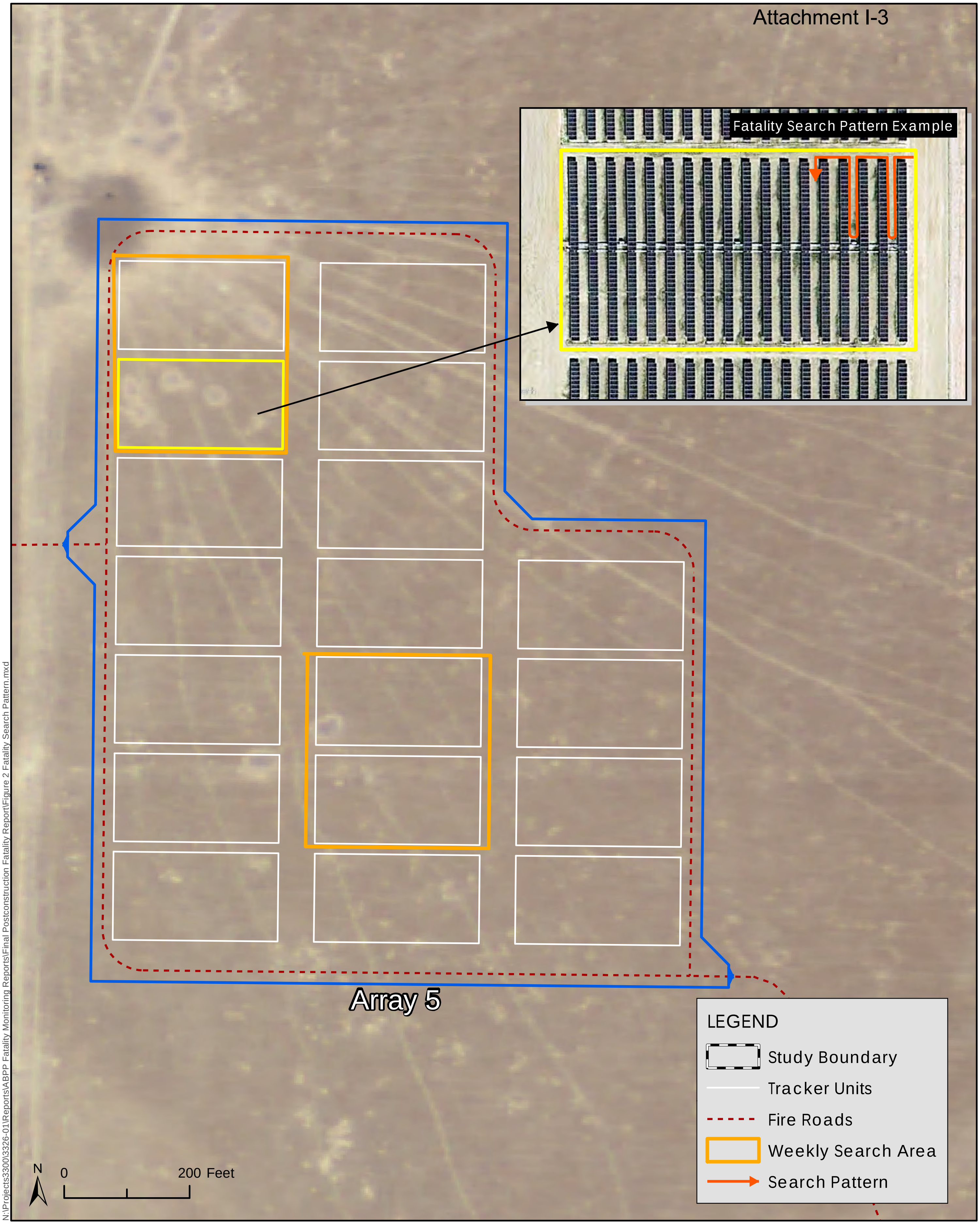
In the arrays, biologists searched tracker units in teams of two. In each tracker unit, biologists walked into every other row of panels and visually scanned both the row walked and each adjacent row. To avoid crossing the drive arms of the tracker units, searchers turned around upon reaching the drive arm, and continued to scan the next row as they proceeded out of the row. Thus, although searchers walked only every other row, they visually scanned adjacent rows to ensure full coverage (Figure 2).

Control plots were randomly placed in adjacent onsite Conservation Lands to measure the level of background mortality. Control plots were designed specifically for comparing background fatality rates to fatality rates within arrays by making them equivalent to the size of a typical SunPower Oasis tracker unit (i.e., equivalent to 18 rows of solar panels, with 40 panels to a row), which measures approximately 79.9 m by 42.8 m (3416 m^2). Six aggregated tracker units comprise a typical tracker block that generates 1.5 megawatts. We used pin flags or wooden stakes to delineate mock panel trackers on the control plots, and searchers followed the same pattern and procedure used for searching the arrays. We did not establish control plots for the 20% sample of Arrays 5, 6, and 9 because the 20% search area for these arrays contained too few trackers to meet the control plot establishment guidelines set forth in the Fatality Monitoring Plan (Appendix A in HTH 2011; the guideline is one control plot [defined in the plan as having the same spatial scale as 2 aggregated tracker blocks, or 12 tracker units] for every 16 tracker blocks [96 tracker units] searched).

Twenty percent of the total fence length was surveyed by one biologist. Each week, the biologist walked the inside portion of the fence while scanning a 6-m-wide belt centered on the fence. In some cases, the fences were not completely built until after weekly searches had already commenced. In these instances, fences were included as part of the regular search routine only after they were completely installed.

Because searches were conducted only on designated days as a part of the search protocol, make-up searches were not conducted if the search day was missed because of inclement weather, holidays, or maintenance work. In estimating the total number of fatalities, the fatality model accounted for search intervals of different lengths due to missed searches (e.g., if a weekly search day was cancelled because of rain, the search effort would resume the following week, and for that search, the interval was 14 days, not 7 days).

Additional Documentation Attachment to Comment 2-F1
Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 2 Fatality Search Pattern.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report
Figure 2: Fatality Search Pattern

2.1.1.2 Data Collection

We documented a fatality event each time a carcass or a feather spot was found. We considered a feather spot a fatality if it had at least two or more primary flight feathers, five or more tail feathers, or ten or more feathers of any type concentrated together in an area 1 square meter (m^2) or smaller (Smallwood 2007). We defined the number of feathers required to constitute a fatality using definitions employed in other fatality studies at wind farms (e.g., Gruver et al. 2009; Erickson 2009; Smallwood et al. 2010). Additionally, feather spots not meeting these requirements but containing flesh, blood, or bone were also considered fatalities.

During fatality searches, we occasionally encountered avian roost areas where signs of preening and molting were evident. Preening and molting spots typically have fewer feathers and are more spread out than feather spots associated with fatalities. Also, roosting areas rarely contain primary or secondary feathers, but are often dotted with droppings. In the solar arrays, we regularly observed flocks of mourning doves (*Zenaida macroura*) and horned larks (*Eremophila alpestris*) roosting. Mourning doves exhibit a complex molt strategy that can occur year-round and includes preformative, prealternate, and definitive prebasic molts (Otis et al. 2008). Likewise, horned lark adults and first-year birds undergo a definitive prebasic molt at the end of the breeding season (typically the end of July) (Beason 1995). Searchers used their biological knowledge to determine whether or not feathers from mourning doves, horned larks, or other species known to be in a molt period should be recorded as a fatality. No data were taken on molt or roost-spot feathers.

When a fatality was detected, we assigned the fatality a unique incident number and recorded data on the fatality and the substrate in which it was found. Incident numbers were written as follows: YYYYMMDD-##, consisting of the year, month, day, and a unique number assigned to each searcher. Each searcher recorded a unique set of numbers, so data can be traced back to individual searchers. To verify species identifications, we took photographs of each fatality and, when necessary, consulted Scott and McFarland's *Bird Feathers: A Guide to North American Species* (2010). We also consulted our feather reference collection, prepared from positively identified fatalities collected on the site over the course of Project monitoring. For each fatality, we recorded location (using Universal Transverse Mercator [UTM] coordinates), time found, taxon, four-letter alpha code, carcass condition, parts found, number and types of feathers, suspected cause of death, and estimated time since death. Whenever possible, we recorded information about the age and sex of the fatality, as well as scavenger type. Additionally, we gathered information on the size and spread of the feather spot and the surrounding substrate, vegetation height, and percent vegetation cover, as well as whether the fatality occurred in an array row walked by a searcher, or in a neighboring row (for fatalities found in the arrays). All carcasses and feather spots discovered by regular weekly searchers were removed.

The suspected cause of death was assessed for all fatalities and assigned to one of the following classes: collision, electrocution, predation, disease, or unknown. It was then further assigned a "Level of Certainty for Suspected Cause" category, as defined in the Migratory Bird Special Purpose Utility Salvage Permit (SPUT) for the Project (issued by the U.S. Fish and Wildlife Service [USFWS] on 10 March 2014 [permit number MB02733B-0]). Level of certainty was assigned as follows: Observed = 100%; Valid = >90%; Probable = >50%; Possible = <50%; or

Unknown/Not Applicable. To make the assessment, searchers examined all carcasses for signs of injury or illness, and assigned a cause of death using the following assumptions:

- Possible solar panel or powerline collision: If fatalities were found in arrays or under powerlines, we assigned collision as the cause of death with >90% certainty if carcasses had injuries consistent with an impact. We assigned collision as the cause of death with >50% certainty if feather spots or carcasses had no noticeable injuries but were found within 10 feet of powerlines. In arrays, we assigned collision as the cause of death with <50% certainty if feathers or flesh were stuck to solar panels, or if smudge marks or imprints, as from an impact, were observed on a panel.

- Electrocution: For fatalities near the MVOH Line, we assigned electrocution as the cause of death with >90% certainty if carcasses had visible injuries consistent with electrocution (e.g., singed feathers, burns on feet, or curled leg scales). Likewise, we assigned the same cause of death and level of certainty to a few fatalities based on circumstantial evidence (e.g., a breaker tripped during a recent rain event for an unknown reason, and a bird nesting on an overhead wire pole was found dead shortly afterward).

- Predation: We assigned predation as the cause of death with >90% certainty if birds were found impaled on tumbleweeds, fence lines or other structures. For decapitated carcasses found in any Project element, we assigned predation as the cause of death with <50% certainty. Fatalities found at sites regularly used by predators (e.g., at a plucking post), as indicated by old remains, were assumed to be predated with >50% certainty.

- Disease: We assigned this cause of death with >50% certainty if a carcass was emaciated or otherwise appeared unhealthy (e.g., if it had growths typical of avian pox).

- Unknown: Fatalities were assigned the designation of unknown cause of death when there was no compelling evidence to indicate how these fatalities occurred (e.g., carcasses had no obvious signs of injuries or illness, or body parts or entrails were present on solar panels but there were no visible imprints or smudge marks that allowed us to distinguish between predation and collision).

2.1.2 Repeat Searches

A series of repeat searches was designed to provide a verification of the results of weekly searches. Repeat searches were designed to create a shorter search interval that would allow carcasses with a short scavenging time to be more readily found and identified. Because repeat searches were intensive, they covered less area than the regular weekly searches. After the first annual report, it became apparent that avian fatalities, particularly long-lasting feather spots, accounted for the bulk of the findings. Likewise, the low number of trackers that were searched during each 5-day repeat search caused confidence intervals on these independent fatality estimates to be greatly inflated, compared to the estimates produced using weekly search data. For these reasons, the utility of repeat searches was greatly reduced, and the decision was made to cease all repeat searches (both 5-day and 1-day repeat searches) from 1 January 2014 onward. The methods used for the repeat searches, conducted before 1 January 2014, are summarized below.

2.1.2.1 5-Day Repeat Searches

Five-day repeats were conducted on all Project elements subject to regular weekly searches, with the exception of the Gen-tie Line, which was not included in the 5-day repeat searches because small birds and bats were assumed to be unlikely to strike high-tension powerlines. All other Project elements were subjected to 5-day repeat searches once every 4 weeks.

During each 5-day repeat search period, searchers covered a quarter of the total area covered during regular weekly searches (i.e., 25% of Arrays 1, 2, and the MVOH Line, and 5% of Arrays 4, 5, 6, 7, 8, 9, and 11), and the same areas were searched for 5 consecutive days. Because of the small size of the Evaporation Pond, searchers walked the entire perimeter of the pond during repeat searches. However, due to the large size of Array 2, 5-day repeat searches of Array 2 Serengeti were conducted separately from those of Array 2 North and South.

When possible, 5-day repeat searches were conducted in areas separate from regular weekly searches, to keep the search interval at a constant span of 7 days for all weekly search areas. In Arrays 1 and 2, however, overlapping search areas were unavoidable because weekly searches encompassed 100% of the arrays.

The first day of each 5-day repeat search was treated as a clearance search, and all fatalities found on the first day were removed from further analysis. Data for fatalities was collected in the same way as weekly search data, with the following exception: feather spots and scavenged carcasses were monitored throughout the search period, and notes were made regarding persistence. All remaining feather spots were collected on the fifth day of the 5-day repeats. For intact carcasses, cameras traps were placed near the carcasses to monitor persistence past the 5-day span of the repeat searches, with the intention of collecting additional data for carcass-persistence trials; however, due to technical issues, camera traps did not function properly during these trials and the data could not be incorporated.

2.1.2.2 1-Day Repeat Searches

One-day repeat searches covered a randomly selected block representing 25% of all elements (i.e., arrays, fences, and control plots) searched in the original weekly or 5-day repeat searches. Blocks were searched on the day following regular weekly searches, every other week (semimonthly), and after each 5-day repeat search, on either the last day of the 5-day search or 1 day after its completion.

2.1.3 Incidental Fatalities

Fatalities were sometimes found outside of regularly searched areas, both by CVSR Project personnel and HTH biologists. When this happened, fatality data were recorded and the fatality was collected in the same manner as if it were found during a weekly search. These fatalities could not be included in the site-wide fatality estimate, however, because the lack of a regular search interval made it impossible to accurately quantify the search effort for the area and the probability of finding the fatality. Nonetheless, all incidental fatalities are reported here, in the SPUT reports, and in reports for other Project salvage collection permits.

2.1.4 Carcass-persistence Trials

Carcasses decompose at rates that are influenced by environmental conditions, and carcasses and feather spots are also moved and dispersed by wind and scavengers. To calculate the number of fatalities that might be available for searchers to find in a given period, it is necessary to estimate the total persistence rates of carcasses. Scavenger species and density vary by region, so site-specific carcass-persistence trials must be conducted to accurately estimate fatality rates.

For our carcass-persistence trials, we acquired avian carcasses from the onsite fatality searches and a local wildlife rehabilitation center. We also collected them opportunistically (e.g., we collected road-killed birds) under State and federal salvage permits. Whenever possible, we used species that naturally occur on the site or in the surrounding area, and limited the handling of carcasses to reduce transfer of foreign scents. We categorized all carcasses into one of two sizes: small (≤100 grams [g]) and large (>100 g). For the purposes of the descriptive statistics and fatality estimates provided in this report, trial data from the first year and second year (between 15 October 2012 and 11 March 2014) are grouped together to provide a more robust fatality estimate. Of the 206 carcasses that we placed for carcass-persistence trials, 101 were large and 105 were small (Appendix B).

To avoid "scavenger swamping" (saturating our study area with more carcasses than resident scavengers are able to remove) (Smallwood et al. 2010), we limited the number of carcasses present in a search area at one time to four. We dropped carcasses from shoulder height and allowed them to fall naturally to the ground. We recorded each carcass location with a Global Positioning System (GPS) unit, and noted the direction and distance to the nearest tower (when carcasses were placed along the Gen-tie Line) or tracker number (when carcasses were placed in arrays). We placed Bushnell Trophy Cameras (Model 119436) within 1–1.5 m of the carcass on a t-post, facing north to avoid allowing sunlight to shine directly into the camera lens. We programmed cameras to take three date- and time-stamped photographs in quick succession after each trigger event; each camera had a 1-second refractory period between pictures.

We checked each carcass and the camera batteries and memory storage cards at least once per week, for up to 6 weeks or until the carcass was scavenged. We classified the carcass as "removed" if the carcass could not be located, or if there were fewer than ten feathers of any type or fewer than two primary feathers remaining. To classify feather spots, we used criteria similar to those used by the regular weekly searchers. Therefore, we classified the scavenging outcome as "not removed" if there were ten or more feathers of any type, two or more primary feathers, or any flesh or bone remaining. If the carcass was no longer in front of the camera and was not readily apparent, we searched the surrounding area using a spiral search pattern. We started the search at the camera's location and spiraled out to 30 m from the camera. If the carcass had been moved to a new location within the search area, but was intact, we repositioned the camera on the carcass in its new location.

During the first year of our study, we collected all remaining feathers and signs of the carcass after the initial scavenging event. However, after the first annual report, it became apparent that, because of the high proportion of feather spots found on site, it was necessary to estimate the full persistence time for carcasses, rather than the time to scavenging (in this report, use of the term *carcass persistence* rather than *carcass removal* reflects this broader focus). Therefore, in this document we report the time to scavenging as the time to the last scavenging event, and for scavenger species, we report the scavenger that resulted in the carcass's removal or conversion to a feather spot. In nine trials, carcasses were collected after the initial scavenging event, when partial or nearly whole carcasses remained behind. We exclude the results of these trials because they lack complete persistence data and we have no basis for estimating the time to the last scavenging event. Additionally, to accurately estimate total persistence, we conducted 30 feather spot persistence trials, in different vegetation heights, to determine appropriate adjustment factors to add to the persistence time of carcasses that were scavenged but left feather spots behind. We monitored each feather spot on a weekly basis for up to 4 weeks. To calculate the adjustment factor, we took the midpoint from the time between the last check when the feather spot was present and the first check when the feather spot was absent. We averaged these persistence times by vegetation class and added them to the total persistence time for all carcasses that left feather spots behind after scavenging.

For 28 of the carcasses that were removed and left no feather spot, the time of scavenging was not captured on camera. For the purpose of our descriptive statistics, we calculated the midpoint between the last photograph in which the carcass was present and the first photograph in which it was absent, and used that as the time of scavenging, to yield the total persistence time.

2.1.5 Searcher-efficiency Trials

Not all fatalities deposited in a search area are observed by searchers because detection is inherently imperfect, being influenced by topography, vegetation, fatality size and type, and the number of fatalities removed by scavengers (Thompson 1994). To determine how efficient searchers are at detecting fatalities, we conducted a series of searcher-efficiency trials, in which we placed trial fatalities (*fatality plants*) throughout the fatality search areas and calculated the average number of trial fatalities found by searchers.

For the purposes of the descriptive statistics and fatality estimates provided in this report, trials from the first year and second year are grouped together to provide a more robust fatality estimate. Therefore, we report on a total of 52 days of searcher-efficiency trials, starting 5 September 2012 and ending 31 July 2014, and representing the entire postconstruction study period.

We used both carcasses and feather spots in various amounts of vegetation cover throughout the year to characterize separate rates of searcher efficiency for fatality size (large or small), fatality type (carcass or feather spot), and visibility. Trial fatalities included specimens of common species found on the CVSR Project site and suitable proxy specimens salvaged from a local wildlife rehabilitation center (Appendix A). To avoid harming scavengers, euthanized specimens were not used for bias trials. In total, we planted 434 fatalities for searcher efficiency trials. Three fatality plants were removed by scavengers, leaving an effective sample size of 431 (113 small and 98 large feather spots, and 113 small and 107 large carcasses).

We assigned each species of carcass to one of two sizes (small or large) based on weight (i.e., small = ≤100 g; large = >100 g), as defined in *The Sibley Guide to Birds* (Sibley 2000). We also assigned a size to each feather spot based on spread of feathers. A small feather spot was defined as feathers from a small or large bird, scattered in a ≤20-square-centimeter (cm^2) area; a large feather spot was defined as feathers from a small or large bird scattered in an area >20 cm^2. In total, we classified all fatality plants into one of four size classes: (small feather spot, large feather spot, small carcass, or large carcass).

We originally categorized visibility into one of three classes: Easy, Moderate, or Difficult, based on a combination of vegetation height and percent vegetation cover (Table 2; Figure 3) within a 1-m^2 area surrounding each fatality plant. However, because the Difficult visibility class was rarely present (N=5), for all analyses, we lumped Moderate and Difficult visibility classes together in the High vegetation height category.

Table 2. Visibility Classifications Assigned to Categories of Vegetation Height and Percent Cover

Vegetation Height (Low <25 cm, Medium 25-50 cm, High >50)	Vegetation Cover (%)	Visibility Classification
Low	0–50	**Easy**
Low	50–100	**Moderate**
Medium	0–25	**Easy**
Medium	25–100	**Moderate**
High	0–50	**Moderate**
High	50–100	**Difficult**

In the field, we used a combination of haphazard and random, stratified sampling to determine the placement of each fatality plant. Haphazard sampling was incorporated to ensure that a representative number of trial fatalities were placed in all visibility classifications. We marked each fatality plant discreetly with tape or flagging so that searchers would know to report their findings as part of the controlled searcher-efficiency trial. We arrived approximately 1 hour in advance of the searchers so that we could set out fatality plants without alerting searchers that they were being tested. We recorded a GPS point for each fatality plant, and assigned it to a visibility group. Searchers contacted the efficiency-trial biologist as they discovered trial plants, and all plants were removed from the field once the fatality search was completed.

a) Easy Visibility

b) Moderate Visibility

Figure 3. **Photographic Examples of Easy (a) and Moderate (b) Visibility Classes for Feather Spots (Top Two Panels) and Carcasses (Bottom Two Panels), Based on Vegetation Height and Percent Cover**

2.2 Statistical Methods

Animals die at an unknown rate, which must be inferred from regular searches of a site. Secondly, fatalities persist for varying amounts of time and are imperfectly detected by searchers. For these reasons, it is often inappropriate to draw conclusions based on the raw number of fatalities in an open system. The need to accurately estimate fatalities given these variables has driven the development of several fatality estimation statistical methods (e.g., see Johnson et al. 2003; Smallwood 2007; and Huso 2011). All of these fatality estimation models are based around several common themes; in particular, all such models are designed to infer information about the total number of fatalities or total fatality "population" based on fatalities that are found. In an open system, the true total number of fatalities is unknown and cannot be determined, but fatality estimators use information based on average scavenging times and average searcher efficiency to form a number range (confidence interval) that likely contains the true number of total fatalities for a given site. The interval can be broadened or constrained based on the level of confidence desired. For this report, we use 90% confidence intervals for all fatality estimates. This means there is a 90% probability, based on our sample size that the true number of fatalities falls within our estimated range.

Because fatality estimates are based on the total number of fatalities found, there is an inherent bias when low numbers of fatalities are discovered. This is often referred to as *sampling bias*; it refers to the fact that small sample sizes may include outliers that are not representative of the wider population (in this case, the total number of fatalities that occur). As the number of fatalities found grows larger, the number, size, and species of fatalities should become more representative of the population, and fatality estimates become more accurate. Throughout this report, we urge caution in the interpretation of estimates based on small sample sizes; also, we did not calculate estimates based on data representing fewer than five fatalities.

As mentioned above, fatality estimation methods share a similar underlying premise. Generally, the fatality estimation formula for a given site may be written as:

$$F = C/rp,$$

where the number of fatalities, F, is the quotient of the number of carcasses found, C, over the product of carcasses left unscavenged, r, and the proportion that an observer sees, p (Huso 2011).

The inputs for r and p are estimated in subgroups of covariates that influence the detectability and persistence of each carcass, such as carcass size, vegetation height, and stage of decay or scavenging (i.e., feather spot versus carcass). Given the tendency for many fatality estimation models to underestimate site-wide fatalities, we chose to use a fatality estimator written by Huso (2011), which was shown to outperform previously developed models by more accurately accounting for imperfect detectability. This model, the Fatality Estimator, was developed to estimate fatalities primarily for wind energy projects; however, it can be applied to other types of sites, including powerlines and solar projects (Huso 2011). The Fatality Estimator uses the conceptual framework of fatalities, combined with bootstrapping from models of r and p, to calculate variances and confidence intervals for the estimate of total fatalities. (*Bootstrapping* is a statistical method used to create a distribution to assign measures of variance to estimates when the underlying distribution of data is either unknown or cannot be represented algebraically (Efron and Tibshirani 1986)—bootstrapping resamples the data, by taking a subsample of the entire data set several thousand times to create a distribution that may be used to infer information about the sample mean).

2.2.1 Estimating Carcass-persistence Rates

Measurements of carcass-persistence rates, r, typically include one or more censoring values. A *censoring value* is used in statistics when a value is only partially known. For example, if a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing, then the date of scavenging is unknown, and an interval censor would be used. Because we used camera traps, the majority of scavenging times were known precisely, and the data were not censored. However, when cameras failed to record the moment of scavenging, we applied interval censoring. Likewise, because feather spots were collected after scavenging events, a right censor was applied to trial carcasses that resulted in feather spots (right censors are typically used when the carcass or feather spot is collected prior to the end of the trial). Finally, owing to camera malfunctions, no photographs were taken of some carcasses prior to scavenging. In these cases, the carcasses and all evidence of the fatalities were removed before the first field observation. The time to scavenging and total persistence time for these carcasses was calculated as the midpoint from the time of placement to the time of the first field check, and a left censor was applied in the model.

There are four commonly used survival model distributions that can be used in the Fatality Estimator for a value of *r:* exponential, Weibull, loglogistic, and lognormal. These four distributions have different rates and shapes of decay curves that attempt to model the survival of carcasses over a given search interval. Because the time of death for detected fatalities is usually unknown, the probability of persistence cannot be calculated exactly for each carcass, but it can be estimated from the selected survival model and bootstrapped to obtain a range of estimates of *r* for each carcass.

We modeled our data using a series of models based on each of these four distributions. For each distribution, we compared models with and without explanatory variables. (An *explanatory variable* is any data set of interest that may have an influential relationship on the dependent variable, or measured outcome, of a study.) Specifically, for each distribution, we compared the following possible models: the null model, which contains no explanatory variables, a model controlling for season as an explanatory variable, a model controlling for size as an explanatory variable, and a model controlling for both season and size as explanatory variables. This resulted in four models for each distribution, for a total of 16 models.

To rank the fit of each survival model to our carcass-persistence trial data, we used Akaike's Information Criterion adjusted for sample size (AICc) (Akaike 1973). AIC and AICc are typically used to compare the relative fit of different models to a dataset. Although the absolute value of AICc may vary, the difference in AICc values among models provides information about which model is most statistically supported. The model with the lowest AICc value is typically held to be most supported by the data, but any model with a change in AICc values of less than 2 from the "best model" is considered to have strong evidence supporting it (Burnham and Anderson 2004).

2.2.2 Estimating Searcher-efficiency Rates

Searcher efficiency, or the proportion of fatalities that an observer sees, *p*, is represented most simply by the following equation:

$$p = \frac{NumberObserved}{NumberAvailable}$$

We compared four models for this dataset: the null model, a model containing size class as an explanatory variable, a model containing visibility class as an explanatory variable, and a model containing both size class and visibility class as explanatory variables.

2.2.3 Estimating Fatalities on the Project Site

The Fatality Estimator bootstrapping procedure calculates an adjusted fatality value for every fatality found based on the search interval, searcher efficiency, and carcass persistence. Because fatalities of different species and different-size feather spots are found in different vegetation heights and percent cover, fatality estimates based on different data sets with the same number of total fatalities can yield very different results. Fatalities found in tall grass, for example, are considered more difficult to find, based on the searcher-efficiency rates calculated at the CVSR Project. Therefore, fatalities found in tall grass are weighted more heavily in the overall estimate.

Within the Fatality Estimator, the bootstrapped values are automatically summed, and a total estimate and 90% confidence intervals are calculated for the Project element and each covariate combination assigned. The Fatality Estimator was developed for wind energy projects, and used individual wind turbines as the sample unit of replication. To apply this tool to the CVSR Project, we used tracker units instead of turbines as the sample unit. For the overhead lines, for which the entire length was sampled, we set the entire feature as the sample unit. For the fences, we made an estimate from the 6411.2-m length searched during weekly fatality searches as a unit, and extrapolated from the estimate to represent the total fence length of 32056 m.

Although the majority of fatalities were included in the fatality estimates, some did not meet the underlying assumptions of the fatality estimate model. Fatalities deemed older than the search interval (i.e., fatalities missed during previous searches) were not included in the Fatality Estimator because rates of imperfect efficiency (i.e., <100%) are already accounted for in the model, and including these old fatalities would falsely inflate estimates. Likewise, incidental fatalities were not included in the Fatality Estimator because they were found outside the defined search effort. Clearance fatalities more than 1 day old (>24 hours) were also excluded from estimates because time since death could not be reliably established.

When possible, we calculated fatality estimates by fatality class [a size designation of small ≤100g, or large >100 g. based on average size of species as defined in *The Sibley Guide to Birds* (Sibley 2000)], season, and cause of death; however, small sample sizes (N<5) sometimes did not allow for estimates to be calculated for all of these explanatory variables.

The date range for all fatality estimates is based on one full year where weekly fatality searches occurred across all Project elements, from 7 November 2013 to 6 November 2014. Although Arrays 1 and 2 were searched at 100% until the end of December 2013, fatalities found in trackers outside the 20% area that was established in January 2014 were excluded from all estimates.

2.2.4 Applying Control Plot Data to Adjust Fatality Rates

If we assume that control plots adequately represent background mortality that could be expected if the CVSR Project did not exist, then we should be able to estimate the mortality rates related to the presence of the Project as the difference between rates within the arrays and rates in the control plots within Conservation Lands. Any such evaluation requires that fatality rates between array areas and Conservation Lands be evaluated and applied on the same spatial and temporal scale. Control plots were designed specifically for this purpose by making them equivalent to the size of a typical tracker unit. This allowed us to calculate a per-tracker unit fatality rate for array areas, and a per-control plot fatality rate for Conservation Lands that represents the same spatial scale. Because the focus of the fatality survey effort was to develop an overall fatality rate for the Project with a certain level of precision, more effort was spent surveying tracker units within arrays than control plots within Conservation Lands. Approximately one control plot was established for every eight tracker units surveyed within the arrays. The larger sample size of tracker-unit sized plots within the arrays versus those in Conservation Lands resulted in higher precision in estimating fatality rates in the array areas as compared to Conservation Lands.

To estimate the fatality rate related to the CVSR Project, we used bootstrap methods and the results from the Fatality Estimator to estimate the mean and 90% confidence intervals of the difference between per-tracker fatality rates within array areas and per-control plot fatality rates within Conservation Lands.. In an attempt to account for differences in sample sizes between array areas and Conservation Lands, we subsampled array areas at a sample size equal to the number of control plots. By applying this method to the results from the Fatality Estimator, we adjusted the individual fatalities to account for imperfect detection due to searcher efficiency and carcass persistence rates.

Definitions:

N_C = Total number of control plots within Conservation Lands that were surveyed for the entire study period,
N_T = Total number of tracker units surveyed within array areas during the study period,
n_c = number of randomly sampled control plots,
n_t = number of randomly sampled tracker units,
F_C = Total estimated fatalities across all n_c over the study period,
F_T = Total estimated fatalities across all n_t over the study period,
F_{con} = estimated background fatality rate based upon control plots over the study period,
F_{trac} = estimated per-tracker unit fatality rate within arrays over the study period,
$F_{b.adj}$ = estimated per-tracker unit fatality rate that is adjusted by subtracting background fatality rates, and
m = the number of bootstrap iterations.
Note that $n_c = n_t = N_C$.

The bootstrap process proceeded as follows:

1. Randomly sample n_c control plots, with replacement, from the N_C control plots at the study site. Note that because we are sampling with replacement, an individual control plot may be represented more than once.
2. Based on the new random sample of n_c control plots, estimate the total fatality rate for control plots, F_C, using the Fatality Estimator .
3. Estimate the per-control plot fatality rate, which equates in spatial scale to the per-tracker unit fatality rate: $F_{con} = F_C/N_C$.
4. Randomly sample n_t tracker units, with replacement, from the N_T tracker units in the study area.
5. Based on the new random sample of n_t tracker units, estimate the total fatality rate for tracker units sampled, F_T, using the Fatality Estimator. Note that we are estimating total fatalities for N_C number of tracker units, and not for the entire facility or the N_T number of tracker units surveyed.
6. Estimate the per-tracker fatality rate: $F_{trac} = F_T/N_C$.
7. Calculate the adjusted, per-tracker fatality rate as the difference between the per-control plot fatality rates and the per-tracker fatality rates from 3 and 6, above ($F_{b.adj} = F_{trac} - F_{con}$).
8. Do this m number of times, yielding m values of $F_{b.adj}$. ($m = 2000$).
9. Estimate the adjusted, per-tracker fatality rate as the mean of the m values of $F_{b.adj}$, and the 90% confidence intervals as the 0.05 and 0.95 quantiles of those values.

Sampling only N_C trackers from the much larger N_T trackers that were actually surveyed at the site is intended to simulate a balanced paired design, as if we had sampled an equal amount of area in the arrays and within the onsite Conservation Lands. If we had not done so, our degree of confidence in the mean per-tracker unit fatality rate for array areas would be much higher than the mean control plot fatality rate in Conservation Lands due to the relatively low sample size of control plots, which could result in biased estimates. It should be noted that when we applied this analysis to results from the Fatality Estimator, we did not account for uncertainty in searcher efficiency and carcass persistence sub-models; and therefore, we invoke an assumption that the parameters of those models are known without error. Consequently, the results of this bootstrap analysis only represent error associated with the random and incomplete sampling of tracker units within arrays and control plots within onsite Conservation Lands (i.e., sampling error).

Section 3.0 Results

3.1 Weekly Searches

A total of 360 avian fatalities were found during weekly fatality searches of Project elements and control plots between 16 August 2013 and 17 November 2014 (Figures 4–11; Appendix C). An additional four clearance fatalities were also found during weekly searches. However, because time since death cannot be reliably established, we do not include clearance fatalities in any further discussion in this section. No bat fatalities were found during the current reporting period.

Of the 360 fatalities found during weekly searches, the majority (65%) was found in arrays, and 307 (85%) fatalities were year-round avian residents (Table 3).

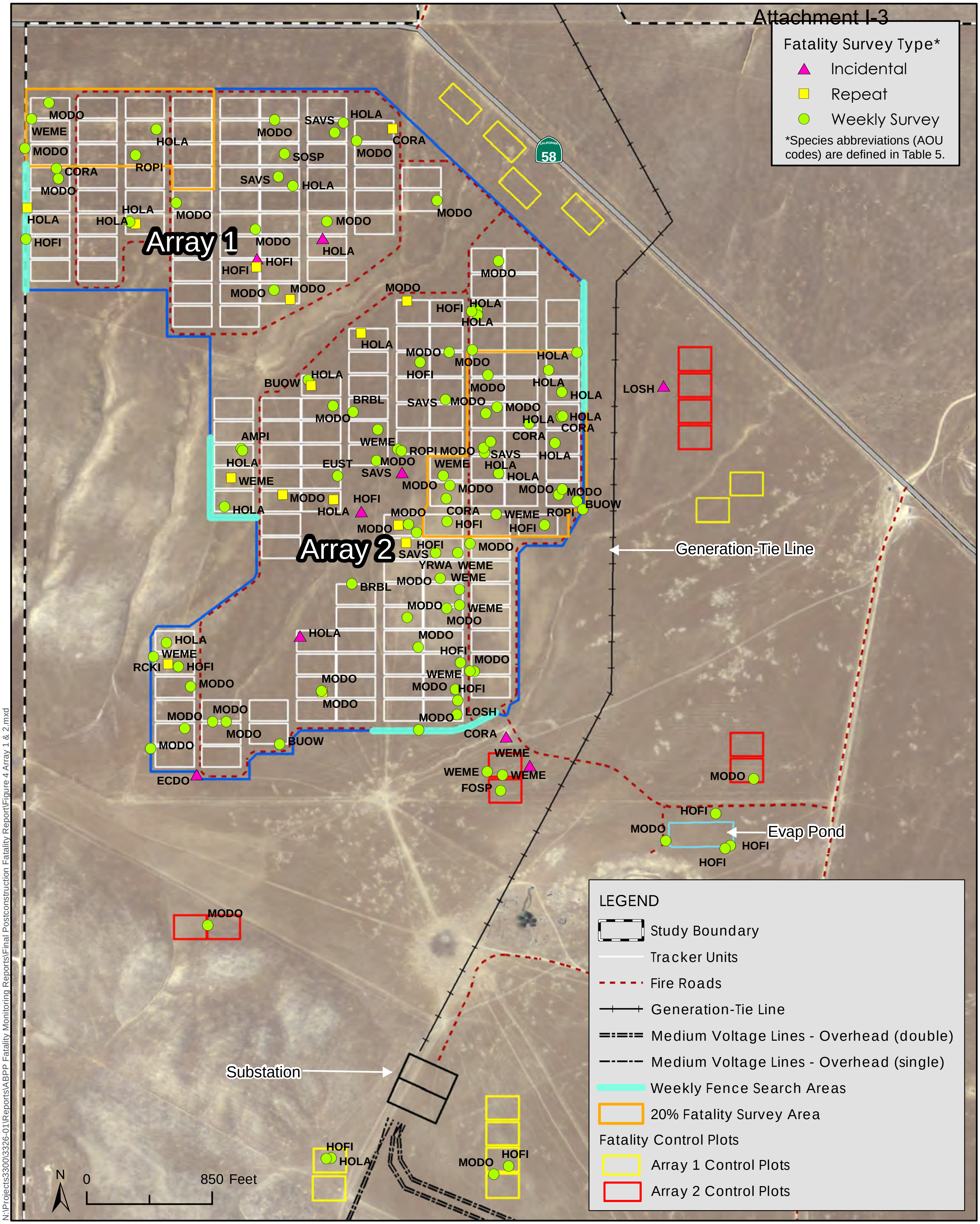
Table 3. Number of Fatalities Found at Each Project Element, by Residency Status

	Migrant	Resident	Winter Resident	Unknown[1]	Total
Arrays	5	217	9	3	234
Control plots	1	16	0	0	17
Evaporation Pond	0	4	0	0	4
Fences	0	11	1	2	14
Gen-tie Line	14	38	11	2	65
MVOH Line	0	21	2	3	26
Total	20	307	23	10	360

Note:
[1] Unidentified species among the fatalities were grouped as having Unknown residency status.

To assess the effect of season on fatalities, we excluded fatalities from Arrays 1 and 2 that were detected outside the reduced 20% search areas before January 2014. Additionally, one fatality found in a control plot was excluded; this control plot was removed in January 2014 to coincide with the reduced search effort in Arrays 1 and 2. Inclusion of these data would inflate seasonal numbers for these areas, because a greater search effort occurred before January. However, we excluded these data only for the analysis presented here, in Section 3.1. All subsequent sections include all available data from this reporting period.

There was seasonal variation in fatalities across the different Project elements (Table 4; Figures 12-16). The arrays and Gen-tie Line showed the most variation in the numbers of fatalities found across seasons (Figures 12 and 15). The largest number of fatalities in the arrays occurred in winter, accounting for 48.3% of all array fatalities (Table 4). There was a steady decline in fatalities in the arrays after winter, and this decline carried into fall 2014. Also, array fatalities were lower in fall 2014 compared with fall 2013. The largest number of fatalities along the Gen-tie Line occurred in fall 2013, accounting for 39.06% of all Gen-tie Line fatalities. Gen-tie Line fatalities declined after fall 2013 but remained fairly constant. Like array fatalities, Gen-tie Line fatalities in fall 2014 were lower than in fall 2013. There was also a slight spike in fatalities in the winter along the MVOH Line, but overall numbers for this Project element were too low to establish trends. Likewise, fatalities found along the fences and at the Evaporation Pond and control plots were too few to establish trends.

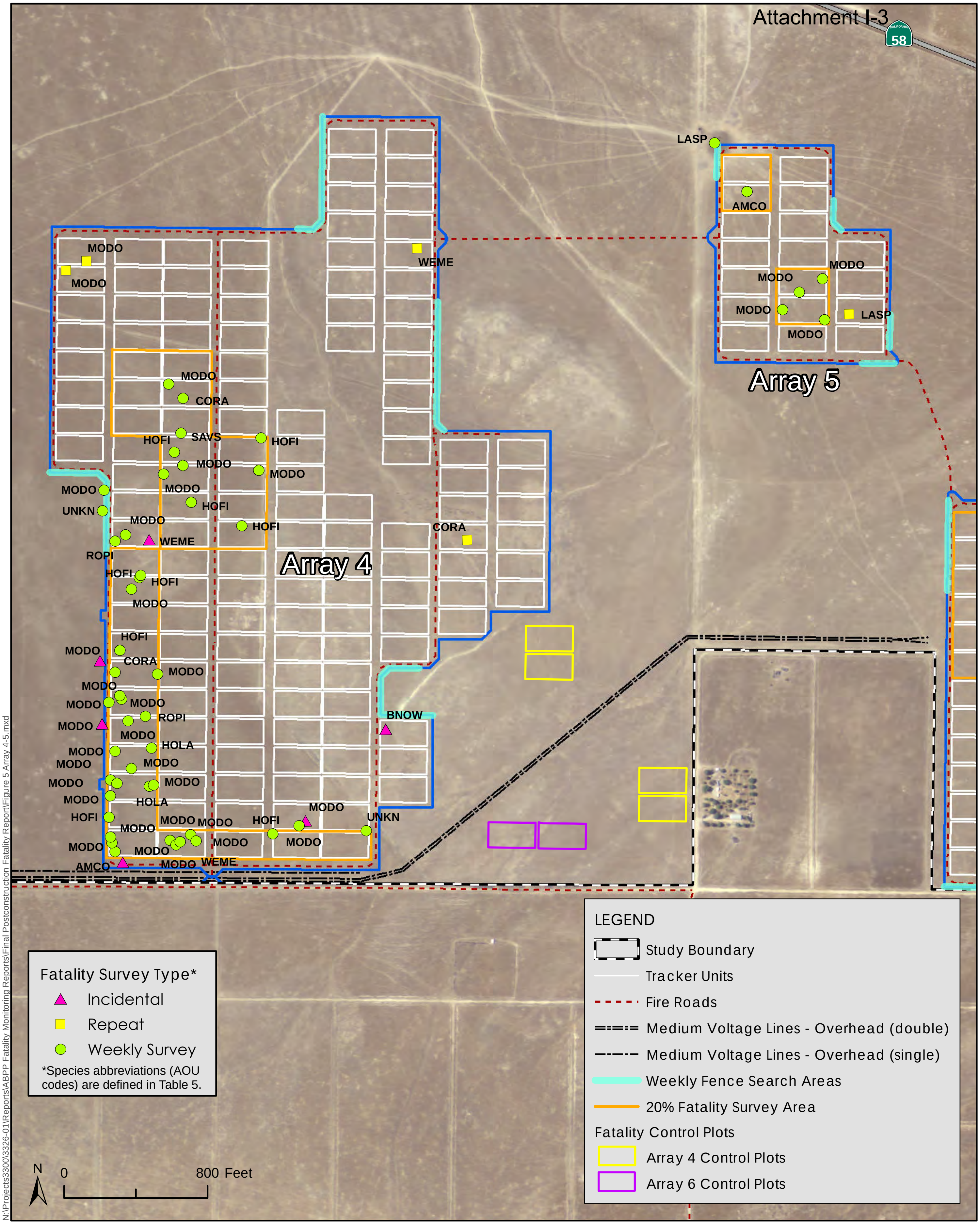


HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report

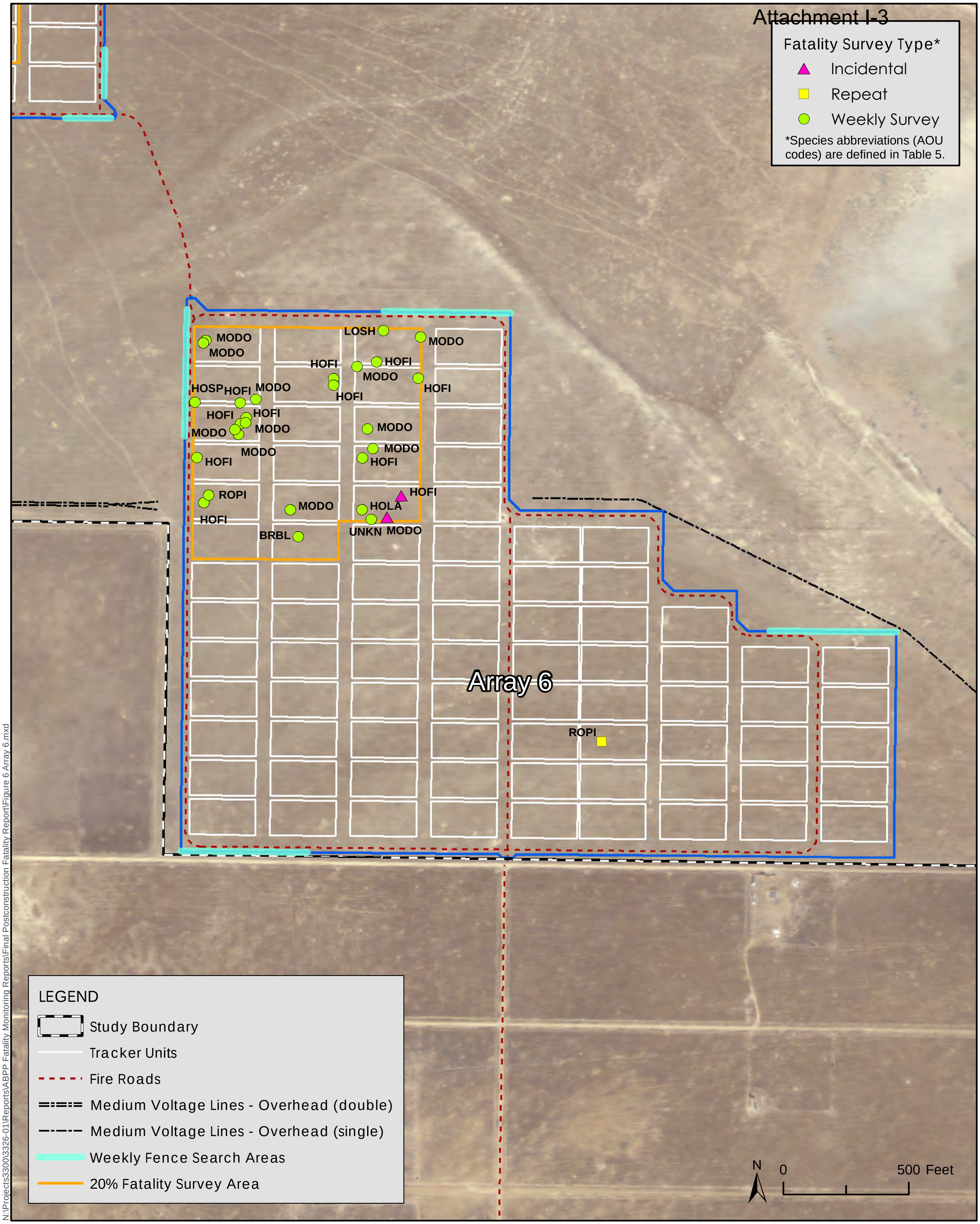
Figure 4: Locations and Species of Postconstruction Fatalities Observed in Array 1 and 2 and Evaporation Pond Elements between 16 August 2013 and 17 November 2014



HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report
Figure 5: Locations and Species of Postconstruction Fatalities Observed in Array 4 and 5 Elements between 16 August 2013 and 7 November 2014



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 6 Array 6.mxd

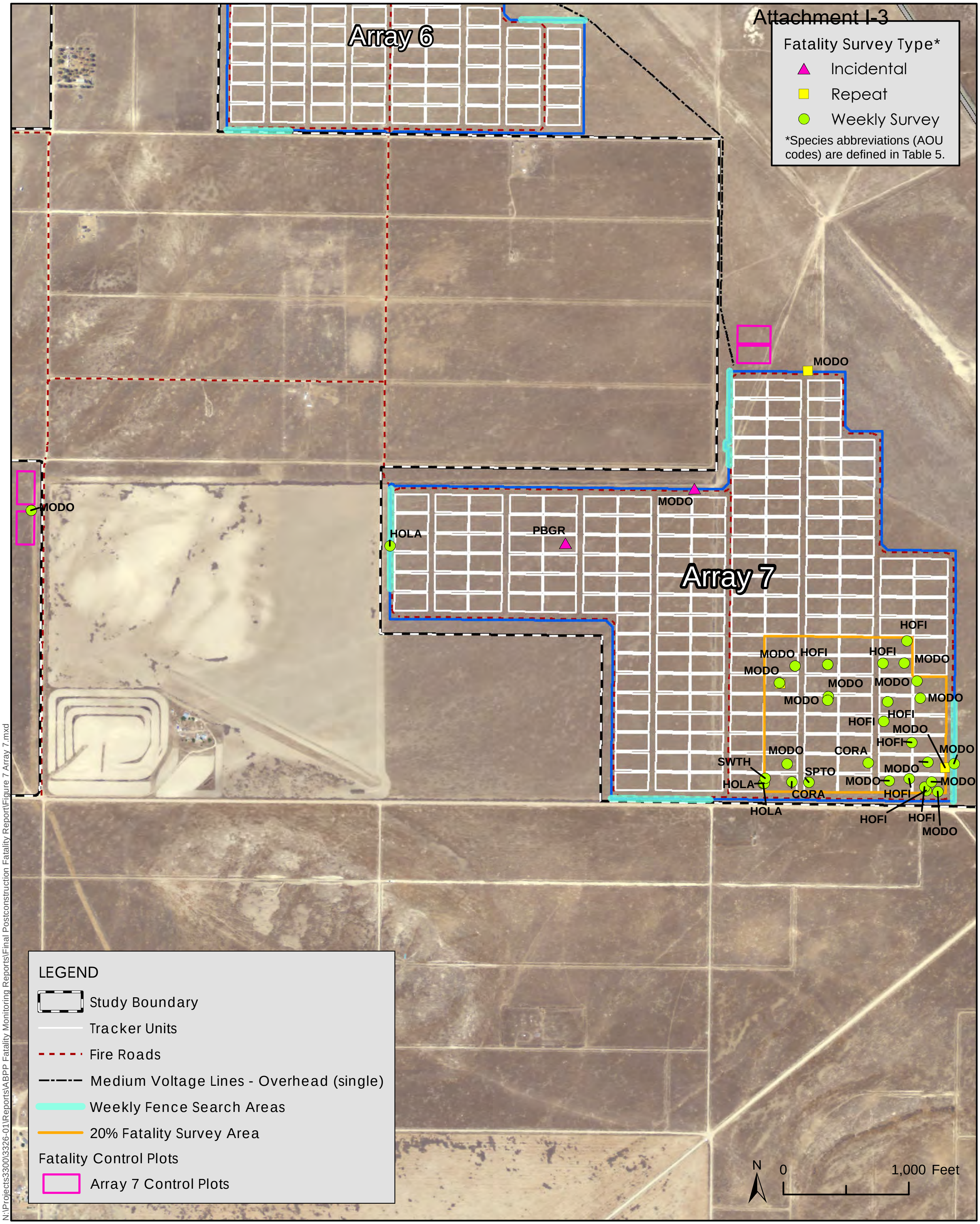
HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report
Figure 6: Locations and Species of Postconstruction Fatalities Observed in Array 6 Elements between 16 August 2013 and 7 November 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3

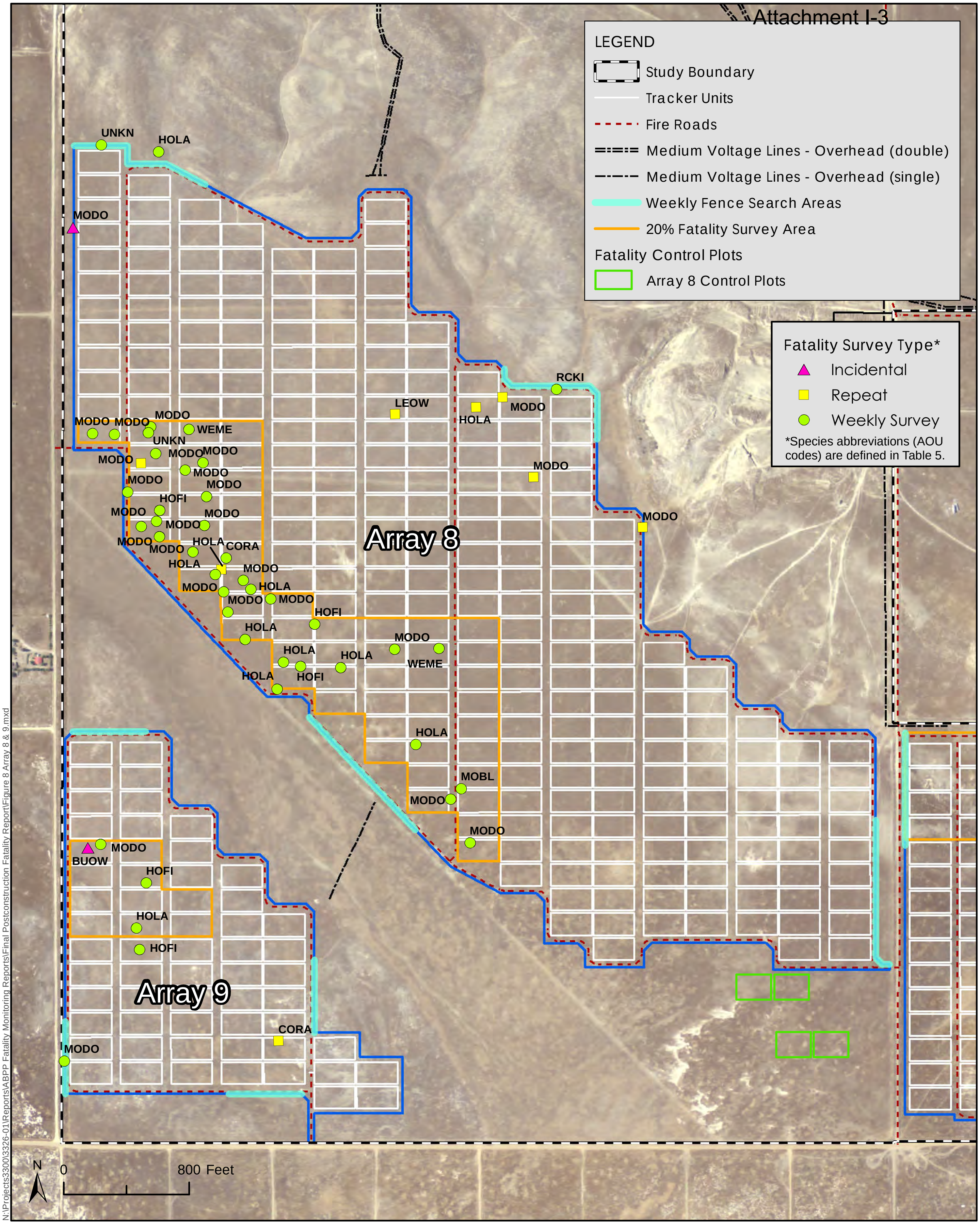


N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 7 Array 7.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report
Figure 7: Locations and Species of Postconstruction Fatalities Observed in Array 7 Elements between 16 August 2013 and 7 November 2014



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 8 Array 8 & 9.mxd

HPR II

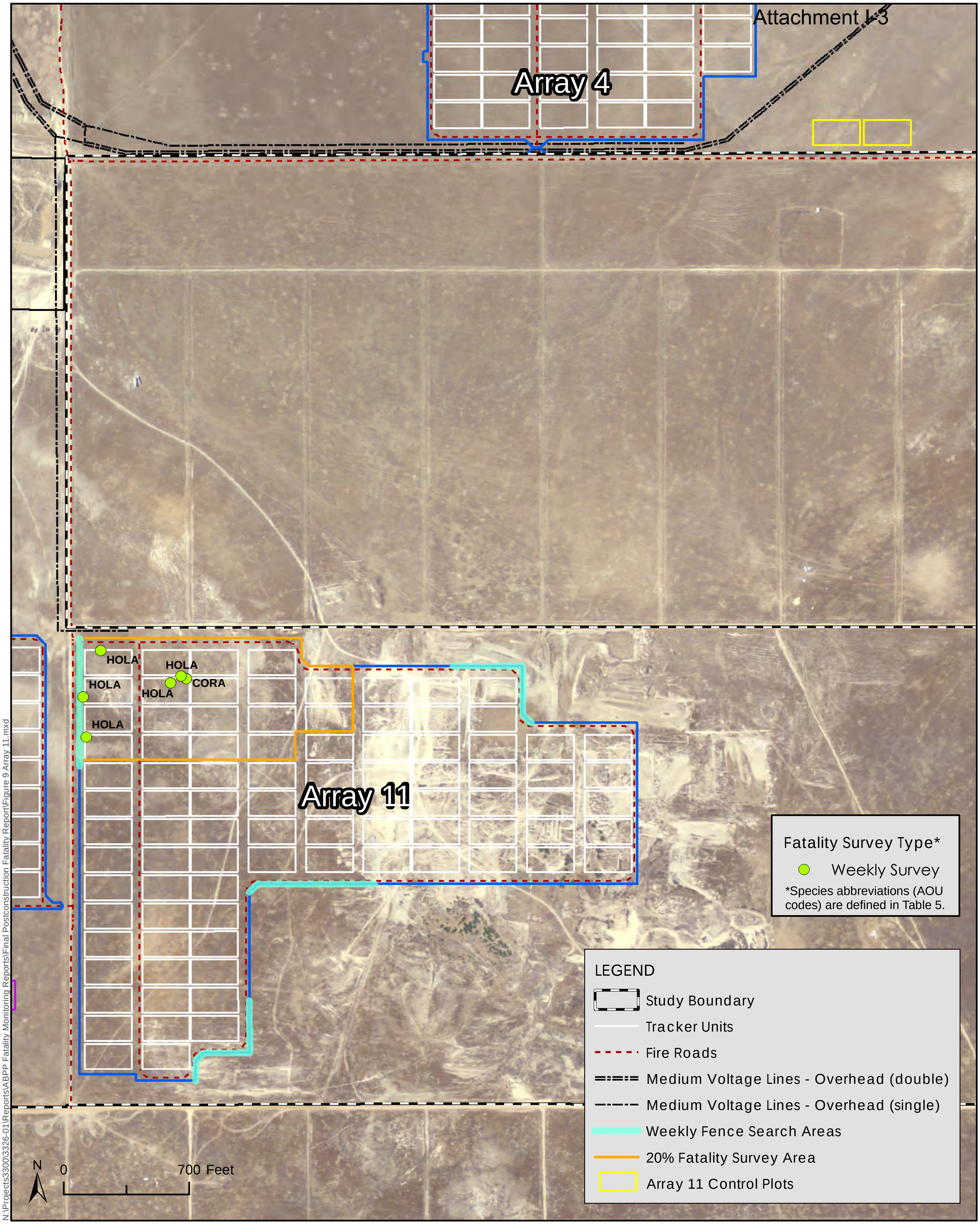
H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report

Figure 8: Locations and Species of Postconstruction Fatalities Observed in Array 8 and 9 Elements between 16 August 2013 and 17 November 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 9 Array 11.mxd

HPR II

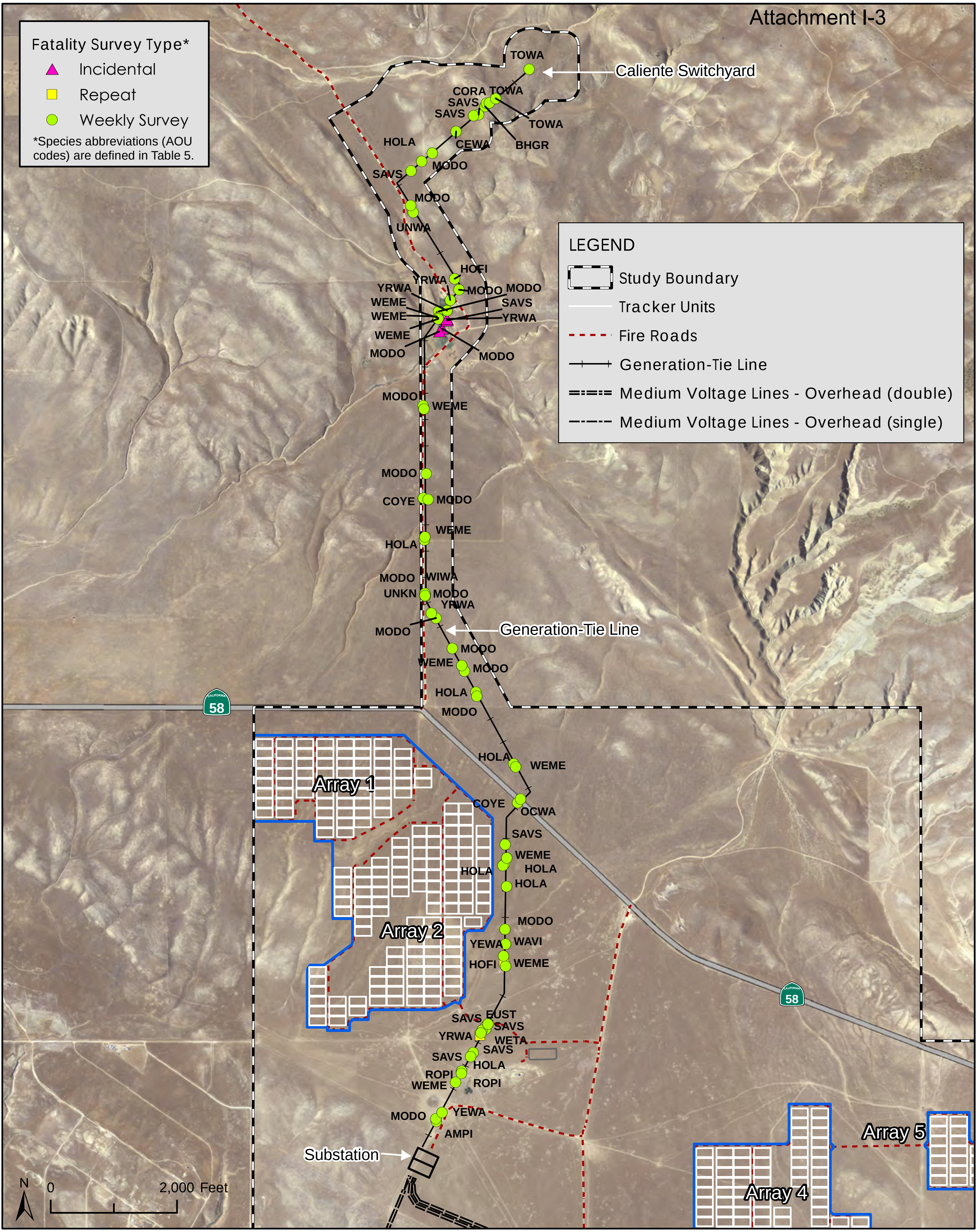
H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report

Figure 9: Locations and Species of Postconstruction Fatalities Observed in Array 11 Elements between 16 August 2013 and 17 November 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 10 Gen-tie Area.mxd

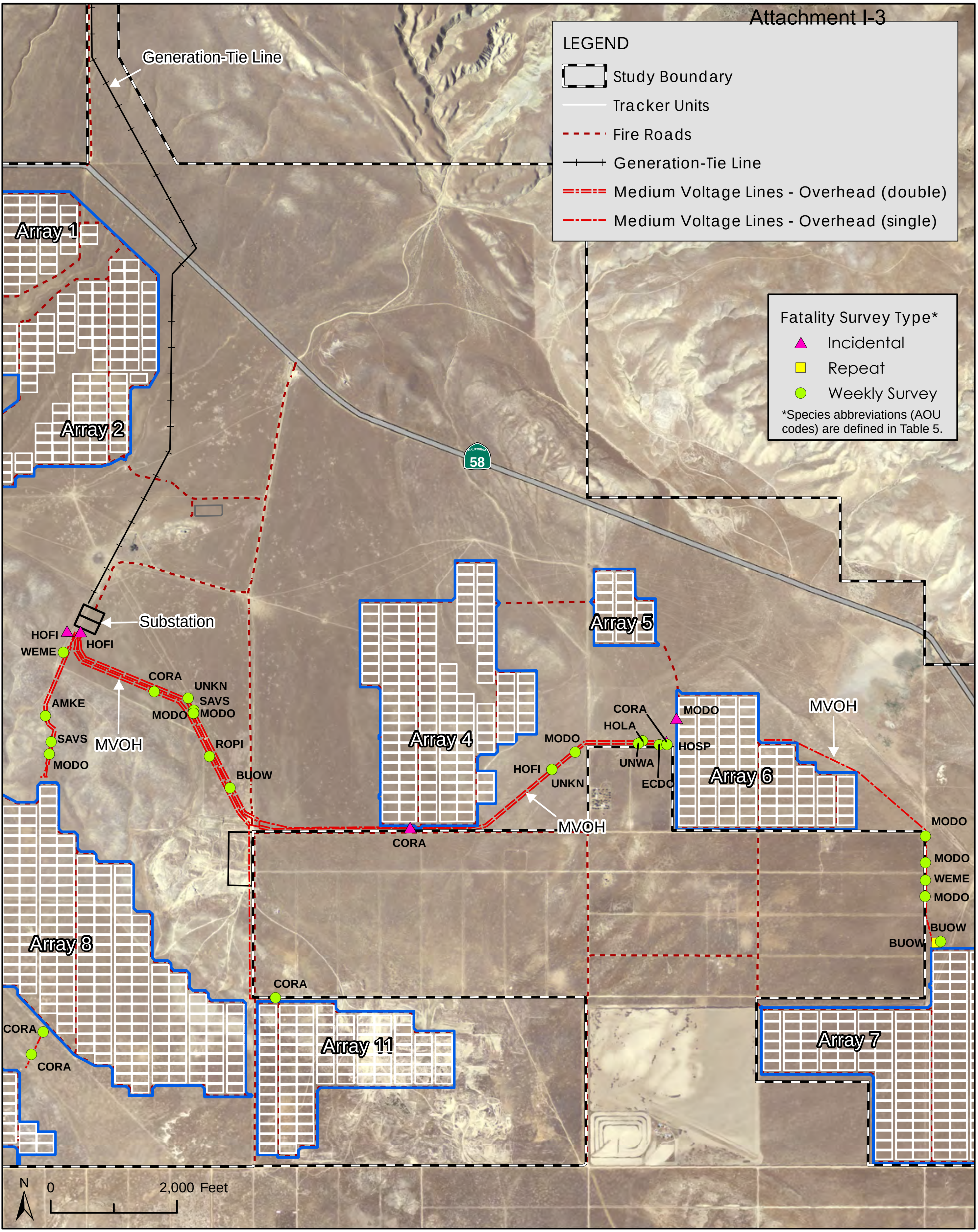
HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report
Figure 10: Locations and Species of Postconstruction Fatalities Observed along Gen-Tie Line between 16 August 2013 and 17 November 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 11 MVOH Area.mxd

HPR II

H.T. HARVEY & ASSOCIATES

Ecological Consultants

California Valley Solar Ranch

ABPP Final Postconstruction Fatality Report

Figure 11: Locations and Species of Postconstruction Fatalities Observed along MVOH Line between 16 August 2013 and 17 November 2014

Table 4. Number (a) and Percentage (b) of Fatalities Found at Each Project Element, by Season (N=300) [1]

(a)	Number of Fatalities				
Location	**Fall 2013**	**Winter**	**Spring**	**Summer**	**Fall 2014**
Arrays	27	85	31	12	21
Control plots	2	7	4	0	3
Evaporation Pond	0	4	0	0	0
Fences	3	8	2	0	1
Gen-tie Line	25	9	11	10	9
MVOH Line	6	11	6	2	1
Total	63	124	54	24	35

(b)	Percentage (%) of Fatalities				
Location	**Fall 2013**	**Winter**	**Spring**	**Summer**	**Fall 2014**
Arrays	15.34	48.30	17.61	6.82	11.93
Control plots	12.50	43.75	25.00	0.00	18.75
Evaporation Pond	0.00	100.00	0.00	0.00	0.00
Fences	21.43	57.14	14.29	0.00	7.14
Gen-tie Line	39.06	14.06	17.19	15.63	14.06
MVOH Line	23.08	42.31	23.08	7.69	3.85
Total	21.00	41.33	18.00	8.00	11.67

Note:

[1] Fatalities in non-20% areas of Arrays 1 and 2 found between 16 August 2013 and 31 December 2013 are excluded

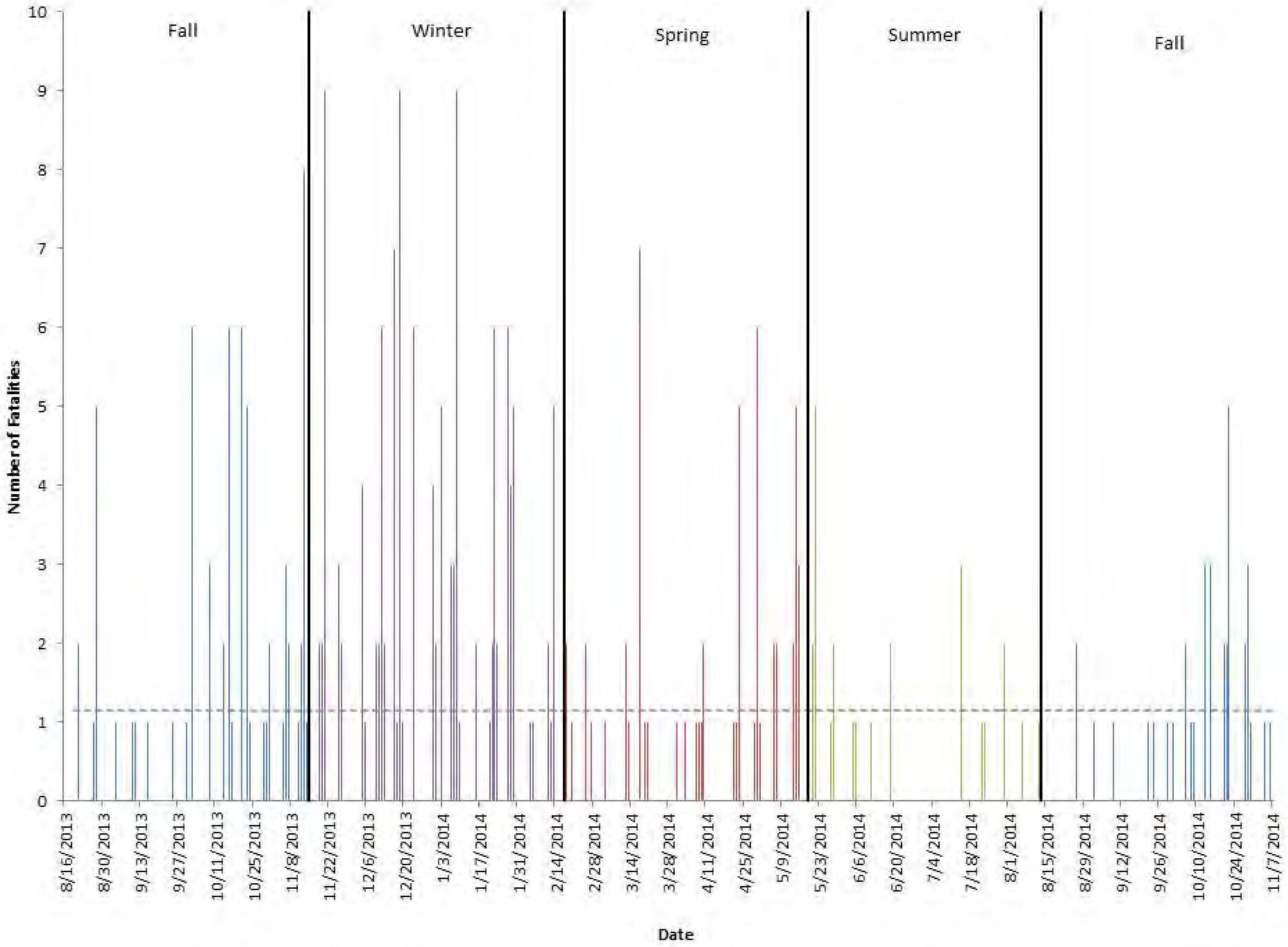


Figure 12. Seasonal Variation in Fatalities Found in Arrays

Note: Fatalities in non-20% areas in Arrays 1 and 2 found between 16 August 2013 and 31 December 2013 are excluded.

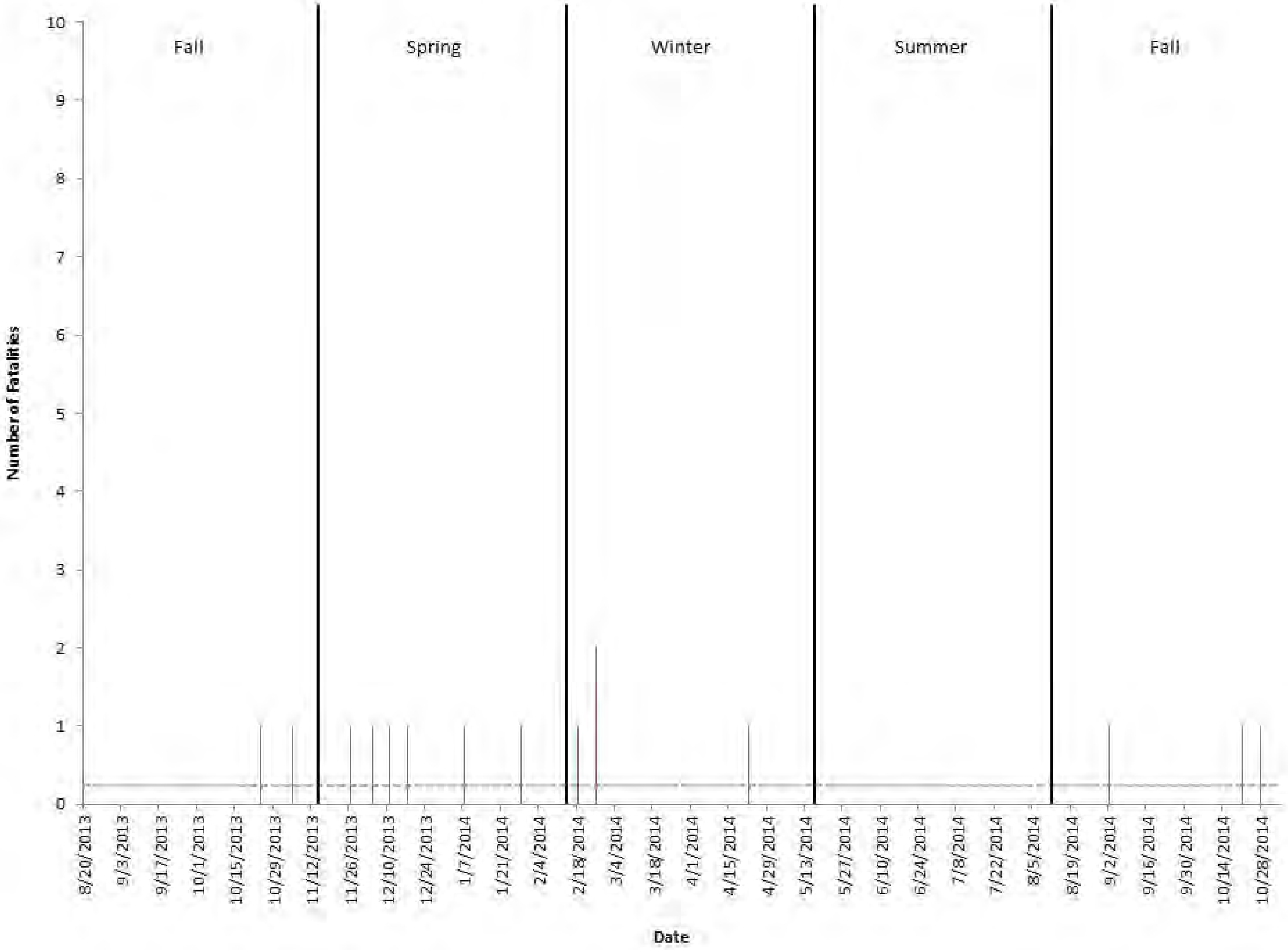


Figure 13. Seasonal Variation in Fatalities Found in Control Plots

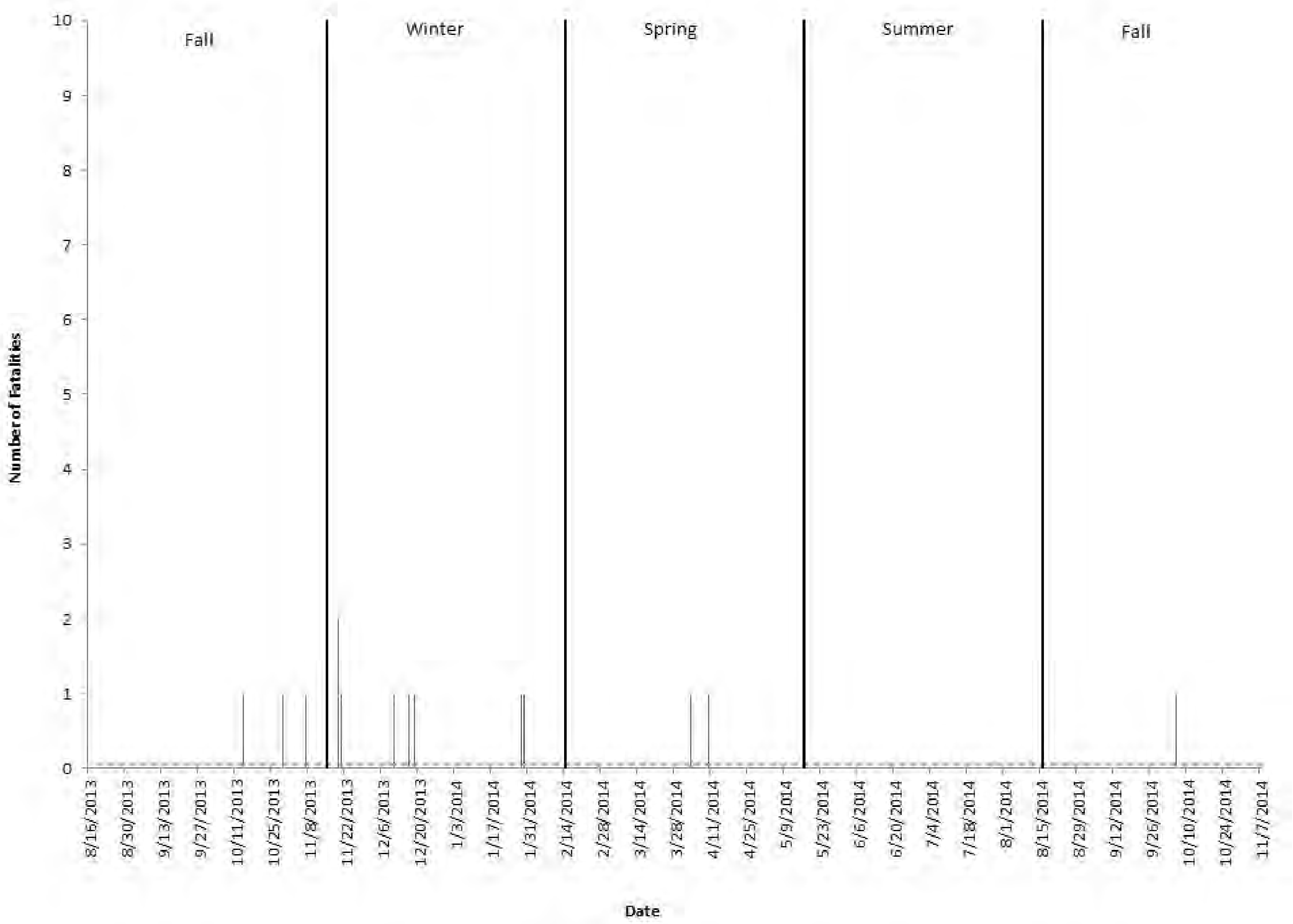


Figure 14. **Seasonal Variation in Fatalities Found along Fences**

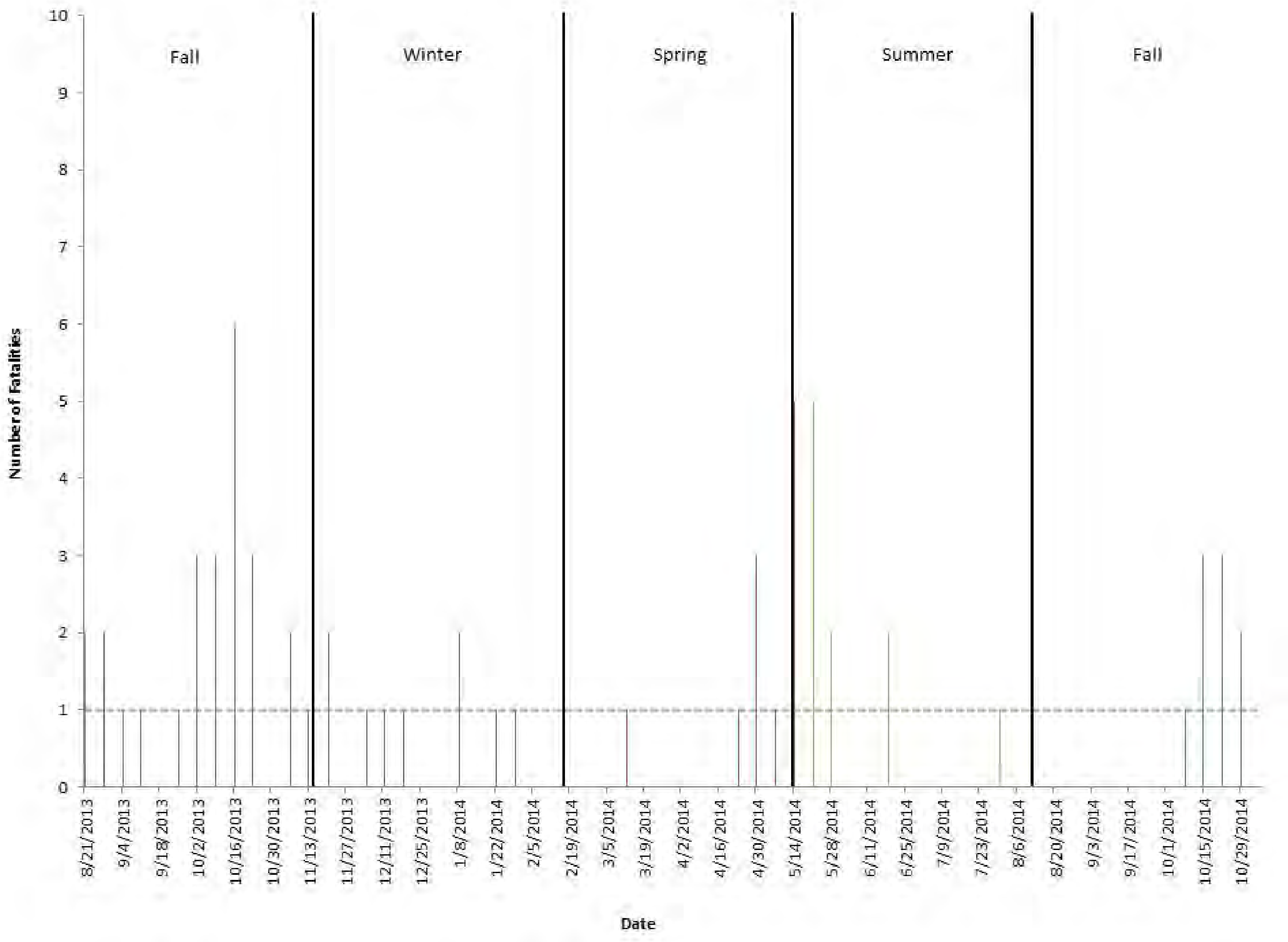


Figure 15. Seasonal Variation in Fatalities Found along Gen-tie Line

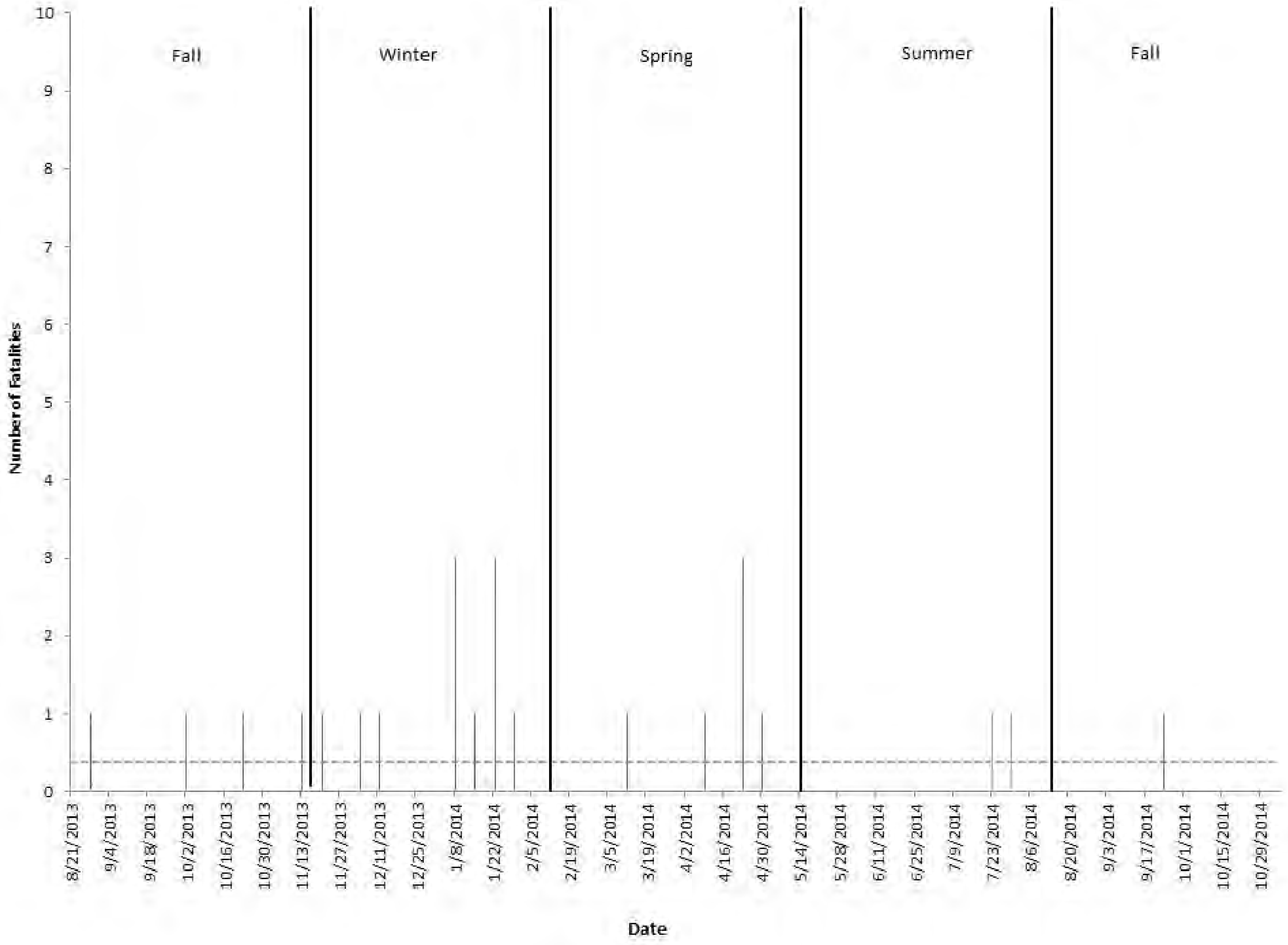


Figure 16. **Seasonal Variation in Fatalities Found along MVOH Line**

3.2 Repeat Searches

This section presents the results of all repeat searches, which (in the final year of monitoring) were conducted from 16 August through 31 December 2013. For reasons discussed in Section 2.1.2, we did not calculate fatality estimates based on the results of the 5-day repeat searches or the 1-day repeat searches in 5-day search areas for this report. However, because the 1-day repeat searches of weekly search areas affected the search interval for weekly searches and occurred in overlapping areas, these results were included in total fatality estimates (consistent with the first annual report [HTH 2014a]).

In total, 54 fatalities were detected during repeat searches across all Project elements and control plots. Eighteen of these fatalities were clearance fatalities and are not discussed further, for reasons described earlier. Therefore, the effective sample size for repeat searches was 36 fatalities. Combining the results of all repeat searches, the largest percentage (83.3%) of fatalities was found in the arrays. Details of fatalities found during each type of repeat search are presented below.

3.2.1 5-Day Repeat Searches

Nineteen fatalities were found during 5-day repeat searches between 16 August and 31 December 2013. An additional 18 clearance fatalities were found but not used in any analyses. One of these fatalities was found directly under the MVOH Line, suggesting collision as the cause of death (>50% certainty, or Probable). The cause of death for the remainder of fatalities was unknown.

3.2.2 1-Day Repeat Searches of Weekly Search Areas

Fifteen fatalities were found during 1-day repeat searches of weekly search areas during this annual reporting period. Two feather spots were found directly under the Gen-tie Line and were considered to have >50% probability of death by collision (Probable). The carcass of a mourning dove was found in Array 2. This carcass had bruising on its right foot and signs of trauma to its right shoulder and chest, suggesting that collision was a Valid (>90% certainty) cause of death. The cause of death for the remainder of fatalities was unknown.

3.2.3 1-Day Repeat Searches of 5-Day Repeat Search Areas

Two fatalities were found during 1-day repeat searches of 5-day repeat search areas between 16 August and 31 December 2013. One was the feather spot of a mourning dove, found along the fence in Array 8 on 18 October. The second was the feather spot of a common raven (*Corvus corax*), found in Array 9 on 8 November. The causes of death could not be discerned for these fatalities.

3.3 Incidental Fatalities

Thirty-five incidental fatalities were found between 16 August 2013 and 17 November 2014. This number includes two fatalities that were found in onsite Conservation Lands. Of the total number of fatalities found incidentally, 46.8% were found in arrays. Only one fatality was found and reported by CVSR Project staff.

Two ravens were found in separate events and both were suspected to have died from electrocution. A pied-billed grebe (*Podilymbus podiceps*) was observed being consumed by a coyote (*Canis latrans*), but because grebes are obligate waterbirds, collision was assigned as the cause of death. A mourning dove was also assumed to have died from collision after a smudge mark was discovered on an otherwise clean panel above a feather spot.

3.4 Trends in Total Fatalities

The subsections that follow present combined counts of fatalities found during weekly searches, repeat searches, and incidental detections. The purpose of combining these counts is to use all available data to help illustrate possible trends associated with Project elements and species.

Overall, 453 fatalities were found during weekly and repeat searches of Project elements, and incidentally. Twenty two of these fatalities were clearance fatalities, and 2 of the incidentally discovered fatalities were found on onsite Conservation Lands. In this section, we do not include any further discussion of clearance fatalities or fatalities found on Conservation Lands outside of control plots. Therefore, the effective sample size discussed for all Project elements in this section is 429 fatalities. The majority of these fatalities were found in arrays (Figure 17).

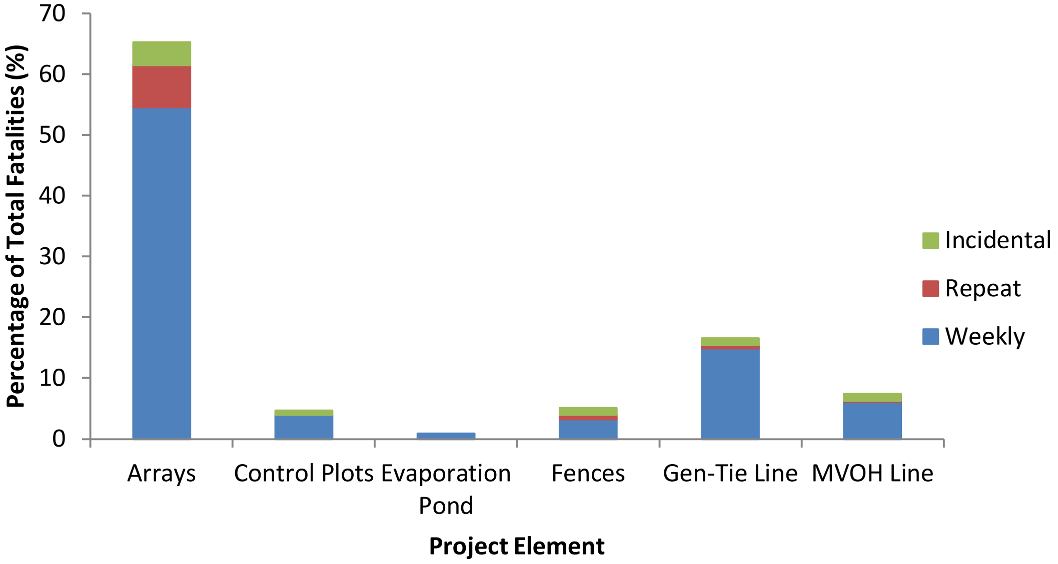


Figure 17. Percentage of Total Fatalities Found during Weekly Searches, Repeat Searches, and Incidentally at All Project Elements (N=429)

Note: Incidental fatalities found in onsite Conservation Lands, and clearance fatalities, are not included.

3.4.1 Cause of Death

Of the 429 fatalities found in Project elements and control plots, the cause of death for the majority (80.9%) could not be reliably discerned. Seventy-three (17.0%) were believed to have died as a result of a collision (50 on the Gen-tie Line, 15 on the MVOH Line, 7 with solar panels, and 1 with a perimeter fence). Two fatalities were believed to be electrocuted (0.5%). Six (1.4%) were believed to have been killed by predators, and one (0.2%) was believed to have died from disease.

Both electrocution deaths occurred along the MVOH Line (Figure 18). Although none of the fatalities found in control plots had a known cause of death, >45% of the fatalities found along the Gen-tie Line and MVOH Line were believed to be the result of collision. This determination was based primarily on the location of fatalities directly or nearly directly under the lines. Only eight fatalities found in arrays were linked to known causes of death (seven panel collisions and one predation event), and the remaining 97.1% of fatalities found in arrays were assigned an unknown cause of death.

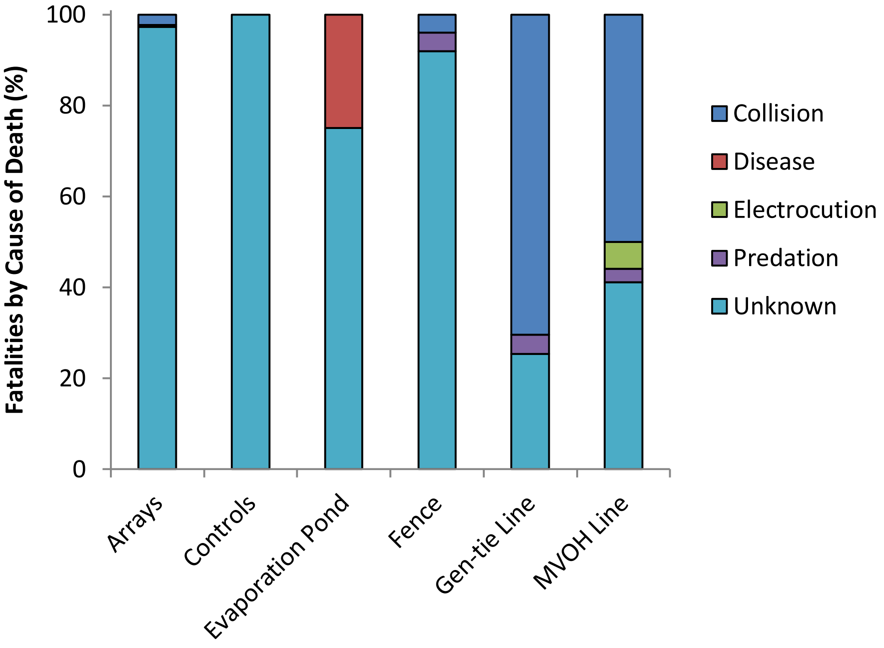


Figure 18. Cause of Death by Project Element

3.4.2 Fatalities by Species

In total, we found fatalities from 36 known avian species and 5 fatalities that did not provide enough information to assign them to a species (Table 5). With the exception of two American coots (*Fulica americana*) found in Arrays 4 and 5, and one pied-billed grebe found in Array 7, all known fatalities were terrestrial avian species.

Mourning doves accounted for the greatest percentage of fatalities (38.9%) found, with horned larks and house finches (*Carpodacus mexicanus*) composing the second (13.5%) and third (13.1%) most frequently observed fatalities, respectively. Fatalities from three special-status species, burrowing owl (*Athene cunicularia*), loggerhead shrike (*Lanius ludovicianus*), and yellow warblers (*Setophaga petechial*) were detected during weekly searches, but combined, these fatalities accounted for only about 3% of the total number of fatalities found during weekly searches.

Table 5. Number of Fatalities Found, by Species

Species	Scientific Name	AOU Code[4]	Fatalities Recorded
Mourning dove[2]	*Zenaida macroura*	MODO	167
Horned lark[1]	*Eremophila alpestris*	HOLA	58
House finch[1]	*Haemorhous mexicanus*	HOFI	56
Western meadowlark[1]	*Sturnella neglecta*	WEME	30
Common raven[2]	*Corvus corax*	CORA	21
Savannah sparrow[1]	*Passerculus sandwichensis*	SAVS	18
Rock pigeon[2]	*Columba livia*	ROPI	11
Burrowing owl[2]	*Athene cunicularia*	BUOW	7
Yellow-rumped warbler[1]	*Dendroica coronata*	YRWA	6
Eurasian collared-dove[2]	*Streptopelia decaocto*	EUCD	4
Unknown passerine[3]		UNKN	4
Brewer's blackbird[1]	*Euphagus cyanocephalus*	BRBL	3
Loggerhead shrike[1]	*Lanius ludovicianus*	LOSH	3
Townsend's warbler[1]	*Dendroica townsendii*	TOWA	3
Unknown large bird[2]		UNKN	3
American coot[2]	*Fulica americana*	AMCO	2
American pipit[1]	*Anthus rubescens*	AMPI	2
Common yellowthroat[1]	*Geothlypis trichas*	COYE	2
European starling[1]	*Sturnus vulgaris*	EUST	2
House sparrow[1]	*Passer domesticus*	HOSP	2
Lark sparrow[1]	*Chondestes grammacus*	LASP	2
Ruby-crowned kinglet[1]	*Regulus calendula*	RCKI	2
Warbler species[1]		UNWA	2
Yellow warbler[1]	*Setophaga petechia*	YEWA	2
American kestrel[2]	*Falco sparverius*	AMKE	1
Black-headed grosbeak[1]	*Pheucticus melanocephalus*	BHGR	1
Barn owl[2]	*Tyto alba*	BANO	1
Cedar waxwing[1]	*Bombycilla cedrorum*	CEDW	1
Fox sparrow[1]	*Passerella iliaca*	FOSP	1

Species	Scientific Name	AOU Code[4]	Fatalities Recorded
Long-eared owl[2]	*Asio otus*	LEOW	1
Mountain bluebird[1]	*Sialia currucoides*	MOBL	1
Orange-crowned warbler[1]	*Vermivora celata*	OCWA	1
Pied-billed grebe[2]	*Podilymbus podiceps*	PBGR	1
Song sparrow[1]	*Melospiza melodia*	SOSP	1
Spotted towhee[1]	*Pipilo maculatus*	SPTO	1
Swainson's thrush[1]	*Catharus ustulatus*	SWTH	1
Unknown raptor[2]		UNKN	1
Unknown small bird[1]		UNKN	1
Warbling vireo[1]	*Vireo gilvus*	WAVI	1
Western tanager[1]	*Piranga ludoviciana*	WETA	1
Wilson's warbler[1]	*Wilsonia pusilla*	WIWA	1
Total			**429**

Notes:
[1] Denotes species modeled as small birds in the Fatality Estimator.
[2] Denotes species modeled as large birds in the Fatality Estimator.
[3] These unidentifiable species were examined and determined to be large or small birds for the purposes of the Fatality Estimator on a case-by-case basis.
[4] Codes designated by the American Ornithologists' Union (AOU) Check-list of North American Birds (AOU 2015). Codes for unknown species are not designated by the AOU. For purposes of this report, unidentifiable large birds, small birds, raptors, or passerines are designated as UNKN. Unidentifiable warblers are designated as UNWA.

3.4.3 Fatalities by Residency Group

When comparing migrants (transient species traveling between summer breeding grounds and wintering grounds), residents (species living in the region year-round), and winter residents (species present in the region only in the winter), across all Project elements, residents accounted for the highest proportion of fatalities in arrays (70.46%), compared with all other Project elements (Table 6). Migrants and winter residents accounted for the highest number of fatalities along the Gen-tie Line (63.64% and 51.85%, respectively), compared with all other Project elements.

Table 6. Percent of Residency Group Fatalities across Project Elements (N=429)

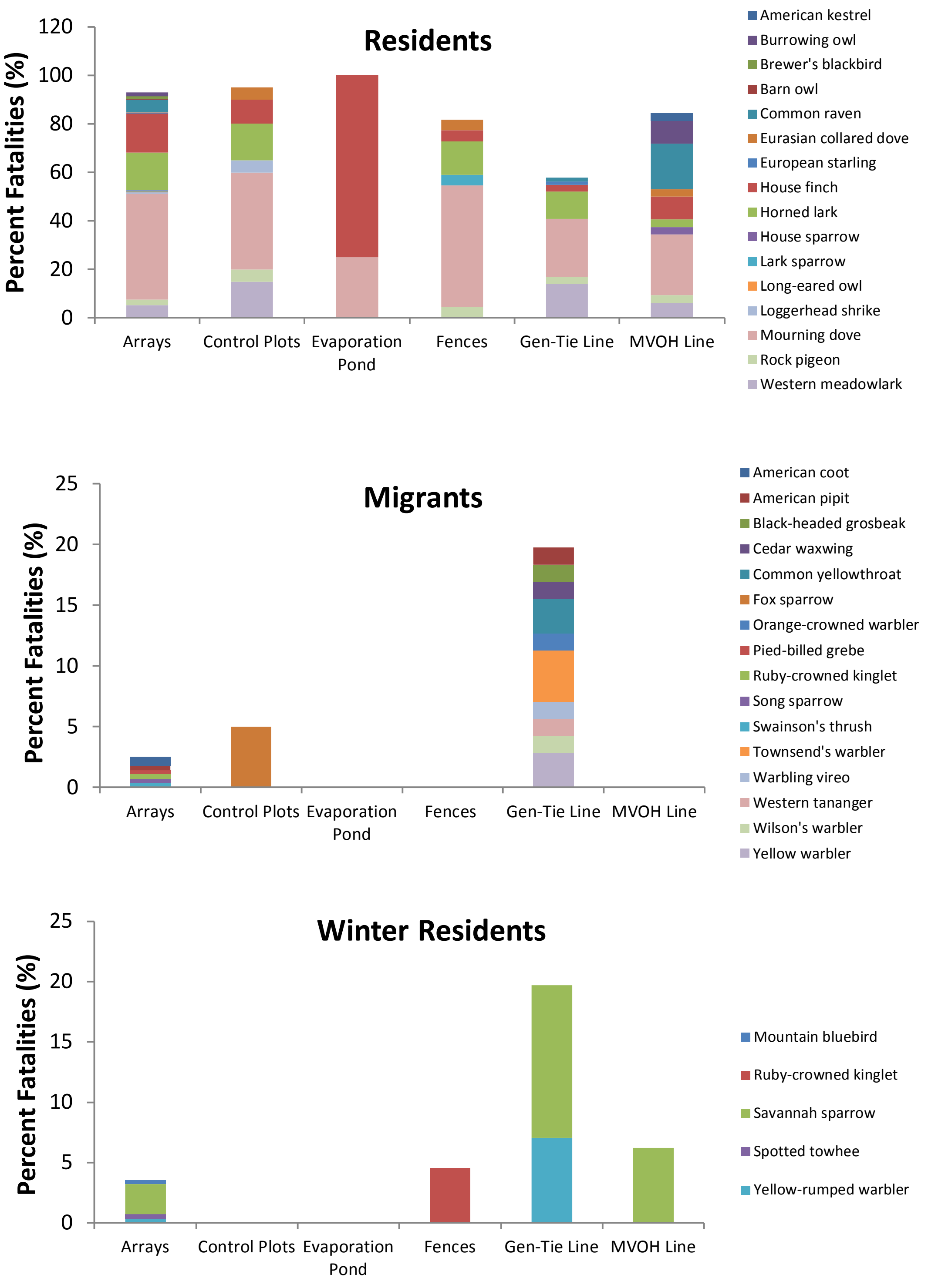
	Percent (%) of Fatalities			
Project Element	**Migrant**	**Resident**	**Winter Resident**	**Unknown**
Arrays	31.82	70.46	37.04	27.27
Control plots	4.55	5.15	0.00	0.00
Evaporation Pond	0.00	1.08	0.00	0.00
Fences	0.00	4.88	3.70	27.27
Gen-Tie Line	63.64	11.11	51.85	18.18
MVOH Line	0.00	7.32	7.41	27.27
Residency Group Total	100	100	100	100

Within each Project element, avian resident fatalities accounted for the highest percentage of fatalities (Table 7, Figure 19). Migrant and winter resident fatalities accounted for the second highest percentage of fatalities (19.72% and 19.72%), but only with the Gen-tie Line.

Table 7. Percent of Residency Group Fatalities within Project Elements (N=429)

	Percent (%) of Fatalities in Each Project Element				
Project Element	**Migrant**	**Resident**	**Winter Resident**	**Unknown**	**Total Percent Fatalities**
Arrays	2.50	92.86	3.57	1.07	100
Control plots	5.00	95.00	0.00	0.00	100
Evaporation Pond	0.00	100.00	0.00	0.00	100
Fences	0.00	81.82	4.55	13.64	100
Gen-tie Line	19.72	57.75	19.72	2.82	100
MVOH Line	0.00	84.38	6.25	9.38	100

Within each Project element, the highest species richness of fatalities was found in the arrays and along the Gen-tie Line, but the overall species composition of fatalities for these Project elements differed. The MVOH line had the third highest species richness of fatalities. In contrast, no migratory species fatalities were found along the MVOH line. The lowest species richness of fatalities was found in control plots, fences and the Evaporation Pond.



Notes: Residency status is based on knowledge of species typically found on the Project site at different times of the year. Unknown species (N=11) are not included in this figure.

Figure 19. Fatalities, by Species and Residency Group, as Percentages of the Total Fatalities in Each Project Element (N=418)

3.4.4 Gen-tie Line Trends by Elevation

Both overhead lines (the Gen-tie and the MVOH Lines) had a high percentage of fatalities with known causes of death. However, the seasonal graphs of the Gen-tie Line monitoring results demonstrate peaks that could be associated with migratory activity, whereas the MVOH Line data did not. The Gen-tie Line is unique among the other Project elements in several ways: it is the only Project element that has a variety of elevations along its length, it crosses over a tamarisk wetland in the area north of State Route 58, and the powerlines are higher above the ground than those associated with the MVOH Line.

To help determine what factor had the largest effect on the differences in fatality rates and species richness of fatalities found along the two lines, we assessed the numbers of fatalities along the Gen-tie Line by elevation. Although elevation consistently increases as the tower numbers increase from the substation (Tower 1) to the Caliente switching station (Tower 23), the number of fatalities found between towers does not indicate a pattern (Figure 20). Similarly, the number of species found at different areas along the Gen-tie Line did not increase with elevation, and did not cluster around the tamarisk wetland located between Gen-tie Line towers 17 and 18 (Figure 21).

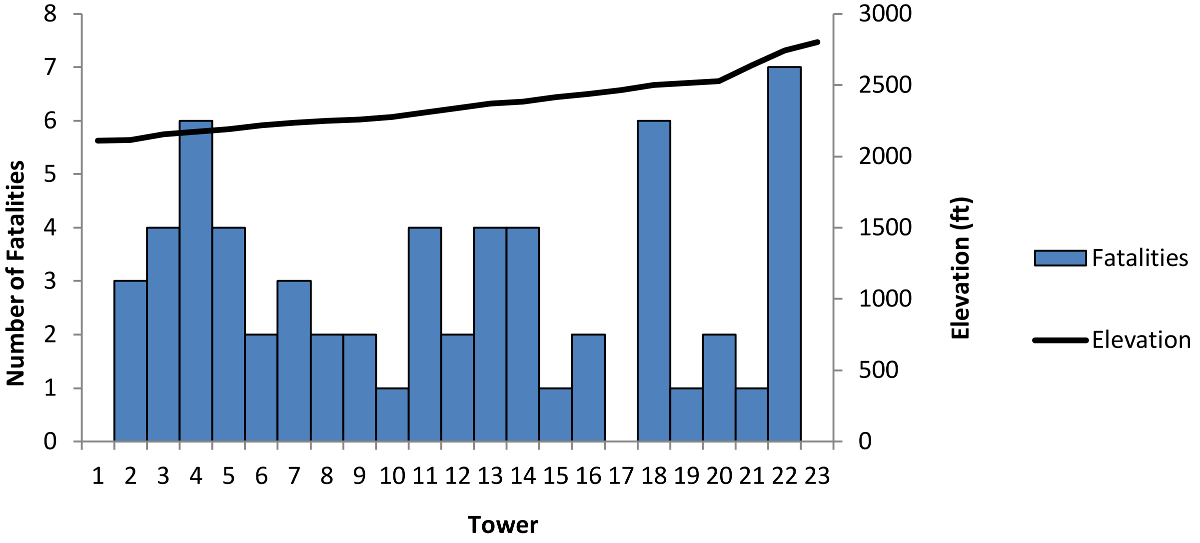


Figure 20. Number of Fatalities along the Gen-tie Line, by Elevation and Tower Number

Note: Fatalities are grouped from tower to tower (e.g., all fatalities found between the substation and Tower 1 are graphed under Tower 1).

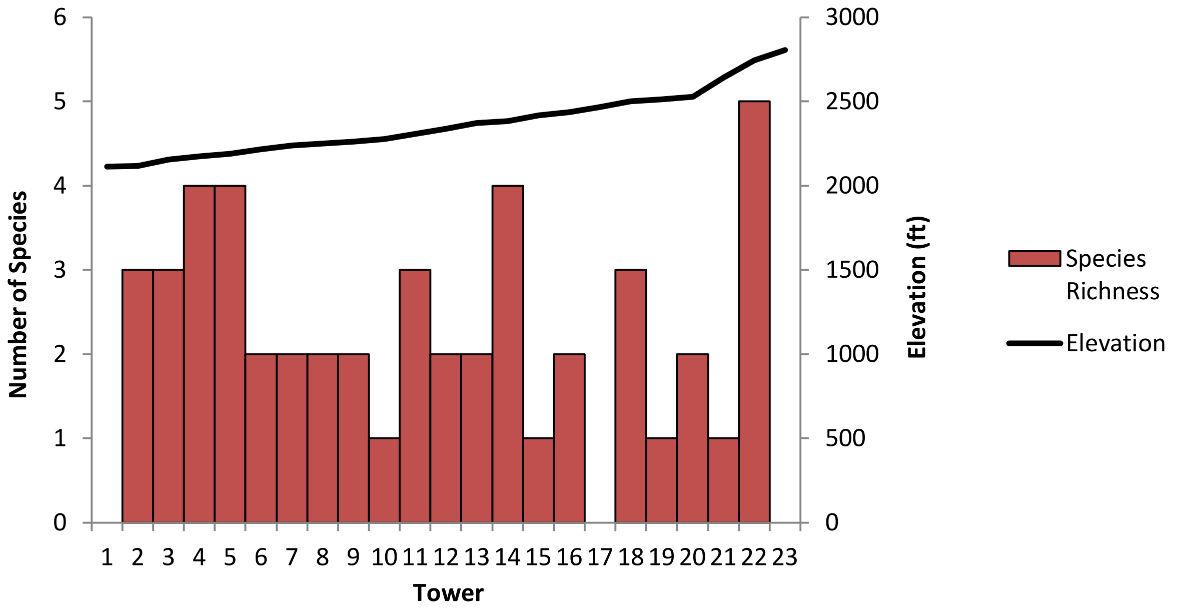


Figure 21. Species Richness of Fatalities Found along the Gen-tie Line, by Elevation and Tower Number

Note: Fatalities are grouped from tower to tower (e.g., all fatalities found between the substation and Tower 1 are graphed under Tower 1. The tamarisk wetland is located between Towers 17 and 18).

3.5 Fatality Estimates

3.5.1 Carcass-persistence Rates

3.5.1.1 Overall Project Site Persistence Rates

Between 15 October 2012 and 11 March 2014, we conducted carcass-persistence trials using 206 fatality plants. Eleven fatality plants were excluded because full persistence data were not collected (i.e., carcasses were collected by staff after the initial scavenging event). One-hundred and five carcasses were placed after the first annual reporting period, but because the results of both years were used to inform persistence times in the Fatality Estimator, the results of all trials are presented here.

From our 30 feather spot persistence trials, we calculated that feather spots persisted an average of 18 days on bare ground, 35 days in low grass (≤25 cm), and 45 days in medium or high grass (>25 cm). We applied these values as adjustment factors for all feather spots that persisted after scavenging, and these are the values we report below, unless otherwise noted. Feather spots that were left on low grass with <50% cover in a 1-m^2 area were assigned the same adjustment factor as those on bare ground.

3.5.1.2 Persistence Rates by Explanatory Variables

Observed scavenger species included common ravens, which scavenged 46.2% of all planted fatalities; San Joaquin kit foxes (*Vulpes macrotis mutica)*, which scavenged 22.1% of all planted fatalities; coyotes, which scavenged 5.6% of all planted fatalities; and one of each of the following: a turkey vulture (*Cathartes aura*), a prairie falcon

(*Falco mexicanus*), and a red-tailed hawk (*Buteo jamaicensis*) (Figure 22). Two planted carcasses, a great horned owl (*Bubo virginianus*) and a red-tailed hawk, remained mostly intact for the full 6-week monitoring period, so no final scavenger species was assigned to these carcasses. Unknown scavengers accounted for 23.6% of all scavenging events.

After 7 days, only 10.8% of all small carcasses remained unscavenged. However, 25.0% of all small carcasses and resultant feather spots remained in place (Figure 23). This effect was even more dramatic for large carcasses: whereas only 25.3% of all carcasses remained after a week, more than half (65.7%) of all large carcasses either remained in place or left feather spots behind.

Figure 22. Scavenger Species Documented in Carcass-persistence Trials

Notes: Clockwise from top left, recorded scavenger species were as follows: common raven, San Joaquin kit fox, turkey vulture, red-tailed hawk, prairie falcon, and a coyote.

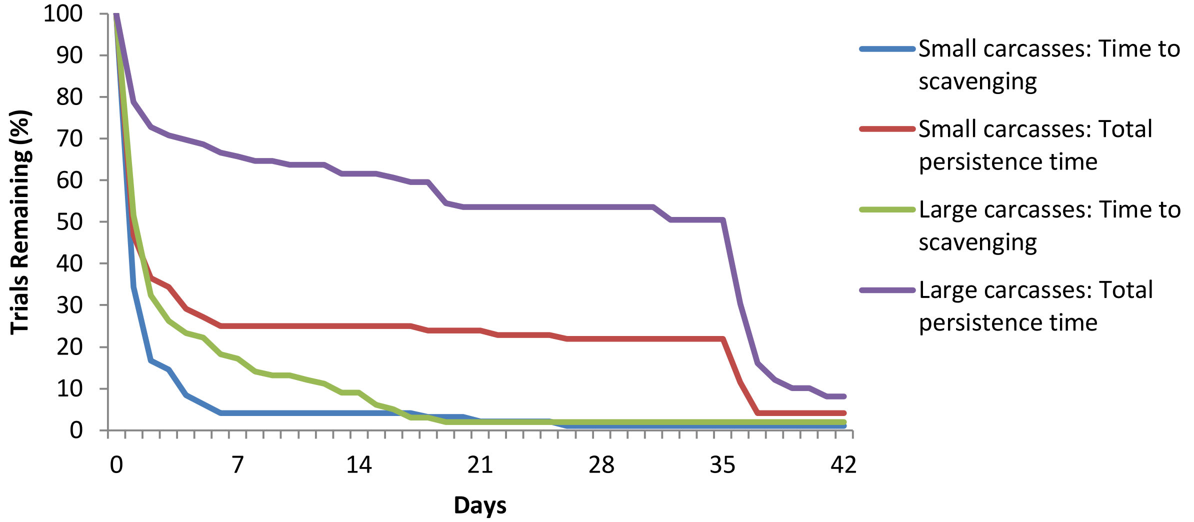


Figure 23. Percent of All Carcasses and Resultant Feather Spots Remaining Over Time (N=195)

Time to scavenging was longest for both large and small carcasses in the winter. Assuming conservatively that carcasses would not persist past the 6-week trial period, mean carcass persistence over the entire year was 9.3 days for small carcasses and 22.2 days for large carcasses. Total persistence times did not exhibit a clear seasonal pattern, but clearly varied by carcass size (Table 8).

Table 8. Average Time to Scavenging and Average Total Persistence, by Size and Season

Season	Carcass Size	N	Average Time to Scavenging (days)	Average Total Persistence (days)
Fall	Small	29	1.52	11.91
	Large	28	2.77	17.80
Winter	Small	29	3.56	9.87
	Large	30	5.16	17.27
Spring	Small	22	1.62	4.30
	Large	28	4.03	30.51
Summer	Small	16	1.08	12.02
	Large	13	2.53	27.34

3.5.1.3 Model Selection for Carcass-persistence Decay Curve

Based on the carcass-persistence data, we compared 16 possible models. The model with the lowest AICc had a lognormal distribution and controlled for carcass size but not season (Table 9). Because the ΔAICc is >2 between this model and the next ranked model, this model alone has substantial support, and we used this model in the fatality estimates.

Table 9. AICc Values for Each of 16 Models of Carcass Persistence

Distribution	Model Formula	AICc	Shape
Exponential	Null	1012.0	1.0
Exponential	Season	1010.7	1.0
Exponential	Size	946.6	1.0
Exponential	Season + Size	949.4	1.0
Loglogistic	Null	680.1	2.41
Loglogistic	Season	684.1	2.39
Loglogistic	Size	637.2	2.06
Loglogistic	Season + Size	639.8	2.04
Lognormal	Null	671.7	3.92
Lognormal	Season	675.7	3.89
Lognormal	**Size**	**631.8**	**3.45**
Lognormal	Season + Size	634.4	3.41
Weibull	Null	699.3	3.21
Weibull	Season	702.3	3.19
Weibull	Size	659.2	2.96
Weibull	Season + Size	663.1	2.95

Notes: AICc = Akaike's Information Criterion, adjusted for sample size. Lognormal model in **bold** is best supported. "Null" indicates models with no explanatory variables.

3.5.2 Searcher-efficiency Rates

Between 5 September 2012 and 31 July 2014, we conducted 434 searcher-efficiency trials in all operational Project elements throughout the site. Three trial specimens (two large carcasses and one small carcass) were removed by scavengers and not used in analysis. Therefore, we used a total of 431 fatality trial specimens: 113 small and 98 large feather spots, and 113 small and 107 large carcasses. Fatality plants were placed in areas with various combinations of vegetation height and percent cover.

Overall searcher efficiency was 50.8% (Table 10). When accounting for size and visibility class, each on their own, searchers were most effective at detecting large carcasses, large feather spots, and fatality plants placed in the Easy visibility class. When accounting for size and visibility class together, searcher efficiency for large carcasses and large feather spots in the Easy visibility class was 80% and 77.1%, respectively. Searcher efficiency was slightly lower for large carcasses in the Moderate visibility class, at 66.7%, and was 50.9% for small carcasses in the Easy visibility class. At 25.5%, searchers were least effective at finding small feather spots in the Moderate visibility class.

Table 10. Results from Searcher-efficiency Trials, September 2012 through July 2014

Category	Detection Rate (%)	N
Overall	50.8	431
Size Class		
Large carcass	72.9	107
Small carcass	41.6	113
Large feather spot	65.3	98
Small feather spot	26.5	113
Visibility Class		
Easy visibility	57.3	211
Moderate visibility	44.5	220
Size Class and Visibility Class		
Large carcass, Easy visibility	80.0	50
Large carcass, Moderate visibility	66.7	57
Small carcass, Easy visibility	50.9	55
Small carcass, Moderate visibility	32.8	58
Large feather spot, Easy visibility	77.1	48
Large feather spot, Moderate visibility	54.0	50
Small feather spot, Easy visibility	27.6	58
Small feather spot, Moderate visibility	25.5	55

3.5.2.1 Model Selection

Based on the searcher-efficiency trial data, we compared four possible models. The model with the lowest AICc controlled for both visibility class and size class (Table 11). Because the ΔAICc is >2 between this model and the next ranked model, this model alone has substantial support, and we used this model in the fatality estimates.

Table 11. AICc Ranking of Searcher-efficiency Models

Model	AICc
Null	599.39
Visibility	594.33
Size Class	543.89
Size Class + Visibility	**536.23**

Notes: AICc = Akaike's Information Criterion, adjusted for sample size.
Model in **bold** is best supported.

3.5.3 Fatality Estimates for Known Causes

After determining the proper model structure for both searcher-efficiency and carcass-persistence trials, we ran a series of fatality estimates. We report fatality estimates only for areas and categories in which more than five fatality detections occurred, because using the Fatality Estimator with five or fewer detections produces highly biased values due to the small sample size.

Fatality estimates were calculated separately for each Project element, with the exception of the Evaporation Pond, where a low sample size precluded running a fatality estimate. Estimates are first provided for fatalities where the cause of death was determined based on direct evidence of collision or electrocution. Following these estimates, we provide estimates for fatalities where the cause of death could not be determined or was natural (i.e., cause of death was disease or predation) (Section 3.5.4).

3.5.3.1 Total Fatality Estimates for Known Causes

Of the 53 fatalities for which the cause of death could be determined, 40 were included in the fatality estimate models (Table 12). Two from the arrays were excluded from the model but then added, unadjusted, to the estimator output, to produce the total fatality estimate for known causes. Eleven fatalities with evidence of electrocution or collision were not included in the fatality estimates: four were excluded because they were found incidentally, five were excluded because they were older than the search interval, and two were excluded because they were found in Array 1 and 2 outside of the 20% search areas established in January 2014.

Table 12. Number of Detections Based on Known Causes in Each Project Element, and Number Included in Fatality Estimates, 7 November 2013 to 6 November 2014

	Fatalities Detected		
Project Element	**Number Included**	**Number Excluded**	**Total Found**
Arrays	0	6[1,2]	6
Control plots	0	0	0
Evaporation Pond	0	0	0
Fences	0	0	0
Gen-tie Line	29	5[3]	34
MVOH Line	11	2[4]	13
Total	**40**	**13**	**53**

Notes:

[1] Two fatalities were excluded because they were incidentals and two fatalities were excluded because they were found outside of the 20% areas for Array 1 and 2 prior to January 2014.

[2] No estimate was provided for this element because of the low sample size; the remaining two fatalities (see Note 1) were added unadjusted to the overall estimator output.

[3] Five fatalities were excluded because they were older than the search interval.

[4] Two electrocuted fatalities were excluded because they were found incidentally.

During the period of 7 November 2013 to 6 November 2014, an estimated 126 birds died from electrocution- or collision-related causes (90% confidence interval: 106–155) at the Project site (Table 13).

Table 13. Estimates of Total Fatalities with Known Causes, 7 November 2013 to 6 November 2014

Project Element	Number of Fatalities Included in Model	Estimate of Fatalities (with Lower and Upper 90% Confidence Limits)
Arrays	0	n/a[1]
Control plots	0	n/a[2]
Evaporation Pond	0	n/a[2]
Fences	0	n/a[2]
Gen-tie Line	29	99 (83, 123)
MVOH Line	11	25 (21, 30)
Total for Project site[1]	**40**	**126 (106, 155)[1]**

Notes:

[1] The two fatalities in the arrays were added unadjusted to the total fatality estimate for the site.

[2] n/a = not applicable; no fatalities caused by electrocution or collision were found in these elements.

3.5.3.2 Fatality Estimates by Project Element

No fatalities that were found in control plots, at the Evaporation Pond, or along fences provided direct evidence of electrocution or collision, so we do not provide a fatality estimate for known causes based on fatalities found in these project elements. Likewise, due to the low number of fatalities found with known causes of death in the array areas, we do not provide a fatality estimate for the array areas.

The overhead powerlines were the only areas for which we estimated the number of fatalities caused by collision or electrocution. Ninety-nine fatalities were estimated to have occurred as a result of collision along the Gen-tie Line (90% confidence interval: 83–123; Table 14). Seasonal estimates were not made for the Gen-tie Line by cause of death because very few fatalities were found in the winter (N=4).

Table 14. Fatality Estimates for the Gen-tie Line, by Cause of Death (Electrocution or Collision), and Fatality Class, 7 November 2013 to 6 November 2014

	Number of Fatalities Included in Model	Estimated Total Number of Fatalities[1]	Lower and Upper 90% Confidence Limits
Cause of Death			
Electrocution	0	0	n/a[1,2]
Collision	29	99	83, 123
Fatality Class			
Large	7	19	15, 24
Small	22	81	65, 104

Notes:

[1] The bootstrap methods used to produce the fatality estimate produce estimates for the entire dataset that differ slightly from the sum of estimates for constituent subgroups of the data.
[2] n/a= not applicable; no electrocution-related fatalities were found in the Gen-tie Line area.

An estimated 25 fatalities occurred along the MVOH Line as a result of collision between 7 November 2013 and 6 November 2014 (90% confidence interval: 21–30; Table 15). Seasonal estimates for the MVOH Line were not calculated due to low sample sizes in the summer, fall, and winter (N=1, N=2, and N=2, respectively). Estimates by size also were not calculated, because of a low sample size for small birds (N=2).

Table 15. Fatality Estimates for the MVOH Line by Cause of Death (Electrocution or Collision), 7 November 2013 to 6 November 2014

	Number of Fatalities Included in Model	Estimated Total Number of Fatalities	Lower and Upper 90% Confidence Limits
Cause of Death			
Electrocution	0[1]	0	n/a[2]
Collision	11	25	21, 30

Notes:
[1] Two electrocution-related fatalities were excluded from the model because they were found incidentally.
[2] n/a = not applicable; no electrocution-related fatalities found along the MVOH Line were included in the model.

3.5.4 Fatality Estimates for Unknown and Natural Causes of Death

For the purposes of these estimates, fatalities with suspected natural causes of death (i.e., predation or disease) are included in this section, along with fatalities for which cause of death could not be determined. We did not calculate separate estimates for predation or disease; instead, these fatalities are grouped in with the total estimates for fatalities with unknown causes of death. Of the 251 fatalities for which the cause of death was natural or could not be determined, 186 were included in the fatality estimate models (Table 16). Of the excluded fatalities, four each from the Evaporation Pond and Gen-tie Line were later added unadjusted to the estimator output, to produce the total fatality estimate for unknown causes. There were 65 fatalities with an unknown or natural cause of death that were not included in the fatality estimates; 20 were excluded because they were found incidentally, 9 were excluded because they were older than the search interval, 1 was excluded because it was found in a control plot that was removed in January 2014 when the search areas for Arrays 1 and 2 were reduced to 20%, and 27 were excluded because they were found in Array 1 and 2 outside of the 20% search areas established in January 2014.

Table 16. Number of Unknown-cause and Natural Fatalities Detected in Each Project Element, and Number Included in Fatality Estimates, 7 November 2013 to 6 November 2014

	Fatalities Detected		
Project Element	**Number Included**	**Number Excluded**	**Total Found**
Arrays	150	45[1]	195
Control plots	14	4[2]	18
Evaporation Pond	0	4[3]	4
Fences	11	4[4]	15
Gen-tie Line	0	4[5]	4
MVOH Line	11	4[6]	15
Total	**186**	**65**	**251**

Notes:

[1] Seven fatalities were excluded because they were older than the search period, 11 fatalities were excluded because they were found incidentally, and 27 were excluded because they were found outside of the 20% search areas for Arrays 1 and 2 prior to January 2014.

[2] Three fatalities were excluded because they were found incidentally, and one fatality was excluded because it was in a control plot that was removed when the search areas for Array 1 and 2 were reduced to 20%.

[3] No estimate was provided for these elements because of the low sample size; however, these detections were later added unadjusted to the estimator output.

[4] Three fatalities were excluded because they were found incidentally, and one fatality was excluded because it was older than the search interval.

[5] No estimate was provided for these elements because of the low sample size; however, these detections were later added unadjusted to the estimator output.

[6] Three fatalities were excluded because they were found incidentally, and one fatality was excluded because it was older than the search interval.

During the period of 7 November 2013 to 6 November 2014, an estimated 2597 birds died from unknown causes (90% confidence interval: 2116-3334) at the Project site (Table 17).

Table 17. Estimates of Unknown-cause and Natural Fatalities, 7 November 2013 to 6 November 2014

Project Element	Number of Fatalities Included in Model	Estimate of Fatalities (with Lower and Upper 90% Confidence Limits)
Arrays	150	2314 (1890, 2965)
Control plots	14	52 (31, 81)
Evaporation Pond	0[1]	n/a[2]
Fences	11	185 (155, 230)
Gen-tie Line	0[1]	n/a[2]
MVOH Line	11	39 (32, 50)
Total for Project site[1]	**186**	**2598 (2116, 3334)**[1]

Notes:

[1] In total, eight fatalities with unknown or natural causes of death were found in the Evaporation Pond area and the Gen-tie Line area. These were added, unadjusted, to the total fatality estimate for the site.

[2] n/a = not applicable; there were fewer than five fatalities in this group. However, the unadjusted numbers were added to the fatality estimates and confidence intervals.

3.5.4.1 Fatality Estimates by Project Element

Because few fatalities were found in the Evaporation Pond and few with unknown causes of death were found along the Gen-tie Line, we do not provide fatality estimates for these fatalities here.

An estimated 2314 fatalities (90% confidence interval: 1890–2965) occurred in the arrays from unknown or natural causes in the year 7 November 2013 to 6 November 2014 (Table 18). The estimated number of fatalities per tracker in the arrays was 2.24 (90% confidence interval: 1.83–2.87), whereas in the control plots it was 1.72 (90% confidence interval: 1.05–2.68; Table 19).

Table 18. Fatality Estimates for the Arrays, by Cause of Death (Unknown), Fatality Class and Season, 7 November 2013 to 6 November 2014

	Number of Fatalities Included in Model	Estimate of Fatalities per Tracker[1]	Lower and Upper 90% Confidence Limits	Estimated Total Number of Fatalities[1]	Lower and Upper 90% Confidence Limits
Cause of Death					
Unknown	150	2.24	1.83, 2.87	2314	1890, 2965
Fatality Class					
Large	84	0.89	0.69, 1.17	920	712, 1209
Small	66	1.34	0.97, 1.89	1385	1002, 1953
Season					
Fall	28	0.32	0.2, 0.46	331	206, 476
Winter	85	1.24	0.94, 1.69	1281	971, 1746

Spring	27	0.47	0.27, 0.77	486	278, 796
Summer	10	0.21	0.07, 0.42	217	72, 434

Note:
[1] The bootstrap methods used to produce the fatality estimate produce estimates for the entire dataset that differ slightly from the sum of estimates for constituent subgroups of the data.

Table 19. Fatality Estimates for the Control Plots, by Cause of Death (Unknown), Fatality Class, and Season, 7 November 2013 to 6 November 2014

	Number of Fatalities Included in Model	Estimate of Fatalities per Tracker[1]	Lower and Upper 90% Confidence Limits	Estimated Total Number of Fatalities[1,2]	Lower and Upper 90% Confidence Limits
Cause of Death					
Unknown	14	1.72	1.05, 2.68	52	31, 81
Fatality Class					
Large	6	0.66	0.27, 1.23	20	8, 37
Small	8	1.06	0.33, 2.0	32	9, 60

Notes:
[1] The bootstrap methods used to produce the fatality estimate produce estimates for the entire dataset that differ slightly from the sum of estimates for constituent subgroups of the data.
[2] Estimated total is for 30 control plots.

An estimated 185 fatalities (90% confidence interval range: 155–230; Table 20) occurred along the fenceline between the dates of 7 November 2013 to 6 November 2014. An estimated 39 fatalities occurred (90% confidence interval range: 32–50) along the MVOH Line that could be attributed to unknown or natural causes (Table 21).

Table 20. Fatality Estimates for the Fences[1], by Cause of Death (Unknown) and Fatality Class, 7 November 2013 to 6 November 2014

	Number of Fatalities Included in Model	Estimated Total Number of Fatalities[2]	Lower and Upper 90% Confidence Limits
Cause of Death			
Unknown	11	185	155, 230
Fatality Class			
Large	6	85	65, 105
Small	5	105	80, 135

Notes:
[1] Estimates were made from 6411.2-m area searched during regular fatality searches and extrapolated to represent total fence area of 32,056 m.
[2] Bootstrap methods used to produce the fatality estimate produce estimates for the entire dataset that differ slightly from the sum of estimates for constituent subgroups of the data.

Table 21. Fatality Estimates for the MVOH Line, by Cause of Death (Unknown), 7 November 2013 to 6 November 2014

	Number of Detections Included in Model	Estimated Total Number of Fatalities	90% Confidence Intervals
Cause of Death			
Unknown	11	39	32, 50

3.6 Annual Background-Adjusted per-Tracker Unit Fatality Rates

The mean annual per-tracker unit fatality rate within arrays (F_{trac}), and per-control plot fatality rate within Conservation Lands (F_{con}), based on bootstrap samples were 2.24 (90% confidence interval range: 1.32 – 3.28) and 1.73 (90% confidence interval range: 0.86 – 2.74), respectively. Note that these bootstrapped estimates and confidence intervals differ slightly from those of the observed data, and are only presented here to give context for the background-adjusted estimate. The mean annual background-adjusted per-tracker unit fatality rate ($F_{b.adj}$) was 0.51 (90% confidence interval range: -0.83-1.81). The mean annual background-adjusted estimate of the number of fatalities within arrays was 526 for the period of 7 November 2013 to 6 November 2014.

Table 22. Resampled Fatality Estimates for the Control Plots, Project Plots, and Background Adjusted Fatality Estimates, 7 November 2013 to 6 November 2014. Based on 2000 iterations

Site	Mean Bootstrapped Fatality/Plot Estimate	Lower and Upper 90% Confidence Limits
Array Tracker Unit Plots	2.24	1.32, 3.28
Control Plots	1.73	0.86, 2.74
Adjusted Fatality Estimate	0.51	-0.83, 1.81[1]

[1] Negative values occur when control plot estimates exceed array tracker unit plot estimates.

Section 4.0 Discussion

This section discusses the patterns observed through monitoring, provides descriptive statistics of trends, and relates these patterns and trends to avian use of the site, and current and future research on comparable topics.

4.1 Patterns Observed in Fatality Detection Efforts

4.1.1 Avian Abundance

Fatalities in the arrays and Gen-tie Line exhibited the most seasonal variation, with definitive spikes in winter and fall 2013, respectively. Overall fatality trends in the arrays from fall 2013 through fall 2014 appear to parallel avian abundance during the same period, which was quantified during avian activity surveys conducted throughout the site and in adjacent offsite areas, as part of ABPP implementation. Avian abundance was moderately low in fall 2013, increased in winter 2013, and then steadily declined from spring to summer, with a small spike again in fall 2014 (HTH 2015). Although we cannot say definitively what the cause of death was for many of the array avian fatalities, it appears that these fatalities mirror trends in abundance; in other words, when birds are more abundant, so are array fatalities. For instance, Columbid activity (i.e., mourning doves) showed a strong seasonal pattern, with average detection rates during point counts highest in winter (HTH 2015). In contrast, although there was a spike in fatalities in fall 2013 along the Gen-tie Line, fatalities there did not parallel avian abundance seasonally in the region.

As defined by the National Drought Monitor (National Drought Mitigation Center 2014), the onset of prolonged drought translated to moderate drought conditions in the Project area by January 2013, extreme drought conditions by January 2014, and exceptional drought conditions by the end of 2014. The results of fatality monitoring may have been influenced by the three-year drought that the Project site is experiencing. The annual average precipitation at the Project site is 10.11 inches, and the site received 8.44 inches in 2011-2012, 4.01 inches in 2012-2013, and 3.43 inches in 2013-2014 (San Luis Obispo County Public Works 2014). Drought conditions were responsible for low vegetative cover in 2014 at areas within the Project site that had been revegetated, as well as undisturbed reference sites (HTH 2014b). Lower vegetative cover likely resulted in decreased food abundance, and may have contributed to declines in overall avian abundance in the Project vicinity. Therefore, overall fatality counts should be interpreted with caution, as they could differ under non-drought conditions.

4.1.2 Utility of Repeat Searches

Repeat searches were originally designed to capture higher numbers of fatalities, especially taxa like bats that are less likely to leave sign behind after scavenging, and to provide verification of the results found in weekly searches. Because it was not practical to conduct repeat searches for any more than 5% of most arrays and 5% of the fences, repeat data from these small areas sampled from our previous year resulted in large sampling bias when extrapolated to the much larger Project elements. Furthermore, after conducting fatality searches for more than a year, it became apparent that avian fatalities accounted for >99% of all fatality finds, and that a sufficient proportion of fatalities (22.6% of all small carcasses and 63.6% of all large carcasses) persisted past the weekly search interval. Together, these reasons led to the decision to cease repeat searches at the CVSR Project.

Despite our decision to stop repeat searches at CVSR, short-interval searches could potentially play an important role in areas with higher scavenging rates and at sites where a large proportion of animals could be scavenged without leaving sign. Also, at sites with higher rates of fatalities, a lower number of searched trackers may be sufficient for accurately estimating site-wide fatalities. However, this method should be implemented only after assessing fatality rates through reconnaissance searches.

4.1.3 Utility of Incidental Detections

Of the 35 fatalities found during this reporting period, only one was found by CVSR operations staff. Fatalities were rarely found in high-traffic areas such as roads, suggesting that data gathered from future incidental reporting will be very limited for analytical purposes. On their own, incidental detections are unlikely to provide enough data to allow tracking of trends in species found, seasonal variations, or trends across Project elements. Despite this limitation, ongoing reporting of these detections may yet assist in identifying and remediating major wildlife hazards on the Project site. The fatality that was discovered by CVSR Project staff during this reporting period was likely caused by electrocution, highlighting the role of the incidental detection protocol.

4.2 Fatality Trends: Cause of Death by Project Element

4.2.1 Fatalities by Cause of Death

4.2.1.1 Arrays

Among avian species expected to be affected by development of the Project, waterbirds were of particular concern. Because waterbirds are sometimes attracted to black-top parking lots or roads, and some solar facilities have reported finding high proportions of waterbirds (Horvath et al. 2009; Grippo et al. 2014; Kagan et al. 2014), obligate waterbirds could potentially be at risk at and near solar arrays. However, during the current year reporting period, only three waterbirds were detected in arrays at CVSR.

It is difficult to discern if waterbird fatalities were low because waterbirds were less attracted to the region during the drought, the birds didn't perceive the arrays as water, or for some other reason. Extreme drought conditions have led to longer-than-normal dry lake conditions in Soda Lake, approximately 2 miles (3 km) south of the Project site. This dry lake supports standing water only during wet years, when it is a major attractant for waterbirds to the region.

Except for the Evaporation Pond (where several waterbird species have been observed by HTH biologists), the Project site lacks aquatic habitats suitable for waterbirds. Therefore, the three waterbirds likely had confused the arrays for water bodies and either collided with a panel or landed in the array. Pied-billed grebes are obligate waterbirds and have difficulty taking flight from land because of the posterior position of their feet (Miller 1942;

Johnsgard 1987). American coots also spend a majority of their lives in water, but they are also capable of making short-distance movements on land. Considering the life history of these species and the lack of suitable habitat on site, the three fatalities were considered collisions; these individuals may have died from predation after they landed in the arrays and were unable to take off, or died from trauma stemming from collision.

A total of ten carcasses were found in the arrays during this reporting period. Of these, the probable cause of death could be established for only three. Previous studies of birds that have died from window collisions suggest that birds rarely have broken necks or other visible skeletal fractures, but intercranial hemorrhaging is almost always present (Klem 1991). Because we did not perform necropsies on whole carcasses found in the field, we were not able to definitively rule out collision as a possible cause of death. Cause of death determinations are further complicated by the possibility that survivors of collisions may be temporarily stunned, and made more susceptible to predation. Given these factors, the cause of death for whole carcasses found without signs of injury or disease were categorized as unknown.

4.2.1.2 Gen-tie Line and MVOH Line

The majority of fatalities found along the Gen-tie and MVOH Lines were located directly or nearly directly under these lines. This pattern suggests that many of these fatalities were caused by powerline collisions, and that the remains were indicative of scavenging, rather than predation. Brown and Drewien (1995) and many others have documented that high-tension powerlines contribute to avian mortality, and especially to the mortality of larger birds such as waterfowl. However, few large carcasses were detected during fatality searches of the Gen-tie and MVOH Lines. Instead, the majority of fatalities found were passerines, possibly reflecting the greater proportion of passerines that occur on the site. Nevertheless, these results suggest that the avian flight diverters installed on the Gen-tie Line may greatly reduce the risk of collisions with larger birds, but are not effective at diverting smaller birds.

In contrast to the fatalities found along the MVOH Line, fatalities found along the Gen-tie Line showed strong seasonal peaks in fall and late spring. Also, Gen-tie Line fatalities included migrant passerines not typically observed on the Project site or expected in the area. The Gen-tie Line and MVOH Line differ from each other in several respects: the Gen-tie Line follows a large elevational change, the lines are higher above the ground than the MVOH Line, and several bird species breed at a pond with tamarisk trees located directly below the Gen-tie Line. To help determine potential differences in fatality patterns between the two types of overhead lines, we produced graphs relating fatality number and species richness to tower number and elevation. These graphs did not suggest any clear linear trends or clustering near the tamarisk pond; fatalities were more or less equally distributed along the Gen-tie Line. Therefore, the differences in height between these two structures may be the main factor effecting differences in fatality rates and species richness of fatalities. The avian flight diverters on the Gen-tie Line appear to be largely ineffective in deterring these migrant and winter resident passerines, possibly because these birds are less apt to see overhead lines during nocturnal movements.

The tamarisk pond was not searched directly for the full year, to avoid disturbing nesting birds during the breeding season. In the fall, dense saltbush (*Atriplex* sp.) made some areas between the pond and Tower 17 impassable. Although the lack of fatality clustering on towers to either side of the tamarisk pond suggests that the higher avian use at the tamarisk pond does not result in a detectable increase in collision in the vicinity of the pond.

It is difficult to study how the mortality of large and small birds along the overhead lines compares with background mortality rates without having a linear control in the landscape. We know of no studies that control for background mortality rates along a linear corridor without an actual linear structure. Instead, most avian mortality studies of high-tension powerlines typically compare fatality rates of powerlines with or without avian flight-diverting structures (Brown and Drewien 1995; Janss and Ferrer 1998). Given that more passerine fatalities were documented along the CVSR Project powerlines than expected, and very few raptor fatalities were documented, a linear control would be useful in understanding how these fatality rates compare with background fatality rates for large and small avian groups in the Project area.

4.2.1.3 Control Plots

The control plots were designed as a way to quantify background levels of mortality on the Project site. All fatalities found in control plots were assigned an unknown cause of death, and all of these fatalities were included in a total fatality estimate that was used to define an adjustment factor for the site. For other research sites where preconstruction surveys are not a viable option, on-site control plots may provide similar data that could not otherwise be obtained. At CVSR, cause of death could not be determined for most array fatalities, so data from the control plots was useful in elucidating what percentage of array fatalities may be assigned to background (natural) causes, rather than indirect or direct Project-related causes.

4.2.1.4 Evaporation Pond

The Evaporation Pond represented a concern because evaporation ponds in xeric environments can attract birds and exposethem to elevated selenium and toxic salt levels. Additionally, the perimeter fence surrounding the pond was considered to represent a collision risk. However, the Evaporation Pond had the lowest number of fatalities during this reporting period, and all fatalities were found on the same day.

The only bird considered to have died from disease during this reporting period was found along the fence of the Evaporation Pond. Because this bird was extremely emaciated, disease seemed to be the plausible cause of death.

During the entire postconstruction monitoring period, Evaporation Pond levels were relatively low. Nonetheless, passerines and waterbirds were occasionally observed in and around the pond before searchers conducted fatality searches. As part of CVSR operations, a bird deterrence protocol (hazing and use of automated deterrence devices) was in place at the Evaporation Pond throughout the designated shorebird nesting season (February through July). These efforts likely resulted in less use of the pond by birds. Given that so few fatalities were detected at the pond, especially during time periods were active deterrence devices were not in use, risk of fatalities occurring at the pond appears to be low.

4.2.1.5 Fences

Few fatalities were detected along array perimeter fences, and only one was attributed to collision. Given the low number of fatalities found at this Project element, risk of fence collision as a whole appears to be low.

4.3 Fatality Estimates

4.3.1 Estimated Fatalities on the CVSR Project Site

During the period of 7 November 2013 to 6 November 2014 (the period used in the Fatality Estimator), there were an estimated 126 fatalities from known causes that occurred on the Project site (90% confidence interval: 106–155).

There were an estimated 2.24 fatalities per tracker (90% confidence interval: 1.83–2.87) from unknown or natural causes of death in the arrays. In control plots, there were an estimated 1.72 fatalities per control plot (90% confidence interval: 1.05–2.68). The confidence intervals for controls are considerably wider in part because fewer trackers were searched in control areas than in array areas for the year.

The confidence interval is much smaller this year, compared to the confidence interval of 3.09 fatalities per tracker reported last year, when we provided a fatality estimate for just Array 1 from nearly 1 year of data. Because we grouped all of the arrays' data, thus creating a larger sample size for a single fatality estimate, we more accurately estimated a fatality rate for the site as a whole. Additionally, by combining 2 years of carcass-persistence and searcher-efficiency data, we decreased the amount of uncertainty in our modeling parameters, which in turn decreased the amount of uncertainty in the fatality estimate as a whole.

Large-scale fatality searches at solar facilities have been a subject of interest since as early as the 1980s (e.g., Wagner et al. 1983), but the methods still vary in search intensity and regularity, fatality estimation methods used, and methods used for determining cause of death (e.g., Althouse and Meade 2014; HTH 2014a). Because of the differences among studies, comparison among rates of fatalities reported remains difficult. Although fatality rates per megawatt are often reported as a useful tool to compare rates among industrial sites and across energy types (Arnett et al. 2008; Smallwood 2013), it is easy to draw incorrect conclusions if the underlying methods differ and if different panel technologies are involved (e.g., a tracker unit generating 0.5 megawatts more than an alternative type may only be 7% larger).

4.3.2 Adjusting Fatality Rates on the CVSR Project Site

Observed fatalities within arrays that could be attributed to collision were limited (N=6 in 2013-2014); thus, fatality estimates at CVSR are primarily based upon fatalities where the cause of death or injury could not be determined. Adjusting these avian fatality rates by background fatality rates measured within control plots substantially reduced the estimated fatality rate that may be related to the CVSR Project. Whether placed within the context of per-acre of arrays or per-acre of tracker units, an annual mean background-adjusted fatality estimate of 526 fatalities indicates that there may be one fatality per 2.3 acres per year that cannot currently be explained by background fatality rates as measured in control plots.. These could be fatalities resulting from collision that leave no evidence of collision (or are moved away from the site of collision by scavengers), or increased fatality rates due to differential rates of avian use and/or predation within the arrays compared to the control plots.

We observed an increase of some avian species within the arrays. Mourning doves were the most common fatality in solar arrays, followed by horned larks and house finches, which combined accounted for 66% of all fatalities. During the first year of study, there were 44 point count detections of seven species perched on the developing arrays of solar panels. After the second year of study, the numbers had increased to 210 total detections of 13 species, including a merlin (*Falco columbarius*). After the third year of study, the numbers had increased to 578 total detections of 15 species; however, 81% of the tally consisted of house finches and mourning doves. Observations of horned larks during avian use surveys averaged higher in the array and Gen-tie survey areas than in the offsite survey areas throughout the study period, especially in winter (HTH 2015).

Modeling results indicated that activity rates for mourning doves increased in construction areas and remained high as the Project moved into the operational phase, suggesting a lasting attraction for these species (HTH 2015). Ninety-nine percent of the observations of mourning doves within the solar generation facility occurred in the arrays, either on the ground or perched on array structures (HTH 2015). Mourning doves are among the most widespread and abundant species in the country; Seamans and Sanders (2014) estimated that there are approximately 275 million mourning doves in the country, and their abundance appears to be stable in the West.

Surveyors at the CVSR Project documented use by scavenger/ predatory birds and mammals (San Joaquin kit fox [*Vulpes macrotis mutica*] and coyote [*Canis latrans*]). A merlin was observed perching and hunting in the developed solar arrays; also observed were a foraging red-tailed hawk and a foraging ferruginous hawk (*Buteo regalis*). Merlins eat mostly sparrow-sized to dove-sized birds (Warkentin et al. 2005) often specializing on hunting a couple of the most abundant species in an area, which would include horned larks, house finches, and mourning doves in the Project area. Each merlin can prey on 2.2 to 2.5 birds per day (Page and Whitacre 1975; Warkentin et al. 2005). They are known to flush flocks to take advantage of the confusion, which surveyors at CVSR have hypothesized may result in strikes with array infrastructure. Differential use of the arrays by avian species combined with predation by raptors, foxes, and coyotes could explain the current estimated difference between fatality rates within arrays and control plots.

We should point out that the sample size for control plots is low, and the number of fatalities within those control plots is even lower. Low sample size can easily lead to biases due to sampling error. Conducting bootstrap analysis on observed data inherently invokes an assumption that the observed data adequately represents the true state of the system. For example, in this case we must assume that the 14 fatalities detected in the 30 control plots (for the 2013/14 survey period) adequately represent fatality rates across all onsite Conservation Lands. Since the 30 control plots only cover a very small fraction of Conservation Lands, this assumption is tenuous. Furthermore, even though N_C trackers are sampled for each bootstrap iteration, they are drawn from the much larger N_T "population" of surveyed trackers (which represents approximately 20% of all trackers). As a result, we effectively sampled a large portion of the total number of trackers over the many bootstrap iterations, but the area over which we sampled control plots remains fixed and small. Therefore, some bias and imbalance remains in the bootstrapped results. We believe that these methods make the best use of the available data to control for background fatality in estimating fatality rates attributable to the CVSR Project and quantifying the uncertainty in those estimates.

In addition to the imbalance in sample area between control and array plots, there are several other factors that may influence these results. The proximity of control plots to arrays should be advantageous because we are comparing similar underlying habitats. However it is possible that fatality rates in lands immediately adjacent to the Project could be affected by their proximity to the Project, and thus would not adequately represent the background fatality rate of the area if the Project was absent all together. The large difference in estimated fatality rates between this year, and the 2013 annual report likely represents a reduction in avian use as continued drought widely impacted bird populations and nesting behavior (Section 4.1.1). Noting this difference among years stresses the importance of comparing fatality rates during the same time periods over successive years, because changes in bird population abundance and behavior may greatly affect analysis results.

More research is needed to address the issue of background fatality rates versus fatality rates attributable to solar photovoltaic projects. Study designs that include avian use studies within arrays and control plots, and studies that balance sample sizes within arrays and control plots would address many of the limitations of this analysis.

4.3.3 Carcass-persistence Rates

Although previous studies have monitored the overall persistence of carcass sign (e.g., feather spots), the practice has not been universally adopted (Balcomb 1986; Hager et al. 2012). Nevertheless, we chose to focus on overall persistence times, rather than time to scavenging alone, because feather spots represent an important source of data for fatality searches. Although some information is lost after scavenging, feather spots may still provide some degree of certainty about cause of death, by their location (e.g., directly under a powerline) and species identification (e.g., feather spots from waterbirds species may lend credibility to the idea that individuals of the species mistake the arrays for water). The results of our carcass-persistence trials revealed that, whereas average scavenging times were less than a week for both small and large carcasses across seasons, average persistence times ranged from 5 days to 30 days. The results also suggest that, although season has a strong influence on scavenging time, it has considerably less influence on overall persistence time. Instead, size seems to have a strong impact on persistence time: small carcasses are much more likely to be removed completely during scavenging, whereas large carcasses tend to leave feather spots behind.

In our study, we were careful to avoid scavenger swamping. Although some previous studies (e.g., Wagner et al. 1983, Ponce et al. 2010, and Derby et al. 2007) likely overloaded the capacity of local scavengers to effectively dispose of placed carcasses (Smallwood et al. 2010), the smaller numbers of carcasses we placed each week helped to ensure that we recorded accurate scavenging times. Still, several carcasses were visited several times before they were scavenged. Kit foxes are one of the few scavenger species present in the area that is capable of food caching (Clark pers. comm.), but they too sometimes visited carcasses without attempting to remove them. Because we made a concerted effort to use fresh carcasses, we feel that this pattern simply highlights the highly opportunistic nature of scavenging.

Our results suggest that, although scavenging times may differ by 1–2 days by season, persistence time of feather spots is most affected by the vegetation height and density where the carcass is placed. Although this may seem self-evident, the effects of vegetation height on carcass persistence has received limited attention in previous studies of carcass persistence or fatality estimates, and it may have significant implications for fatality estimates at sites where ground vegetation is cleared or purposely kept short, particularly when search intervals are longer than a week.

4.3.4 Searcher-efficiency Rates

Overall searcher-efficiency rates between 2012 and 2014 were comparable to efficiency rates at other wind and solar energy facilities, where rates have ranged from 32% to 67% (Nicholson et al. 2005; Derby et al. 2007; Leslie et al. 2012; Johnston et al. 2013; Martin et al. 2013).

Our study incorporated feather spots along with carcasses in the searcher-efficiency trial design. Feather spots are rarely incorporated into fatality studies, but many fatality studies report a majority of fatalities from feather spots (Derby et al. 2007; WEST 2004; Johnston et al. 2013; Martin et al. 2013; Althouse and Meade 2014), either because scavenging is rapid or because there are longer search intervals. Thus, visibility associated with the condition of the fatality is rarely representative of true conditions and could affect fatality estimates. In our study, fatality searchers were most effective at finding large carcasses and large feather spots in easy visibility conditions, and least effective at finding small feather spots in both easy and moderate visibility conditions, and at finding small carcasses in moderate visibility conditions. When attempting to recover a missed trial specimen in one of the latter three classes, and even when standing within a few feet of the specimen, searchers often had difficulty visually locating it. Undoubtedly, these fatality types were difficult to detect because they blend in with vegetation, even when vegetation height is low. The large differences in detectability between carcasses and feather spots point to the importance of incorporating feather spots into studies, to yield more robust fatality estimates.

Section 5.0 Recommendations

During the course of this fatality monitoring study, we have identified areas where further research is needed to guide the design of future fatality monitoring studies at utility-scale solar facilities. The following recommendations outline research areas and measures that we believe are important.

- Projects covering large amounts of area may have a significant portion of fatalities from natural background mortality. To determine the contribution of background mortality, a spatially balanced study employing control plots similar in size, layout, and overall total area, should be used to estimate background fatality rates with comparable accuracy to the developed project site.

- Focused research on the causes of feather spots and the average number of feather spots created from a single fatality should be considered.

- If site-wide fatality monitoring is deemed necessary and the primary goal is to determine annual operational fatality rates, then site-wide fatality monitoring should be started once the full project becomes operational and for at least one year. Fatality searches phased in as portions of the project become operational can be used to document fatalities prior to site-wide searches, and to conduct searcher efficiency and carcass persistence trials to develop the survey design. Fatality monitoring survey design, including spatial coverage requirements and survey frequency can be optimized after the collection of preliminary data.

- Intensive daily repeat fatality surveys are not necessary to conduct fatality estimates. The reduced spatial and temporal coverage of these intensive surveys may lead to less precise estimates when extrapolated to obtain site-wide annual estimates, and are only recommended when required to link timing of fatalities to specific events (e.g., weather patterns or operational changes).

- Avian use studies should consider bird census techniques that are potentially more effective in documenting species richness and relative abundance of birds in project areas that will be covered by arrays. Typical point count study designs may not be effective at detecting birds that tend to remain concealed under panels during counts. Line transect methods may provide a better index of avian use before and after construction. Birds under panels will likely be more visible from line transects oriented perpendicular to the array tracker rows than they would be from fixed-location point count sites located outside the arrays. If possible, line transect survey intervals should mirror fatality search intervals, to assess whether fatality rates correspond with bird activity levels. If survey intervals cannot mirror fatality search intervals, we recommend a minimum of monthly avian activity searches using line transects to determine relative abundance and trends in populations during periods of avian fatality monitoring.

- Projects incorporating high-tension powerlines should assess whether the project site is located in an important route for migratory songbirds. Because many migratory songbirds fly at night, typical deterrence devices that have been successful with raptors may not be as effective at preventing collisions by songbirds.

- To assess fatalities along linear project features such as powerlines, study designs should incorporate linear controls, to provide background mortality rates for such features.

- To the extent practicable, powerlines should not be placed over wetland features, where large numbers of birds may roost and nest. Wetland features, such as the tamarisk wetland along the Gen-tie Line, provide habitat for common and sensitive species, such as the tricolored blackbird (*Agelaius tricolor*), now emergency-listed under the California Endangered Species Act.

- We recommend that necropsies be performed on a subset of carcasses when practicable, especially when external injuries are not present; birds that have died because of collisions may not have external signs of injury, but typically exhibit intercranial hemorrhaging that can be identified during a necropsy. Performing necropsies on a subsample of carcasses may lead to more information about the cause of death.

- The use of scent dogs in fatality monitoring efforts should be considered to increase the accuracy and narrow the confidence level of fatality estimates, especially in areas with high density vegetation. Scent dogs have been shown to be more efficient at detecting some fatality classes than human searchers and have a higher likelihood of detecting rare events than humans, given equal levels of survey effort (HTH, unpublished data). Studies on sites with varying topography, complex habitat features, and dense vegetation may benefit from scent dog searches because the dogs rely on olfactory, rather than visual, cues.

- Feather spots should be incorporated into bias-trial protocols to produce more robust fatality estimates and to provide more comparable industry-wide fatality estimates, especially for studies with longer search intervals.

Section 6.0 References

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 *in* B. N. Petran and F. Csaki (Editors), 2nd International Symposium on Information Theory Akademiai Kiado, Budapest, Hungary.

Althouse and Meade. 2014. Topaz Solar Farms 2013 Fourth Quarter/Second Annual Report for Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. Paso Robles, California.

[AOU] American Ornithologists' Union. 2015. The AOU Check-list of North American Birds, 7th Edition [online]: http://www.aou.org/checklist/north/print.php. Accessed 16 January 2015.

Arnett, E. B., W. Brown, and W. P. Erickson. 2008. Patterns of bat fatalities at wind energy facilities in North America. Journal of Wildlife Management 72(1):61–78.

Baerwald, E. F., and R. M. R. Barclay, 2009. Geographic variation in activity and fatality of migratory bats at wind energy facilities. Journal of Mammalogy 90(6):1341–1349.

Balcomb, R. 1986. Songbird carcasses disappear rapidly from fields. Auk 103(4):817–820.

Beason, R. C. 1995. Horned lark (*Eremophila alpestris*). No. 195 i*n* A. Poole (Editor), The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York.
[online]: http://bna.birds.cornell.edu/bna/species/195. Doi:10.2173/bna.195

Brown, W. M., and R. C. Drewien. 1995. Evaluation of two power line markers to reduce crane and waterfowl collision mortality. Wildlife Society Bulletin 23(2):217–227.

Burnham, K. P., and D. R. Anderson. 2004. Understanding AIC and BIC in Model Selection. Sociological Methods & Research 33(2):261-304.

Clark, H. O., Jr. Senior Wildlife Ecologist. H. T. Harvey & Associates. 10 October 2013-email correspondence with Meredith Janzen of H. T. Harvey & Associates, regarding food caching by San Joaquin kit fox.

Derby, C., A. Dahl, W. Erickson, K. Bay, and J. Hoban. 2007. Postconstruction Monitoring Report for Avian and Bat Mortality at the NPPD Ainsworth Wind Farm. 27 February. Prepared for Nebraska Public Power District. Prepared by Western Ecosystems Technology, Inc.

Efron, B, and R. Tibshirani. 1986. Bootstrap methods for standard errors, confidence intervals and other measures of statistical accuracy. Statistical Science 1:54–77.

Erickson, W. 2009. Avian and Bat Monitoring Plan at Martinsdale Wind Farm. Draft. Prepared by WEST, Inc. [online]: http://dnrc.mt.gov/trust/wind/martinsdale/EIS/AppendixcMonitoring%20Protocol.pdf.

Grippo, M., J. W. Hayse, and B. L. O'Conner. 2014. Solar energy development and aquatic ecosystems in the Southwestern United States: Potential impacts, mitigation, and research needs. Environmental Management. Doi: 1007/s00267-014-0384-x.

Gruver, J., M. Sonnenburg, K. Bay, and W. Erickson. 2009. Post-construction bat and bird fatality study at the Blue Sky Green Field Wind Energy Center, Fond du Lac County, Wisconsin final report. Prepared by WEST, Inc. [online]: http://city.milwaukee.gov/ImageLibrary/Groups/cityGreenTeam/documents/birdbatblueskygrfieldstudy.pdf.

Hager, S. B., B. J. Cosentino, and K. J. McKay. 2012. Scavenging affects persistence of avian carcasses resulting from window collisions in an urban landscape. Journal of Field Ornithology 83(2):203–211.

Horváth, G., G. Kriska, P. Malik, and B. Robertson. 2009. Polarized light pollution: A new kind of ecological photopollution. Frontiers of Ecology and Environment 7(6):317–325.

[HTH] H. T. Harvey & Associates. 2011. Avian and Bat Protection Plan for the California Valley Solar Ranch Project. Fresno, California.

[HTH] H. T. Harvey & Associates. 2014a. California Valley Solar Ranch Project Avian and Bat Protection Plan Annual Postconstruction Fatality Report 16 August 2012–15 August 2013. San Luis Obispo, California.

[HTH] H. T. Harvey & Associates. 2014b. California Valley Solar Ranch San Luis Obispo County, California Year 2 (2014) On-site Vegetation Monitoring Report. Fresno, California.

[HTH] H. T. Harvey & Associates. 2015. California Valley Solar Ranch, San Luis Obispo County, California, Final Avian Activity Surveys Report: October 2011–October 2014.

Huso, M. 2011. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. Doi: 10.1002/env.1052.

Janss, G. F. E., and M. Ferrer. 1998. Rate of bird collision with power lines: Effects of conductor-marking and static wire-marking. Journal of Field Ornithology 69:8–17.

Johnsgard, P. A. 1987. 3 comparative egocentric and locomotory behaviors. Paper 5 *in* Johnsgard, P. A., Diving Birds of North America.

Johnson, G. D., W. P. Erickson, M. D. Strickland, M. F. Sheperd, D. A. Sheperd, and S. A. Sarappo. 2003. Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota. American Midland Naturalist 150:332–342.

Johnston, D. S., J. A. Howell, S. B. Terrill, N. Thorngate, J. Castle, J. P. Smith, T. J. Mabee, J. H. Plissner, N. A. Schwab, P. M. Sanzenbacher, and C. M. Grinnell. 2013. Bird and Bat Movement Patterns and Mortality at the Montezuma Hills Wind Resource Area. CEC-500-2013-015. California Energy Commission.

Kagan, R. A., T. C. Viner, P. W. Trail, and E. O. Espinosa. 2014. Avian mortality at solar energy facilities in southern California: A preliminary analysis. National Fish and Wildlife Forensics Laboratory. [online]: http://docketpublicenergy.ca/gov/PublicDocuments/09-AFC-07C/TN201977_20140407T161504_Center_Supplemental_Opposition_to_Motion.pdf

Klem, D., Jr. 1991. Bird injuries, cause of death, and recuperation from collisions with windows. Journal of Field Ornithology 61(1):115–119.

Leslie, D., J. Schwartz, and B. Karas. 2012. Altamont Pass Wind Resource Area Bird Fatality Study, Bird Years 2005-2010. November. M87. ICF 00904.08. Prepared for Alameda County Community Development Agency, Hayward, California. Prepared by ICF International, Sacramento, California.

Martin, C., E. Arnett, and M. Wallace. 2013. Evaluating Bird and Bat Post-construction Impacts at the Sheffield Wind Facility, Vermont; 2012 Annual Report. Department of Natural Resources Management, Texas Tech University, Lubbock, Texas.

McCrary, M. D., R. L. McKernan, R. W. Schreiber, W. D. Wagner, and T. C. Sciarrotta. 1986. Avian mortality at a solar energy power plant. Journal of Field Ornithology 57:135–141.

Miller, R. F. 1942. The pied-billed grebe, a breeding bird of the Philadelphia region. Cassinia 32:22–34.

National Drought Mitigation Center. 2014. United States drought monitor weekly comparison. Lincoln, Nebraska. [online]: http://droughtmonitor.unl.edu/MapsAndData/WeeklyComparison.aspx. Accessed December 2014.

Nicholson, C. P., R. D. Tankersley Jr., J. K. Fiedler, and N. S. Nicholas. 2005. Assessment and Prediction of Bird and Bat Mortality at Wind Energy Facilities in the Southeastern United States: Final Report, 2005. Tennessee Valley Authority, Knoxville, Tennessee.

Otis, D. L., J. H. Schulz, D. Miller, R. E. Mirarchi, and T. S. Baskett. 2008. Mourning dove (*Zenaida macroura*). No. 117 *in* A. Poole (Editor), The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York. [online]: http://bna.birds.cornell.edu/bna/species/117.

Ponce, C., J. C. Alonso, G. Argandoña, and M. Carrasco. 2010. Carcass removal by scavengers and search accuracy affect bird mortality estimates at power lines. Animal Conservation 13:603–612.

San Luis Obispo County Public Works. 2014. Volunteer Precipitation Gauge Station Monthly Precipitation Report: California Valley CDF # 175. [online]: http://slocountywater.org. Accessed October 2014.

Scott, S. D., and C. McFarland. 2010. Bird Feathers: A Guide to North American Species. Stackpole Books, Mechanicsburg, Pennsylvania.

Shuford , W.D., and Gardali, T., editors. 2008. California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field of Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento.

Sibley, D. A. 2000. The Sibley Guide to Birds. Alfred A. Knopf, New York, New York.

Smallwood, K. S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71:2781–2791.

Smallwood, K. S. 2013. Comparing bird and bat fatality rates among North American wind-energy projects. Wildlife Society Bulletin 37:19–33.

Smallwood, K. S., D. A. Bell, S. A. Snyder, and J. E. Didonato. 2010. Novel scavenger removal trials increase wind turbine-caused avian fatality estimates. Journal of Wildlife Management 74(5):1089–1097.

Thompson, S.K., and G.A. Seber. 1994. Detectability in conventional and adaptive sampling. Biometrics, 50(3): 712-724.

Wagner, W. D., R. L. McKernan, P. A. Flanagan, and R. W. Schreiber. 1983. Wildlife Interactions at Solar One Facility, Daggett, California: Fall 1982 Interim Report.

Warkentin, I.G., N.S. Sodhi, R.H.M. Espie, A.F. Poole, L.W. Oliphant and P. C. James. 2005. Merlin (*Falco columbarius*). In The Birds of North America Online, No. 44 (A. Poole, Ed.). Cornell Lab of Ornithology, Ithaca, New York.

[WEST] Western Ecosystems Technology, Inc. 2004, Stateline Wind Project Wildlife Monitoring Final Report. Cheyenne, Wyoming, and Walla Walla, Washington, and Northwest Wildlife Consultants, Inc., Pendleton, Oregon.

Appendix A. Avian Species Used in Searcher-efficiency Trials, September 2012 to November 2014 (N = 434)

Species	Carcass Size	Number of Fatality Plants Placed[1]
Acorn woodpecker (*Melanerpes formicivorus*)	Large	1[2]
America coot (*Fulica americana*)	Large	9
American crow (*Corvus brachyrhynchos*)	Large	11
American kestrel (*Falco sparverius*)	Large	1
Band-tailed pigeon (*Patagioenas fasciata*)	Large	6
Barn owl (*Tyto alba*)	Large	5
Black-crowned night heron (*Nycticorax nycticorax*)	Large	1
Black-headed grosbeak (*Pheucticus melanocephalus*)	Small	1
Brewer's blackbird (*Euphagus cyanocephalus*)	Small	4
Brown-headed cowbird (*Molothrus ater*)	Small	6
Burrowing owl (*Athene cunicularia*)	Large	1
California quail (*Callipepla californica*)	Large	12
California towhee (*Melozone crissalis*)	Small	1
Cedar waxwing (*Bombycilla cedrorum*)	Small	1
Chestnut-backed chickadee (*Poecile rufescens*)	Small	1
Cliff swallow (*Petrochelidon pyrrhonota*)	Small	8[2]
Common raven (*Corvus corax*)	Large	16
Common yellowthroat (*Geothylpis trichas*)	Small	1
Cooper's hawk (*Accipiter cooperii*)	Large	12
Eared grebe (*Podiceps nigricollis*)	Large	1
Eurasian collared-dove (*Streptopelia decaocto*)	Large	7
European starling (*Sturnus vulgaris*)	Small	2
Great horned owl (*Bubo virginianus*)	Large	16
Greater roadrunner (*Geococcyx californianus*)	Large	4
Green heron (*Butorides virescens*)	Large	2
Horned lark (*Eremophila alpestris*)	Small	36
House finch (*Carpodacus mexicanus*)	Small	53
House sparrow (*Passer domesticus*)	Small	17
Lark sparrow (*Chondestes grammacus*)	Small	2
Lesser goldfinch (*Spinus psaltria*)	Small	1
Lincoln sparrow (*Melospiza lincolnii*)	Small	3
Long-eared owl (*Asio otus*)	Large	3
Mourning dove (*Zenaida macroura*)	Large	70
Red-shouldered hawk (Buteo lineatus)	Large	30[2]
Red-tailed hawk (*Buteo jamaicensis*)	Large	2
Rock pigeon (*Columba livia*)	Large	15

Species	Carcass Size	Number of Fatality Plants Placed[1]
Savannah sparrow (*Passerculus sandwichensis*)	Small	7
Sharp-shinned hawk (*Accipiter striatus*)	Large	1
Short-eared owl (*Asio flammeus*)	Large	1
Swainson's thrush (*Catharus ustulatus*)	Small	2
Unknown small	Small	3
Unknown large	Large	1
Unknown raptor	Large	3
Unknown songbird	Small	3
Varied thrush (*Ixoreus naevius*)	Small	1
Warbling vireo (*Vireo gilvus*)	Small	1
Western meadowlark (*Sturnella neglecta*)	Small	25
Western scrub-jay (*Aphelocoma californica*)	Small	2
White-crowned sparrow	Small	2
White-tailed kite (*Elanus leucurus*)	Large	1
Yellow warbler (*Setophaga petechia*)	Small	9
Yellow-billed magpie (*Pica nuttalli*)	Large	7
Yellow-rumped warbler (*Dendroica coronata*)	Small	3

Notes:
[1] Numbers represent both carcasses and feather spots placed
[2] One individual was removed by a scavenger

Appendix B. Avian Species Used in Carcass-persistence Trials (N=206)

Species	Carcass Size	Number Placed
Acorn woodpecker (*Melanerpes formicivorus*)	Small	6
American coot (*Fulica americana*)	Large	4
American crow (*Corvus brachyrhynchos*)	Large	18†
American goldfinch (*Spinus tristis*)	Small	2
American kestrel (*Falco sparverius*)	Large	3
American robin (*Turdus migratorius*)	Large	3
Anna's hummingbird (*Calypte anna*)	Small	3
Band-tailed pigeon (*Patagioenas fasciata*)	Large	3†
Barn owl (*Tyto alba*)	Large	5†
Black turnstone (*Arenaria melanocephala*)	Large	1
Brewer's blackbird (*Euphagus cyanocephalus*)	Small	6
Blackbird sp.	Small	1
Bullock's oriole (*Icterus bullockii*)	Small	1
Bushtit (*Psaltriparus minimus*)	Small	2
California gull (*Larus californicus*)	Large	1
California thrasher (*Toxostoma redivivum*)	Small	1
California quail (*Callipepla californica*)	Large	2*
California towhee (*Melozone crissalis*)	Small	4
Cedar waxwing (*Bombycilla cedrorum*)	Small	2
Cliff swallow (*Petrochelidon pyrrhonota*)	Small	4
Common raven (*Corvus corax*)	Large	2
Cooper's hawk (*Accipiter cooperii*)	Large	1
Eurasian collared-dove (*Streptopelia decaocto*)	Large	7
European starling (*Sturnus vulgaris*)	Small	4
Great horned owl (*Bubo virginianus*)	Large	9
Greater roadrunner (*Geococcyx californianus*)	Large	2
Hermit thrush (*Catharus guttatus*)	Small	1
Horned grebe (*Podiceps auritus*)	Large	2
Horned lark (*Eremophila alpestris*)	Small	3
House finch (*Haemorhous mexicanus*)	Small	16
House sparrow (*Passer domesticus*)	Small	6†
House wren (*Troglodytes aedon*)	Small	2
Lesser goldfinch (*Spinus psaltria*)	Small	2
Lincoln's sparrow (*Melospiza lincolnii*)	Small	1
Mourning dove (*Zenaida macroura*)	Large	11*
Northern flicker (*Colaptes auratus*)	Large	2
Northern fulmar (*Fulmarus glacialis*)	Large	1
Northern mockingbird (*Mimus polyglottos*)	Small	5

Species	Carcass Size	Number Placed
Nuttall's woodpecker (*Picoides nuttallii*)	Small	3
Peregrine falcon (*Falco peregrinus*)	Large	1
Pine siskin (*Spinus pinus*)	Small	1
Red-necked phalarope (*Phalaropus lobatus*)	Small	1†
Red-shouldered hawk (*Buteo lineatus*)	Large	7†
Red-tailed hawk (*Buteo jamaicensis)*	Large	9†
Red-winged blackbird (*Agelaius phoeniceus*)	Small	2
Rock dove/pigeon (*Columba livia*)	Large	4
Ruby-crowned kinglet (*Regulus calendulai*)	Small	1
Savannah sparrow (*Passerculus sandwichensis*)	Small	2
Sharp-shinned hawk (*Accipiter striatus*)	Large	1†
Song sparrow (*Melospiza melodia*)	Small	1
Western bluebird (*Sialia mexicana*)	Small	1
Western meadowlark (*Sturnella neglecta*)	Large	1
Western screech-owl (*Megascops kennicottii*)	Large	5
Western scrub-jay (*Aphelocoma californica*)	Small	9
White-crowned sparrow (*Zonotrichia leucophrys*)	Small	4
White-tailed kite (*Elanus leucurus*)	Large	2†
Yellow-rumped warbler (*Setophaga coronata*)	Small	2

Notes:
* = Reclassified:
- One California quail was a nestling and was classified as a small carcass.
- Two mourning doves were juveniles and were classified as small carcasses.

† Excluded from analysis:
- Two American crows were excluded from analysis because full persistence data were lacking.
- One band-tailed pigeon was excluded from analysis because full persistence data were lacking.
- One barn owl was excluded from analysis because full persistence data were lacking.
- One house sparrow was excluded from analysis due to removal by biologist prior to scavenging.
- One red-necked phalarope was excluded from analysis due to camera malfunctioning.
- One red-shouldered hawk was excluded from analysis because full persistence data were lacking.
- Two red-tailed hawks were excluded from analysis because full persistence data were lacking.
- One sharp-shinned hawk was excluded from analysis because full persistence data were lacking.
- One white-tailed kite was excluded from analysis because full persistence data were lacking.

Appendix C. Weekly Fatality Search Results: 16 August 2013 to 17 November 2014

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20130828-41	34.5kV Line	8/28/2013	UNWA	Feather spot: 16 primaries and secondaries, four tail, and 40+ contour feathers from unknown warbler.	C	>50	11S	236786	3913033
20131002-51	34.5kV Line	10/2/2013	SAVS	Whole carcass: no obvious sign of injury but feathers falling out of chest from possible collision point.	C	>90	11S	234643	3913250
20131023-46	34.5kV Line	10/23/2013	AMKE	Feather spot: all feather types. At least >100 body feathers and >12 wing and tail feathers.	C	>50	11S	233929	3913261
20131113-41	34.5kV Line	11/13/2013	MODO	Feather spot: 5-6 contours in clumps	U	n/a	11S	238157	3912540
20131113-106	34.5kV Line	11/13/2013	MODO	Feather spot: 50 body and 3 primary feathers.	C	>50	11S	234646	3913264
20131113-107	34.5kV Line	11/13/2013	CORA	Feather spot: 30 body feathers.	U	n/a	11S	234458	3913361
20131120-91	34.5kV Line	11/20/2013	MODO	Feather spot: 3 Tail feathers. 9 body feathers found clumped	U	n/a	11S	234645	3913250
20131204-26	34.5kV Line	12/4/2013	BUOW	Feather spot: 50+ body feathers	U	n/a	11S	238214	3912029
20131211-41	34.5kV Line	12/11/2013	WEME	Feather spot: Three flight feathers (all tail) and 15 to 20 body feathers.	C	>50	11S	238150	3912327
20140108-124	34.5kV Line	1/8/2014	BUOW	Feather spot: 10+ flight and body feathers.	U	n/a	11S	234808	3912884
20140108-125	34.5kV Line	1/8/2014	MODO	Feather spot: 100+ body and flight feathers.	U	n/a	11S	238146	3912249

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140108-126	34.5kV Line	1/8/2014	MODO	Feather spot: 3 secondary, 1 primary, and 10 body feathers.	C	>50	11S	236480	3913001
20140115-36	34.5kV Line	1/15/2014	HOLA	Feather spot: 15 body feathers.	U	n/a	11S	236807	3913045
20140122-36	34.5kV Line	1/22/2014	UNKN	Feather spot: 15 body feathers from unknown large bird.	U	n/a	11S	234620	3913324
20140122-37	34.5kV Line	1/22/2014	UNKN	Feather spot: 20 body feathers from unknown raptor.	U	n/a	11S	236364	3912921
20140122-38	34.5kV Line	1/22/2014	HOFI	Feather spot: Five flight and 40+ body feathers.	U	n/a	11S	236364	3912921
20140129-56	34.5kV Line	1/29/2014	WEME	Feather spot: 10 flight feathers and 15 - 20 body feathers.	U	n/a	11S	234025	3913564
20140312-101	34.5kV Line	3/12/2014	CORA	Feather spot: 11 body feathers.	C	>50	11S	233867	3911735
20140409-56	34.5kV Line	4/9/2014	MODO	Feather spot: 80 + body feathers.	C	>50	11S	233941	3913077
20140423-101	34.5kV Line	4/23/2014	CORA	Feather spot: 11 body feathers.	C	>50	11S	234994	3911864
20140423-102	34.5kV Line	4/23/2014	CORA	Feather spot: 20 body feathers.	C	>50	11S	233807	3911629
20140423-36	34.5kV Line	4/23/2014	ROPI	Partial Carcass: 40 + body and wing feathers attached to bone	C	>50	11S	234714	3913039
20140430-56	34.5kV Line	4/30/2014	MODO	Feather spot: Eight flight and four body feathers.	C	>50	11S	238153	3912412
20140723-21	34.5kV Line	7/23/2014	HOSP	Whole carcass: Fresh intact nestling with small wound on foot and under neck and beak. Directly under powerline and adjacent to utility pole.	P	>50	11S	236924	3913023

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140730-21	34.5kV Line	7/30/2014	ECDO	Feather spot: Clump of five or six body feathers connected by dried blood. Directly under powerline and adjacent to utility pole.	C	>50	11S	236887	3913023
20140924-101	34.5kV Line	9/24/2014	SAVS	Whole carcass: Beak open and lower mandible broken.	C	>50	11S	233952	3913134
20130822-56	Array 1	8/22/2013	CORA	Feather spot: cluster of body feathers.	U	n/a	11S	233463	3915644
20130829-41	Array 1	8/29/2013	HOLA	Feather spot: approximately 20 body feathers.	U	n/a	11S	233950	3915592
20130829-86	Array 1	8/29/2013	MODO	Feather spot: 40+ contour feathers, two rectrices, some coverts and scapulars.	U	n/a	11S	233466	3915623
20130919-47	Array 1	9/19/2013	HOLA	Feather spot: 12 flight feathers (primary, secondary, and tail). More than 20 contour feathers.	U	n/a	11S	234059	3915719
20130919-16	Array 1	9/19/2013	MODO	Feather spot: 100+ body feathers, five tail feathers and two flight feathers.	U	n/a	11S	234018	3915516
20130919-17	Array 1	9/19/2013	MODO	Feather spot: 60+ body feathers, two tail feathers, and two wing coverts.	U	n/a	11S	233904	3915378
20130926-41	Array 1	9/26/2013	MODO	Feather spot: 100+ body feathers, 16+ flight feathers (primaries, secondaries, and retrices).	U	n/a	11S	233708	3915565
20131010-67	Array 1	10/10/2013	SAVS	Feather spot: ten Flight and 75 body feathers (breast, coverts) .	U	n/a	11S	233921	3915612
20131010-91	Array 1	10/10/2013	SAVS	Feather spot: 150 body feathers (belly breast mantle coverts) and 20 flight feathers (primary, secondary, tail).	U	n/a	11S	234040	3915699
20131017-101	Array 1	10/17/2013	HOLA	Partial carcass: partial wing with bone and few contour feathers.	U	n/a	11S	233611	3915529
20131017-102	Array 1	10/17/2013	SOSP	Feather spot: three wing and 75 contour feathers.	U	n/a	11S	233935	3915659

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131017-41	Array 1	10/17/2013	HOLA	Feather spot: 500+ body feathers.	U	n/a	11S	233672	3915718
20131107-106	Array 1	11/7/2013	MODO	Feather spot: One wing and 20 body feathers.	U	n/a	11S	233870	3915505
20131205-66	Array 1	12/5/2013	MODO	Feather spot: 24 body feathers and two secondary feathers with dried blood.	U	n/a	11S	234085	3915681
20140102-101	Array 1	1/2/2014	MODO	Feather spot: 10 flight and 25 body feathers.	U	n/a	11S	234247	3915552
20140102-122	Array 1	1/2/2014	MODO	Feather spot: 20+ body and three primary feathers.	U	n/a	11S	233452	3915780
20140605-41	Array 1	6/5/2014	ROPI	Feather spot: 15–18 body and/or secondary feathers.	U	n/a	11S	233627	3915666
20141009-21	Array 1	10/9/2014	WEME	Feather spot: Approximately 30 body feathers in several clumps.	U	n/a	11S	233415	3915748
20141030-101	Array 1	10/30/2014	MODO	Feather spot: Three tail feathers, one primary, and approximately 30 body feathers.	U	n/a	11S	233917	3915729
20140304-56	Array 11	3/4/2014	HOLA	Feather spot: 100 body feathers, four wing parts, and 15 flight feathers.	U	n/a	11S	234910	3911748
20140506-56	Array 11	5/6/2014	HOLA	Feather spot: 25 flight and 15 body feathers.	U	n/a	11S	234913	3911680
20140527-21	Array 11	5/27/2014	HOLA	Feather spot: Three wing partials. Ten loose flight feathers. 70 body feathers.	U	n/a	11S	234943	3911826
20140722-91	Array 11	7/22/2014	HOLA	Feather spot: 20+ flight feathers, 100+ body feathers.	U	n/a	11S	235078	3911778
20140812-101	Array 11	8/12/2014	HOLA	Partial carcass: Partial wing, four coverts, and four flight feathers, all attached.	U	n/a	11S	235060	3911767
20140909-121	Array 11	9/9/2014	CORA	Feather spot: One secondary feather and approximately body feathers.	U	n/a	11S	235087	3911773

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131029-1	Array 1-2 Fence	10/29/2013	ROPI	Feather spot: 20 contour feathers.	U	n/a	11S	234527	3914904
20131119-36	Array 1-2 Fence	11/19/2013	MODO	Feather spot: 200+ feathers including body, tail, wing, and contour feathers	U	n/a	11S	233399	3915688
20131119-37	Array 1-2 Fence	11/19/2013	MODO	Feather spot: 15 contour, 3 tail feathers	U	n/a	11S	233618	3914440
20131210-56	Array 1-2 Fence	12/10/2013	MODO	Feather spot: 12-15 body feathers.	U	n/a	11S	234173	3914460
20140128-21	Array 1-2 Fence	1/28/2014	HOFI	Feather spot: 20+ flight and 150+ body feathers.	U	n/a	11S	233395	3915500
20140107-123	Array 2	1/7/2014	HOFI	Feather spot: 100+ body feathers.	U	n/a	11S	234246	3914889
20140121-112	Array 2	1/21/2014	MODO	Feather spot: Two flight and 40 body feathers.	U	n/a	11S	234478	3914936
20140121-113	Array 2	1/21/2014	MODO	Feather spot: Four flight and 70 body feathers. Heavily clumped body feathers.	U	n/a	11S	234326	3915038
20140128-41	Array 2	1/28/2014	MODO	Feather spot: Five to six flight and 15+ body feathers. Some skin connected to the downy feathers.	U	n/a	11S	234357	3915121
20140128-42	Array 2	1/28/2014	WEME	Feather spot: 10 flight and 100+ body feathers.	U	n/a	11S	234348	3914900
20140211-21	Array 2	2/11/2014	MODO	Feather spot: 10 body feathers; two loose and eight attached to single piece of skin.	U	n/a	11S	234340	3915188
20140211-22	Array 2	2/11/2014	BUOW	Feather spot: 20 flight and 100 body feathers.	U	n/a	11S	234516	3914922
20140408-66	Array 2	4/8/2014	HOLA	Feather spot: Approximately 20 body feathers.	U	n/a	11S	234474	3915043
20140429-91	Array 2	4/29/2014	HOLA	Feather spot: Feathers of right wing and 50+ body feathers. Possibly from same as 20140506-	U	n/a	11S	234466	3915194

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
				36.					
20140506-36	Array 2	5/6/2014	HOLA	Feather spot: 20 body feathers and left wing. Possibly from same as 20140429-91.	U	n/a	11S	234526	3915229
20140513-41	Array 2	5/13/2014	HOLA	Feather spot: Eight flight feathers.	U	n/a	11S	234356	3914984
20140513-42	Array 2	5/13/2014	CORA	Feather spot: Approximately 30 body feathers.	U	n/a	11S	234246	3914936
20140520-101	Array 2	5/20/2014	HOLA	Feather spot: Nine flight feathers. Approximately 15 body feathers.	U	n/a	11S	234492	3915148
20140520-66	Array 2	5/20/2014	HOFI	Feather spot: 40 body feathers.	U	n/a	11S	234447	3914875
20140826-101	Array 2	8/26/2014	HOLA	Feather spot: Approximately 200 body and flight feathers.	U	n/a	11S	234328	3915028
20140826-126	Array 2	8/26/2014	MODO	Feather spot: Approximately 30 body feathers and four secondary feathers.	U	n/a	11S	234333	3915109
20141021-41	Array 2	10/21/2014	HOLA	Feather spot: Five primary and approximately 25 contour feathers.	U	n/a	11S	234489	3915097
20141028-101	Array 2	10/28/2014	CORA	Feather spot: Approximately 30 body feathers.	U	n/a	11S	234422	3915085
20141104-21	Array 2	11/4/2014	MODO	Feather spot: Clump of 10 body feathers with blood and piece of bone.	U	n/a	11S	234486	3914947
20131105-11	Array 2 Control	11/5/2013	MODO	Feather spot: wing and feathers, bone, and heart. Twenty primaries and secondaries, one wing, 10 tail, and 100+ body feathers.	U	n/a	11S	234298	3913537
20131112-63	Array 2 Control	11/12/2013	MODO	Feather spot: 20 body feathers	U	n/a	11S	233665	3914133

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131126-101	Array 2 Control	11/26/2013	WEME	Feather spot: 10-15 body feathers. 2 tail feathers.	U	n/a	11S	234312	3914369
20131210-107	Array 2 Control	12/10/2013	HOFI	Feather spot: 11 body feathers	U	n/a	11S	233953	3913581
20131217-111	Array 2 Control	12/17/2013	HOLA	Feather spot: 200 body feathers, skin	U	n/a	11S	233963	3913582
20130827-21	Array 2 North	8/27/2013	HOLA	Partial carcass: right wing with exposed bone and dried muscle tendons/ligaments.	U	n/a	11S	234323	3915324
20130827-26	Array 2 North	8/27/2013	MODO	Feather spot: seven tail feathers, 30 body feathers, one primary feather.	U	n/a	11S	234310	3915241
20130903-57	Array 2 North	9/3/2013	HOLA	Feather spot: five tail, five primary, three secondary, and 100+ body feathers.	U	n/a	11S	234323	3915312
20130910-37	Array 2 North	9/10/2013	HOLA	Partial carcass: two wings, five tail feathers and 30+ body feathers.	U	n/a	11S	234492	3915098
20130924-51	Array 2 North	9/24/2013	ROPI	Feather spot: five secondary feathers and one clump of five body feathers.	U	n/a	11S	234156	3915037
20130924-11	Array 2 North	9/24/2013	BUOW	Feather spot: approximately 50 contour feathers and 12 primaries. Secondary larger feather spot on adjacent Conservation Land.	U	n/a	11S	233969	3915190
20131008-41	Array 2 North	10/8/2013	AMPI	Feather spot: eight primary feathers in two clumps.	U	n/a	11S	233825	3915053
20131015-36	Array 2 North	10/15/2013	SAVS	Feather spot: partial wing (10 primary and secondary feathers), three tail feathers, five wing coverts and 15 breast feathers. Some fresh blood on feathers and feathers with fresh blood also found on panel above fatality.	U	n/a	11S	234251	3915140
20131015-106	Array 2 North	10/15/2013	HOLA	Feather spot: two secondaries and few coverts attached by small amount of flesh.	U	n/a	11S	233828	3915049

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131015-41	Array 2 North	10/15/2013	EUST	Feather spot: five to eight tail feathers, five to ten wing feathers, and 50+ contour feathers.	U	n/a	11S	234023	3914990
20131022-51	Array 2 North	10/22/2013	MODO	Feather spot: 20 contour feathers.	U	n/a	11S	234262	3915238
20131022-52	Array 2 North	10/22/2013	MODO	Feather spot: two wing feathers (secondaries).	U	n/a	11S	234149	3915041
20131112-81	Array 2 North	11/12/2013	WEME	Feather spot: 1 primary feather. 30 belly, breast and mantle feathers.	U	n/a	11S	234109	3915083
20131112-41	Array 2 North	11/12/2013	HOFI	Feather spot: 200-300 body feathers. 3-4 wing feathers.	U	n/a	11S	234201	3915219
20131112-42	Array 2 North	11/12/2013	HOFI	Feather spot: 5 primaries attached together with very dried skin.	U	n/a	11S	234311	3915321
20131126-111	Array 2 North	11/26/2013	SAVS	Whole carcass: Carcass, body without head. Impaled on tumbleweed.	P	<90	11S	234341	3915050
20131217-38	Array 2 North	12/17/2013	HOLA	Feather spot: Partial wing, with 200 body feathers and 20+ primary, secondary, and tail feathers.	U	n/a	11S	233787	3914934
20131217-51	Array 2 North	12/17/2013	MODO	Feather spot: 10 flight and 30 body feathers	U	n/a	11S	234370	3915423
20131231-16	Array 2 North	12/31/2013	MODO	Feather spot: 15+ flight and 200+ body feathers. Dried blood on feathers.	U	n/a	11S	234254	3914963
20131231-41	Array 2 North	12/31/2013	SAVS	Feather spot: 12 flight and 40+ body feathers.	U	n/a	11S	234104	3915019
20131231-42	Array 2 North	12/31/2013	WEME	Feather spot: 20+ flight and 200+ body feathers.	U	n/a	11S	234241	3914983
20131231-43	Array 2 North	12/31/2013	BRBL	Feather spot: 50+ body and ~12 flight feathers.	U	n/a	11S	234059	3915121
20131231-26	Array 2 North	12/31/2013	MODO	Feather spot: Five flight and 50 body feathers.	U	n/a	11S	234018	3915135

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20130910-52	Array 2 South	9/10/2013	LOSH	Feather spot: 30 flight feathers and 20 body feathers.	U	n/a	11S	234253	3914489
20130917-21	Array 2 South	9/17/2013	MODO	Feather spot: 30+ breast/body feathers, two secondaries, one tail feather and one primary feather.	U	n/a	11S	233705	3914565
20131029-37	Array 2 South	10/29/2013	MODO	Feather spot: 15+ wing feathers and 300 body feathers.	U	n/a	11S	233690	3914479
20131029-38	Array 2 South	10/29/2013	BRBL	Feather spot: 50+ body feathers. 6 contour and tail feathers.	U	n/a	11S	234045	3914766
20131029-56	Array 2 South	10/29/2013	MODO	Feather spot: two clumps of body feathers with six feathers in each clump.	U	n/a	11S	233776	3914490
20131105-61	Array 2 South	11/5/2013	YRWA	Feather spot: five tail feathers, ten or more primary and secondary feathers, 15+ rump feathers and 50+ mantle, belly, and breast feathers.	U	n/a	11S	234220	3914825
20131112-61	Array 2 South	11/12/2013	WEME	Feather spot: 4 secondaries. 50+ breast and belly feathers. 30+ mantle feathers	U	n/a	11S	234266	3914715
20131112-56	Array 2 South	11/12/2013	WEME	Feather spot: 2 primaries. 50+ breast, belly, and mantle feathers	U	n/a	11S	234266	3914823
20131119-61	Array 2 South	11/19/2013	WEME	Feather spot: 6 tail. 10 secondaries. 5+ primaries. 75+ breast body and mantle feathers.	U	n/a	11S	234267	3914747
20131119-62	Array 2 South	11/19/2013	MODO	Feather spot: 6 flight feathers. 25 body feathers	U	n/a	11S	234292	3914841
20131126-36	Array 2 South	11/26/2013	HOFI	Feather spot: 20 breast feathers attached to a piece of skin	U	n/a	11S	233681	3914607
20131126-37	Array 2 South	11/26/2013	HOFI	Feather spot: 100+ body feathers and 15+ flight feathers	U	n/a	11S	234182	3914868
20131126-46	Array 2 South	11/26/2013	MODO	Feather spot: 150+ body feathers, 15+ remiges, and 4+ retrices.	U	n/a	11S	233748	3914491

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131210-26	Array 2 South	12/10/2013	BUOW	Feather spot: Mostly body and wing feathers. One wing with bone attached, apparently plucked from carcass. Feathers and feather dust smudge on panel.	C	>50	11S	233885	3914440
20131210-27	Array 2 South	12/10/2013	MODO	Feather spot: Multiple tail and untertail coverts and body feathers.	U	n/a	11S	234178	3914631
20131217-26	Array 2 South	12/17/2013	MODO	Feather spot: 15 body feathers connected by skin.	U	n/a	11S	234292	3914577
20131217-113	Array 2 South	12/17/2013	HOLA	Feather spot: beak with flight feathers and 500 body feathers.	U	n/a	11S	233658	3914657
20131217-112	Array 2 South	12/17/2013	MODO	Feather spot: 1 flight and 60 body feathers	U	n/a	11S	234228	3914772
20131217-101	Array 2 South	12/17/2013	WEME	Feather spot: 25 body feathers	U	n/a	11S	234283	3914578
20131231-91	Array 2 South	12/31/2013	HOFI	Feather spot: 300 body and 20 flight feathers.	U	n/a	11S	234264	3914596
20131231-93	Array 2 South	12/31/2013	MODO	Feather spot: 20 flight and 100+ body feathers in several clumps.	U	n/a	11S	233975	3914547
20131231-94	Array 2 South	12/31/2013	MODO	Feather spot: 10 body feathers clumped.	U	n/a	11S	234239	3914709
20131231-95	Array 2 South	12/31/2013	MODO	Feather spot: 30 body and one flight feather.	U	n/a	11S	234157	3914693
20131231-112	Array 2 South	12/31/2013	HOFI	Feather spot: 70 body feathers.	U	n/a	11S	234256	3914518
20131231-126	Array 2 South	12/31/2013	WEME	Feather spot: Eight flight and 100 body feathers. Long smudge of body fluids along two trackers and panels with approximately ten feathers attached.	C	<50, >0	11S	233630	3914629

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131231-111	Array 2 South	12/31/2013	MODO	Feather spot: 10 flight and 200 body feathers.	U	n/a	11S	234252	3914541
20131231-127	Array 2 South	12/31/2013	MODO	Feather spot: 30 body feathers and four flight feathers.	U	n/a	11S	234166	3914885
20130828-38	Array 4	8/28/2013	HOFI	Feather spot: approximately 40 body feathers tightly clumped.	U	n/a	11S	235818	3912726
20131002-66	Array 4	10/2/2013	MODO	Feather spot: nine flight and body feathers.	U	n/a	11S	235580	3912843
20131002-81	Array 4	10/2/2013	WEME	Feather spot: ten body feathers.	U	n/a	11S	235660	3912716
20131023-101	Array 4	10/23/2013	MODO	Feather spot: three contour and 10-15 clumped body feathers.	U	n/a	11S	235566	3912961
20131030-36	Array 4	10/30/2013	MODO	Feather spot: 50+ body feathers and six contour and tail feathers.	U	n/a	11S	235544	3912717
20131106-82	Array 4	11/6/2013	ROPI	Feather spot: four tail feathers and 75+ body feathers.	U	n/a	11S	235561	3913230
20131113-108	Array 4	11/13/2013	MODO	Feather spot: 300 body and 10 wing feathers	U	n/a	11S	235658	3913495
20131113-61	Array 4	11/13/2013	MODO	Feather spot: Partial wing with clumps of wing coverts. Body feathers.	U	n/a	11S	235542	3912727
20131113-62	Array 4	11/13/2013	MODO	Feather spot: 4 secondary and 20 body feathers.	U	n/a	11S	235587	3913148
20131113-91	Array 4	11/13/2013	MODO	Feather spot: 2 primaries. 20 body feathers- some clumped	U	n/a	11S	235643	3912719
20131120-77	Array 4	11/20/2013	MODO	Feather spot: 4 tail and 30 body feathers	U	n/a	11S	235646	3913342
20131120-108	Array 4	11/20/2013	MODO	Feather spot: 30 body feathers. 1 secondary feather.	U	n/a	11S	235543	3912797

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131120-101	Array 4	11/20/2013	HOFI	Feather spot: Severn to eight feathers and 50 body feathers. Some with blood on feathers.	U	n/a	11S	235665	3913379
20131204-51	Array 4	12/4/2013	MODO	Feather spot: 24 body feathers connected with tissue.	U	n/a	11S	235863	3912739
20131211-56	Array 4	12/11/2013	MODO	Feather spot: Five+ flight (two primary feathers) and 50+ body feathers.	U	n/a	11S	235544	3912824
20131211-106	Array 4	12/11/2013	MODO	Feather spot: 15 flight and 150 body feathers.	U	n/a	11S	235544	3912956
20131211-107	Array 4	12/11/2013	MODO	Feather spot: 10 flight and 150 body feathers.	U	n/a	11S	235553	3912873
20131211-51	Array 4	12/11/2013	MODO	Feather spot: Body and flight feathers.	U	n/a	11S	235678	3912728
20131218-36	Array 4	12/18/2013	MODO	Feather spot: 50+ contour/body feathers and 15 flight feathers	U	n/a	11S	235808	3913345
20131218-37	Array 4	12/18/2013	MODO	Feather spot: 25 body feathers, including two clumps of 10 feathers each.	U	n/a	11S	235563	3912967
20131218-41	Array 4	12/18/2013	SAVS	Feather spot: 100+ body and 20 flight feathers.	U	n/a	11S	235677	3913411
20131218-42	Array 4	12/18/2013	MODO	Feather spot: 2 flight and 30+ contour feathers	U	n/a	11S	235628	3913002
20131218-38	Array 4	12/18/2013	HOLA	Feather spot: 200+ body feathers and 10 unidentified feathers.	U	n/a	11S	235610	3912812
20131218-39	Array 4	12/18/2013	MODO	Feather spot: 100 body and 2 flight feathers.	U	n/a	11S	235555	3912818
20131218-26	Array 4	12/18/2013	MODO	Feather spot: 30+ body and 5 flight feathers.	U	n/a	11S	235687	3912717
20140108-56	Array 4	1/8/2014	MODO	Feather spot: One wing covert, one tail feather, and 40 body feathers.	U	n/a	11S	235617	3912814

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140108-127	Array 4	1/8/2014	HOFI	Feather spot: 2 flight and 30+ body feathers and partial beak.	U	n/a	11S	235540	3912761
20140115-91	Array 4	1/15/2014	HOFI	Feather spot: 100 body and three flight feathers.	U	n/a	11S	235601	3913167
20140122-101	Array 4	1/22/2014	UNKN	Feather spot: piece of wing with feathers connected by skin, five flight and four covert feathers from unknown passerine.	U	n/a	11S	235977	3912728
20140122-104	Array 4	1/22/2014	HOFI	Feather spot: beak, organs, blood, and feathers. 20 flight and 200 body feathers.	U	n/a	11S	235777	3913251
20140129-41	Array 4	1/29/2014	HOFI	Feather spot: Three flight and 75 body feathers.	U	n/a	11S	235603	3913171
20140212-56	Array 4	2/12/2014	HOFI	Feather spot: wing clump, 15+ flight and 100 body feathers, across length of tracker row.	U	n/a	11S	235692	3913293
20140319-56	Array 4	3/19/2014	MODO	Feather spot: 10+ body feathers.	U	n/a	11S	235576	3912924
20140423-111	Array 4	4/23/2014	CORA	Feather spot: Approximately 30 body feathers.	U	n/a	11S	235556	3913007
20140430-57	Array 4	4/30/2014	HOLA	Feather spot: Wing segments - 50 flight and 40 body feathers.	U	n/a	11S	235615	3912877
20140507-91	Array 4	5/7/2014	MODO	Feather spot: 20 flight and 250 body feathers.	U	n/a	11S	235579	3913240
20140604-21	Array 4	6/4/2014	HOFI	Feather spot: Six loose flight feathers and approximately 70 body feathers.	U	n/a	11S	235813	3913400
20140611-56	Array 4	6/11/2014	CORA	Feather spot: Ten body feathers.	U	n/a	11S	235682	3913470
20140806-91	Array 4	8/6/2014	HOFI	Whole carcass: Very desiccated, keel exposed, internal tissues decomposed.	U	n/a	11S	235565	3913044

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20141001-56	Array 4	10/1/2014	AMCO	Feather spot: 10 flight feathers and approximately 200 body feathers.	U	n/a	11S	235549	3912702
20141022-44	Array 4	10/22/2014	MODO	Feather spot: Three tail feathers, five secondaries, and approximately 200 body feathers.	U	n/a	11S	235653	3912711
20141022-21	Array 4	10/22/2014	MODO	Feather spot: 15 body feathers in three distinct clumps.	U	n/a	11S	235679	3913356
20141029-93	Array 4	10/29/2014	ROPI	Feather spot: 10 flight feathers and 10 body feathers.	U	n/a	11S	235606	3912931
20131218-21	Array 4 Fence	12/18/2013	MODO	Feather spot: 100+ body and five tail feathers. Feathers found in several distinct clumps.	U	n/a	11S	235544	3913317
20140129-82	Array 4 Fence	1/29/2014	UNKN	Feather spot: 100 body feathers, four wing parts,15 flight feathers from unknown large bird.	U	n/a	11S	235541	3913282
20131120-37	Array 5	11/20/2013	MODO	Feather spot: 40+ body feathers. ~12 Secondaries. 3 Tail feathers	U	n/a	11S	236776	3913579
20131120-38	Array 5	11/20/2013	MODO	Feather spot: 20 body, 3 tail, and 6 contour feathers found in several clumps.	U	n/a	11S	236734	3913627
20140108-41	Array 5	1/8/2014	MODO	Feather spot: Eight to ten flight and 15+ body feathers.	U	n/a	11S	236705	3913598
20140129-81	Array 5	1/29/2014	AMCO	Feather spot: Approximately 100 body feathers.	U	n/a	11S	236649	3913800
20140205-91	Array 5	2/5/2014	MODO	Feather spot: Three clumped feathers attached to skin.	U	n/a	11S	236774	3913649
20131120-36	Array 5 Fence	11/20/2013	LASP	Feather spot: 100 body and contour feathers. 20+ wing and tail feathers. Beak with attached feathers.	U	n/a	11S	236596	3913884
20130930-21*	Array 6	9/30/2013	BUOW	Feather spot: two body feathers, four flight feathers (1 primary, 3 secondaries).	U	n/a	11S	237124	3913027

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20130930-22*	Array 6	9/30/2013	HOLA	Feather spot: 40 body feathers, two secondary feathers, several distinct clumps of 5-10 body feathers.	U	n/a	11S	237161	3913037
20131021-41	Array 6	10/21/2013	HOLA	Feather spot: wing parts, 30+ body, four tail, and 12-15 wing feathers. Some feathers clumped together with wing parts.	U	n/a	11S	237187	3913020
20131125-36	Array 6	11/25/2013	HOFI	Feather spot: 15 primary and secondary feathers. 30+ body and contour feathers.	U	n/a	11S	237209	3913199
20131216-36	Array 6	12/16/2013	MODO	Feather spot: 2 tail, 5 contour and 20 body feathers	U	n/a	11S	237100	3913022
20131216-37	Array 6	12/16/2013	MODO	Feather spot: 2 tail, 20 contour, and 30 body feathers	U	n/a	11S	237002	3913230
20131230-41	Array 6	12/30/2013	LOSH	Feather spot: 20 flight (wing and tail) and 100+ body feathers. Feathers were on the north side of the panel in a large area at the edge of the array. Some feathers and fluids were on the nearby panel.	C	<50, >0	11S	237218	3913237
20131230-42	Array 6	12/30/2013	HOFI	Feather spot: 10 flight and 30 body feathers.	U	n/a	11S	237156	3913180
20131230-43	Array 6	12/30/2013	MODO	Feather spot: six flight and two body feathers.	U	n/a	11S	237202	3913094
20131230-44	Array 6	12/30/2013	HOFI	Feather spot: 20+ flight feathers and 300+ body feathers	U	n/a	11S	237189	3913083
20140106-112	Array 6	1/6/2014	MODO	Feather spot: Six flight and 40 body feathers.	U	n/a	11S	237048	3913129
20140106-67	Array 6	1/6/2014	HOFI	Feather spot: 200+ body, four primary, and 10+ secondary feathers. Beak with fresh blood.	U	n/a	11S	237042	3913153
20140127-56	Array 6	1/27/2014	HOFI	Feather spot: 50+ body and 25+ flight feathers.	U	n/a	11S	236988	3913088

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140127-57	Array 6	1/27/2014	HOFI	Feather spot: 100+ body feathers.	U	n/a	11S	237049	3913135
20140127-58	Array 6	1/27/2014	HOFI	Whole carcass: found inside the "C" piles head first on ground below the cable trays. Carcass in rigor but no obvious broken dens-neck and keel bone intact. Eyes intact-fluid filled. Ceres present.	U	n/a	11S	237042	3913128
20140127-59	Array 6	1/27/2014	HOFI	Feather spot: 25 flight and 100 body feathers.	U	n/a	11S	237259	3913178
20140127-60	Array 6	1/27/2014	HOFI	Feather spot: 10 flight and 15+ body feathers.	U	n/a	11S	237156	3913172
20140204-66	Array 6	2/4/2014	MODO	Feather spot: 200+ body and 40 flight feathers.	U	n/a	11S	237039	3913115
20140218-111	Array 6	2/18/2014	MODO	Feather spot: One tail feather and 40 body feathers connected by skin.	U	n/a	11S	237035	3913121
20140317-2	Array 6	3/17/2014	MODO	Feather spot: Approximately 100 body feathers.	U	n/a	11S	237185	3913194
20140317-39	Array 6	3/17/2014	MODO	Feather spot: 30 body and 4 four flight feathers.	U	n/a	11S	237061	3913157
20140317-21	Array 6	3/17/2014	MODO	Feather spot: 80+ body and 16 wing and tail feathers. One partial wing clump with dried skin and blood.	U	n/a	11S	237196	3913118
20140421-36	Array 6	4/21/2014	BRBL	Feather spot: Approximately 15 body feathers; some are connected to one another.	U	n/a	11S	237109	3912989
20140714-11	Array 6	7/14/2014	UNKN	Feather spot: 13 body feathers from unknown passerine.	U	n/a	11S	237198	3913008
20140714-41	Array 6	7/14/2014	HOFI	Feather spot: Approximately eight flight feathers and 70 body feathers.	U	n/a	11S	236995	3913033

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140714-42	Array 6	7/14/2014	HOSP	Feather spot: Approximately 30 body feathers.	U	n/a	11S	236987	3913155
20140922-21	Array 6	9/22/2014	ROPI	Feather spot: Six primaries, six secondaries and 10 body feathers.	U	n/a	11S	237001	3913042
20141013-122	Array 6	10/13/2014	MODO	Feather spot: Approximately 20 body feathers and two secondary feathers connected with tissue.	U	n/a	11S	237263	3913228
20141020-21	Array 6	10/20/2014	MODO	Feather spot: 15 body feathers, two secondary feathers, and two tail feathers.	U	n/a	11S	236999	3913227
20131010-101*	Array 7	10/10/2013	MODO	Feather spot: ten body feathers.	U	n/a	11S	238673	3911160
20131010-26*	Array 7	10/10/2013	WEME	Feather spot: clump of eight body feathers attached by skin.	U	n/a	11S	238462	3911291
20131031-36	Array 7	10/31/2013	MODO	Feather spot: 50 body feathers and six tail feathers.	U	n/a	11S	238532	3910993
20131031-71	Array 7	10/31/2013	MODO	Feather spot: 100 body feathers and 15 flight feathers - some clumped.	U	n/a	11S	238635	3910988
20131107-76	Array 7	11/7/2013	MODO	Feather spot: Approximately 30 feathers found on the solar panel. One flight feather found on the ground.	U	n/a	11S	238612	3911192
20131114-91	Array 7	11/14/2013	SPTO	Feather spot: 10+ tail, 5+ primary and secondary, and 50+ body feathers.	U	n/a	11S	238337	3910994
20131205-47	Array 7	12/5/2013	HOFI	Feather spot: 10 flight and 50 body feathers	U	n/a	11S	238522	3911138
20131212-56	Array 7	12/12/2013	HOFI	Feather spot: 100+ body feathers and 10+ flight feathers.	U	n/a	11S	238533	3911185
20131212-57	Array 7	12/12/2013	HOFI	Feather spot: 120+ body feathers and 20+ flight feathers. Found tangled with tumbleweed against cable tray.	U	n/a	11S	238523	3911279

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131219-56	Array 7	12/19/2013	HOFI	Feather spot: 80+ body and 15+ flight feathers tangled in tumbleweed.	U	n/a	11S	238389	3911279
20140102-11	Array 7	1/2/2014	HOFI	Whole carcass: no sign of injury or illness.	U	n/a	11S	238622	3910967
20140102-12	Array 7	1/2/2014	HOFI	Feather spot: Approximately 25 primary feathers, 400 body feathers, and some fresh organs.	U	n/a	11S	238618	3910976
20140102-126	Array 7	1/2/2014	MODO	Feather spot: Six primary and ~15 body feathers.	U	n/a	11S	238310	3911277
20140102-127	Array 7	1/2/2014	MODO	Feather spot: One flight and 10+ body feathers.	U	n/a	11S	238627	3911036
20140109-102	Array 7	1/9/2014	HOFI	Feather spot: Five to ten flight and 150 body feathers.	U	n/a	11S	238589	3911085
20140123-36	Array 7	1/23/2014	MODO	Feather spot: 40+ body and one flight feather.	U	n/a	11S	238605	3911234
20140123-101	Array 7	1/23/2014	HOFI	Feather spot: Seven flight and 50 to 100 body feathers.	U	n/a	11S	238581	3910997
20140213-101	Array 7	2/13/2014	MODO	Feather spot: 15 body feathers clumped.	U	n/a	11S	238650	3910964
20140213-102	Array 7	2/13/2014	MODO	Feather spot: 40 body and one tail feather.	U	n/a	11S	238271	3911237
20140213-103	Array 7	2/13/2014	HOFI	Feather spot: 12 flight feathers and 100+ body feathers.	U	n/a	11S	238583	3911332
20140213-66	Array 7	2/13/2014	MODO	Feather spot: 16 body and two flight feathers.	U	n/a	11S	238575	3911278
20140220-125	Array 7	2/20/2014	MODO	Feather spot: 200+ body feathers and 30+ flight feathers.	U	n/a	11S	238389	3911201
20140227-41	Array 7	2/27/2014	MODO	Feather spot: Five flight and 30+ body feathers.	U	n/a	11S	238387	3911192

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140313-41	Array 7	3/13/2014	MODO	Feather spot: One wing covert and 12 body feathers.	U	n/a	11S	238285	3911040
20140320-36	Array 7	3/20/2014	CORA	Feather spot: 15 body feathers.	U	n/a	11S	238482	3911038
20140410-36	Array 7	4/10/2014	CORA	Feather spot: Approximately 30 body feathers.	U	n/a	11S	238296	3910996
20140501-111	Array 7	5/1/2014	HOLA	Feather spot: Approximately 30 flight and 50 body feathers.	U	n/a	11S	238226	3910993
20140515-36	Array 7	5/15/2014	SWTH	Feather spot: Approximately 200 body feathers and five flight feathers.	U	n/a	11S	238231	3911006
20140515-37	Array 7	5/15/2014	HOLA	Feather spot: Approximately 50 body feathers and five flight feathers.	U	n/a	11S	238228	3910994
20131107-41	Array 7 Fence	11/7/2013	MODO	Feather spot: Part of wing. Flight, secondary, and body feathers.	U	n/a	11S	238691	3911031
20140410-101	Array 7 Fence	4/10/2014	HOLA	Feather spot: 13 flight feathers.	U	n/a	11S	237332	3911591
20131024-41	Array 7 Control	10/24/2013	MODO	Feather spot: one tail feather, five or six wing feathers, and 20+ contour feathers.	U	n/a	11S	236462	3911697
20130916-72	Array 8 Circuit 2	9/16/2013	UNKN	Feather spot: wing held together by flesh, and approximately 100 body feathers from unknown passerine.	U	n/a	11S	233456	3912480
20130930-81	Array 8 Circuit 2	9/30/2013	MODO	Feather spot: hundreds of feathers of multiple types.	U	n/a	11S	234055	3911662
20131014-41	Array 8 Circuit 2	10/14/2013	WEME	Feather spot: 50+ body feathers, and six contour and tail feathers.	U	n/a	11S	233535	3912484
20131021-21	Array 8 Circuit 2	10/21/2013	HOFI	Feather spot: 18 body feathers, and single clump of 10+ body feathers and additional loose feathers.	U	n/a	11S	233737	3912016

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131021-22	Array 8 Circuit 2	10/21/2013	MODO	Feather spot: two tail feathers, 15+ coverts and 50+ body feathers in several clumps.	U	n/a	11S	233592	3912166
20131021-91	Array 8 Circuit 2	10/21/2013	MODO	Feather spot: one wing feather, two contour, and seven body feathers.	U	n/a	11S	233565	3912352
20131021-107	Array 8 Circuit 2	10/21/2013	MODO	Feather spot: 50-100 body feathers.	U	n/a	11S	233599	3912126
20131021-106	Array 8 Circuit 2	10/21/2013	HOFI	Feather spot: approximately 15 wing and approximately 30 body feathers.	U	n/a	11S	233767	3912097
20131111-106	Array 8 Circuit 2	11/11/2013	MODO	Feather spot: One wing attached to two contour feathers. Few more body feathers	U	n/a	11S	233436	3912298
20131118-106	Array 8 Circuit 2	11/18/2013	MODO	Feather spot: 50 body, 2 tail, and 2 wing feathers	U	n/a	11S	233683	3912149
20131118-107	Array 8 Circuit 2	11/18/2013	MODO	Feather spot: 27 body and 1 tail feathers	U	n/a	11S	233559	3912296
20131125-106	Array 8 Circuit 2	11/25/2013	MODO	Feather spot: 1 tail feather, 100 body feathers, and one wing feather. Clump of body feathers attached and blood on one feather.	U	n/a	11S	233560	3912418
20131125-41	Array 8 Circuit 2	11/25/2013	HOLA	Feather spot: 9 - 10 body feathers	U	n/a	11S	233631	3912072
20131209-106	Array 8 Circuit 2	12/9/2013	MODO	Feather spot: 20 body and 3 flight feathers	U	n/a	11S	233469	3912439
20131209-91	Array 8 Circuit 2	12/9/2013	MODO	Feather spot: 10 flight and numerous body feathers	U	n/a	11S	233390	3912479
20131216-67	Array 8 Circuit 2	12/16/2013	MODO	Feather spot: 18 body feathers and five primary feathers.	U	n/a	11S	233466	3912307
20131216-59	Array 8 Circuit 2	12/16/2013	MODO	Feather spot: 19 body feathers and one flight feather.	U	n/a	11S	233461	3912491

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131216-106	Array 8 Circuit 2	12/16/2013	HOLA	Feather spot: 10 flight and 300 body feathers.	U	n/a	11S	233645	3912169
20131216-66	Array 8 Circuit 2	12/16/2013	MODO	Feather spot: 45 body and 4 primary feathers. Clump of body feathers attached.	U	n/a	11S	233921	3912043
20131223-101	Array 8 Circuit 2	12/23/2013	WEME	Feather spot: 250+ body and 30 flight feathers	U	n/a	11S	234007	3912042
20131223-56	Array 8 Circuit 2	12/23/2013	MODO	Feather spot: two distinct clumps: One with 20+ grey and white body feathers and a second clump of 25 brown and grey body feathers.	U	n/a	11S	233412	3912366
20140106-36	Array 8 Circuit 2	1/6/2014	HOLA	Feather spot: 200+ body and three flight feathers and beak.	U	n/a	11S	233704	3912025
20140120-41	Array 8 Circuit 2	1/20/2014	HOLA	Feather spot: One flight and 10-15 contour feathers.	U	n/a	11S	233577	3912200
20140127-111	Array 8 Circuit 2	1/27/2014	MOBL	Feather spot: 4 flight and 25 body feathers clumped together	U	n/a	11S	234041	3911768
20140317-36	Array 8 Circuit 2	3/17/2014	HOFI	Whole carcass: Possible panel collision. Beak keratin damaged/uplifted slightly, indicating possible blunt force trauma.	C	>90	11S	233473	3912328
20140317-1	Array 8 Circuit 2	3/17/2014	HOLA	Whole carcass: No sign of injury or illness.	U	n/a	11S	233815	3912011
20140317-37	Array 8 Circuit 2	3/17/2014	HOLA	Feather spot: 20 body and two flight feathers.	U	n/a	11S	233690	3911973
20140317-38	Array 8 Circuit 2	3/17/2014	HOLA	Partial carcass: partial wing (eight flight feathers). Assorted body feathers all attached at joint.	U	n/a	11S	233956	3911857
20140331-36	Array 8 Circuit 2	3/31/2014	MODO	Feather spot: Approximately 50 body feathers.	U	n/a	11S	233525	3912405

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140407-101	Array 8 Circuit 2	4/7/2014	MODO	Feather spot: Eight body feathers and two clumps of body feathers with connected tissue.	U	n/a	11S	233535	3912245
20140929-21	Array 8 Circuit 2	9/29/2014	CORA	Feather spot: Approximately 20 body feathers.	U	n/a	11S	233599	3912231
20141006-126	Array 8 Circuit 2	10/6/2014	MODO	Feather spot: Approximately body feathers and four secondaries.	U	n/a	11S	233631	3912187
20141013-1	Array 8 Circuit 2	10/13/2014	MODO	Feather spot: Eight flight feathers and approximately 40 contour feathers.	U	n/a	11S	233347	3912482
20141013-121	Array 8 Circuit 2	10/13/2014	MODO	Feather spot: Three tail feathers and approximately 60 contour feathers.	U	n/a	11S	233471	3912277
20141020-41	Array 8 Circuit 2	10/20/2014	MODO	Feather spot: 10-12 body feathers.	U	n/a	11S	234020	3911748
20131014-106	Array 8 Fence	10/14/2013	RCKI	Whole carcass: no obvious sign of injury.	C	>50	11S	234252	3912538
20131216-56	Array 8 Fence	12/16/2013	HOLA	Feather spot: 100+ body and 10 flight feathers, leg and thigh, and one inch diameter skin. Some parts found impaled on tumbleweed. Likely a loggerhead shrike kill.	P	>90	11S	233494	3913025
20141006-41	Array 8 Fence	10/6/2014	UNKN	Feather spot: Approximately body feathers from unknown small bird.	U	n/a	11S	233383	3913042
20140108-111	Array 9	1/8/2014	HOFI	Feather spot: 30 flight and 200+ body feathers.	U	n/a	11S	233406	3911476
20140213-56	Array 9	2/13/2014	HOFI	Feather spot: 100+ breast feathers, two parts of upper wing, and 20 individual flight feathers.	U	n/a	11S	233423	3911605
20140515-22	Array 9	5/15/2014	HOLA	Whole carcass: No sign of injury or illness.	U	n/a	11S	233401	3911518
20141106-41	Array 9	11/6/2014	MODO	Feather spot: Approximately 25 body feathers.	U	n/a	11S	233337	3911683

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140403-51	Array 9 Fence	4/3/2014	MODO	Feather spot: 100 body feathers and four flight feathers.	U	n/a	11S	233252	3911264
20131204-52	Controls	12/4/2013	MODO	Feather spot: 20 flight and tail feathers. 200 body feathers.	U	n/a	11S	236280	3912639
20140107-91	Controls	1/7/2014	WEME	Feather spot: 10 flight and 50+ body feathers.	U	n/a	11S	234343	3914361
20140107-66	Controls	1/7/2014	ECDO	Feather spot: 20 flight and 150+ body feathers.	U	n/a	11S	236446	3912721
20140128-111	Controls	1/28/2014	MODO	Feather spot: 30+ body feathers matted and connected to skin and blood.	U	n/a	11S	234862	3914336
20140218-66	Controls	2/18/2014	MODO	Feather spot: 30 body feathers.	U	n/a	11S	236475	3911690
20140225-101	Controls	2/25/2014	HOLA	Feather spot: 50+ body and ~20 flight feathers.	U	n/a	11S	236464	3911592
20140225-102	Controls	2/25/2014	HOFI	Feather spot: ~15 flight and 40+ body feathers.	U	n/a	11S	234329	3913553
20140422-56	Controls	4/22/2014	HOLA	Feather spot: 10 body feathers.	U	n/a	11S	236467	3911647
20140902-21	Controls	9/2/2014	ROPI	Feather spot: Three body feathers and one secondary feather clumped together with blood. Several feathers are together in a sheath.	U	n/a	11S	236446	3911574
20141021-101	Controls	10/21/2014	MODO	Feather spot: Approximately 200 body feathers, four primary and nine secondary feathers.	U	n/a	11S	238328	3912064
20141028-1	Controls	10/28/2014	FOSP	Feather spot: Approximately 150 body feathers.	U	n/a	11S	234338	3914329
20131223-36	Evaporation Pond	12/23/2013	HOFI	Feather spot: 100+ body feathers and 20+ flight feathers (partial wing); feathers mostly clumped. Found at the north end of the	U	n/a	11S	234781	3914267

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
				pond.					
20131223-16	Evaporation Pond	12/23/2013	HOFI	Whole carcass: found at southeast corner of fence. No rigor mortis and the keel bone could be felt. Carcass appeared malnourished. Feathers around cloaca are matted with feces. Dried blood around edges of the beak.	D	>50	11S	234809	3914200
20131223-57	Evaporation Pond	12/23/2013	HOFI	Feather spot: 10+ body feathers and one flight feather.	U	n/a	11S	234798	3914194
20131223-58	Evaporation Pond	12/23/2013	MODO	Feather spot: Majority of tail segment. 10 flight and eight body feathers. Found at southwest corner outside pond fence.	U	n/a	11S	234676	3914214
20130821-21	Gen-tie Line	8/21/2013	MODO	Feather spot: three tail feathers, 15+ flight feathers, 50+ breast and body feathers.	C	>50	11S	234284	3916921
20130821-23	Gen-tie Line	8/21/2013	MODO	Feather spot: fewer than flight feathers, and 30+ breast and body feathers.	C	>50	11S	234279	3917046
20130828-36	Gen-tie Line	8/28/2013	UNKN	Feather spot: about 15 body feathers from unknown passerine.	C	>50	11S	234254	3916454
20130828-37	Gen-tie Line	8/28/2013	HOLA	Feather spot: about 50 body feathers and two secondary feathers.	C	>50	11S	234595	3915151
20130904-61	Gen-tie Line	9/4/2013	MODO	Feather spot: three primaries, two secondaries, approximately 20 body feathers.	C	>50	11S	234487	3915964
20130911-72	Gen-tie Line	9/11/2013	HOLA	Feather spot: 75 body feathers, one tail, three primary, and four secondary feathers.	U	n/a	11S	234601	3915040
20130925-52	Gen-tie Line	9/25/2013	UNWA	Partial carcass: clump of small body feathers attached to spinal bone fragments from unknown warbler.	C	>50	11S	234246	3918342
20131002-71	Gen-tie Line	10/2/2013	SAVS	Whole carcass: found with broken neck.	C	>90	11S	234254	3918510

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131002-36	Gen-tie Line	10/2/2013	SAVS	Feather spot : 100 body feathers (breast, mantle, rump, coverts), and partial wing (15 primary and secondary feathers).	U	n/a	11S	234478	3914356
20131002-73	Gen-tie Line	10/2/2013	SAVS	Feather spot: 100+ body feathers (belly, breast, mantle, rump, coverts), and 20 flight feathers (primary and secondary).	C	>50	11S	234459	3914349
20131009-66	Gen-tie Line	10/9/2013	SAVS	Whole carcass: no visible external injuries.	C	>50	11S	234601	3915243
20131009-106	Gen-tie Line	10/9/2013	HOFI	Feather spot: 15 primaries and 150 body feathers.	U	n/a	11S	234447	3917982
20131009-107	Gen-tie Line	10/9/2013	YRWA	Partial carcass: half carcass impaled by loggerhead shrike.	P	>90	11S	234405	3917830
20131016-109	Gen-tie Line	10/16/2013	HOLA	Feather spot: four wing feathers and 30+ contour feathers.	C	>50	11S	234260	3916727
20131016-107	Gen-tie Line	10/16/2013	WEME	Feather spot: ten wing, 150 body, and few tail feathers.	U	n/a	11S	234361	3917795
20131016-108	Gen-tie Line	10/16/2013	WEME	Feather spot: ten wing, few tail, and 300+ body feathers	C	>50	11S	234262	3916740
20131016-110	Gen-tie Line	10/16/2013	WEME	Feather spot: partial wing, plus 20 wing, a few tail, and 100 contour feathers.	U	n/a	11S	234664	3915616
20131016-41	Gen-tie Line	10/16/2013	EUST	Feather spot: four or five wing feathers, two or three tail feathers, and 100-200 contour feathers.	U	n/a	11S	234479	3914368
20131016-42	Gen-tie Line	10/16/2013	SAVS	Whole carcass: no obvious sign of injury.	U	n/a	11S	234589	3918770
20131023-91	Gen-tie Line	10/23/2013	YRWA	Feather spot: four wing feathers and 20 body feathers.	C	>50	11S	234422	3917880
20131023-94	Gen-tie Line	10/23/2013	YRWA	Whole carcass: no obvious sign of injury.	U	n/a	11S	234281	3916371

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131023-95	Gen-tie Line	10/23/2013	CORA	Feather spot: 15 wing feathers and a few body feathers.	C	>50	11S	234628	3918824
20131106-101	Gen-tie Line	11/6/2013	MODO	Feather spot: 30 body and wing feathers.	U	n/a	11S	234359	3918593
20131106-102	Gen-tie Line	11/6/2013	MODO	Feather spot: 15 body feathers, clumped.	C	>50	11S	234432	3916086
20131113-81	Gen-tie Line	11/13/2013	SAVS	Feather spot: 15+ flight feathers found in two distinct clumps attached by dried skin. 80 mantle, breast, and rump feathers.	C	>50	11S	234564	3918767
20131120-106	Gen-tie Line	11/20/2013	WEME	Feather spot: 150 body and 20 wing and tail feathers.	U	n/a	11S	234323	3914104
20131120-107	Gen-tie Line	11/20/2013	HOLA	Feather spot: 200 body and 4 wing feathers	U	n/a	11S	234586	3915142
20131204-66	Gen-tie Line	12/4/2013	WEME	Feather spot: 12 body feathers	C	>50	11S	234420	3916114
20131211-92	Gen-tie Line	12/11/2013	WEME	Feather spot: 100 body feathers and 10+ flight feathers (primary, secondary, and tail).	C	>50	11S	234278	3917359
20131218-57	Gen-tie Line	12/18/2013	MODO	Feather spot: 15+ body feathers. 1 Tail feather.	C	>50	11S	234586	3914835
20140108-101	Gen-tie Line	1/8/2014	MODO	Feather spot: 15+ flight and 200+ body feathers. Dried blood on feathers.	U	n/a	11S	234257	3918309
20140108-102	Gen-tie Line	1/8/2014	WEME	Feather spot: Four flight, approximately 18 body, and 2 covert feathers.	C	>50	11S	234607	3915178
20140122-16	Gen-tie Line	1/22/2014	WEME	Feather spot: Clump of five flight feathers held together with skin and loose flight feathers, and 30+ body feathers.	C	>50	11S	234362	3917791
20140129-111	Gen-tie Line	1/29/2014	HOLA	Feather spot: Approximately 10 flight, 50 body feathers.	C	>50	11S	234484	3915983

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140312-36	Gen-tie Line	3/12/2014	HOLA	Feather spot: Approximately 100 body and 20 flight feathers.	C	>50	11S	234654	3915632
20140423-56	Gen-tie Line	4/23/2014	BHGR	Whole carcass: found directly under powerline. Left wing appears to be dislocated.	C	>50	11S	234622	3918809
20140430-101	Gen-tie Line	4/30/2014	MODO	Feather spot: Approximately 100 body and 12 flight feathers.	C	>50	11S	234254	3916463
20140430-36	Gen-tie Line	4/30/2014	MODO	Feather spot: Approximately 50 body feathers and 15 flight feathers.	C	>50	11S	234303	3916347
20140430-37	Gen-tie Line	4/30/2014	TOWA	Whole carcass: Directly under powerline. Right wing appears to be dislocated at shoulder.	C	>50	11S	234642	3918826
20140507-36	Gen-tie Line	5/7/2014	WAVI	Feather spot: Six flight and 200+ body feathers.	C	>50	11S	234587	3914762
20140514-91	Gen-tie Line	5/14/2014	TOWA	Whole carcass: Directly under powerline. Signs of blunt-force trauma to right abdomen. Organs exposed.	C	>90	11S	234674	3918846
20140514-92	Gen-tie Line	5/14/2014	TOWA	Whole carcass: Directly under powerline. Signs of blunt-force trauma to right abdomen. Organs exposed.	C	>50	11S	234908	3919061
20140514-95	Gen-tie Line	5/14/2014	WIWA	Feather spot: Approximately 80 body feathers and 25 flight feathers.	C	>50	11S	234253	3916458
20140514-93	Gen-tie Line	5/14/2014	COYE	Feather spot: Ten flight and 15 body feathers.	C	>50	11S	234261	3916928
20140514-94	Gen-tie Line	5/14/2014	MODO	Feather spot: Five flight feathers and 30 body feathers.	C	>50	11S	234253	3916468
20140521-41	Gen-tie Line	5/21/2014	MODO	Feather spot: One flight feather and approximately 100 body feathers. Within limits of tower pad and directly under powerline.	C	>50	11S	234377	3916198
20140521-42	Gen-tie Line	5/21/2014	OCWA	Feather spot: 20 flight and approximately 250 body feathers. 3 meters off center of powerline.	C	>50	11S	234682	3915460

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140521-43	Gen-tie Line	5/21/2014	COYE	Feather spot: Approximately 75 body feathers. Directly under powerline.	C	>50	11S	234667	3915443
20140521-44	Gen-tie Line	5/21/2014	WETA	Feather spot: 25 flight feathers and approximately 125 body feathers. Directly under powerline.	C	>50	11S	234489	3914380
20140521-45	Gen-tie Line	5/21/2014	ROPI	Feather spot: Six flight feathers and 40 body feathers. Directly under powerline.	C	>50	11S	234354	3914156
20140528-56	Gen-tie Line	5/28/2014	YEWA	Feather spot: Approximately 80 body feathers and six flight feathers. Directly under powerline.	C	>50	11S	234253	3913960
20140528-57	Gen-tie Line	5/28/2014	YEWA	Feather spot: Approximately 60 body feathers. Directly under powerline.	C	>50	11S	234575	3914705
20140618-11	Gen-tie Line	6/18/2014	CEDW	Feather spot: 15 primary feathers, approximately 100 body feathers, and five tail feathers. Directly under powerline.	C	>50	11S	234477	3918693
20140618-12	Gen-tie Line	6/18/2014	MODO	Feather spot: Ten tail and primary feathers, and approximately 200 body feathers. Within limits of tower pad and directly under powerline.	C	>50	11S	234466	3917928
20140730-41	Gen-tie Line	7/30/2014	ROPI	Feather spot: Feathers spread out over large area (approximately 50 meters) and weathered. Approximately 30 feathers directly under powerline, and remaining spread over 50-meter area.	C	>50	11S	234353	3914146
20141008-56	Gen-tie Line	10/8/2014	AMPI	Feather spot: Approximately 60 body feathers and 20 flight feathers. Directly under line.	C	>50	11S	234224	3913918
20141015-101	Gen-tie Line	10/15/2014	SAVS	Feather spot: Two flight feathers and approximately 100 body feathers. Directly under line.	C	>50	11S	234400	3914225
20141015-102	Gen-tie Line	10/15/2014	MODO	Feather spot: Approximately 10 flight feathers and 100 body feathers. Directly under line.	C	>50	11S	234223	3913930

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20141015-103	Gen-tie Line	10/15/2014	MODO	Feather spot: Approximately 40 flight feathers and a partial wing.	U	n/a	11S	234364	3917827
20141022-41	Gen-tie Line	10/22/2014	HOLA	Partial carcass: Headless carcass and approximately 200 body feathers. Directly under line.	P	<50, >0	11S	234306	3918554
20141022-42	Gen-tie Line	10/22/2014	WEME	Feather spot: Approximately 200 body feathers, three primary feathers. Directly under line.	C	>50	11S	234583	3914657
20141022-43	Gen-tie Line	10/22/2014	HOLA	Feather spot: Approximately 100 body feathers. Directly under line.	C	>50	11S	234413	3914244
20141029-91	Gen-tie Line	10/29/2014	MODO	Feather spot: Approximately 100 body feathers. Directly under line.	C	>50	11S	234274	3917374
20141029-92	Gen-tie Line	10/29/2014	YRWA	Feather spot: Approximately 100 body feathers and 25 flight feathers. Directly under line.	C	>50	11S	234454	3914337

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Appendix D. 5-Day Repeat Fatality Search Results: 16 August 2013 to 31 December 2013

Fatality ID	Area	Date Detected	Number of Days Fatality Persisted	Species¹	Observation Details	Cause of Death²	% Certainty	Easting	Northing
20130925-16R	Array 1	9/25/2013	3	MODO	Feather spot: Two tail feathers and 14 body feathers.	U	n/a	233937	3915357
20130925-36R	Array 1	9/25/2013	3	HOFI	Feather spot: Partial wing and 50 body feathers, scattered contour feathers, secondaries, and primaries.	U	n/a	233869	3915427
20131023-36R	Array 1	10/23/2013	3	CORA	Feather spot: 15 contour feathers.	U	n/a	234160	3915427
20131119-41R*	Array 1	11/19/2013	3	HOFI	Feather spot: 300+ body feathers, 5+ wing feathers, and three tail feathers from an adult male.	U	n/a	234008	3915554
20131023-71R	Array 1-2 fence	10/23/2013	3	CORA	Feather spot: 15 contour feathers.	U	n/a	234160	3915703
20130826-56R*	Array 2 Serengeti	8/26/2013	n/a	MODO	Feather spot: Five primaries, two secondaries, and 16+ body feathers.	U	n/a	234458	3915140
20131001-101R	Array 2 North	10/1/2013	4	HOLA	Feather spot: Three flight feathers.	U	n/a	234178	3915346
20131001-41R	Array 2 North	10/1/2013	4	HOLA	Feather spot: Six flight feathers and 30 body feathers.	U	n/a	233974	3915178

Notes:
[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5.
[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.
* = Clearance fatality

Fatality ID	Area	Date Detected	Number of Days Fatality Persisted	Species[1]	Observation Details	Cause of Death[2]	% Certainty	Easting	Northing
20131002-106R	Array 2 North	10/2/2013	2	HOLA	Whole carcass: Adult male. No sign of injury or illness. Found directly under panel.	U	n/a	234081	3915283
20130902-81R*	Array 2 South	9/2/2013	n/a	HOLA	Feather spot: 11 flight feathers.	U	n/a	234293	3914596
20130902-86R*	Array 2 South	9/2/2013	n/a	HOLA	Feather spot: 20+ flight feathers and 100+ body feathers. Adult male.	U	n/a	234027	3914724
20131101-106R	Array 2 South	11/1/2013	n/a	MODO	Feather spot: Four tail feathers and more than one hundred body feathers.	U	n/a	233977	3914544
20131016-46R	Array 4	10/16/2013	3	CORA	Feather spot: 17 contour feathers.	U	n/a	236160	3913218
20131114-101R	Array 4	11/14/2013	2	WEME	Feather spot: 100+ body feathers and 15+ wing and tail feathers. Feathers present on solar panel, indicating either panel strike or avian scavenging.	U	n/a	236086	3913716
20131210-38R*	Array 4	12/10/2013	n/a	WEME	Feather spot: > 20 body feathers and >20 primary and secondary feathers.	U	n/a	235592	3913712
20131212-114R	Array 4	12/12/2013	2	MODO	Feather spot: Five flight feathers and 60 body feathers	U	n/a	235523	3913707
20131213-39R	Array 4	12/13/2013	n/a	MODO	Feather spot: 75+ body feathers, 12+ tail feathers	U	n/a	235488	3913692
20131210-102R*	Array 4 Fence	12/10/2013	n/a	MODO	Feather spot: Approximately 30 feathers.	U	n/a	235654	3913759

Notes:

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Fatality ID	Area	Date Detected	Number of Days Fatality Persisted	Species[1]	Observation Details	Cause of Death[2]	% Certainty	Easting	Northing
20130821-86R	Array 5	8/21/2013	3	LASP	Feather spot: Seven flight feathers and approximately 100 body feathers. Adult.	U	n/a	236818	3913588
20131111-36R*	Array 5	11/11/2013	n/a	HOFI	Feather spot: 20 primary and secondary feathers, 100+ body feathers, bill.	U	n/a	236620	3913535
20131210-103R*	Array 5	12/10/2013	n/a	MODO	Feather spot: 3 tail feathers, 2 flight feathers, and 15 body feathers.	U	n/a	235544	3913728
20131108-56R	Array 6	11/8/2013	n/a	ROPI	Feather spot: 150+ belly, rump, and scapular feathers, five tail feathers, and ten or more primary and secondary feathers.	U	n/a	237422	3912732
20131210-113R*	Array 6	12/10/2013	n/a	MODO	Feather spot: 10 primary feathers and 40 body feathers.	U	n/a	235536	3913664
20131210-112R*	Array 7	12/10/2013	n/a	MODO	Feather spot: 50 body feathers and 4 flight feathers.	U	n/a	235713	3913580
20130821-41R	Array 8	8/21/2013	2	HOLA	Feather spot: 15+ contour feathers.	U	n/a	234095	3912508
20130822-42R	Array 8	8/22/2013	2	LEOW	Feather spot: 20 contour and breast feathers.	U	n/a	233937	3912500
20131111-46R*	Array 8	11/11/2013	n/a	WEME	Feather spot: 200+ breast and body feathers.	U	n/a	233768	3912809
20131209-101R*	Array 8	12/09/2013	n/a	MODO	Feather spot: 5-10 flight feathers and 30 body feathers.	U	n/a	234381	3912071

Notes:
[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5.
[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.
* = Clearance fatality

Fatality ID	Area	Date Detected	Number of Days Fatality Persisted	Species[1]	Observation Details	Cause of Death[2]	% Certainty	Easting	Northing
20131209-102R*	Array 8	12/09/2013	n/a	MODO	Feather spot: 2 tail feathers, 2 flight feathers, and 50 body feathers.	U	n/a	234371	3912219
20131209-36R*	Array 8	12/9/2013	n/a	MODO	Feather spot: 200 + body feathers and 20+ primary feathers.	U	n/a	234156	3912315
20131210-37R	Array 8	12/10/2013	3	MODO	Feather spot: 50+ body feathers and 30+ flight and tail feathers.	U	n/a	234202	3912369
20131014-46R*	Array 8 fence	10/14/2013	n/a	MODO	Feather spot: 30 + contour feathers.	U	n/a	234050	3912692
20121111-101R*	Array 8 fence	11/11/2013	n/a	MODO	Feather spot: 30 body feathers and one flight feather.	U	n/a	233369	3912447
20131210-101R	Array 8 fence	12/10/2013	3	MODO	Feather spot: Ten to fifteen flight feathers and 30 body feathers.	U	n/a	234411	3912264
20131203-56R	MVOH	12/3/2013	3	BUOW	Feather spot: 20 body feathers.	C	>50	238194	3912024
20131007-81R*	MVOH	10/7/2013	n/a	WEME	Feather spot: 100+ body feathers and flight feathers.	C	>50	234591	3913326
20131007-82R*	MVOH	10/7/2013	n/a	WEME	Feather spot: Approximately 15 feathers and tail feathers.	C	>50	234781	3912925

Notes:

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Appendix E. 1-Day Repeat Search Results: 16 August 2013 to 31 December 2013

Fatality ID	Area	Date Detected	Species[1]	Observation Details	Cause of Death[2]	% Certainty	Easting	Northing
1-day repeat searches of regular weekly search areas								
20131018-61R	Array 1	10/18/2013	HOLA	Feather spot: One covert feather and 15 flight feathers.	U	n/a	233623	39155240
20131009-36R	Array 2 North	10/8/2013	HOLA	Feather spot: Approximately 30 contour feathers.	U	n/a	234013	3914941
20131218-111R	Array 2 North	12/18/2013	MODO	Whole carcass: Trauma to right shoulder and chest. Bruising on right foot. Trauma appears to have partially healed. Found directly under panel, but no mark on panel.	C	>90	233908	3914955
20131218-11R	Array 2 North	12/18/2013	WEME	Feather spot: Seven flight feathers and 200+ body feathers. Presence of loose clumps of feathers on flat solar panels suggests that the bird was very recently scavenged by a raven.	U	n/a	233803	3914993
20130911-36R	Array 2 South	9/11/2013	MODO	Feather spot: Approximately 15 breast and contour feathers.	U	n/a	234145	3914884
20131106-81R	Array 2	11/6/2013	RCKI	Feather spot: 100+ feathers.	U	n/a	233660	3914613
20131204-36R	Array 2 South	12/4/2013	SAVS	Feather spot: 100+ body feathers, 12 primaries and secondaries.	U	n/a	234160	3914847
20131211-06R	Array 2 Serengeti	12/11/2013	CORA	Feather spot: Approximately 20 body feathers.	U	n/a	234489	3915098

Notes:
[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5.
[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

Fatality ID	Area	Date Detected	Species[1]	Observation Details	Cause of Death[2]	% Certainty	Easting	Northing
20131231-76R	Array 6	12/31/2013	MODO	Feather spot: 20 body feathers and five contour feathers.	U	n/a	235570	3913160
20131108-61R	Array 7	11/08/2013	MODO	Feather spot: Partial wing and ten body feathers.	U	n/a	238669	3911022
20131220-1R	Array 7	12/20/2013	ECDO	Feather spot: Two tertiary feathers and 18 body feathers in two clumps.	U	n/a	237717	3912921
20130917-47R	Array 8	9/17/2013	MODO	Feather spot: Approximately 30 body feathers. Likely preen spot.	U	n/a	233440	3912421
20131112-26R	Array 8	11/12/2013	HOLA	Feather spot: 30 body feathers.	U	n/a	233589	3912209
20131024-61R	Gen-tie Line	10/24/2013	HOFI	Feather spot:	C	>50	238669	3911022
20131205-21R	Gen-tie Line	12/5/2013	SAVS	Feather spot: 16 flight and 50+ body feathers.	C	>50	234448	3914325
1-day repeat searches of 5-day repeat search areas								
20131018-01R	Array 8 fence	10/18/2013	MODO	Feather spot: Approximately 15 body feathers.	U	n/a	234147	3912526
20131108-01R	Array 9	11/8/2013	CORA	Feather spot: Seven contour feathers in a clump. Feathers were sheared at the base, indicating mammalian scavenging.	U	n/a	233670	3911290

Notes:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

Appendix F. Incidental Fatalities: 16 August 2013 to 17 November 2014

Incident ID	Site	Search Date	Species Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140129-67	MVOH line	1/29/2014	MODO	Feather spot: 20+ flight and 150+ body feathers. Blood on ground near feather spot and on some flight and body feathers. Time of death probably 48 hours due to fresh blood.	U	n/a	11S	236973	3913150
20140203-91	MVOH line	2/3/2014	HOFI	Feather spot: Beak (upper and lower), approximately 200 body and 30+ flight feathers.	U	n/a	11S	234046	3913667
20140416-106	MVOH line	4/16/2014	CORA	Whole carcass: Bird found dead on nest. Nest material in mouth. Maggots present on carcass. No visible signs of electrocution.	E	<50%, >0	11S	236922	3913037
20140512-106	MVOH line	5/12/2014	CORA	Whole carcass: Bird found dead at base of power pole with one singed wing. Found by operations and maintenance crew, and bird was scavenged before it could be recovered by a biologist.	E	>90%	11S	235671	3912665
20140313-91	Array 1	3/13/2014	HOFI	Feather spot: 50+ body and 15+ flight feathers	U	n/a	11S	233871	3915444
20140313-11	Array 1	3/13/2014	HOLA	Partial carcass: One wing and dried torso; chest cavity open and organs absent. No head. One foot attached.	U	n/a	11S	234008	3915482
20140121-111	Array 1-2 Fence	1/21/2014	ECDO	Feather spot: 30 body feathers and one secondary feather.	U	n/a	11S	233711	3914383
20130924-101	Array 2 North	9/24/2013	MODO	Feather spot: five clumped body feathers; ten body feathers total. Two clumps of feathers as though plucked, and one feather in sheath (so not molted).	U	n/a	11S	234156	3914993
20130927-101	Array 2 North	9/27/2013	CORA	Feather spot: three primary feathers, one secondary feather.	U	n/a	11S	234353	3914440
20140306-111	Array 2	3/6/2014	HOFI	Feather spot: 200 body and 50 flight feathers. Bill (in two pieces) with attached feathers.	U	n/a	11S	234069	3914915
20140319-41	Array 2	3/19/2014	HOLA	Feather spot: 8 tail, 10 wing, and 100 body feathers	U	n/a	11S	233934	3914662
20131217-61	Array 2 Control	12/17/2013	WEME	Feather spot: 50 body and 15 flight feathers	U	n/a	11S	234400	3914379

Notes:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

Incident ID	Site	Search Date	Species Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131217-36	Array 2 Control	12/17/2013	LOSH	Feather spot: Partial wing, seven primaries and 30+ body feathers.	U	n/a	11S	234702	3915154
20131107-36	Array 4	11/7/2013	BANO	Feather spot: 20+ primary/wing and 30+ body/contour feathers.	U	n/a	11S	236014	3912900
20131119-67	Array 4	11/19/2013	MODO	Feather spot: 200+ body feathers. 11 large feathers (primary and secondary). Dirty panels with clean spot.	C	<50%, >0	11S	235874	3912747
20131218-101	Array 4	12/18/2013	MODO	Feather spot: Three tail, 15 flight, and 30 body feathers.	U	n/a	11S	235562	3912684
20140122-103	Array 4	1/22/2014	WEME	Feather spot: Two flight (Primaries) and approximately 100 body feathers.	U	n/a	11S	235619	3913231
20131211-121	Array 4 Fence	12/11/2013	MODO	Feather spot: 200 body and few flight feathers	U	n/a	11S	235531	3913027
20140122-94	Array 4 Fence	1/22/2014	MODO	Feather spot: 200 body and 30 flight feathers.	U	n/a	11S	235532	3912920
20140106-66	Array 6	1/6/2014	HOFI	Feather spot: 200+ body, one primary, and three secondary feathers.	U	n/a	11S	237235	3913036
20140106-111	Array 6	1/6/2014	MODO	Feather spot: 100+ body feathers.	U	n/a	11S	237217	3913010
20140122-91	Array 7	1/22/2014	MODO	Whole carcass: Whole carcass + 40 body feathers near fence and 30 clumped body feathers about 30 ft. away.	U	n/a	11S	238075	3911713
20140410-21	Array 7	4/10/2014	PBGR	Feather spot: Approximately 500 body feathers and 30 flight feathers with fresh blood. Coyote observed consuming bird in morning. Unclear if predation or scavenging event; however, it was determined that the death was indirectly caused by the array, because the grebe likely perceived the array as a body of water, and once it landed on the ground was unable to take flight again.	C	<50%, >0	11S	237759	3911588
20131118-108	Array 8 Control	11/18/2013	MODO	Feather spot: 200 body and 20 wing feathers	U	n/a	11S	234339	3913452
20130916-71	Array 8 Fence	9/16/2013	UNKN	Partial Carcass: Headless body and wing with a few feathers stuck to fence from unknown large bird.	U	n/a	11S	234825	3912821
20140224-67	Array 8 Fence	2/24/2014	MODO	Feather spot: 200+ body feathers and flight feathers.	U	n/a	11S	233323	3912883
20131119-68	Array 9	11/19/2013	BUOW	Feather spot: 10 contour feathers	U	n/a	11S	233283	3917787
20140226-201	Conservation Land	2/26/2014	MODO	Feather spot: 22 flight feathers and many contour feathers.	U	n/a	11S	235386	3911179

Notes:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

Incident ID	Site	Search Date	Species Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20141030-1	Conservation Land	10/30/2014	MODO	Feather spot: 14 flight feathers and approximately 50 contour feathers.	U	n/a	11S	235467	3913108
20140326-201	MVOH	3/26/2014	HOFI	Feather spot: Approximately 20 body feathers connected by flesh.	U	n/a	11S	234111	3913663
20131002-72	Gen-tie Line	10/2/2013	SAVS	Feather spot: 75 body feathers, 15 flight feathers, and some wing bits.	U	n/a	11S	234404	3917782
20131016-106	Gen-tie Line	10/16/2013	YRWA	Feather spot: 15-20 wing feathers and 100+ body feathers.	U	n/a	11S	234403	3917789
20131023-92	Gen-tie Line	10/23/2013	MODO	Feather spot: 30 body feathers.	U	n/a	11S	234378	3917743
20131023-93	Gen-tie Line	10/23/2013	WEME	Feather spot: 15 body feathers.	U	n/a	11S	234354	3917803
20131211-91	Gen-tie Line	12/11/2013	MODO	Feather spot: Five flight feathers (all tail feathers) and five body feathers. Found in Tamarisk wetland at suspected predatory bird feeding spot.	P	>50	11S	234365	3917730

Notes:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

Appendix G. Fatality Data Errata for CVSR ABPP Annual Postconstruction Fatality Report, 16 August 2012 to 15 August 2013

Incident ID	Site	Search Date	Species Code[1]	UTM Zone	Easting	Northing	Observation Details	Errata Notes
20120927-1	Array 1	9/27/2012	MODO	11S	233981	3915723	Feather spot: >10 body feathers	Later determined to be feathers from roosting and preening mourning doves. Remove from the record.
20121127-103	Array 2 North	11/27/2012	MODO	11S	234496	3915315	Feather spot: Ten body feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-104	Array 2 North	11/27/2012	HOLA	11S	234475	3915069	Feather spot: Ten+ body, five secondary, eight covert, and six primary feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-102	Array 2 North	11/27/2012	MODO	11S	234372	3915321	Feather spot: ten + body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-101	Array 2 North	11/27/2012	MODO	11S	234368	3915324	Feather spot: Body feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-1	Array 2 North	11/27/2012	LEOW	11S	234062	3915269	Feather spot: ten + body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-300	Array 2 North	11/27/2012	HOLA	11S	234407	3914929	Feather spot: ten primary and ten+ body feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-200	Array 2 North	11/27/2012	WEME	11S	234484	3915273	Feather spot: ten+ body and four primary feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-201	Array 2 North	11/27/2012	HOLA	11S	234384	3915103	Feather spot: approximately 25 flight feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-11	Array 2 South	11/27/2012	MODO	11S	233636	3914428	Feather spot: two tail feathers and several body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.

Note:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN.

Incident ID	Site	Search Date	Species Code[1]	UTM Zone	Easting	Northing	Observation Details	Errata Notes
20121127-3	Array 2 South	11/27/2012	MODO	11S	234115	3914603	Feather spot: >10 body feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-2	Array 2 South	11/27/2012	MODO	11S	233967	3914604	Feather spot: >10 body feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-6	Array 2 South	11/27/2012	MODO	11S	234182	3914887	Feather spot: >10 body feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-7	Array 2 South	11/27/2012	MODO	11S	234166	3914885	Feather spot: >10 body feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-8	Array 2 South	11/27/2012	UNKN	11S	234174	3914646	Feather spot: two primary feathers and approximately ten body feathers from unknown RODO-sized bird.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-9	Array 2 South	11/27/2012	MODO	11S	234071	3914509	Feather spot: body feathers and three primaries	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121204-16	Array 2 South	12/4/2012	MODO	11S	233692	3914434	Feather spot: 15+ body and two tail feathers, and one secondary feather,	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121204-21	Array 2 South	12/4/2012	MODO	11S	234074	3914506	Feather spot: two flight and 50+ body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121204-13	Array 2 South	12/4/2012	CORA	11S	234245	3914577	Feather spot: two flight feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121204-3	Array 2 South	12/4/2012	UNKN	11S	233883	3914885	Feather spot: two primary feathers with a few body feathers from unknown large bird.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130107-1	Array 8 Circuit 2	1/7/2013	HOLA	11S	233519	3912284	Feather spot: ten+ primary and 20+ body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130107-20	Array 8 Circuit 2	1/7/2013	MODO	11S	233740	3912137	Feather spot: Few tertiary and 20 body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130107-21	Array 8 Circuit 2	1/7/2013	MODO	11S	233986	3911832	Feather spot: three primary, two secondary, and one body feather.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.

Note:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN.

Incident ID	Site	Search Date	Species Code[1]	UTM Zone	Easting	Northing	Observation Details	Errata Notes
20130107-11	Array 8 Circuit 2	1/7/2013	MODO	11S	234117	3911957	Feather spot: 15+ body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-44	Array 4	1/9/2013	MODO	11S	235594	3912563	Feather spot: Six retrices and 20 contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-45	Array 4	1/9/2013	EUST	11S	235610	3912878	Feather spot: ten primary, nine secondary, two tertials, and ten contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-6	Array 4	1/9/2013	MODO	11S	235905	3912709	Feather spot: seven secondary and 40+ contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-7	Array 4	1/9/2013	MODO	11S	235609	3912839	Feather spot: eight retrices and ten+ contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-31	Array 4	1/9/2013	MODO	11S	235608	3912813	Feather spot: seven primary, ten secondary, and 50+ contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-32	Array 4	1/9/2013	MODO	11S	235568	3912818	Feather spot: four tail, two secondary, and seven contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-26	Array 4	1/9/2013	MODO	11S	235603	3913901	Feather spot: seven retrices and 20+ contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-41	Array 4	1/9/2013	MODO	11S	235601	3913521	Feather spot: two retrices and 25+ contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-8	Array 5	1/9/2013	MODO	11S	236647	3915788	Feather spot: four retrices and five contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-27	Array 5	1/9/2013	MODO	11S	236668	3913775	Feather spot: five retrices, one secondary, three wing coverts, and two primary feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-46	Array 5	1/9/2013	MODO	11S	236702	3913640	Feather spot: four retrices two secondary and 20+ contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.

Note:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN.

Incident ID	Site	Search Date	Species Code[1]	UTM Zone	Easting	Northing	Observation Details	Errata Notes
20130114-1	Array 8 Circuit 2	1/14/2013	MODO	11S	233450	3912428	Feather spot: four wing coverts, 50 contour, and three primary feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130116-11	Array 4	1/16/2013	MODO	11S	235677	3912709	Feather spot: two retrices, two secondary, and 15 breast feathers.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130123-	Array 4	1/23/2013	MODO	11S	235639	3913403	Feather spot: four tail, four primary, two secondary, and 40 contour feathers.	Incidental fatality was not reported in 2012-2013 report. Include in the record.
20130123-46	Gen-tie Line	1/23/2013	LASP	11S	234390	3917813	Feather spot: two fresh primaries. Found in wetland area.	Species was incorrectly identified as LOSH, but was later correctly identified as a LASP. Revise species to lark sparrow in the record.
20130214-6	Array 1	2/14/2013	WEME	11S	234022	3915705	Feather spot: 20+ flight feathers and over 100 body feathers.	UTM coordinates were incorrect. Coordinates are correct herein.
20130220-46	34.5kV Line	2/20/2013	MODO	11S	234612	3913242	Feather spot: five+ tail and 30+ body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130508-36	34.5kV Line	5/8/2013	UNKN	11S	233833	3911676	Feather spot: approximately 15 body feathers and one flight feather from unknown small bird.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130508-82	Array 4	5/8/2013	HOFI	11S	235724	3913524	Feather spot: seven wing feathers still attached and one secondary feather.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130508-6	Gen-tie Line	5/8/2013	WAVI	11S	234450	3914310	Whole carcass: possible broken neck and possible power line collision.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130509-56	Array 1	5/9/2013	HOLA	11S	234156	3915632	Feather spot: mostly body feathers, some primary feathers.	Fatality was not reported in 2012-2013 annual report. Include in the record.

Note:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN.

Incident ID	Site	Search Date	Species Code[1]	UTM Zone	Easting	Northing	Observation Details	Errata Notes
20130514-56	Array 2 North	5/14/2013	UNKN	11S	234342	3915286	Feather spot: cranium/skull covered by feathers from unknown small bird.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130515-57	Gen-tie Line	5/15/2013	HOFI	11S	234582	3914702	Partial carcass: Top half of wing.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130515-58	Gen-tie Line	5/15/2013	YRWA	11S	234424	3917882	Feather spot: approximately 10 flight feathers and 30 body feathers.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130515-56	Gen-tie Line	5/15/2013	UNKN	11S	234707	3915476	Feather spot: body and primary feathers from unknown small bird.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130529-72	Gen-tie Line	5/29/2013	YEWA	11S	234265	3917142	Feather spot: approximately 100 body feathers and 15 flight feathers.	Species was incorrectly identified as YRWA, but was later correctly identified as YEWA. Revise species to YEWA in the record.
20130529-28	Gen-tie Line	5/29/2013	YRWA	11S	234296	3917715	Feather spot: 12 flight and 30 body feathers. Found directly under the powerline.	Species was identified as warbler sp., but later correctly identified as YRWA. Revise to YRWA in the record.
20130604-46	Array 2 South	6/4/2013	CORA	11S	234368	3914685	Feather spot: approximately 35 body feathers.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130613-41	Array 1	6/13/2013	EUST	11S	234294	3915204	Partial carcass: two primaries, clump of body feathers, and part of wing.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130619-41	34.5kV Line	6/19/2013	HOSP	11S	235931	3912655	Feather spot: five flight and 15 contour feathers found directly under the powerline.	UTM Coordinates incorrect in 2012-2013 annual report. Coordinates should be revised as 11S 235931 m E 3912655 m N in the record.
20130626-46	Conservation Lands	6/26/2013	BUOW	11S	234199	3912839	Feather spot: approximately 20 pin feathers.	Incidental fatality was not reported in 2012-2013 annual report. Include in the record.
20130708-21	Array 6	7/8/2013	HOFI	11S	237194	3913141	Feather spot: Single distinct clump of 15+ body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.

Note:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN.

Incident ID	Site	Search Date	Species Code[1]	UTM Zone	Easting	Northing	Observation Details	Errata Notes
20130708-22	Array 6	7/8/2013	CORA	11S	237101	3912945	Feather Spot, Skin: ten primary and secondary feathers, 20-30 single contour feathers, three+ clumps of body feathers, and some skin fragments.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130708-23	Array 6	7/8/2013	HOLA	11S	237752	3912687	Feather spot: 100+ body feathers, eight flight feathers (primaries and secondaries), one leg, half of beak with attached lore and malar feathers, bone and skin fragments including eye socket.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130708-71	Array 6	7/8/2013	LASP	11S	234028	3911758	Feather spot: 100+ body feathers and about 12 flight feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130708-26	Array 6	7/8/2013	ROPI	11S	237689	3912612	Feather spot: 30 contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130708-27	Array 6	7/8/2013	BRBL	11S	237691	3912611	Feather spot: 100+ body feathers and 20 flight feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130709-61	Array 7	7/9/2013	HOLA	11S	237689	3912656	Feather spot: approximately three flight feathers, two tail feathers and 40 body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.

Note:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN.

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

25 December 2013

Dave Hacker
Environmental Scientist
California Department of Fish and Wildlife
Region 4 Renewable Energy Projects
3196 Higuera Street, Suite A
San Luis Obispo, CA 93401

Justin Sloan
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
1130 E. Shaw Ave., Suite 206
Fresno, CA 93710

John McKenzie
Senior Environmental Planner
Environmental Division
SLO County Planning & Building Department
976 Osos Street, Room 200
San Luis Obispo, CA 93408

Subject: **Notification of Avian Fatality in Compliance with Condition of Approval #44 of the Conditional Use Permit (DRC 2008-00097) for the California Valley Solar Ranch, San Luis Obispo California**

Dear Mr. Sloan, Mr. Hacker, and Mr. McKenzie:

As per Condition of Approval #44 of the Conditional Use Permit (CUP; DRC 2008-00097) for the California Valley Solar Ranch (CVSR) project, a Brine Evaporation Pond Design, Monitoring, and Management Plan (BEPMMP) was developed that details the design and function of the evaporation pond, and includes measures to monitor and report bird fatalities detected at the pond. Reporting measure 9.2 of the BEPMMP requires that a biologist notify the California Department of Fish and Wildlife (CDFW), the U. S. Fish and Wildlife Service (USFWS), San Luis Obispo County (County), and the County's Environmental Monitor within 2 days of discovering a carcass if dead or entangled birds are detected at the pond.

On 24 December 2013, I was informed that H. T. Harvey & Associates Field Biologist, Melinda Mohamed, observed four avian fatalities, three house finches (*Haemorhous mexicanus*) and 1 mourning dove (*Zenaida macroura*) at the CVSR Brine Evaporation Pond on 23 December 2013 (Figure 1). Two of the house finches and the mourning dove fatalities were observed as feather spots and the remaining house finch was observed intact. The three feather spots represent birds that were likely attracted to the pond area for drinking water that were subsequently preyed upon by raptorial predators. The cause of death for the intact house finch is unknown and may be different from the other fatalities. I have included the data for each of the four fatalities on the ensuing two pages of this notification.

Feel welcome to contact me with questions if you require further information regarding this notification.

Sincerely,

Brian B. Boroski, Ph.D., *agent on behalf of High Plains Ranch II, LLC*
Vice President

CC:
Bill Cotton, NRG (Bill.cotton@nrgenergy.com)
Julie Babcock, NRG (Julie.Babcock@nrgenergy.com)
Margie Harker, NRG (Margie.haker@nrgenergy.com)

Data for the four avian fatalities found on 23 December 2013 at the Brine Evaporation Pond at CVSR

Incident 20131223-36:

Species: HOFI

Parts found: 100+ body feathers, ~20 flight feathers (including partial wing)

Cause of death: unknown

Scavenger/predator type: unknown

Estimated time since death: <1 week—high visibility of featherspot on bare ground make it unlikely the spot was missed during the last weekly survey

Additional notes: spread was large—body feathers blown by high wind, but flight feathers were mostly clumped

UTM: 11S 0234781 3914267

Incident 20131223-58:

Species: MODO

Parts found: tail segment (majority, 10 flight and 8 body feathers)

Cause of death: unknown

Scavenger/predator type: unknown

Estimated time since death: <1 week (default)

Additional notes: outside evaporation pond

UTM: 11S 0234676 3914214

Incident 20131223-16:

Species: HOFI

Parts found: whole carcass

Cause of death: unknown

Scavenger/predator type: unknown

Estimated time since death: <24 hours—dirt stuck in blood around mouth is still moist

Additional notes: No rigor mortis, malnourished, can feel keel; feathers around cloaca are matted with feces, dried blood around edges of beak

UTM: 11S 0234809 3914200

Incident 20131223-57:

Species: HOFI

Parts found: 10+ body feathers, 1 flight feather

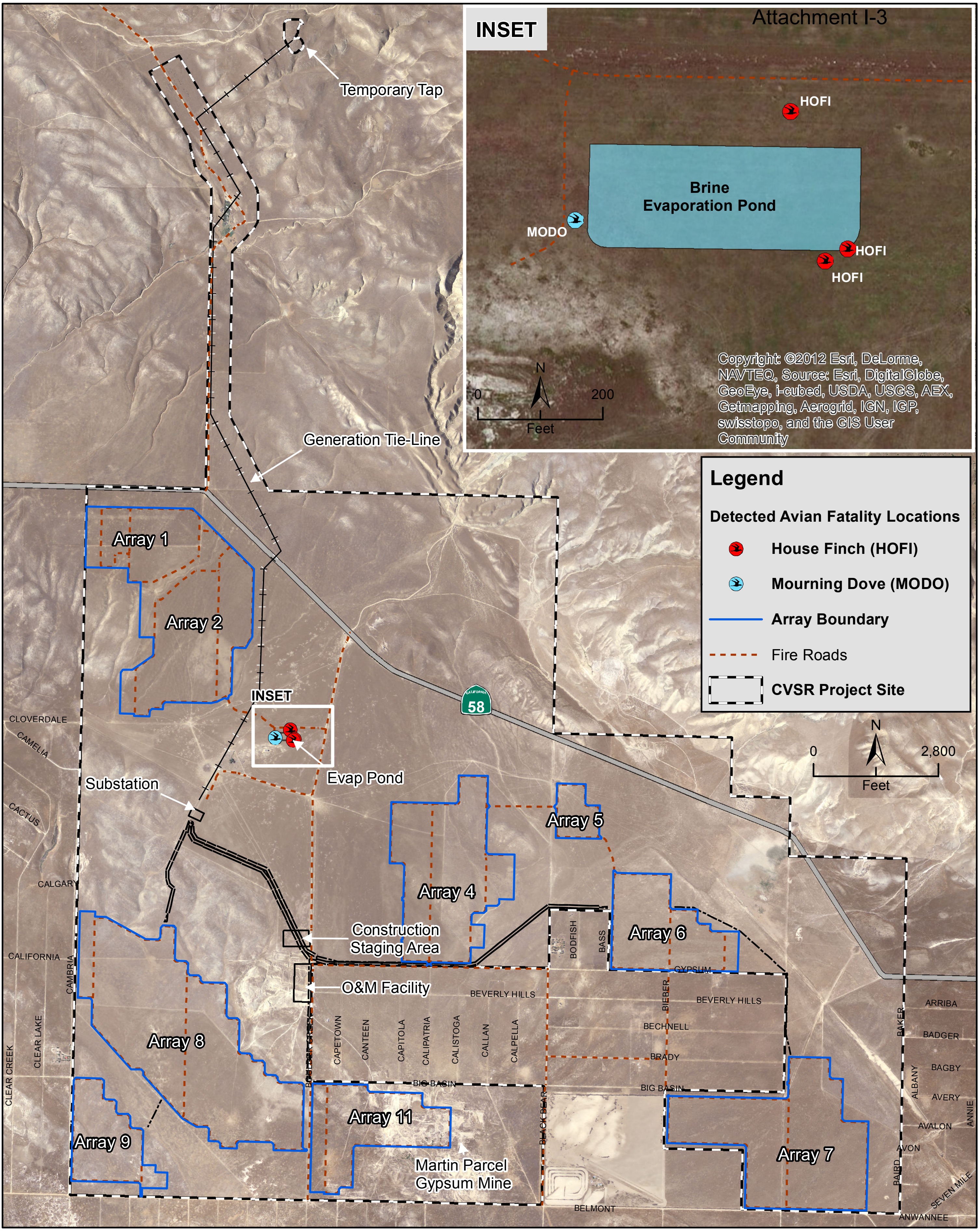
Cause of death: unknown

Scavenger/predator type: unknown

Estimated time since death: <1 week—assuming would have been found last week and feathers would have blown away.

Additional notes:

UTM: 11S 0234798 3914194



Copyright: ©2012 Esri, DeLorme, NAVTEQ, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

N:\Projects3300\3326-01\Reports\Avian Fatality During Construction\Figure 1 Avian Fatality Locations at the Brine Evaporation Pond at CVSR - Dec 2013.mxd

HPR II

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

California Valley Solar Ranch

Figure 1: Location of the Four Avian Fatalities found on 23 December 2013 at the Brine Evaporation Pond at CVSR

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

24 February 2014

Justin Sloan
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
1130 E. Shaw Ave., Suite 206
Fresno, CA 93710

Dave Hacker
Environmental Scientist
California Department of Fish and Wildlife
Region 4 Renewable Energy Projects
3196 Higuera Street, Suite A
San Luis Obispo, CA 93401

John McKenzie
Senior Environmental Planner
San Luis Obispo County
Planning & Building Department
Environmental Division
976 Osos Street, Room 200
San Luis Obispo, CA 93408

Subject: California Valley Solar Ranch Project Avian Bat Protection Plan Quarterly Avian Fatality Report (Aug-Nov 2013)

Dear Sirs:

On behalf of High Plains Ranch II LLC, we are submitting the Quarterly Avian Fatality Report (Aug-Nov 2013) for the California Valley Solar Ranch (CVSR) Project, San Luis Obispo, California. This report is being submitted per the reporting requirements of the CVSR Avian Bat Protection Plan in compliance with the U.S. Fish and Wildlife Service Biological Opinion (81420-2011-F-0511) and San Luis Obispo County Conditional Use Permit (DRC2008-00097) for the CVSR Project. San Luis Obispo County Condition of Approval #58 requires an Avian Fatality Monitoring Plan for the Project as part of the Avian Bat Protection Plan, which requires quarterly reports detailing any project-related bird deaths or injuries detected during the monitoring study. As required to satisfy COA #58, of the CVSR Project Conditional Use Permit, we are submitting these reports to the County, U.S. Fish and Wildlife Service, and California Department of Fish and Wildlife.

If you should have any questions or comments, please do not hesitate to contact me at (408) 426-7326 or jklingmann@harveyecology.com.

Sincerely,

Julie Klingmann
Associate, Senior Wildlife Ecologist

cc: Ray Kelly, NRG Solar, LLC
Bill Cotton, NRG Solar, LLC
Paul Zavesoff, High Plains Ranch II, LLC

Cal Poly Technology Park, Building 83, Suite 1B • San Luis Obispo, CA 93407 • Ph: 805.756.7400 • F: 805.756.7441

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

30 January 2014

Justin Sloan
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
1130 E. Shaw Ave., Suite 206
Fresno, CA 93710

Dave Hacker
Environmental Scientist
California Department of Fish and Wildlife
Region 4 Renewable Energy Projects
3196 Higuera Street, Suite A
San Luis Obispo, CA 93401

John McKenzie
Senior Environmental Planner
San Luis Obispo County
Planning & Building Department
Environmental Division
976 Osos Street, Room 200
San Luis Obispo, CA 93408

Subject: California Valley Solar Ranch Project Avian Bat Protection Plan Quarterly Avian Fatality Report (May-Aug 2013)

Dear Sirs:

On behalf of High Plains Ranch II LLC, we are submitting the Quarterly Avian Fatality Report (May-Aug 2013) for the California Valley Solar Ranch (CVSR) Project, San Luis Obispo, California. This report is being submitted per the reporting requirements of the CVSR Avian Bat Protection Plan in compliance with the U.S. Fish and Wildlife Service Biological Opinion (81420-2011-F-0511) and San Luis Obispo County Conditional Use Permit (DRC2008-00097) for the CVSR Project. San Luis Obispo County Condition of Approval #58 requires an Avian Fatality Monitoring Plan for the Project as part of the Avian Bat Protection Plan, which requires quarterly reports detailing any project-related bird deaths or injuries detected during the monitoring study. As required to satisfy COA #58, of the CVSR Project Conditional Use Permit, we are submitting these reports to the County, U.S. Fish and Wildlife Service, and California Department of Fish and Wildlife.

If you should have any questions or comments, please do not hesitate to contact me at (408) 426-7326 or jklingmann@harveyecology.com.

Sincerely,

JKlingmann

Julie Klingmann
Associate, Senior Wildlife Ecologist

cc: Dave Hacker, California Department of Fish and Wildlife
Office of the General Counsel, California Department of Fish and Wildlife w/o enclosure
Climate Science and Renewable Energy Program, California Department of Fish and Wildlife w/o enclosure
Justin Sloan, US Fish and Wildlife Service
Ray Kelly, NRG Solar, LLC
Bill Cotton, NRG Solar, LLC
Paul Zavesoff, High Plains Ranch II, LLC

Cal Poly Technology Park, Building 83, Suite 1B • San Luis Obispo, CA 93407 • Ph: 805.756.7400 • F: 805.756.7441

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

12 May 2014

Justin Sloan
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
1130 E. Shaw Ave., Suite 206
Fresno, CA 93710

John McKenzie
Senior Environmental Planner
San Luis Obispo County
Planning & Building Department
Environmental Division
976 Osos Street, Room 200
San Luis Obispo, CA 93408

Dave Hacker
Environmental Scientist
California Department of Fish and Wildlife
Region 4 Renewable Energy Projects
3196 Higuera Street, Suite A
San Luis Obispo, CA 93401

Subject: California Valley Solar Ranch Project Avian Bat Protection Plan Quarterly Avian Fatality Report (November 2013 – February 2014)

Dear Sirs:

On behalf of High Plains Ranch II LLC, we are submitting the Quarterly Avian Fatality Report (16 November 2013- 15 February 2014) for the California Valley Solar Ranch (CVSR) Project, San Luis Obispo, California. This report is being submitted per the reporting requirements of the CVSR Avian Bat Protection Plan in compliance with the U.S. Fish and Wildlife Service Biological Opinion (81420-2011-F-0511) and San Luis Obispo County Conditional Use Permit (DRC2008-00097) for the CVSR Project. San Luis Obispo County Condition of Approval #58 requires an Avian Fatality Monitoring Plan for the Project as part of the Avian Bat Protection Plan, which requires quarterly reports detailing any project-related bird deaths or injuries detected during the monitoring study. As required to satisfy COA #58, of the CVSR Project Conditional Use Permit, we are submitting these reports to the County, U.S. Fish and Wildlife Service, and California Department of Fish and Wildlife.

If you should have any questions or comments, please do not hesitate to contact me at (408) 426-7326 or jklingmann@harveyecology.com.

Sincerely,

Julie Klingmann
Associate, Senior Wildlife Ecologist

cc: Rob Wilson, NRG Solar, LLC
Julie Babcock, NRG Solar, LLC
Paul Zavesoff, High Plains Ranch II, LLC

Cal Poly Technology Park, Building 83, Suite 1B • San Luis Obispo, CA 93407 • Ph: 805.756.7400 • F: 805.756.7441

H.T. HARVEY & ASSOCIATES
Ecological Consultants

Memorandum

12 January 2015 **Project #3326-03**

To: **Erin Dean, Office of Law Enforcement (OLE) Resident Agent in Charge (RAC), U.S. Fish and Wildlife Service (USFWS)**
Heather Beeler, Regional Migratory Bird Permit Office (RMBPO), USFWS
Kenneth Sanchez, Assistant Field Supervisor, Endangered Species Program, USFWS
Dave Hacker, California Department of Fish and Wildlife (CDFW) Manager, CDFW Region 4 Renewable Energy Projects

From: **Brian Boroski, Dave Johnston, and Doug Drynan, H. T. Harvey & Associates (HTH)**

Subject: **Fourth quarter and 2014 annual report of avian mortality and injury, as per migratory bird Special Purpose Utility (SPUT) salvage permit (MB02733B-0) for the California Valley Solar Ranch (CVSR)**

As per Condition E of the CVSR SPUT permit (MB02733B-0), we are submitting an annual report of avian mortality and injury for 2014. The annual report submission deadline overlaps with reporting requirements for the fourth quarterly report; therefore, this submission also serves as the quarterly report of avian mortality and injury for the fourth quarter (October through the end of December). Data were collected for each fatality (i.e. carcass, partial carcass, or feather spot) and injury detected during regular fatality surveys of the CVSR site. As of mid-November 2014, the systematic fatality monitoring program as outlined in the Avian and Bat Fatality Monitoring Plan for the CVSR Project was completed. Any subsequent reporting of avian mortality from that point forward will be from incidental observations by CVSR staff.

Data from fatality detections were entered in the spreadsheet database that USFWS supplied with the SPUT permit. An electronic version of this spreadsheet has been sent to each recipient listed above. With this annual report we are also attaching a summary of data omissions and changes that were noted after the quarterly reports had been submitted (Table 1, attached).

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Certification: I certify that the information in this report is true and correct to the best of my knowledge. I understand that any false statement herein may subject me to criminal penalties under 18 USC 1001.

Signature:

Date:
12 January 2015

Brian B. Boroski, Ph.D.
Vice President

Enclosure
Attachment (Table 1)

cc: Robb Wilson, Bill Baker, and Julie Babcock, NRG Solar, LLC
Julie Klingmann, HTH

Table 1. California Valley Solar Ranch Project 2014 SPUT Annual Report documentation of 2014 database changes and additions[1].

Specimen Number	Discovery Date	Species Common Name	Scientific Name	Transect/Subplot Number	Notes on Changes and Additions
20140107-91	1/7/2014	Western meadowlark	*Sturnella neglecta*	Control 2C-5	Latitude and Longitude coordinates incorrect. Updated coordinates to Lat: 35.33714704, Long: -119.9228773.
20140108-126	1/8/2014	Mourning dove	*Zenaida macroura*	MVOH Line	Distance to Project Feature should have been included. Added distance and changed Cause of Death % certainty to >50%, since fatality is within 10 feet of line.
20140108-102	1/8/2014	Western meadowlark	*Sturnella neglecta*	Gen-Tie Line	Distance to Project Feature should have been included. Added distance and changed Cause of Death % certainty to >50%, since fatality is within 10 feet of line.
20140121-111	1/21/2014	Eurasian collared dove	*Streptopelia decaocto*	Array 1-2 Fence	Distance & Azimuth to Project Feature should have been included. Added Distance of 0 feet and Direction as NA.
20140122-94	1/22/2014	Mourning dove	*Zenaida macroura*	Array 4 Fence	Distance & Azimuth to Project Feature should have been included. Added Distance of 0 feet and Direction as NA.
20140122-37	1/22/2014	Unknown raptor	*NA*	MVOH Line	Distance to Project Feature should have been included. Added distance of 13 feet.
20140122-38	1/22/2014	House finch	*Carpodacus mexicanus*	MVOH Line	Distance to Project Feature should have been included. Added distance of 13 feet.
20140122-16	1/22/2014	Western meadowlark	*Sturnella neglecta*	Gen-Tie Line	Distance to Project Feature should have been included. Added distance and changed Cause of Death % certainty to >50%, since fatality is within 10 feet of line.

---

[1] All changes noted in this table are also highlighted in yellow in the attached 2014 SPUT spreadsheet database.

Specimen Number	Discovery Date	Species Common Name	Scientific Name	Transect/Subplot Number	Notes on Changes and Additions
20140128-21	1/28/2014	House finch	*Carpodacus mexicanus*	Array 1-2 Fence	Distance & Azimuth to Project Feature should have been included. Added Distance of 5 feet and Direction east.
20140129-82	1/29/2014	Unknown large bird	*NA*	Array 4 Fence	Distance & Azimuth to Project Feature should have been included. Added Distance of 0 feet and Direction NA.
20140129-111	1/29/2014	Horned lark	*Eremophila alpestris*	Gen-Tie Line	Distance to Project Feature should have been included. Added distance and changed Cause of Death % certainty to >50%, since fatality is within 10 feet of line.
20140224-67	2/24/2014	Mourning dove	*Zenaida macroura*	Array 8 Fence	Distance & Azimuth to Project Feature should have been included. Added Distance of 3.2 feet and Direction east.
20140312-101	3/12/2014	Common raven	*Corvus corax*	MVOH Line	Distance to Project Feature should have been included. Added distance and changed Cause of Death % certainty to >50%, since fatality is within 10 feet of line.
20140312-36	3/12/2014	Horned lark	*Eremophila alpestris*	Gen-Tie Line	Distance to Project Feature should have been included. Added distance and changed Cause of Death % certainty to >50%, since fatality is within 10 feet of line.
20140313-11	3/13/2014	Horned lark	*Eremophila alpestris*	Array 1	Accidental omission from 2014 Q1 report.
20140317-36	3/17/2014	House finch	*Carpodacus mexicanus*	Array 8 Circuit 2	Changed Cause of Death % Certainty from >50% to >90% based on re-evaluation of specimen and beak injury.
20140326-201	3/26/2014	House finch	*Carpodacus mexicanus*	Along Fence surrounding substation	Distance & Azimuth to Project Feature should have been included. Added Distance of 0 feet and Direction NA.

Specimen Number	Discovery Date	Species Common Name	Scientific Name	Transect/Subplot Number	Notes on Changes and Additions
20140403-51	4/3/2014	Mourning dove	*Zenaida macroura*	Array 9 Fence	Distance & Azimuth to Project Feature should have been included. Added Distance of 0 feet and Direction NA.
20140409-56	4/9/2014	Mourning dove	*Zenaida macroura*	MVOH Line	Distance to Project Feature is 2 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.
20140410-21	4/10/2014	Pied-billed grebe	*Podilymbus podiceps*	Array 7	Cause of Death originally noted as Unknown. Changed Cause of Death to Panel Collision with <50% Certainty.
20140410-101	4/10/2014	Horned lark	*Eremophila alpestris*	Array 7 Fence	Distance & Azimuth to Project Feature should have been included. Added Distance of 0 feet and Direction NA.
20140423-101	4/23/2014	Common raven	*Corvus corax*	MVOH Line	Distance to Project Feature is 5 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.
20140423-102	4/23/2014	Common raven	*Corvus corax*	MVOH Line	Distance to Project Feature is 0 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.
20140423-36	4/23/2014	Rock pigeon	*Columba livia*	MVOH Line	Distance to Project Feature is 3 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.
20140430-56	4/30/2014	Mourning dove	*Zenaida macroura*	MVOH Line	Distance to Project Feature is 6 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.
20140430-101	4/30/2014	Mourning dove	*Zenaida macroura*	Gen-Tie Line	Distance to Project Feature is 0 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.

Specimen Number	Discovery Date	Species Common Name	Scientific Name	Transect/Subplot Number	Notes on Changes and Additions
20140430-36	4/30/2014	Mourning dove	*Zenaida macroura*	Gen-Tie Line	Distance to Project Feature is 2 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.
20140514-93	5/14/2014	Common yellowthroat	*Geothlypis trichas*	Gen-Tie Line	Distance to Project Feature is 10 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.
20140521-41	5/21/2014	Mourning dove	*Zenaida macroura*	Gen-Tie Line	Distance to Project Feature is 0 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.
20140521-42	5/21/2014	Orange-crowned warbler	*Vermivora celata*	Gen-Tie Line	Distance to Project Feature is 10 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.
20140521-43	5/21/2014	Common yellowthroat	*Geothlypis trichas*	Gen-Tie Line	Distance to Project Feature is 0 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.
20140528-57	5/28/2014	Yellow warbler	*Dendroica petechia*	Gen-Tie Line	Distance to Project Feature is 0 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.
20140618-12	6/18/2014	Mourning dove	*Zenaida macroura*	Gen-Tie Line	Distance to Project Feature is 0 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.
20140723-21	7/23/2014	House sparrow	*Passer domesticus*	MVOH Line	Distance to Project Feature was not included. Added Distance of 0 feet.
20140730-21	7/30/2014	Eurasian collared dove	*Streptopelia decaocto*	MVOH Line	Distance to Project Feature was not included. Distance to Project Feature is 0 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.

Specimen Number	Discovery Date	Species Common Name	Scientific Name	Transect/Subplot Number	Notes on Changes and Additions
20140730-41	7/30/2014	Rock pigeon	*Columba livia*	Gen-Tie Line	Distance to Project Feature was not included. Distance to Project Feature is 0 feet off line. Changed Cause of Death % certainty to >50% since fatality is within 10 feet of line.

H.T. HARVEY & ASSOCIATES
Ecological Consultants

Memorandum

---

15 July 2014 **Project #3326-03**

To: **Erin Dean, Office of Law Enforcement (OLE) Resident Agent in Charge (RAC), U.S. Fish and Wildlife Service (USFWS)**
Heather Beeler, Regional Migratory Bird Permit Office (RMBPO), USFWS
Kenneth Sanchez, USFWS
Dave Hacker, California Department of Fish and Wildlife (CDFW) Manager, CDFW Region 4 Renewable Energy Projects

From: **Brian Boroski, Dave Johnston, and Doug Drynan, H. T. Harvey & Associates (HTH)**

Subject: **Quarterly report of avian mortality and injury, as per migratory bird Special Purpose Utility (SPUT) salvage permit (MB02733B-0) for the California Valley Solar Ranch (CVSR)**

As per Condition E of the CVSR SPUT permit (MB02733B-0), we are submitting a quarterly report of avian mortality and injury for the second quarter of 2014 (April through the end of June). Data were collected for each fatality and injury detected during regular fatality surveys of the CVSR site. These data were entered in the spreadsheet database that USFWS supplied with the SPUT permit. An electronic version of this spreadsheet has been sent to each recipient listed above. Condition H(1)(a) of the permit requires that a hardcopy version be mailed to the Region 6 CDFW Regional Manager. At the direction of Mr. Dave Hacker, the CDFW Region 4 Renewable Energy Projects contact, all future correspondence and reporting relating to this permit should also be sent to him. He also indicated that it was not necessary to send CDFW hardcopy versions of the spreadsheet, and that electronic submission of reports was sufficient.

As requested, with this 2nd quarterly report, we have attached historical fatality data from 2012 and 2013, in the USFWS spreadsheet database format, for your records. These data have been summarized and presented in the reports required by the Avian and Bat Protection Plan for the CVSR Project.

Certification: I certify that the information in this report is true and correct to the best of my knowledge. I understand that any false statement herein may subject me to criminal penalties under 18 USC 1001.

Signature: Date:

15 July 2014

Brian B. Boroski, Ph.D.
Vice President

Enclosure

cc: Robb Wilson, Bill Baker, and Julie Babcock, NRG Solar, LLC
Julie Klingmann, HTH

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch Project
Avian and Bat Protection Plan
Sixth Quarterly Postconstruction Fatality Report
16 November 2013 - 15 February 2014

Prepared for:

HPR II, LLC
California Valley Solar Ranch
13505 Carissa Highway, Highway 58
Santa Margarita, CA 93453

Prepared by:

H. T. Harvey & Associates
Project # 3326-03

Prepared per:

Avian And Bat Protection Plan for the California Valley Solar Ranch Project

U.S. Fish and Wildlife Service
Biological Opinion (81420-2011-F-0511)
San Luis Obispo County
Conditional Use Permit (DRC2008-00097)

May 2014

Table of Contents

Figures

Tables

Appendices

List of Contributors

Brian B. Boroski, Ph.D., Vice President
David Johnston, Ph.D., Associate Wildlife Ecologist
Doug Drynan, B.S., Project Manager, Senior Wildlife Ecologist
Kim M. Briones, M.S., Wildlife Ecologist
Meredith K. Jantzen, M.S., Wildlife Ecologist

Section 1.0 Introduction

Through adoption of Resolution #2011-119, the Board of Supervisors of San Luis Obispo County (the County) approved the California Valley Solar Ranch Project (CVSR Project) Conditional Use Permit (DRC 2008-00097) on 19 April 2011. The Conditional Use Permit is subject to the Conditions of Approval (COAs) set forth in Exhibit 6 attached to the Resolution.

The Conditional Use Permit allows High Plains Ranch II, LLC (and any successor in interest for the life of the CVSR Project) to construct and operate a 250-megawatt photovoltaic solar power plant within an approximately 4685-acre site (Project site), located mostly south of State Route (SR) 58, about 6.4 kilometers (km) east of Soda Lake Road, immediately north of the California Valley subdivision, in the Shandon-Carrizo planning area of San Luis Obispo County (Figure 1).

COA #58 of the Conditional Use Permit requires an Avian and Bat Protection Plan (ABPP) and a quarterly report detailing any Project-related bird or bat deaths or injuries detected during the monitoring study defined in COA #58c. To satisfy COA #58c, H. T. Harvey & Associates (HTH), on behalf of High Plains Ranch II, LLC, has prepared this postconstruction fatality report, which documents the number of avian and bat fatalities counted during Project postconstruction monitoring between 16 November 2013 and 15 February 2014.

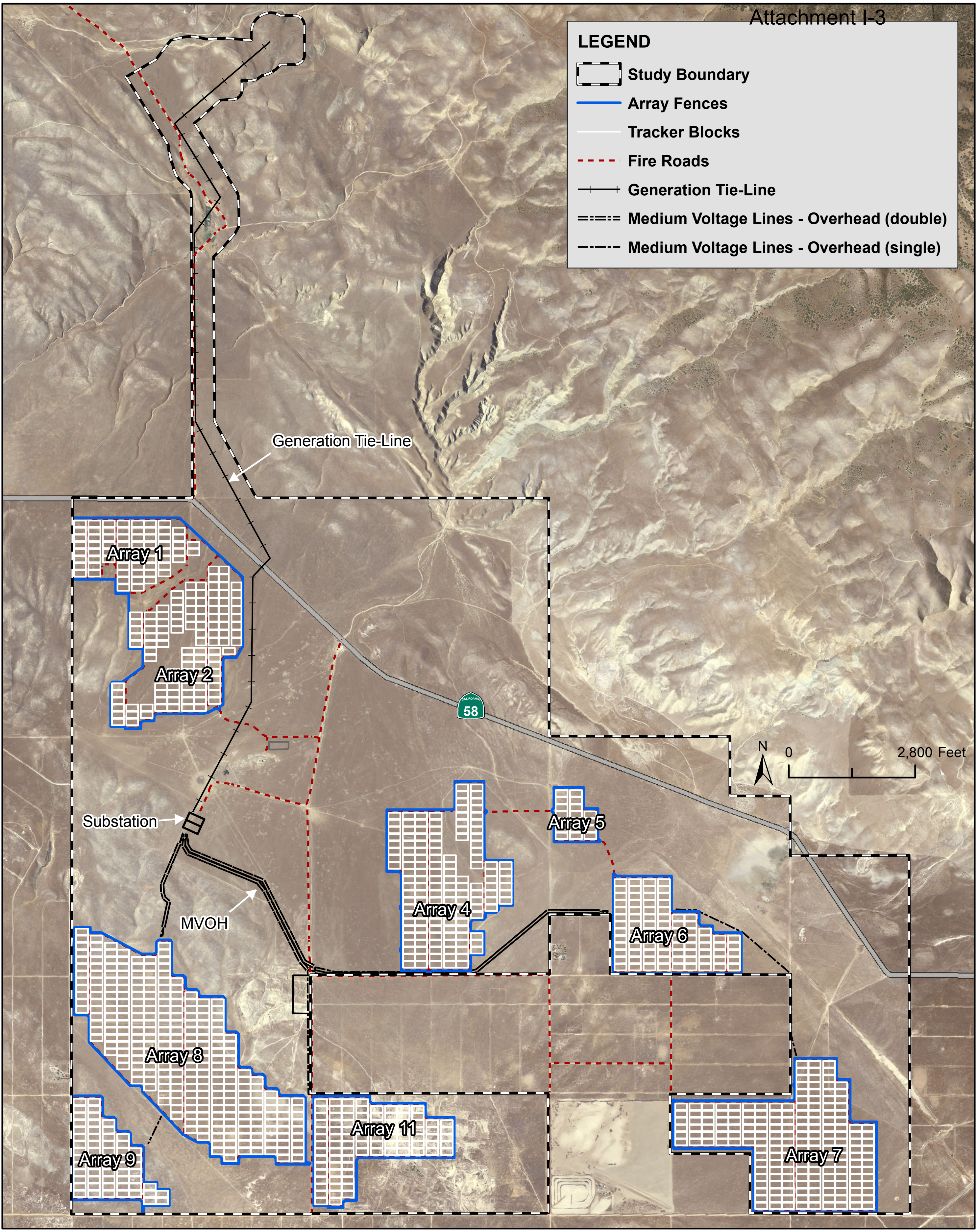
The Project elements searched during this period were the Gen-tie Line; Medium-voltage Overhead (MVOH) Line; Evaporation Pond; Arrays 1, 2, 4, 5, 6, 7, 8, 9, and 11; and the perimeter fences and control plots associated with arrays 1, 2, 4, 6, 7, 8, and 11. This quarterly[1] report does not include the results of searcher efficiency trials, carcass removal trials, or data analyses, nor does it include detailed discussions. These features are provided in the annual reports.

---

[1] The quarters referred to are the monitoring quarters specified in the COA. The first five quarters were 16 August to 15 November 2012, 16 November 2012 to 15 February 2013, 16 February to 15 May 2013, 16 May to 15 August 2013, and 16 August to 15 November. The period covered by this report is 16 November 2013 to 15 February 2014, and the next quarter will be 16 February to 15 May 2014.

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\6th Quarterly Report\Figure 1 Project Site.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch

ABPP Sixth Quarterly Postconstruction Fatality Report

Figure 1: Project Site with Gen-tie Line, MVOH Line and Nine Arrays

Section 2.0 Methods

Because construction of different Project elements was completed at different times, fatality searches began at varying times in the year, depending on the Project element searched (Table 1). During initial surveys of Array 2 in 2013 only the portions of the array where the Serengeti style of photovoltaic panels were installed were surveyed because that was the only portion of Array 2 that was operational at the time. Fatality surveys were expanded to 100% of Array 2 once the entire array became operational. Because all of the Serengeti style panels are installed in the north portion of Array 2, results for the Serengeti portion are included as part of Array 2 North. With the exception of Array 1, Array 2, the Gen-tie and MVOH Line, all Project elements were surveyed at 20% coverage for each element area through 31 December 2013. Beginning in January 2014, survey efforts in Array 1 and 2 were reduced to 20% coverage and the total number of control plots were reduced from 38 to 30 based on the results of a statistical error assessment (power analysis), which confirmed that sampling at least 20% of the total area of an array, or about 30 tracker units, is sufficient to provide a precise estimate of fatality rate (HTH 2014). Additionally, surveys for control plot searches were combined on one day each week to further streamline the survey effort.

Table 1. Fatality Search Commencement Dates by Project Element

Project Element	Date Fatality Searches Began
Gen-tie Line	6 June 2012
Array 1	20 September 2012
Array 2 (Serengeti portion only)	25 September 2012
Array 1 control plot	1 November 2012
Array 1 and 2 fence	25 September 2012
Array 2 North (including Serengeti) and South	27 November 2012
Array 2 control plot	30 October 2012
Array 8 (20% sample)	7 January 2013
Array 4 (20% sample)	9 January 2013
Array 4 control plots	6 February 2013
Array 4 fence (20% sample)	16 January 2013
Array 5 and fence (20% sample)	9 January 2013
MVOH Line	30 January 2013
Array 8 control plots	4 February 2013
Array 8 fence (20% sample)	20 May 2013

Note: The Serengeti portion of Array 2 was searched separately only until 27 November 2012, so the Survey period reflects the time when the Serengeti portion was sampled separately from the rest of Array2.

Fatalities were counted when surveyors found smudge marks and feather spots directly on a Project element (such as a solar panel) or feather spots on the ground; fur accompanied by flesh, blood, or bone; or a carcass. We considered a feather spot a fatality if it had at least two or more primary flight feathers, five or more tail feathers, or ten or more feathers of any type concentrated together in an area 1 square meter (m^2) or smaller (Smallwood 2007). Feathers spots not meeting these requirements but containing flesh, blood, or bone were also considered a fatality. All carcasses and feather spots were collected during each fatality survey, except in areas that overlapped with repeat surveys in Arrays 1 and 2 (see methods for "5-day Repeat Surveys").

Preening spots often have fewer feathers and are more spread out than feather spots associated with fatalities. Roosting areas rarely contain primary or secondary feathers, but are often dotted with droppings. In the solar arrays, we regularly observed flocks of roosting mourning doves (*Zenaida macroura)* and horned larks (*Eremophila alpestris*). Mourning doves exhibit a complex molt strategy, which can occur year round and includes preformative, prealternate, and definitive prebasic molts (Otis et al. 2008). Likewise, horned lark adults and first-year birds undergo a definitive prebasic molt at the end of the breeding season (typically the end of July) (Beason 1995). Searchers used their biological knowledge to determine whether or not feathers from mourning doves, horned larks, or other species known to be in a molt period should be recorded as a fatality. When feathers were determined to be part of a molt or roost spot, no data were taken.

Fatalities of non-avian or non-bat taxa were documented when found, but are not discussed in this report. However, all specimens including non-avian and non-bat fatalities were reported pursuant to state and federal salvage permit requirements. Incidental avian fatalities observed outside regular survey periods or surveyed areas were documented and are reported separately from fatalities found during regularly scheduled searches in this report. Additionally, fatalities of sensitive species were reported to the California Natural Diversity Database.

We gave each fatality a unique incident number. Incident numbers were written as follows: YYYYMMDD—#. Each searcher recorded a unique set of numbers, so data can be traced back to individual searchers. To further verify species identifications, we took photos of each fatality, and when necessary, we consulted Scott and McFarland's Bird Feathers identification book (2010). For each fatality, we recorded location (using Universal Transverse Mercator [UTM] coordinates), time found, taxon, common name, four-letter alpha code, carcass condition, parts found, number and types of feathers, and estimated time since death. Whenever possible, we recorded information about the age and sex of the fatality, as well as scavenger type. Additionally, we gathered information on the size and spread of the feather spot and the surrounding substrate, vegetation height, and percent vegetation cover, as well as whether the fatality occurred in a searcher or non-searcher row (for fatalities found in the arrays). All carcasses and feather spots discovered by regular weekly searchers were removed to avoid attracting scavengers and the potential to confuse searchers on subsequent searches if scavengers scattered parts of the carcass.

2.1 Weekly Fatality Searches

Weekly fatality searches were performed for the Evaporation Pond, Gen-tie Line; MVOH Line; Arrays 1, 2, 4, 5, 6, 7, 8, 9, and 11; and the associated control plots and fences for each array. Each week, we selected random start locations for each Project element using a random number generator. Random selection was based on tower numbers (for the Gen-tie Line), line segment (for the MVOH Line), numbered array corners (for the solar arrays), and numbered fence corners (for the perimeter fence).

A team of two biologists searched a 30-meter (m)-wide transect centered under the complete length of the Gen-tie Line. Because of the relatively shorter height of the MVOH Line, it was assumed that carcasses would have less potential to distribute over a wide area (HTH 2011); therefore, the transect area along the entire length of the MVOH Line was only 18 m wide. Each person searched half the transect width and half the tower or pole radial areas for both the Gen-tie and MVOH Lines. On the Gen-tie Line, each person searched a 15-m-wide transect for large birds and a 6-m-wide transect for small birds and bats. On the MVOH Line, each person searched a 9-m-wide transect for small and large birds.

In the arrays, biologists searched tracker units in teams of two. In each tracker unit, biologists walked into every other row of panels and visually scanned both the row walked and each adjacent row. To avoid crossing the drive arms of the tracker units, searchers turned around upon reaching the drive arm, and continued to scan the next row as they proceeded out of the row. Thus, although searchers walked only every other row, they visually scanned adjacent rows to ensure full coverage.

To determine background rates of mortality, control plots were established on adjacent onsite Conservation Lands (plots were within 1 km of Arrays 1, 2, 4, 6, 7, 8, and 11). Each control plot had the same dimensions as a tracker unit (i.e., equivalent to 18 rows of solar panels, with 40 panels to a row). We used pin flags or wooden stakes to delineate mock panel trackers on the control plots, and searchers followed the same pattern and procedure used for searching the arrays. Control plots were not established for the 20% sample of Array 5 or 9 because the 20% search area for these arrays contained too few trackers to meet the control plot establishment guidelines set forth in the Avian and Bat Fatality Monitoring Plan for the California Valley Solar Ranch (Appendix A *in* HTH 2011; one control plot for 16 tracker units searched).

Fence segments surveyed for Arrays 1, 2, 4, 5, 6, 7, 8, 9, and 11 (100% of Array 1 and 2 fences through 31 December 2013 and then 20% from 1 January 2014 on; and 20% of Array 4, 5, 6, 7, 8, 9, and 11 fences) were each searched by one biologist. Each week, the biologist walked the inside portion of the fence while scanning a 6-m-wide belt centered on the fence. In some cases, the fences were not completely built until after weekly searches had already commenced. In these instances, fences were included only as part of the regular search routine after they were completely installed.

The Evaporation Pond was surveyed by two biologists. Each week, one biologist walked the perimeter of the pond inside the fenced area while scanning the pond and a 6-m-wide belt centered on the fence. Before entering the fenced area, the biologist also scanned the pond to assess avian activity. The second biologist walked the perimeter of the pond outside the fenced area.

In most cases, missed surveys were not repeated in the same week because they were conducted only on designated days as part of the survey protocol. For estimating the total number of fatalities, the fatality model accounted for search intervals of different lengths due to missed surveys (e.g., if a weekly search day was cancelled because of rain, the search effort would resume the following week and for that search, the interval was 14 days, not 7 days).

2.2 5-day Repeat Surveys

In addition to regular weekly searches, two types of repeat surveys were conducted. The 5-day repeat surveys were designed to serve several functions: (1) to identify a portion of the fatalities missed by regular weekly searchers, (2) to give limited estimates of the permanence of both feather spots and carcasses, (3) to provide an independent estimate of site-wide fatalities, and (4) to help estimate carcass deposition rates. Five-day repeat surveys were conducted on all Project elements subject to regular weekly searches, with the exception of the Gen-tie Line, which was not included in the 5-day repeat surveys because it was assumed that small birds and bats would be unlikely to strike high-tension power lines. Each of the remaining sites was subjected to 5-day repeat surveys once every 4 weeks, and surveys were organized so that a 5-day repeat was conducted for a different site each week.

During each 5-day repeat survey period, searchers covered the same 25% or 5% portion of a given Project element (Arrays 1, 2, 4, 5, 6, 7, 9, 11, and MVOH Line) for 5 consecutive days. Repeat searches of arrays also included searches of associated perimeter fences and control plots. However, because of the size of Array 2, conducting a 5-day survey of both Array 2 Serengeti and Array 2 North and South was not feasible. Therefore, these portions of Array 2 were treated as separate sites for the purposes of 5-day repeat surveys.

Five-day repeat surveys were originally conducted in the same areas as regular weekly searches for all arrays. However, in June 2013, this protocol was changed, and new, non-overlapping areas were established for 5-day repeat surveys in Arrays 4, 5, and 8, to keep the search interval at a constant span of 7 days for all weekly searches. In Arrays 1 and 2, however, overlapping search areas were unavoidable because weekly searches encompass 100% of the arrays. Under the revised protocol, feather spots and scavenged carcasses were still collected on the fifth day of each 5-day repeat survey, but any intact carcasses found were used in the carcass-removal trials, and camera traps were placed by the carcasses to record the activity of scavengers and monitor the persistence of the carcass past the 5-day span of the repeat survey. Then, the first day of each 5-day repeat survey was treated as a clearance search, and all fatalities found on the first day were removed from further analysis.

2.3 1-Day Repeat Surveys

One-day repeats (carcass-detectability bias-correction surveys) represent a second type of repeat search, designed to identify a portion of the fatalities missed by weekly searchers. Every other week, a 1-day repeat survey was conducted on the day following regular weekly searches. One-day repeat searches were also conducted after each 5-day repeat survey on either the last day of the 5-day survey or 1 day after completion of the 5-day survey. These repeat searches were conducted to provide further estimates of the detectability of small bird and bat carcasses. Each 1-day repeat survey covered a randomly selected 25% of all elements searched in the weekly or 5-day repeat survey. For example, the 1-day repeat survey of Array 2 included a search of 25% of the array, 25% of the fence, and 25% of the associated control plots.

2.4 Discontinuation of Repeat Surveys

The first fatality estimates for the Project site were completed in the fall of 2013. Although 5-day repeats were designed to provide a verification of the results found by weekly searches, the low number of tracker units that were searched for each 5-day repeat survey resulted in greatly inflated confidence intervals for these independent estimates compared to the estimates of the weekly searches. As a result, the value of these independent estimates was greatly reduced. Five-day repeats were also designed to create a shorter search interval that would allow carcasses with a short scavenging time to be more readily found and identified. However, after completing the 5-day repeat surveys for more than a year, it became apparent that avian fatalities, particularly long-lasting feather spots, accounted for the bulk of the survey detections. Because repeat surveys are labor intensive, there is generally a tradeoff between the total area that can be covered, and the frequency of the searches. All repeat surveys (both 5-day and 1-day repeat surveys) ceased 1 January 2014 onward because of this tradeoff in combination with the reasons outlined above.

Section 3.0 Results

3.1 Weekly Fatality Searches

All Project elements were surveyed weekly, with the following exceptions:

- Surveys were not conducted for Arrays 4, 5, 9, and 11, the Gen-tie Line and the MVOH line on 20 November 2013 and for Arrays 1 and 7 on 21 November 2013, in observance of the Thanksgiving holiday.
- Surveys were not conducted for Array 2 on 24 December 2013, for 4, 5, 9, and 11, the Gen-tie Line and the MVOH line on 25 December 2013, and for Arrays 1 and 7 on 26 December 2013, and for Array 8 on 30 December 2013 in observance of the Christmas holidays.
- Surveys were not conducted for Arrays 4, 5, 9, 11, the Gen-tie Line and the MVOH line on 1 January 2014 in observance of the New Year's Day holiday.
- Surveys were not conducted in Arrays 1, 7, and 9 on 30 January 2014 and 6 February 2014 because of inclement weather conditions.
- Surveys were not conducted in Array 2 on 6 February 2014 because of inclement weather conditions.

One hundred and fifty-two avian fatalities were counted between 16 November 2013 and 15 February 2014 in the surveyed operational portions of the Project site (Appendix A, Table A-1). One hundred and forty-five of the avian fatalities were counted from feather spots, and seven were counted from whole or partial carcasses. All fatalities were mapped (Figures 2 through 6), and a summary of the fatality searches was compiled (Table 2). Twelve avian species, plus four unidentified birds, including one passerine, one raptor and two large birds, were represented in the detected fatalities (Appendix A, Table A-2). As documented in previous quarterly fatality reports, mourning doves were the most numerous fatalities observed (70) and house finches (*Carpodacus mexicanus*) were the second highest fatality (37). Fewer western meadowlark (*Sturnella neglecta*) fatalities (17) were observed than in previous quarters. No bat fatalities were observed during this survey period.

The whole of Array 2 presented the most fatalities (27) and Array 4 presented the second highest number of fatalities (22). Most of the avian fatalities found in all survey areas were indicated by feather spots. However, a small number of whole and partial carcasses were also discovered. In solar arrays, feather spots were primarily observed on the ground near panels, but portions of three fatalities were found near and on panels. Each of the panel fatalities presented some combination of feathers and/or body fluids smudged across the panels. Two out of the four whole carcasses that were found showed signs of death by either predation or illness. One carcass was clearly predated, based on decapitation of the carcass, which is typical of many avian predators. The other carcass showed signs of illness based on low body fat (palpable keel) and the presence of fecal matter in matted down feathers near the cloaca. For two other whole carcasses, no injuries were apparent and the cause of death was therefore difficult to determine.

Table 2. Summary of Avian Fatality Searches Conducted between 16 November 2013 and 15 February 2014, and Fatality Totals

Project Element	Total Fatalities	Fatalities Counted from Feather Spots	Fatalities Indicated by Evidence Other than Feather Spots, and Notes
Array 1	1	1	n/a
Array 1 controls	1	1	n/a
Array 2 North	8	7	One whole carcass was decapitated, suggesting either avian or mammalian predation.
Array 2 South	19	19	n/a
Array 1–2 fence	3	3	n/a
Array 2 controls	4	5	n/a
Array 4	22	21	One partial carcass, consisting of feathers, internal organs and bill.
Array 4 fence	2	2	n/a
Array 4 controls	1	1	na
Array 5	5	5	n/a
Array 5 fence	1	1	n/a
Array 6	15	14	One whole carcass found below cable tray. No obvious sign of injury.
Array 6 fence and controls	0	0	n/a
Array 7	15	13	One whole carcass with no obvious sign of injury and one partial carcass consisting of feathers and internal organs.
Array 7 fence or controls	0	0	n/a
Array 8 Circuit 2	15	15	n/a
Array 8 fence	1	0	One partial carcass consisting of feathers, skin, one leg and one thigh.
Array 8 controls	0	0	n/a
Array 9	2	2	n/a
Array 9 fence	0	0	n/a
Array 11 and fence	0	0	n/a
Array 11 controls	1	1	n/a

MVOH Line	13	14	n/a
Gen-tie Line	10	10	n/a
Evaporation Pond	4	3	One whole carcass with dried blood on bill, dried feces around cloaca, and keel noticeably palpable.
Reduced search effort to 20% beginning 1 January 2014			
Array 1	1	1	n/a
Array 2	7	7	n/a
Array 1-2 fence	1	1	n/a
Total Fatalities	**152**		

Notes:

[1] This table only includes fatalities detected during fatality searches. Incidental fatalities are reported in the text of Section 3.1 and Table A-2 in Appendix A.

One avian fatality was counted in Array 1 prior to reducing the search effort to 20% and one fatality was counted in a control plot associated with Array 1 (Table 2; Figure 2) after reducing the control plot survey effort. One avian fatality was counted in Array 1 (Table 2, Figure 3) after reducing the search effort to 20%. All fatalities were counted from feather spots.

Thirty-four fatalities were counted in the Array 2 elements, including Array 2 North and South, perimeter fence and associated controls, prior to reducing the search effort to 20%. Eight avian fatalities were counted in Array 2 North (Table 2; Figure 2). One of these fatalities was counted from a decapitated carcass. This type of injury is consistent with a predation event. Nineteen avian fatalities were counted in Array 2 South (Table 2; Figure 2), all based upon feather spots. One burrowing owl (*Athene cunicularia*), a California Species of Special Concern, accounted for one of these fatalities. Additionally, feathers and smudged body fluid from a western meadowlark fatality were observed on top of one panel and may indicate a panel strike. Seven fatalities, all feather spots, were counted along the perimeter fence surrounding Arrays 1 and 2. Four avian fatalities were counted from feather spots in control plots associated with Array 2. After reducing the search effort to 20%,seven avian fatalities were counted in Array 2 and one fatality was counted along the perimeter fence surrounding Arrays 1 and 2 (Table 2; Figure 3). All fatalities found after reducing the search effort were counted from feather spots.

Twenty-five avian fatalities were counted in Array 4 elements, including Array 4, the perimeter fence and control plots (Table 2; Figure 4). Twenty-two fatalities were counted in Array 4. One fatality was counted in a control plot associated with Array 4. Two fatalities were found along the perimeter fence and were counted from feather spots. All but one of these fatalities were counted from feather spots. One partial carcass, consisting of feathers, internal organs, and bill was also found in the array.

Six avian fatalities were counted in Array 5 elements, including Array 5 and the perimeter fence (Table 2; Figure 4). One fatality was observed in Array 5 and one was observed along the perimeter fence. All were counted from feather spots.

Fifteen fatalities were observed in Array 6 (Table 2; Figure 4). All but one fatality were counted from feather spots. The whole carcass of a house finch was found below cable trays within the array and did not show signs of injury or illness. One loggerhead shrike (*Lanius ludovicianus*), a California Species of Special Concern, accounted for one of these fatalities. Feathers and smudge marks from body fluid were observed on a panel suggesting a panel strike. No fatalities were observed along the Array 6 perimeter fence or control plots.

Fifteen fatalities were counted in Array 7 (Table 2; Figure 5). All but two of these fatalities were counted from feather spots. One whole carcass of a house finch showed no signs of injury or illness. One partial carcass of a house finch consisted of feathers and internal organs. No fatalities were observed along the fence or in control plots associated with Array 7.

Fifteen fatalities, all counted from feather spots, were counted in Array 8 Circuit 2 (Table 2; Figure 6). Feathers from one of these fatalities were smudged across one panel suggesting a panel strike. One fatality, counted from a partial carcass, was found along the perimeter fence surrounding the array. Several portions of this fatality were impaled on a tumbleweed branch, suggesting that this was a loggerhead shrike kill. No fatalities were observed in control plots associated with this array.

Two fatalities were found in Array 9 (Table 2; Figure 6). Both fatalities were counted from feather spots. No fatalities were observed along the perimeter fence associated with this array.

One fatality was found in a control plot associated with Array 11 (Table 2; Figure 6). No fatalities were found in Array 11 or the perimeter fence associated with this array.

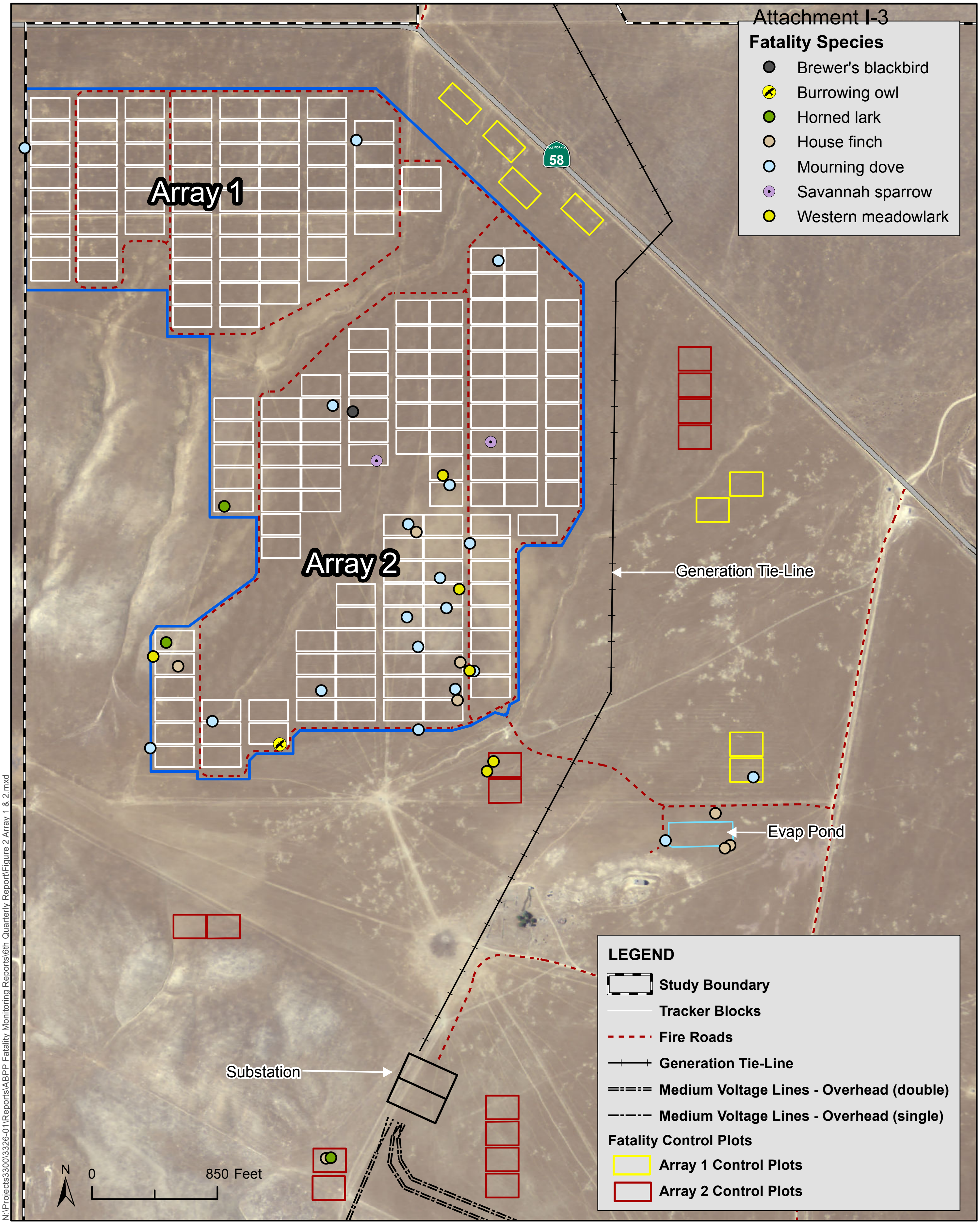
Thirteen fatalities were counted along the MVOH Line (Table 2; Figure 7). All of these fatalities were counted from feather spots and all were found directly, or nearly directly, under the MVOH Line.

Ten fatalities were counted along the Gen-tie Line (Table 2; Figure 8). All of these fatalities were counted from feather spots and all were found directly, or nearly directly, under the Gen-tie Line.

Four fatalities were found in or around the Evaporation Pond (Table 2; Figure 2). Two fatalities were counted from feather spots and both were found outside of the perimeter fence surrounding the pond. One additional feather spot was found outside the fenced area. One whole house finch carcass was also found outside the fence surrounding the pond. This bird may have been ill at the time of death. A palpable keel indicated low body weight and matted feather and feces around the cloaca may also indicate illness.

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

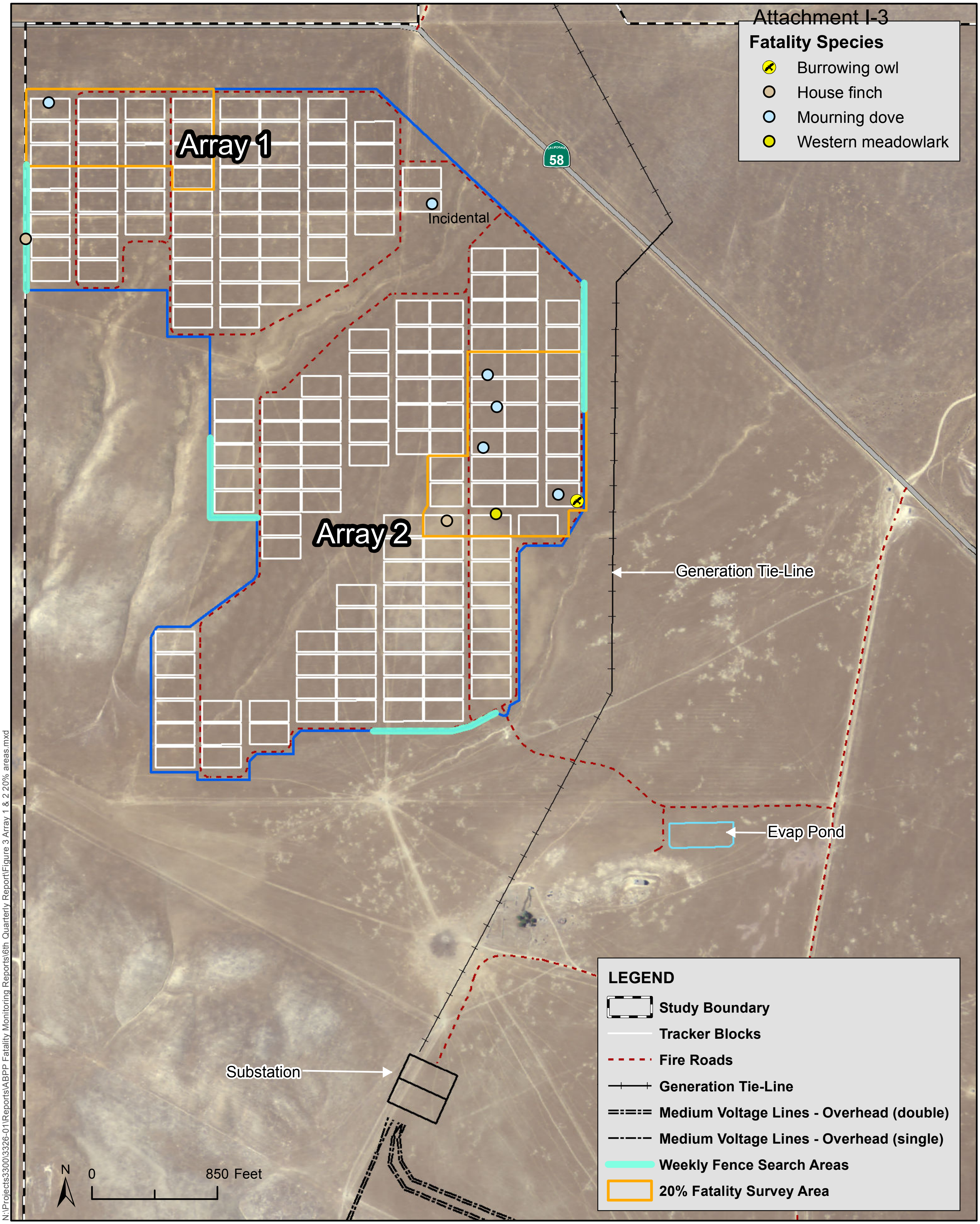
California Valley Solar Ranch

ABPP Sixth Quarterly Postconstruction Fatality Report

Figure 2: Locations and Species of Postconstruction Fatalities Observed in Array 1 and 2 Elements, and the Evaporation Pond between 16 November 2013 and 15 February 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\6th Quarterly Report\Figure 3 Array 1 & 2 20% areas.mxd

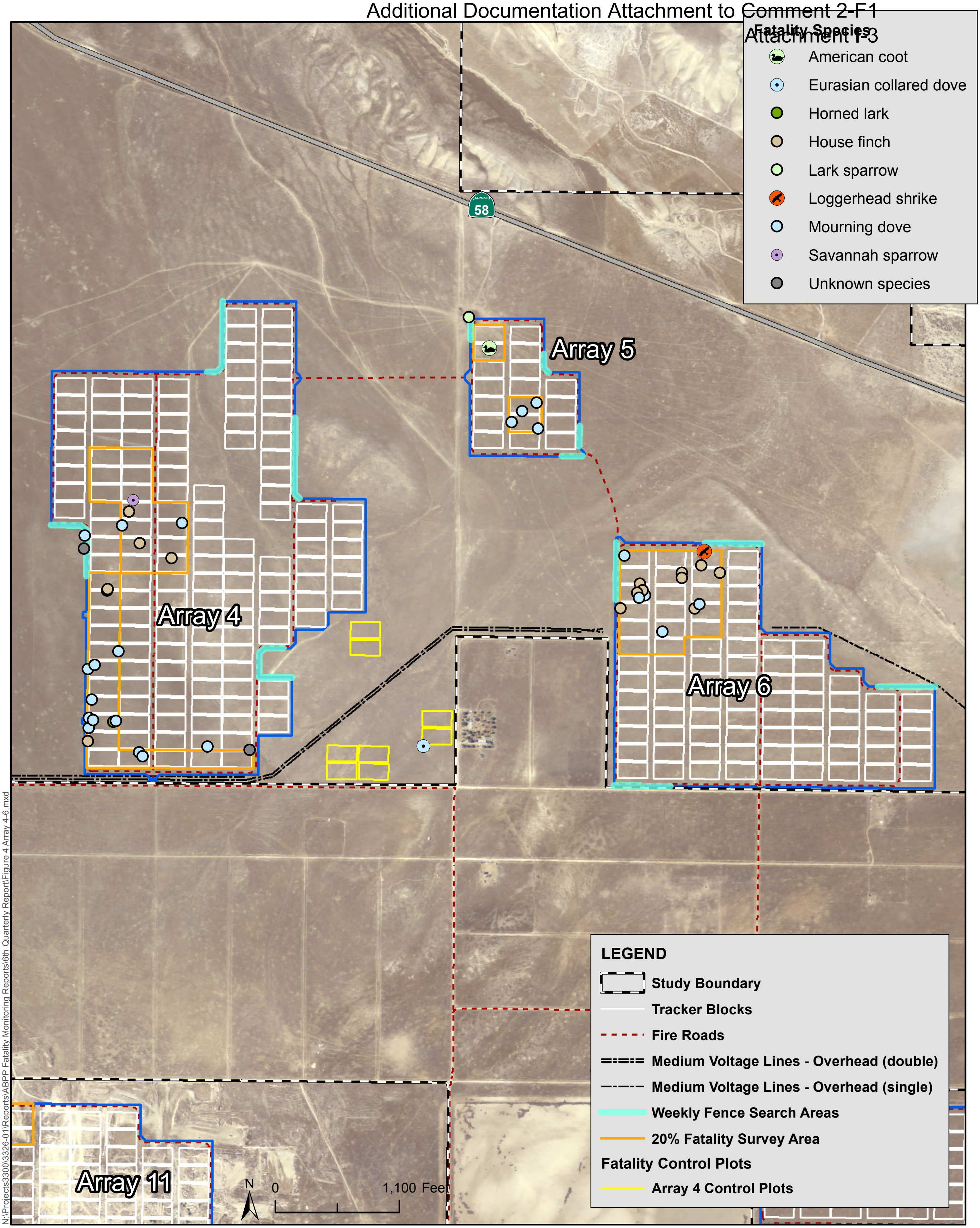
HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch

ABPP Sixth Quarterly Postconstruction Fatality Report

Figure 3: Locations and Species of Postconstruction Fatalities Observed in Arrays 1 and 2 Elements Surveyed at 20% Coverage between 16 November 2013 and 15 February 2014



HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

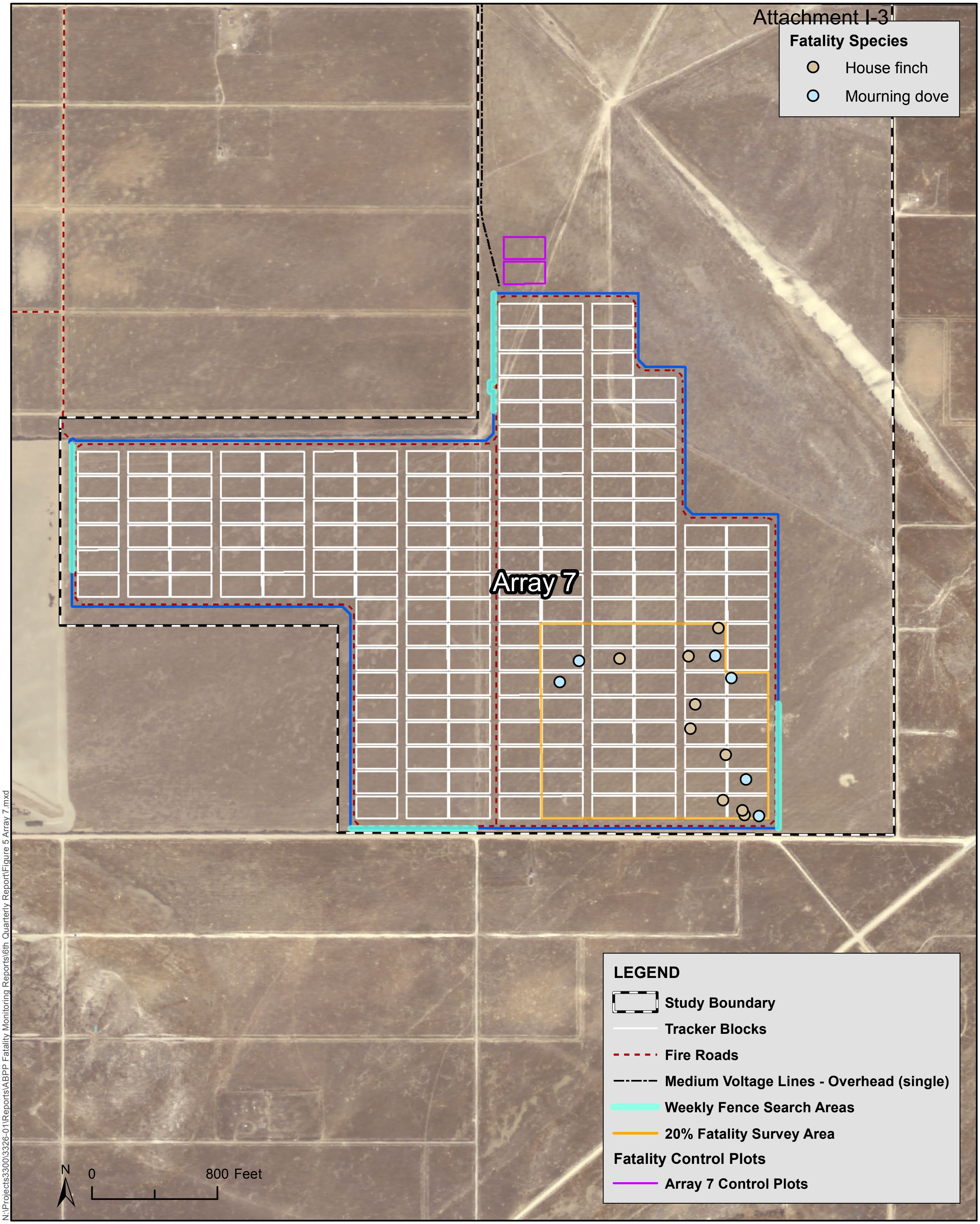
California Valley Solar Ranch

ABPP Sixth Quarterly Postconstruction Fatality Report

Figure 4: Locations and Species of Postconstruction Fatalities Observed in Array 4, 5, and 6 Elements between 16 November 2013 and 15 February 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



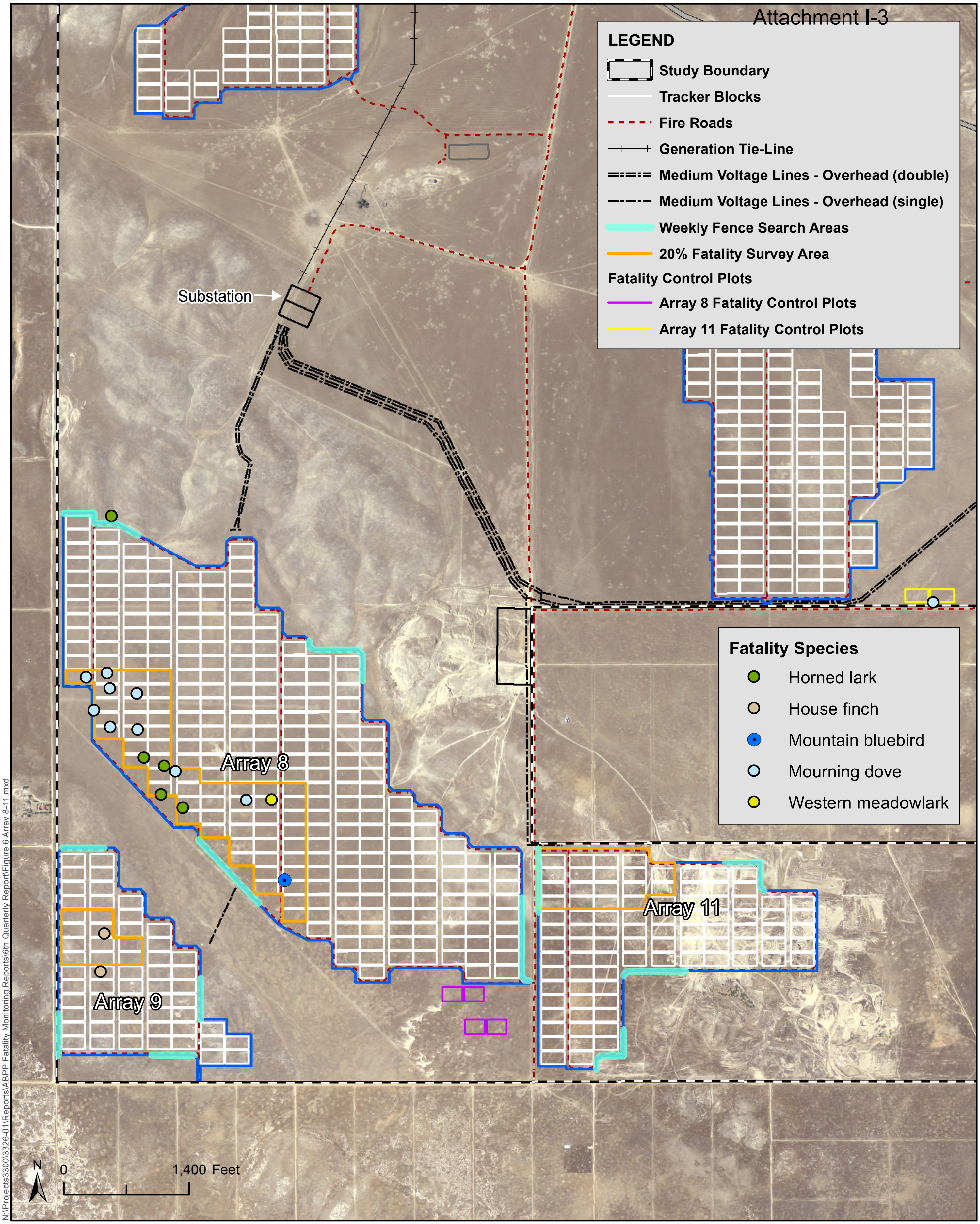
N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\6th Quarterly Report\Figure 5 Array 7.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Sixth Quarterly Postconstruction Fatality Report

Figure 5: Locations and Species of Postconstruction Fatalities Observed in Array 7 Elements between 16 November 2013 and 15 February 2014



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\6th Quarterly Report\Figure 6 Array 8-11.mxd

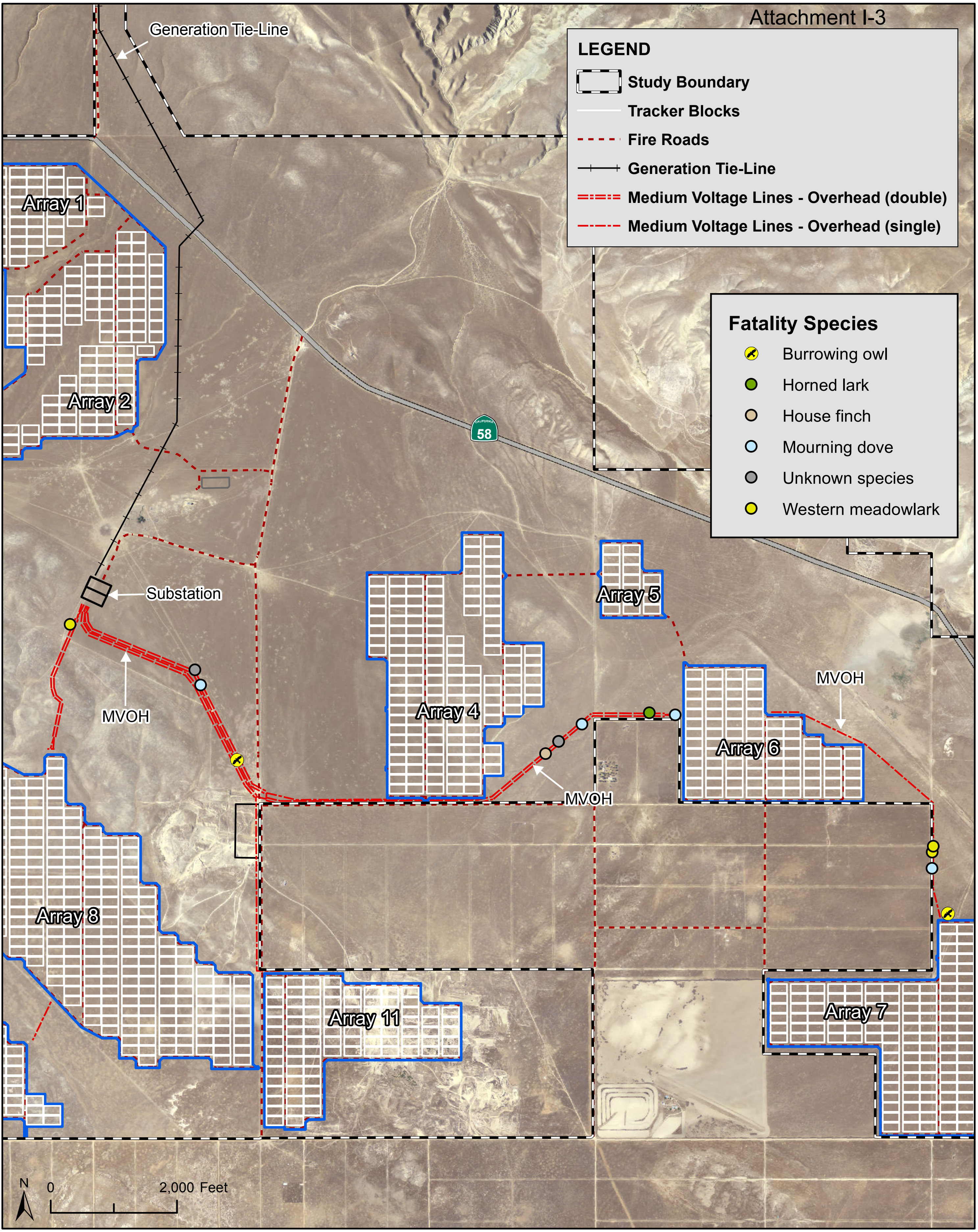
HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch

ABPP Sixth Quarterly Postconstruction Fatality Report

Figure 6: Locations and Species of Postconstruction Fatalities Observed in Array 8, 9, and 11 Elements between 16 November 2013 and 15 February 2014



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\6th Quarterly Report\Figure 7 MVOH Area.mxd

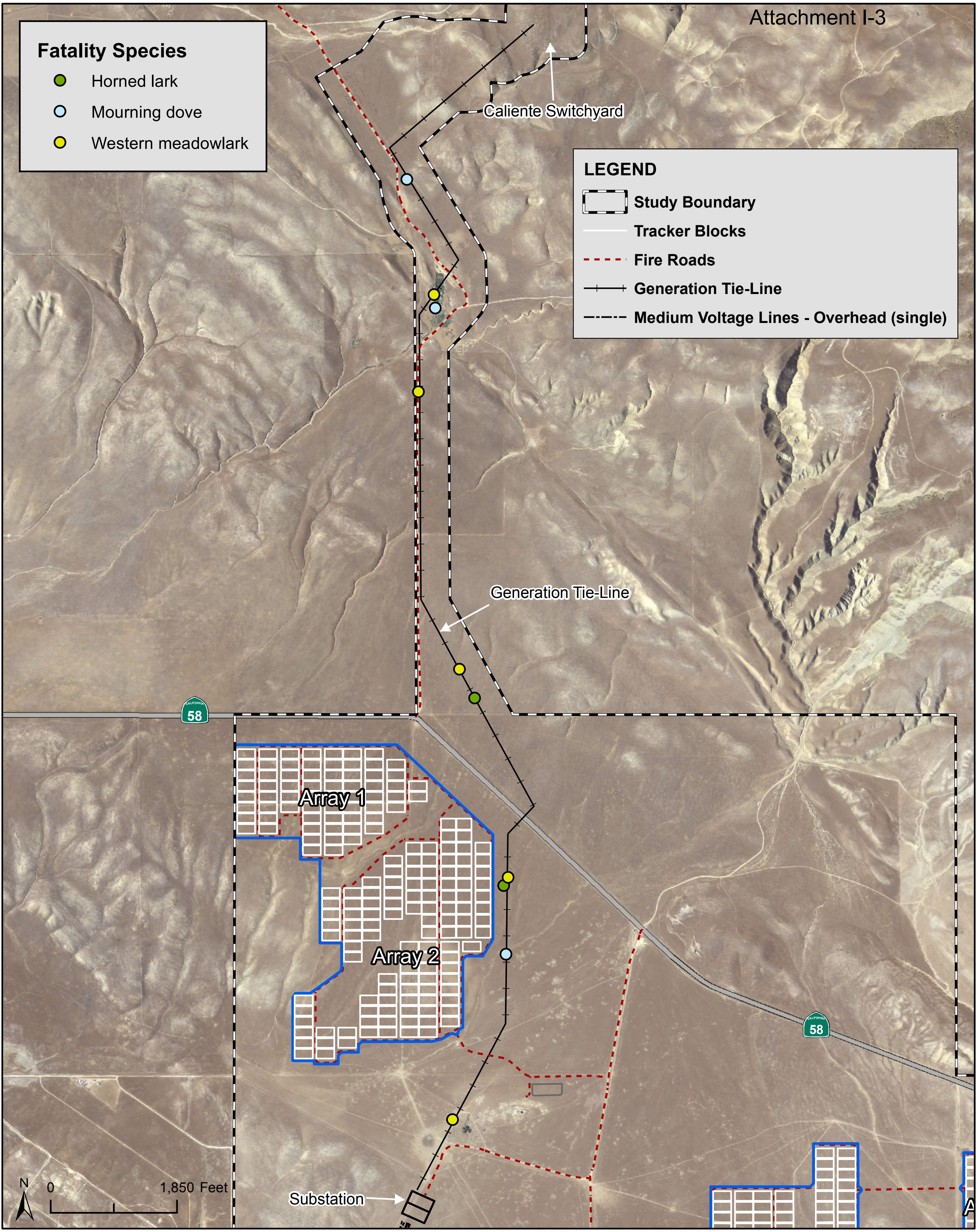
HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Sixth Quarterly Postconstruction Fatality Report
Figure 7: Locations and Species of Postconstruction Fatalities Observed along MVOH line between 16 November 2013 and 15 February 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\6th Quarterly Report\Figure 8 Gen-tie Area.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Sixth Quarterly Postconstruction Fatality Report

Figure 8: Locations and Species of Postconstruction Fatalities Observed along Gen-tie Line between 16 November 2013 and 15 February 2014

Fourteen additional avian fatalities were found incidentally along the MVOH line, and in Arrays 2, 4, 6, 7, 8, 9 and their associated elements (Appendix A, Table A-3). All but one of these fatalities were counted from feather spots. One whole carcass of a mourning dove was found along the perimeter fence associated with Array 7. This carcass did not show signs of injury or illness. Additionally, one burrowing owl feather spot was found in Array 9.

3.2 5-day Repeat Surveys

During the 5-day repeat surveys conducted during this reporting period, 11 avian fatalities were observed (Table 3). Of these 11 fatalities, one was found in Array 1, six were found in Array 4, one was found on the Array 4 fence, one was found in Array 8, one was found on the Array 8 fence, and one was found along the MVOH line. No fatalities were found in any of the other arrays or project elements. No bat fatalities were observed during this survey period.

3.2.1 Array 1

Array 1 and its associated fence were surveyed two times during this reporting period. No fatalities were found during the week of 16 December 2013, but one was found during the week of 17 November: a feather spot of a house finch. This feather spot persisted until the fifth day of the survey, when it was collected.

3.2.2 Array 4

Array 4 was searched one time during this reporting period, during the week of 9 December. On 9 December, searchers were shut-out of all arrays due to safety concerns, shifting the first day of the repeat survey to Tuesday, 10 December. The fifth day of the repeat survey was not rescheduled due to scheduling conflicts. Three mourning dove feather spots and one feather spot of a western meadowlark were found on 10 December. Because this was the first day of the search period, they were collected immediately. On 12 December, a mourning dove feather spot was found. This feather spot persisted until the next and final day of the survey period, when it was collected. On 13 December, we found another mourning dove feather spot in this array. Because it was found on the last day of the search period, it was collected immediately.

3.2.3 Array 4 Fence

The Array 4 fence was searched one time during this period, during the week of 9 December. On 9 December, workers were shut out of the array due to safety concerns, so neither the fence nor the array was searched until 10 December. On 10 December, we found a mourning dove feather spot along the fence. Because it was found on the first day of the search, it was considered a clearance carcass, and it was collected immediately.

3.2.4 Array 8

Array 8 was surveyed one time during this reporting period, and one fatality was found. On 10 December, the feather spot of a mourning dove was found. It persisted until the end of the week, when it was collected.

3.2.1 Array 8 Fence

The fence of Array 8 was surveyed one time during this reporting period, and one fatality was found. On 10 December, we found a mourning dove feather spot. It persisted until the end of the week, when it was collected.

3.2.2 MVOH Line

The MVOH Line was surveyed one time during this reporting period, and we found one fatality. On 3 December, the feather spot of a burrowing owl was found along the MVOH Line. The feather spot persisted until the last day of the 5-day survey, when it was collected.

3.3 1-Day Repeat Surveys

3.3.1 Weekly Search Areas

Seven avian fatalities were observed in Project areas that were surveyed during 1-day repeat surveys that occurred in this reporting period (Table 4). No bat fatalities were observed during this period. All fatalities were found in the 1-day repeat survey areas of Array 2 North and South, Array 2 Serengeti, Array 6, Array 7, and the Gen-tie Line; no fatalities were found in the 1-day repeat survey areas of any other Project element.

3.3.1.1 Array 2 North and South

The feather spot of a savannah sparrow (*Passerculus sandwichensis*) was found in Array 2 South on 4 December. On 18 December, two fatalities were found in Array 2 North. A western meadowlark was found at mid-day in Array 2 North, when the panels were flat, and some feathers and blood were located on the panel. Because loose clumps of feathers were located on the panel, it is likely that the carcass was found and scavenged within approximately three hours prior to its discovery. The location of the scavenged remains on the panels rules out the possibility that it was scavenged by a mammal. Therefore, it was likely scavenged by a bird such as a common raven. We also found a mourning dove carcass in Array 2 North on 18 December. It had visible blunt force trauma to its chest and right shoulder, and visible bruising on its right foot. The wounds were not fresh, so it is likely that the trauma occurred several days prior, and had begun to heal when the bird died. We determined that all three of these fatalities were new, due to the freshness of the carcasses and high visibility of the locations where they were found.

3.3.1.2 Array 2 Serengeti

On 11 December, a common raven feather spot was found in Array 2 Serengeti. This fatality was likely missed by weekly searchers.

3.3.1.3 Array 6

On 31 December, searchers found the large feather spot comprising a mourning dove in Array 6. This fatality was likely missed by weekly searchers.

3.3.1.4 Array 7

On 20 December, the feather spot of a Eurasian collared dove was found in Array 7. This feather spot was thought to be a fresh feather spot that was not missed by weekly searchers.

3.3.1.5 Gen-Tie Line

On 5 December, a savannah sparrow feather spot was found along the Gen-tie Line. Some of the feathers were matted into the ground, so it is likely that this feather spot was missed by weekly searchers.

3.3.2 5-day Repeat Survey Areas

During the 1-day repeat surveys of 5-day search areas, conducted between 16 November and 31 December, no fatalities were observed in the Project areas that were surveyed.

Table 3. Results of 5-Day Repeat Surveys Conducted between 16 November 2013 and 15 February 2014

Location	Survey Period	Date Fatality Detected	Number of Days that Fatality Persisted	Species	UTM Zone	Easting	Northing	Observation Details
Array 1	17-21 Nov 2013	19 Nov 2013	3	HOFI	11S	234008	3915554	Feather spot of an adult male house finch consisting of 5+ wing feathers, 300+ body feathers, and 3 tail feathers.
Array 4	10-13 Dec 2013	10 Dec 2013	NA	MODO	11S	235544	3913728	Feather spot consisting of 3 tail feathers, 2 flight feathers, and 15 body feathers.
Array 4	10-13 Dec 2013	10 Dec 2013	NA	MODO	11S	235713	3913580	Feather spot consisting of 50 body feathers and 4 flight feathers.
Array 4	10-13 Dec 2013	10 Dec 2013	NA	MODO	11S	235536	3913664	Feather spot consisting of 10 primary feathers and 40 body feathers.
Array 4	10-13 Dec 2013	10 Dec 2013	NA	WEME	11S	235592	3913712	Feather spot consisting of 20+ body feathers and 20+ primary and secondary feathers.
Array 4	10-13 Dec 2013	12 Dec 2013	2	MODO	11S	235523	3913707	Feather spot consisting of 5 body feathers and 60 body feathers.
Array 4	10-13 Dec 2013	13 Dec 2013	NA	MODO	11S	235488	3913692	Feather spot consisting of 75+ body feathers and 12+ tail feathers.
Array 4 Fence	10-13 Dec 2013	10 Dec 2013	NA	MODO	11S	235654	3913759	Feather spot consisting of 10+ tail feathers and 20+ body feathers.
Array 8	9-13 Dec 2013	10 Dec 2013	4	MODO	11S	234202	3912369	Feather spot consisting of 50+ body feathers and 30+ flight and tail feathers.
Array 8	9-13 Dec 2013	10 Dec 2013	4	MODO	11S	234411	3912264	Feather spot consisting of 10-15 flight feathers and 30 body feathers. Likely missed during previous search.

UTM = Universal Transverse Mercator.

Species Codes
HOFI – house finch
MODO – Mourning dove
WEME – Western meadowlark

Table 4. Results of 1-Day Repeat Surveys Conducted in Weekly Search Areas between 16 November 2013 and 15 February 2014

Site	Date of Weekly Search	Date Fatality Detected	Species	UTM Zone	Easting	Northing	Observation Details
Array 2 North	17 Dec 2013	18 Dec 2013	MODO	11S	233908	3914955	Fresh carcass with blunt force trauma to abdomen and right shoulder and bruising on right foot. Found in a grass clump directly below tilted panel. Wounds look recent but not fresh. It is likely that they occurred several days earlier and had begun to heal when the bird died.
Array 2 North	17 Dec 2013	18 Dec 2013	WEME	11S	233803	3914993	Feather spot consisting of 7 flight feathers and 200+ body feathers. Feathers spread across row and panel. Presence of loose clumps of feathers on flat solar panels suggests that the bird was very recently scavenged by a raven.
Array 2 South	3 Dec 2013	4 Dec 2013	SAVS	11S	234160	3914847	Feather spot consisting of 100+ body feathers, and 12 primaries and secondaries. Likely a new feather spot.
Array 2 Serengeti	10 Dec 2013	11 Dec 2013	CORA	11S	234489	3915098	Feather spot consisting of ~20 body feathers. Likely missed by weekly searchers.
Array 6	30 Dec 2013	31 Dec 2013	MODO	11S	235570	3913160	Feather spot consisting of 20 body feathers and 5 contour feathers. Likely missed by weekly searchers.
Array 7	19 Dec 2013	20 Dec 2013	ECDO	11S	237717	3912921	Feather spot consisting of two tertiary and 18 body feathers, in two clumps along the middle of the cable tray.
Gen-tie Line	4 Dec 2013	5 Dec 2013	SAVS	11S	234448	3914325	Feather spot consisting of 16 flight and 50+ body feathers. Feathers are matted into vegetation. Likely missed by weekly searchers.

UTM = Universal Transverse Mercator.

Species Codes
CORA – Common raven
ECDO – Eurasian collard dove
MODO – Mourning dove
SAVS – Savannah sparrow
WEME – Western meadowlark

Section 4.0 Discussion

4.1 Weekly Fatality Searches

Following the trend observed in previous quarterly fatality reports, the majority (95%, or 145 of 152) of post construction fatalities detected in the sixth quarter were counted from feather spots, making it difficult to determine the definitive causes of death. Feather spots may indicate collision with a solar panel or a power line, but in the absence of evidence of bodily injuries, it is impossible to determine the direct cause of death. For example, feather spots can indicate nonlethal panel strikes, with fatalities occurring when predators take advantage of a stunned bird. In this situation, although the cause of death is only indirectly related to the presence of the panels, it would still be classified as being caused by a collision. The injured, but partially healed mourning dove found in Array 2 during repeat surveys supports the assertion that collisions may not result in immediate death, but are ultimately the cause of death. Feather spots may also indicate that a lethal panel collision or power line collision occurred, and that the body was later scavenged. Alternatively, feather spots may simply indicate direct mammalian or avian predation. Because no direct observations of predation or collisions were made during this period, causes of death could not be determined.

Mourning doves commonly roost under the panels and this species comprises the greatest numbers of fatalities. When they were flushed, we observed these birds quickly navigating through the panels; in this high-clutter environment, some birds may fly into structural elements of the array and not necessarily the upper side of the panel. Species that fly in flocks seem to be at a greater risk of collision; it has been posited that birds flying in the rear of flocks are more likely to be unaware of upcoming obstacles (Janss 2000). Additionally, the relatively high densities of these species' flocks may provide greater opportunities for avian and mammalian predators to prey on these birds. House finches represented the second most frequently detected species of fatality. A similar pattern of mortality was observed for mourning doves and house finches in the 2nd quarterly report covering 16 November 2012 to 15 February 2013. In contrast, horned lark fatalities declined from previous quarters and they were observed much less frequently in arrays than mourning doves and house finches. The reduction in the number of horned larks may be due to vegetative growth under the arrays following construction.

Because surveys of the control plots detected background avian mortality, a corresponding percentage of the total fatalities found in each of the arrays was likely attributable to natural causes unrelated to the solar panels and other Project infrastructure. In the next annual fatality report, the fatality estimate for the Project will be adjusted accordingly to reflect this background mortality.

Although assessing cause of death from feather spots is difficult, all feather spots found along the Gen-tie and MVOH Lines were located directly, or nearly directly, under these lines. The location of these fatalities suggests that these fatalities were caused by power line collisions and that the remains found were indicative of scavenging, rather than predation. We believe that predation by resident predators also contributed to some of these fatalities.

Consistent with all previous quarters, total fatalities were higher for the entirety of Array 2 compared to Array 1 when searched at 100% coverage. After reducing the search effort in both arrays, the outcome was similar for these arrays, with more fatalities in the 20% search area of Array 2 compared with the 20% search area of Array 1. As discussed in previous quarterly reports, the Gen-tie Line, which is located directly east of and closest to Array 2 may provide a protected area where scavengers may consume carcasses found near this transmission line. Of all sites surveyed at 20% for the entire quarter, Array 4 had the highest number of fatalities and Arrays 6, 7, and 8 had the second highest number of fatalities. In comparison, Arrays 9 and 11 had very few fatalities. Vegetation in Arrays 9 and 11 is very sparse and composed predominantly of bare ground. It’s likely that fewer fatalities were found in Arrays 9 and 11 because fewer birds were attracted to these areas due to the lack of suitable roosting and foraging habitat. No fatalities were found in Array 5, possibly because of the small size of this array and the low number of trackers (four) searched.

While only four fatalities were observed at the evaporation pond, all were discovered on the same day. One intact carcass showed signs of illness (emaciation) and trauma (beak injury), so the direct cause of death remains inconclusive. That several fatalities were found during the same survey is not unusual because large flocks of birds, especially house finches, were periodically observed outside the pond for several weeks during the early part of the 6th quarter. These flocks likely attracted predators which could be associated with these fatalities.

4.2 Repeat Surveys

A general assumption of fatality searches is that searchers are not 100% efficient at finding carcasses, because of both environmental and individual constraints (e.g., vegetation height, visual obstacles such as support poles for the arrays, and observer fatigue). The results of the 1-day and the 5-day repeat surveys support this assumption, because several of the fatalities were missed by weekly searchers. Although the number of fatalities found by weekly searchers (but missed by repeat searchers) was not examined, there are recorded cases of weekly searchers finding fatalities that repeat searchers did not find; therefore, searcher misses go in both directions. Also, the low rates of consistency between the findings of regular weekly searchers and those of repeat searchers suggest that search outcomes may be affected by both random differences and differences that vary by individual searcher. For example, a taller searcher will have a reduced field of vision into adjacent rows compared to a shorter searcher. This variation is unlikely to be fully compensated for, even with conscious efforts to look under the panels. Likewise, there are tradeoffs based on where searchers focus their field of vision: if a searcher focuses on tufts of tall grass on the sides of array rows, he or she may overlook fatalities directly underfoot, and vice versa.

All 5-day and 1-day repeat searches were discontinued during this quarter. These repeat surveys were determined to provide limited value in terms of extra information.

Section 5.0 Literature Cited

Beason, R. C. 1995. Horned lark (*Eremophila alpestris*). No. 195 i*n* A. Poole (Editor), The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York. [online]: http://bna.birds.cornell.edu/bna/species/195. Doi:10.2173/bna.195

[HTH] H. T. Harvey and Associates. 2011. Avian and Bat Protection Plan for the California Valley Solar Ranch Project. Fresno, California.

[HTH] H. T. Harvey and Associates. 2014. California Valley Solar Ranch Project Avian and Bat Protection Plan Annual Postconstruction Fatality Report 16 August 2012 - 15 August 2013. San Luis Obispo, California

Janss, G. F. E. 2000. Avian mortality from power lines: A morphological approach of a species-specific mortality. Biological Conservation 95:353–359.

Otis, D. L., J. H. Schulz, D. Miller, R. E. Mirarchi, and T. S. Baskett. 2008. Mourning dove (*Zenaida macroura*). No. 117 *in* A. Poole (Editor), The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York. [online]: http://bna.birds.cornell.edu/bna/species/117.

Scott, S. D., and C. McFarland. 2010. Bird Feathers: A Guide to North American Species. Stackpole Books, Mechanicsburg, Pennsylvania.

Smallwood, K. S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781–2791.

Appendix A. Weekly Fatality Search Results—16 November to 15 February 2014

Table A-1. Results of Fatality Searches from 16 November to 15 February 2014

Site	Survey Date	Species Code	UTM Zone[1]	Easting	Northing	Observation Details
MVOH	20 Nov 2013	MODO	11S	234645	3913250	Feather Spot: Three tail feathers and nine body feathers found clumped.
MVOH	4 Dec 2013	BUOW	11S	238214	3912029	Feather Spot: 50+ body feathers.
MVOH	11 Dec 2013	WEME	11S	238150	3912327	Feather Spot: three flight feathers (all tail) and 15 to 20 body feathers.
MVOH	8 Jan 2014	BUOW	11S	234808	3912884	Feather Spot: 10+ flight and body feathers.
MVOH	8 Jan 2014	MODO	11S	238146	3912249	Feather Spot: 100+ body and flight feathers.
MVOH	8 Jan 2014	MODO	11S	236480	3913001	Feather Spot: three secondary, one primary, and 10 body feathers.
MVOH	15 Jan 2014	HOLA	11S	236807	3913045	Feather Spot: 15 body feathers.
MVOH	22 Jan 2014	Unknown large bird	11S	234620	3913324	Feather Spot: 15 body feathers.
MVOH	22 Jan 2014	Unknown raptor	11S	236364	3912921	Feather Spot: 20 body feathers.
MVOH	22 Jan 2014	HOFI	11S	236364	3912921	Feather Spot: five flight and 40+ body feathers. Additional feathers, likely from same individual, found approximately 90 meters south along line.
MVOH	29 Jan 2014	WEME	11S	234025	3913564	Feather Spot: 10 flight feathers and 15 to 20 body feathers.
MVOH	29 Jan 2014	WEME	11S	238163	3912336	Feather Spot: one flight feather and 30 body feathers.

---

[1] UTM = Universal Transverse Mercator.

Species Codes

AMCO-American coot
BRBL – Brewer's blackbird
BUOW – Burrowing owl
ECDO-Eurasian collared dove
HOFI – House finch
HOLA – Horned lark
LASP-Lark sparrow
LOSH-Loggerhead shrike
MOBL-Mountain bluebird
MODO-Mourning dove
SAVS-Savannah sparrow
WEME-Western meadowlark

Site	Survey Date	Species Code	UTM Zone¹	Easting	Northing	Observation Details
MVOH	29 Jan 2014	MODO	11S	236973	3913150	Feather Spot: 20+ flight and 150+ body feathers. Blood on ground near feather spot and on some flight and body feathers. Time of death probably within 48 hours due to fresh blood.
Array 1	5 Dec 2013	MODO	11S	234085	3915681	Feather Spot: 24 body feathers and two secondary feathers.
Array 1	2 Jan 2014	MODO	11S	233452	3915780	Feather Spot: 20+ body and three primary feathers.
Array 1 Controls	28 Jan 2014	MODO	11S	234862	3914336	Feather Spot: 30+ body feathers matted and connected to skin and blood.
Array 1-2 Fence	19 Nov 2013	MODO	11S	233399	3915688	Feather Spot: 200+ feathers including body, tail, wing, and contour feathers.
Array 1-2 Fence	19 Nov 2013	MODO	11S	233618	3914440	Feather Spot: 15 contour and three tail feathers.
Array 1-2 Fence	10 Dec 2013	MODO	11S	234173	3914460	Feather Spot: 12-15 body feathers.
Array 1-2 Fence	28 Jan 2014	HOFI	11S	233395	3915500	Feather Spot: 20+ flight and 150+ body feathers.
Array 2	7 Jan 2014	HOFI	11S	234246	3914889	Feather Spot: 100+ body feathers.
Array 2	21 Jan 2014	MODO	11S	234478	3914936	Feather Spot: two flight and 40 body feathers.
Array 2	21 Jan 2014	MODO	11S	234326	3915038	Feather Spot: four flight and 70 body feathers. Heavily clumped body feathers.
Array 2	28 Jan 2014	MODO	11S	234357	3915121	Feather Spot: five to six flight feathers and 15+ body feathers. Some skin connected to the downy feathers.
Array 2	28 Jan 2014	WEME	11S	234348	3914900	Feather Spot: 10 flight and 100+ body feathers.

Species Codes

AMCO-American coot
BRBL – Brewer's blackbird
BUOW – Burrowing owl
ECDO-Eurasian collared dove
HOFI – House finch
HOLA – Horned lark
LASP-Lark sparrow
LOSH-Loggerhead shrike
MOBL-Mountain bluebird
MODO-Mourning dove
SAVS-Savannah sparrow
WEME-Western meadowlark

Site	Survey Date	Species Code	UTM Zone¹	Easting	Northing	Observation Details
Array 2	11 Feb 2014	MODO	11S	234340	3915188	Feather Spot: 10 body feathers; two loose and eight attached to single piece of skin.
Array 2	11 Feb 2014	BUOW	11S	234516	3914922	Feather Spot: 20 flight and 100 body feathers.
Array 2 Control	26 Nov 2013	WEME	11S	234312	3914369	Feather Spot: 10-15 body feathers. Two tail feathers.
Array 2 Control	10 Dec /2013	HOFI	11S	233953	3913581	Feather Spot: 11 body feathers.
Array 2 Control	17 Dec 2013	HOLA	11S	233963	3913582	Feather Spot: 200 body feathers and some skin.
Array 2 Control	7 Jan 2014	WEME	11S	234243	3914361	Feather Spot: 10 flight and 50+ body feathers.
Array 2 North	26 Nov 2013	SAVS	11S	234341	3915050	Whole Carcass: carcass, body without head.
Array 2 North	17 Dec 2013	HOLA	11S	233787	3914934	Feather Spot: partial wing with 200 body feathers and 20+ primary, secondary, and tail feathers.
Array 2 North	17 Dec 2013	MODO	11S	234370	3915423	Feather Spot: 10 flight and 30 body feathers.
Array 2 North	31 Dec 2013	MODO	11S	234254	3914963	Feather Spot: 15+ flight and 200+ body feathers. Dried blood on feathers.
Array 2 North	31 Dec 2013	MODO	11S	234018	3915135	Feather Spot: five flight and 50 body feathers.
Array 2 North	31 Dec 2013	SAVS	11S	234104	3915019	Feather Spot: 12 flight and 40+ body feathers.
Array 2 North	31 Dec 2013	WEME	11S	234241	3914983	Feather Spot: 20+ flight and 200+ body feathers.

Species Codes

AMCO-American coot
BRBL – Brewer's blackbird
BUOW – Burrowing owl
ECDO-Eurasian collared dove
HOFI – House finch
HOLA – Horned lark
LASP-Lark sparrow
LOSH-Loggerhead shrike
MOBL-Mountain bluebird
MODO-Mourning dove
SAVS-Savannah sparrow
WEME-Western meadowlark

Site	Survey Date	Species Code	UTM Zone[1]	Easting	Northing	Observation Details
Array 2 North	31 Dec 2013	BRBL	11S	234059	3915121	Feather Spot: 50+ body feathers and approximately 12 flight feathers.
Array 2 South	19 Nov 2013	WEME	11S	234267	3914747	Feather Spot: six tail feathers, 10 secondary feathers, 5+ primaries, and 75+ breast body and mantle feathers.
Array 2 South	19 Nov 2013	MODO	11S	234292	3914841	Feather Spot: six flight feathers and 25 body feathers.
Array 2 South	26 Nov 2013	HOFI	11S	233681	3914607	Feather Spot: 20 breast feathers attached to a piece of skin.
Array 2 South	26 Nov 2013	HOFI	11S	234182	3914868	Feather Spot: 100+ body feathers and 15+ flight feathers.
Array 2 South	26 Nov 2013	MODO	11S	233748	3914491	Feather Spot: 150+ body feathers, 15+ remiges, and four+ retrices.
Array 2 South	10 Dec 2013	BUOW	11S	233885	3914440	Feather Spot: mostly body and wing feathers. One wing with bone attached, apparently plucked from carcass.
Array 2 South	10 Dec 2013	MODO	11S	234178	3914631	Feather Spot: multiple tail and undertail coverts and body feathers.
Array 2 South	17 Dec 2013	WEME	11S	234283	3914578	Feather Spot: 25 body feathers.
Array 2 South	17 Dec 2013	MODO	11S	234228	3914772	Feather Spot: one flight and 60 body feathers.
Array 2 South	17 Dec 2013	HOLA	11S	233658	3914657	Feather Spot: bird's bill with flight feathers and 500 body feathers.
Array 2 South	17 Dec 2013	MODO	11S	234292	3914577	Feather Spot: 15 body feathers connected by skin.
Array 2 South	31 Dec 2013	MODO	11S	234252	3914541	Feather Spot: 10 flight and 200 body feathers.

Species Codes

AMCO-American coot
BRBL – Brewer's blackbird
BUOW – Burrowing owl
ECDO-Eurasian collared dove
HOFI – House finch
HOLA – Horned lark
LASP-Lark sparrow
LOSH-Loggerhead shrike
MOBL-Mountain bluebird
MODO-Mourning dove
SAVS-Savannah sparrow
WEME-Western meadowlark

Site	Survey Date	Species Code	UTM Zone¹	Easting	Northing	Observation Details
Array 2 South	31 Dec 2013	HOFI	11S	234256	3914518	Feather Spot: 70 body feathers.
Array 2 South	31 Dec 2013	WEME	11S	233630	3914629	Feather Spot: eight flight and 100 body feathers. Long smudge of body fluids along two trackers and panels with approximately ten feathers attached.
Array 2 South	31 Dec 2013	MODO	11S	234166	3914885	Feather Spot: 30 body feathers and four flight feathers.
Array 2 South	31 Dec 2013	HOFI	11S	234264	3914596	Feather Spot: 300 body and 20 flight feathers.
Array 2 South	31 Dec 2013	MODO	11S	233975	3914547	Feather Spot: 20 flight and 100+ body feathers in several clumps.
Array 2 South	31 Dec 2013	MODO	11S	234239	3914709	Feather Spot: 10 body feathers clumped.
Array 2 South	31 Dec 2013	MODO	11S	234157	3914693	Feather Spot: one flight feather and 30 body feathers.
Array 4	20 Nov 2013	HOFI	11S	235665	3913379	Feather Spot: seven to eight flight feathers and 50 body feathers. Some blood on feathers.
Array 4	20 Nov 2013	MODO	11S	235543	3912797	Feather Spot: one secondary feather with 30 body feathers.
Array 4	20 Nov 2013	MODO	11S	235646	3913342	Feather Spot: four tail and 30 body feathers.
Array 4	4 Dec 2013	MODO	11S	235863	3912739	Feather Spot: 24 body feathers connected with tissue.
Array 4	11 Dec 2013	MODO	11S	235544	3912956	Feather Spot: 15 flight and 150 body feathers.
Array 4	11 Dec 2013	MODO	11S	235553	3912873	Feather Spot: 10 flight and 150 body feathers.

Species Codes

AMCO-American coot
BRBL – Brewer's blackbird
BUOW – Burrowing owl
ECDO-Eurasian collared dove
HOFI – House finch
HOLA – Horned lark
LASP-Lark sparrow
LOSH-Loggerhead shrike
MOBL-Mountain bluebird
MODO-Mourning dove
SAVS-Savannah sparrow
WEME-Western meadowlark

Site	Survey Date	Species Code	UTM Zone[1]	Easting	Northing	Observation Details
Array 4	11 Dec 2013	MODO	11S	235678	3912728	Feather Spot: body and flight feathers.
Array 4	11 Dec 2013	MODO	11S	235544	3912824	Feather Spot: 5+ flight (two primary feathers) and 50+ body feathers
Array 4	18 Dec 2013	MODO	11S	235687	3912717	Feather Spot: 30+ body and five flight feathers.
Array 4	18 Dec 2013	MODO	11S	235808	3913345	Feather Spot: 50+ contour and body feathers and 15 flight feathers.
Array 4	18 Dec 2013	MODO	11S	235563	3912967	Feather Spot: 25 body feathers, including two clumps of 10 each.
Array 4	18 Dec 2013	HOLA	11S	235610	3912812	Feather Spot: 200+ body and 10 unidentified feathers.
Array 4	18 Dec 2013	MODO	11S	235555	3912818	Feather Spot: 100 body and two flight feathers.
Array 4	18 Dec 2013	SAVS	11S	235677	3913411	Feather Spot: 100+ body and 20 flight feathers.
Array 4	18 Dec 2013	MODO	11S	235628	3913002	Feather Spot: two flight and 30+ contour feathers.
Array 4	8 Jan 2014	HOFI	11S	235540	3912761	Feather Spot: two flight and 30+ body feathers and partial bill.
Array 4	8 Jan 2014	MODO	11S	235617	3912814	Feather Spot: one wing covert, one tail feather, and 40 body feathers.
Array 4	15 Jan 2014	HOFI	11S	235601	3913167	Feather Spot: 100 body and three flight feathers.
Array 4	22 Jan 2014	Unknown passerine	11S	235977	3912728	Feather Spot: piece of wing with feathers connected by skin, five flight and four covert feathers.

Species Codes

AMCO-American coot
BRBL – Brewer's blackbird
BUOW – Burrowing owl
ECDO-Eurasian collared dove
HOFI – House finch
HOLA – Horned lark
LASP-Lark sparrow
LOSH-Loggerhead shrike
MOBL-Mountain bluebird
MODO-Mourning dove
SAVS-Savannah sparrow
WEME-Western meadowlark

Site	Survey Date	Species Code	UTM Zone[1]	Easting	Northing	Observation Details
Array 4	22 Jan 2014	HOFI	11S	235777	3913251	Partial Carcass: Bill, organs, blood, and feathers. 20 flight and 200 body feathers.
Array 4	29 Jan 2014	HOFI	11S	235603	3913171	Feather Spot: three flight and 75 body feathers scattered over multiple rows.
Array 4	12 Feb 2014	HOFI	11S	235692	3913293	Feather Spot: wing clump, 15+ flight and 100 body feathers, across length of tracker row.
Array 4 Control	7 Jan 2014	ECDO	11S	236446	3912721	Feather Spot: 20 flight and 150+ body feathers.
Array 4 Fence	18 Dec 2013	MODO	11S	235544	3913317	Feather Spot: 100+ body and five tail feathers. Feathers found in several distinct clumps.
Array 4 Fence	29 Jan 2014	Unknown large bird	11S	235541	3913282	Feather Spot: 100 body feathers.
Array 5	20 Nov 2013	MODO	11S	236776	3913579	Feather Spot: 40+ body feathers. Approximately 12 Secondaries and three tail feathers.
Array 5	20 Nov 2013	MODO	11S	236734	3913627	Feather Spot: 20 body, three tail, and six contour feathers found in several clumps.
Array 5	8 Jan 2014	MODO	11S	236705	3913598	Feather Spot: eight to ten flight and 15+ body feathers.
Array 5	29 Jan 2014	AMCO	11S	236649	3913800	Feather Spot: approximately 100 body feathers.
Array 5	5 Feb 2014	MODO	11S	236774	3913649	Feather Spot: three clumped feathers attached to skin.
Array 5 Fence	20 Nov 2013	LASP	11S	236596	3913884	Feather Spot: 100 body and contour feathers. 20+ wing and tail feathers. Bill with attached feathers.
Array 6	25 Nov 2013	HOFI	11S	237209	3913199	Feather Spot: 15 primary and secondary feathers. 30+ body and contour feathers.

Species Codes

AMCO-American coot
BRBL – Brewer's blackbird
BUOW – Burrowing owl
ECDO-Eurasian collared dove
HOFI – House finch
HOLA – Horned lark
LASP-Lark sparrow
LOSH-Loggerhead shrike
MOBL-Mountain bluebird
MODO-Mourning dove
SAVS-Savannah sparrow
WEME-Western meadowlark

Site	Survey Date	Species Code	UTM Zone[1]	Easting	Northing	Observation Details
Array 6	16 Dec 2013	MODO	11S	237100	3913022	Feather Spot: two tail, five contour, and 20 body feathers.
Array 6	16 Dec 2013	MODO	11S	237002	3913230	Feather Spot: two tail, 20 contour, and 30 body feathers.
Array 6	30 Dec 2013	LOSH	11S	237218	3913237	Feather Spot: 20 flight (wing and tail) and 100+ body feathers. Feathers were on the north side of the panel in a large area at the edge of the array. Some feathers and fluids were on the nearby panel.
Array 6	30 Dec 2013	HOFI	11S	237156	3913180	Feather Spot: 10 flight and 30 body feathers.
Array 6	30 Dec 2013	MODO	11S	237202	3913094	Feather Spot: six flight and two body feathers.
Array 6	30 Dec 2013	HOFI	11S	237189	3913083	Feather Spot: 20+ flight feathers and 300+ body feathers.
Array 6	6 Jan 2014	MODO	11S	237048	3913129	Feather Spot: six flight and 40 body feathers.
Array 6	6 Jan 2014	HOFI	11S	237042	3913153	Feather Spot: 200+ body, four primary, and 10+ secondary feathers. Beak with fresh, red blood.
Array 6	27 Jan 2014	HOFI	11S	236988	3913088	Feather Spot: 50+ body and 25+ flight feathers.
Array 6	27 Jan 2014	HOFI	11S	237049	3913135	Feather Spot: 100+ body feathers.
Array 6	27 Jan 2014	HOFI	11S	237042	3913128	Whole Carcass: found inside the "C" piles head first on ground below the cable trays. Carcass in rigor but no obvious broken bones; neck and keel bone intact. Eyes intact and fluid filled. Ceres present.
Array 6	27 Jan 2014	HOFI	11S	237259	3913178	Feather Spot: 25 flight and 100 body, spread over four rows.

Species Codes

AMCO-American coot
BRBL – Brewer's blackbird
BUOW – Burrowing owl
ECDO-Eurasian collared dove
HOFI – House finch
HOLA – Horned lark
LASP-Lark sparrow
LOSH-Loggerhead shrike
MOBL-Mountain bluebird
MODO-Mourning dove
SAVS-Savannah sparrow
WEME-Western meadowlark

Site	Survey Date	Species Code	UTM Zone[1]	Easting	Northing	Observation Details
Array 6	27 Jan 2014	HOFI	11S	237156	3913172	Feather Spot: 10 flight and 15+ body feathers, spread over three rows.
Array 6	4 Feb 2014	MODO	11S	237039	3913115	Feather Spot: 200+ body and 40 flight feathers. San Joaquin kit fox den 20 yards from feather spot.
Array 7	5 Dec 2013	HOFI	11S	238522	3911138	Feather Spot: 10 flight and 50 body feathers.
Array 7	12 Dec 2013	HOFI	11S	238533	3911185	Feather Spot: 100+ body feathers and 10+ flight feathers.
Array 7	12 Dec 2013	HOFI	11S	238523	3911279	Feather Spot: 120+ body feathers and 20+ flight feathers. Found tangled with tumbleweed against the cable tray.
Array 7	19 Dec 2013	HOFI	11S	238389	3911279	Feather Spot: 80+ body and 15+ flight feathers, tangled into a tumbleweed.
Array 7	2 Jan 2014	HOFI	11S	238622	3910967	Whole Carcass
Array 7	2 Jan 2014	HOFI	11S	238618	3910976	Partial Carcass: approximately 25 primary feathers, 400 body feathers, and some fresh organs.
Array 7	2 Jan 2014	MODO	11S	238310	3911277	Feather Spot: six primary and approximately 15 body feathers.
Array 7	2 Jan 2014	MODO	11S	238627	3911036	Feather Spot: one flight and 10+ body feathers.
Array 7	9 Jan 2014	HOFI	11S	238589	3911085	Feather Spot: five to ten flight and 150 body feathers.
Array 7	23 Jan 2014	HOFI	11S	238581	3910997	Feather Spot: seven flight and 50 to 100 body feathers
Array 7	23 Jan 2014	MODO	11S	238605	3911234	Feather Spot: 40+ body feathers and one flight feather.

Species Codes

AMCO-American coot
BRBL – Brewer's blackbird
BUOW – Burrowing owl
ECDO-Eurasian collared dove
HOFI – House finch
HOLA – Horned lark
LASP-Lark sparrow
LOSH-Loggerhead shrike
MOBL-Mountain bluebird
MODO-Mourning dove
SAVS-Savannah sparrow
WEME-Western meadowlark

Site	Survey Date	Species Code	UTM Zone¹	Easting	Northing	Observation Details
Array 7	13 Feb 2014	MODO	11S	238650	3910964	Feather Spot: 15 body feathers clumped.
Array 7	13 Feb 2014	MODO	11S	238271	3911237	Feather Spot: 40 body and one tail feathers.
Array 7	13 Feb 2014	HOFI	11S	238583	3911332	Feather Spot: 12 flight feathers and 100+ body feathers.
Array 7	13 Feb 2014	MODO	11S	238575	3911278	Feather Spot: 16 body and two flight feathers.
Array 8 Circuit 2	18 Nov 2013	MODO	11S	233683	3912149	Feather Spot: 50 body, two tail, and two wing feathers.
Array 8 Circuit 2	18 Nov 2013	MODO	11S	233559	3912296	Feather Spot: 27 body feathers and one tail feather.
Array 8 Circuit 2	25 Nov 2013	MODO	11S	233560	3912418	Feather Spot: one tail feather, 100 body feathers, and one wing feather. Clump of body feathers attached and blood on one feather
Array 8 Circuit 2	25 Nov 2013	HOLA	11S	233631	3912072	Feather Spot: nine to ten body feathers. Possible panel strike. Spot of organic material with feathers on bottom of front side of panel.
Array 8 Circuit 2	9 Dec 2013	MODO	11S	233469	3912439	Feather Spot: 20 body and three flight feathers.
Array 8 Circuit 2	9 Dec 2013	MODO	11S	233390	3912479	Feather Spot: 10 flight and numerous body feathers.
Array 8 Circuit 2	16 Dec 2013	HOLA	11S	233645	3912169	Feather Spot: 10 flight and 300 body feathers.
Array 8 Circuit 2	16 Dec 2013	MODO	11S	233461	3912491	Feather Spot: 19 body feathers and one flight feather.
Array 8 Circuit 2	16 Dec 2013	MODO	11S	233921	3912043	Feather Spot: 45 body and four primary feathers. Clump of body feathers attached.

Species Codes

AMCO-American coot
BRBL – Brewer's blackbird
BUOW – Burrowing owl
ECDO-Eurasian collared dove
HOFI – House finch
HOLA – Horned lark
LASP-Lark sparrow
LOSH-Loggerhead shrike
MOBL-Mountain bluebird
MODO-Mourning dove
SAVS-Savannah sparrow
WEME-Western meadowlark

Site	Survey Date	Species Code	UTM Zone[1]	Easting	Northing	Observation Details
Array 8 Circuit 2	16 Dec 2013	MODO	11S	233466	3912307	Feather Spot: 18 body feathers and five primary feathers.
Array 8 Circuit 2	23 Dec 2013	WEME	11S	234007	3912042	Feather Spot: 250+ body and 30 flight feathers.
Array 8 Circuit 2	23 Dec 2013	MODO	11S	233412	3912366	Feather Spot: two distinct clumps: one with 20+ grey and white body feathers and a second of 25+ brown and grey body feathers.
Array 8 Circuit 2	6 Jan 2014	HOLA	11S	233704	3912025	Feather Spot: 200+ body feathers, three flight feathers, and beak.
Array 8 Circuit 2	20 Jan 2014	HOLA	11S	233577	3912200	Feather Spot: one flight and 10 to 15 contour feathers.
Array 8 Circuit 2	27 Jan 2014	MOBL	11S	234041	3911768	Feather Spot: four flight and 25 body feathers clumped together.
Array 8 Fence	16 Dec 2013	HOLA	11S	233494	3913025	Partial Carcass: 100+ body and 10 flight feathers, leg and thigh, one inch diameter piece of skin. Some parts found impaled on tumbleweed. Likely a Loggerhead shrike kill.
Array 9	18 Jan 2014	HOFI	11S	233406	3911476	Feather Spot: 30 flight and 200+ body feathers.
Array 9	13 Feb 2014	HOFI	11S	233423	3911605	Feather spot: 100+ body feathers. Two parts of upper wing (alula area). 20 individual flight feathers.
Array 11 Control	4 Dec 2013	MODO	11S	236280	3912639	Feather Spot: 20 flight and tail feathers and 200 body feathers.
Evaporation Pond	23 Dec 2013	HOFI	11S	234809	3914200	Whole Carcass: carcass found on up against SE corner and on the outsife of the fence. No rigor mortis and the keel bone could be felt. Carcass appeared malnourished. Feathers around cloaca are matted with feces. Dried blood around edges of the beak.
Evaporation Pond	23 Dec 2013	HOFI	11S	234781	3914267	Feather spot: 100+ body feathers and 20+ flight feathers (partial wing); feathers mostly clumped. Found at the north end of the pond.

Species Codes

AMCO-American coot
BRBL – Brewer's blackbird
BUOW – Burrowing owl
ECDO-Eurasian collared dove
HOFI – House finch
HOLA – Horned lark
LASP-Lark sparrow
LOSH-Loggerhead shrike
MOBL-Mountain bluebird
MODO-Mourning dove
SAVS-Savannah sparrow
WEME-Western meadowlark

Site	Survey Date	Species Code	UTM Zone[1]	Easting	Northing	Observation Details
Evaporation Pond	23 Dec 2013	HOFI	11S	234798	3914194	Feather Spot: 10+ body and one flight feather. Found on the south side of the pond, outside the fence.
Evaporation Pond	23 Dec 2013	MODO	11S	234676	3914214	Feather Spot: majority of tail segment. 10 flight and eight body feathers. Found at the southwest corned outside the fence.
Gen-Tie Line	20 Nov 2013	WEME	11S	234323	3914104	Feather Spot: 150 body and 20 wing and tail feathers.
Gen-Tie Line	20 Nov 2013	HOLA	11S	234586	3915142	Feather Spot: 200 body and four wing feathers.
Gen-Tie Line	4 Dec 2013	WEME	11S	234420	3916114	Feather Spot: 12 body feathers.
Gen-Tie Line	11 Dec 2013	MODO	11S	234365	3917730	Feather Spot: five flight feathers (all tail feathers) and five body feathers. Found in tamarisk at known predatory bird feeding spot.
Gen-Tie Line	11Dec 2013	WEME	11S	234278	3917359	Feather Spot: 100 body feathers and 10+ flight feathers (primary, secondary, and tail).
Gen-Tie Line	18 Dec 2013	MODO	11S	234586	3914835	Feather Spot: 15+ body feathers and one tail feather.
Gen-Tie Line	8 Jan 2014	MODO	11S	234257	3918309	Feather Spot: 15+ flight and 200+ body feathers.
Gen-Tie Line	8 Jan 2014	WEME	11S	234607	3915178	Feather Spot: four flight, approximately 18 body, and two covert feathers.
Gen-Tie Line	22 Jan 2014	WEME	11S	234362	3917791	Feather Spot: clump of five flight feathers held together with skin, some unattached flight feathers, and 30+ body feathers
Gen-Tie Line	29 Jan 2014	HOLA	11S	234484	3915983	Feather Spot: approximately 10 flight and approximately 50 body feathers.

UTM = Universal Transverse Mercator.

Species Codes

AMCO-American coot
BRBL – Brewer's blackbird
BUOW – Burrowing owl
ECDO-Eurasian collared dove
HOFI – House finch
HOLA – Horned lark
LASP-Lark sparrow
LOSH-Loggerhead shrike
MOBL-Mountain bluebird
MODO-Mourning dove
SAVS-Savannah sparrow
WEME-Western meadowlark

Table A-2. Total Number of Fatalities for Each Species Detected during Postconstruction Monitoring between 16 November 2013 and 15 February 2014 (Listed Here in Alphabetical Order)[1]

Species	Number of Fatalities
American Coot	1
Brewer's blackbird	1
Burrowing owl	4
Eurasian collared dove	1
House finch	37
Horned lark	12
Lark sparrow	1
Loggerhead shrike	1
MOBL-Mountain bluebird	1
Mourning dove	70
Savannah sparrow	3
Unknown large bird	2
Unknown passerine	1
Unknown raptor	1
Western meadowlark	16
Total	**152**

---

[1] This table only includes fatalities detected during weekly fatality searches. Incidental fatalities are reported in the text of Section 3.1 and Table A-3 in Appendix A.

Table A-3. Incidental Fatalities Found from 16 November to 15 February 2014

Site	Survey Date	ALPHA Code	UTM Zone	Easting	Northing	Observation Details
34.5kV Line	3 Feb 2014	HOFI	11S	234046	3913667	Feather Spot: Beak (upper and lower), approximately 200 body and 30+ flight feathers.
Array 1-2 Fence	21 Jan 2014	ECDO	11S	233711	3914383	Feather Spot: 30 body feathers.
Array 2 Control	17 Dec 2013	LOSH	11S	234702	3915154	Feather Spot: Partial wing, seven primaries and approximately 30 body feathers.
Array 2 Control	17Dec 2013	WEME	11S	234400	3914379	Feather Spot: 50 body and 15 flight feathers.
Array 4	19 Nov 2013	MODO	11S	235874	3912747	Feather Spot: Approximately 200 body feathers, 11 large feathers (primary and secondary).
Array 4	18 Dec 2013	MODO	11S	235562	3912684	Feather Spot: Three Tail, 15 flight, and 30 body feathers.
Array 4	22 Jan 2014	WEME	11S	235619	3913231	Feather Spot: Two flight (Primaries) and approximately 100 body feathers.
Array 4 Fence	11 Dec 2013	MODO	11S	235531	3913027	Feather Spot: Approximately 200 body and few flight feathers.
Array 4 Fence	22 Jan 2014	MODO	11S	235532	3912920	Feather Spot: Approximately 200 body and 30 flight feathers.
Array 6	6 Jan 2014	MODO	11S	237217	3913010	Feather Spot: Approximately 100 body feathers.
Array 6	6 Jan 2014	HOFI	11S	237235	3913036	Feather Spot: Approximately 200 body, one primary, and three secondary feathers.
Array 7	22 Jan 2014	MODO	11S	238075	3911713	Whole Carcass: Whole carcass + 40 body feathers found near fence, and 30 clumped body feathers about 30 ft. away.
Array 8 Control	18 Nov 2013	MODO	11S	234339	3913452	Feather Spot: Approximately 200 body and 20 wing feathers.
Array 9	19 Nov 2013	BUOW	11S	233283	3917787	Feather Spot: Ten contour feathers.

UTM = Universal Transverse Mercator.

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch Project Avian and Bat Protection Plan Eighth Quarterly Postconstruction Fatality Report

16 May 2014 - 15 August 2014

Prepared for:

HPR II, LLC
California Valley Solar Ranch
13505 Carissa Highway, Highway 58
Santa Margarita, CA 93453

Prepared by:

H. T. Harvey & Associates
Project # 3326-03

Prepared per:

Avian And Bat Protection Plan for the California Valley Solar Ranch Project

U.S. Fish and Wildlife Service
Biological Opinion (81420-2011-F-0511)
San Luis Obispo County
Conditional Use Permit (DRC2008-00097)

November 2014

Table of Contents

Figures

Tables

Appendices

List of Contributors

Brian B. Boroski, Ph.D., Vice President
Dave S. Johnston, Ph.D., Associate Wildlife Ecologist
Douglas A. Drynan, B.S., Project Manager, Senior Wildlife Ecologist
Kim M. Briones, M.S., Wildlife Ecologist
Meredith K. Jantzen, M.S., Wildlife Ecologist
Heather Ogston, Technical Editor

Section 1.0 Introduction

Through adoption of Resolution #2011-119, the Board of Supervisors of San Luis Obispo County (the County) approved the California Valley Solar Ranch Project (CVSR Project) Conditional Use Permit (DRC 2008-00097) on 19 April 2011. The Conditional Use Permit is subject to the Conditions of Approval (COAs) set forth in Exhibit 6 attached to the Resolution.

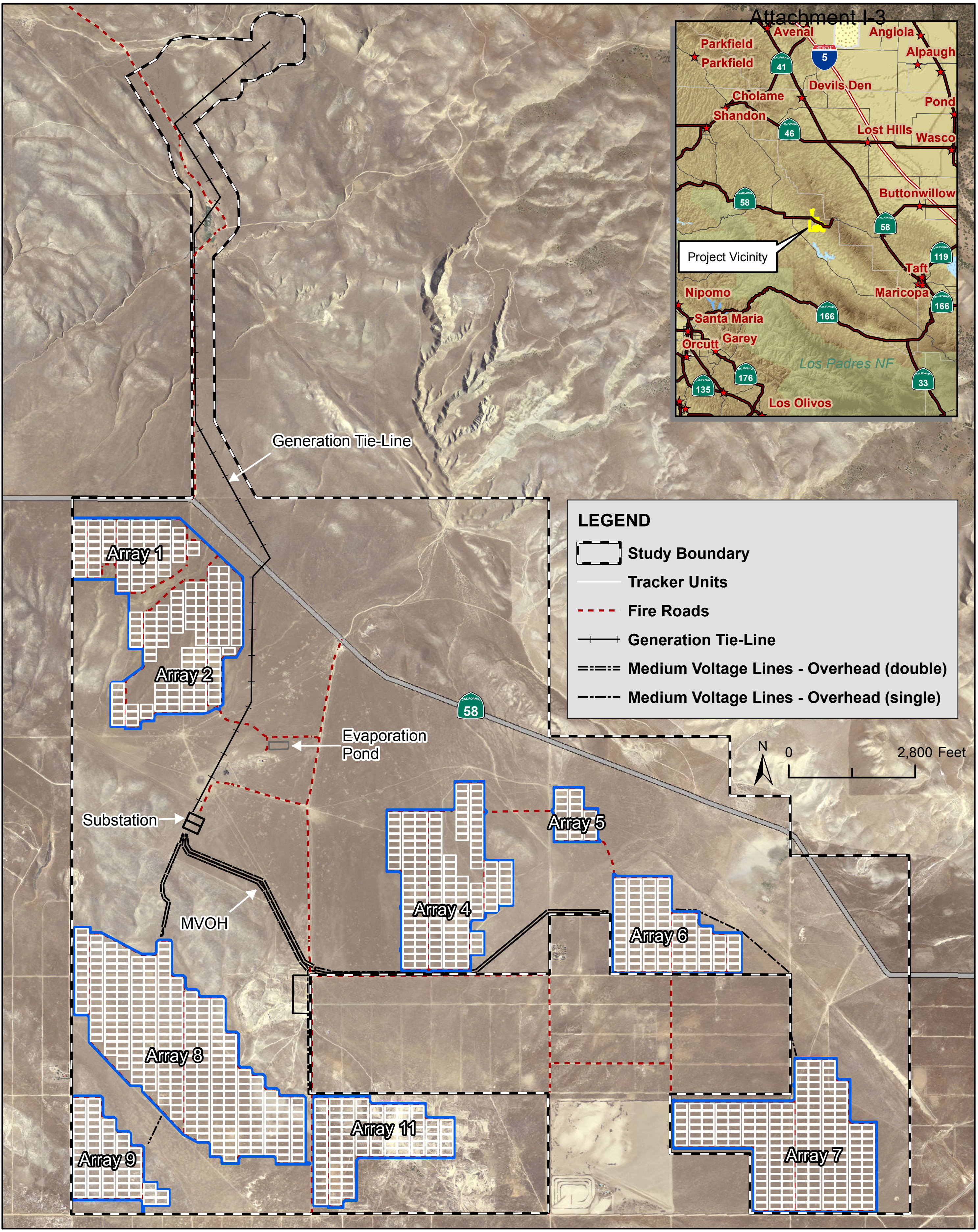
The Conditional Use Permit allows High Plains Ranch II, LLC (and any successor in interest for the life of the CVSR Project), to construct and operate a 250-megawatt photovoltaic solar power plant within an approximately 4685-acre site (Project site), located mostly south of State Route (SR) 58, about 6.4 kilometers (km) east of Soda Lake Road, immediately north of the California Valley subdivision, in the Shandon-Carrizo planning area of San Luis Obispo County (Figure 1).

COA #58 of the Conditional Use Permit requires an Avian and Bat Protection Plan (ABPP) and a quarterly report detailing any Project-related bird or bat deaths or injuries detected. To satisfy COA #58, H. T. Harvey & Associates (HTH), on behalf of High Plains Ranch II, LLC, has prepared this postconstruction fatality report, which documents the number of avian and bat fatalities counted during Project postconstruction monitoring between 16 May and 15 August 2014.

The Project elements searched during this period were the Generation-tie (Gen-tie) Line; Medium-voltage Overhead (MVOH) Line; Evaporation Pond; Arrays 1, 2, 4, 5, 6, 7, 8, 9, and 11; the perimeter fences for each array; and control plots associated with Arrays 1, 2, 4, 6, 7, 8, and 11. This quarterly[1] report does not include the results of searcher-efficiency trials, carcass-removal trials, or data analyses, nor does it include detailed discussions. These features are provided in the annual reports. Quarterly and annual reports detailing any Project-related bird or bat deaths or injuries detected are required for 3 years following the beginning of the CVSR Project operation. The fatality monitoring program as defined in the ABPP continues for one year after completion of construction.

---

[1] The quarters referred to are the monitoring quarters specified in the COA. The first seven quarters were 16 August to 15 November 2012, 16 November 2012 to 15 February 2013, 16 February to 15 May 2013, 16 May to 15 August 2013, 16 August to 15 November 2013, 16 November 2013 to 15 February 2014, and 16 February to 15 May 2014. This quarterly report covers 16 May to 15 August 2014, and the next quarter will be 16 August to 15 November 2014.



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\8th Quarterly Report\Figure 1 Project Site.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Eighth Quarterly Postconstruction Fatality Report
Figure 1: Project Site with Gen-tie Line, MVOH Line, Evaporation Pond, Nine Arrays and Control Plots

Section 2.0 Methods

2.1 Overview of Fatality Searches to Date

Because construction of different Project elements was completed at different times, fatality searches began at varying times in the year, depending on the Project element searched (Table 1). During initial surveys of Array 2 in 2013, only the Serengeti style portions of the array were surveyed because only these areas of Array 2 were operational at the time. Fatality surveys were expanded to 100% of Array 2 once the entire array became operational. With the exception of Array 1, Array 2, and the Gen-tie and MVOH Lines, all Project elements were each surveyed at 20% coverage through 31 December 2013. Beginning in January 2014, survey efforts in Arrays 1 and 2 were reduced to 20% coverage, and the total number of control plots was reduced from 38 to 30. These changes within Arrays 1 and 2 were made based on the results of a statistical error assessment which confirmed that sampling at least 20% of the total area of an array, or about 30 tracker units per array, is sufficient to provide an accurate estimate of fatality rate (HTH 2014). Additionally, searches of control plots were combined to occur on 1 day each week to further increase the efficiency of the survey effort.

Table 1. Fatality Search Commencement Dates by Project Element

Project Element	Date Fatality Searches Began
Gen-tie Line	6 June 2012
Array 1[1]	20 September 2012
Array 2 (Serengeti portion only)[2]	25 September 2012
Array 1 and 2 fence[1]	25 September 2012
Array 2 control plots	30 October 2012
Array 1 control plot	1 November 2012
Array 2 North (including Serengeti) and South[1, 2]	27 November 2012
Array 8 (20% sample)	7 January 2013
Array 4 (20% sample)	9 January 2013
Array 5 and fence (20% sample)	9 January 2013
Array 4 fence (20% sample)	16 January 2013
MVOH Line	30 January 2013
Array 8 control plots	4 February 2013
Array 4 control plots	6 February 2013
Array 8 fence (20% sample)	20 May 2013
Array 6 and fence (20% sample) and control plots	30 September 2013
Array 7 and fence (20% sample) and control plots	10 October 2013
Array 9 and fence (20% sample)	6 November 2013
Array 11 and fence (20% sample), and control plots	6 November 2013
Evaporation Pond	11 November 2013

Note:

[1] Sampling reduced to 20% of total array area (starting 2 January and 7 January 2014 for Array 2 and 1, respectively).

[2] The Serengeti portion of Array 2 was searched separately only until 27 November 2012 (3 days).

2.2 Data Recordation

Fatalities were counted if surveyors found smudge marks and feather spots directly on a Project element (such as a solar panel) or feather spots on the ground; feathers or bat fur accompanied by flesh, blood, or bone; or a carcass. Searchers considered a feather spot a fatality if it had at least two or more primary flight feathers, five or more tail feathers, or ten or more feathers of any type concentrated together in an area 1 square meter (m^2) or smaller (Smallwood 2007). Feather spots not meeting these requirements but containing flesh, blood, or bone were also considered a fatality.

Preening spots typically have fewer feathers and are more spread out than feather spots associated with fatalities. Roosting areas rarely contain primary or secondary feathers but are often dotted with droppings. In the solar arrays, searchers regularly observed flocks of roosting mourning doves (*Zenaida macroura)* and horned larks (*Eremophila alpestris*). Mourning doves exhibit a complex molt strategy which can occur year round and includes preformative, prealternate, and definitive prebasic molts (Otis et al. 2008). Likewise, horned lark adults and first-year birds undergo a definitive prebasic molt at the end of the breeding season (typically the end of July) (Beason 1995). Searchers used their biological knowledge to determine whether or not feathers from mourning doves, horned larks, or other species known to be in a molt period should be recorded as a fatality. No data were taken on molt or roost-spot feathers.

Fatalities of nonavian or nonbat taxa were documented when found, but are not presented or discussed in this report. However, all specimens, including nonavian and nonbat fatalities, were reported pursuant to State and federal salvage permit requirements. Additionally, a Migratory Bird Special Purpose Utility Salvage Permit (SPUT) for the Project was issued by the U.S. Fish and Wildlife Service (USFWS) on 10 March 2014 (permit number MB02733B-0). Pursuant to this permit, data on all avian fatalities collected during routine surveys or incidentally were submitted on a quarterly basis using the electronic injury or mortality report spreadsheet provided by USFWS. Although no incidental fatalities (i.e., outside regular survey periods or surveyed areas) were detected during this reporting period, such detections are distinguished from fatalities found during regularly scheduled searches.

The suspected cause of death was assessed for all fatalities and assigned to one of the following classes: collision, electrocution, predation, or unknown. It was then further assigned a "Level of Certainty for Suspected Cause" category, as defined in the SPUT (Observed = 100%; Valid = >90%; Probable = >50%; Possible = <50%; or Unknown/Not Applicable). To make the assessment, searchers carefully examined all carcasses for signs of injury or illness. No carcasses found during the reporting period showed signs of illness. Although whole carcasses with noticeable injuries (e.g., a broken wing, beak, or other blunt-force trauma) were not found during this reporting period, such specimens, when found in arrays or along powerlines, are assumed to represent deaths caused by collision, with a high level of certainty (Valid) for suspected cause of death. Whole carcasses exhibiting no signs of injury, as well as feather spots found in the arrays and along perimeter fences, were assigned an unknown cause of death because there was no compelling evidence to indicate how these fatalities occurred. However, when visibly uninjured whole carcasses and feather spots were found directly or nearly directly under the Gen-tie or MVOH Lines, these fatalities were considered powerline collisions, with Probable (>50%) certainty. Most of the fatalities found directly under these powerlines were of migratory species rarely documented in the arrays; this suggests that the birds were flying at a height where a powerline interaction could occur, potentially resulting in fatality. Lastly, although no electrocutions were found during the reporting period, these cases are typically assigned Valid (>90%) certainty if the carcass shows signs of burning or singeing on the legs, wings, or body.

Each fatality was assigned a unique incident number. Incident numbers were written as follows: YYYYMMDD—#. Each searcher recorded a unique set of numbers, so that data can be traced back to individual searchers. To further verify species identities, searchers photographed each fatality, and, when necessary, consulted Scott and McFarland's *Bird Feathers: A Guide to North American Species* (2010). For each fatality, the following data were recorded: location (using Universal Transverse Mercator [UTM] coordinates), time found, taxon, common name, four-letter alpha code, carcass condition, parts found, number and types of feathers, and estimated time since death. Whenever possible, information about the age and sex of the fatality, as well as scavenger type, was noted. Additionally, searchers gathered information on the size and spread of the feather spot and the surrounding substrate, vegetation height, and percent vegetation cover, as well as whether the fatality occurred in a searcher or nonsearcher row (for fatalities found in the arrays). All carcasses and feather spots discovered by regular weekly searchers were removed to avoid attracting scavengers and to prevent confusion in subsequent searches (which might occur if scavengers scattered parts of carcasses).

2.3 Fatality Search Methods

Weekly fatality searches were performed for the Evaporation Pond, Gen-tie Line; MVOH Line; Arrays 1, 2, 4, 5, 6, 7, 8, 9, and 11; fences for each array; and the associated control plots for arrays 1, 2, 4, 6, 7, 8, and 11. Each week, random start locations were selected for each Project element using a random number generator. Random selection was based on tower numbers (for the Gen-tie Line), line segment (for the MVOH Line), numbered array corners (for the solar arrays), and numbered fence corners (for the array perimeter fences).

A team of two biologists searched a 30-meter (m)-wide transect centered under the complete length of the Gen-tie Line. Because of the relatively shorter height of the MVOH Line, it was assumed that carcasses would have less potential to be distributed over a wide area (HTH 2011); therefore, the transect area along the entire length of the MVOH Line was only 18 m wide. Each person searched half the transect width and half the tower or pole radial areas for both the Gen-tie and MVOH Lines. Under the Gen-tie Line, each person searched a 15-m-wide transect for large birds and a 6-m-wide transect for small birds and bats. Under the MVOH Line, each person searched a 9-m-wide transect for small and large birds.

In the arrays, biologists searched tracker units in teams of two. In each tracker unit, searchers walked into every other row of panels and visually scanned both the row walked and each adjacent row. To avoid crossing the drive arms of the tracker units, searchers turned around upon reaching the drive arm, and continued to scan the next row as they proceeded out of the row. Thus, although searchers walked only every other row, they visually scanned adjacent rows to ensure full coverage.

To determine background rates of mortality, control plots were established on adjacent on-site Conservation Lands (plots were within 1 km of Arrays 1, 2, 4, 6, 7, 8, and 11). Each control plot had the same dimensions as a tracker unit (i.e., equivalent to 18 rows of solar panels, with 40 panels to a row). Wooden stakes were used to delineate mock panel trackers on the control plots, and searchers followed the same pattern and procedure used for searching the arrays. Control plots were not established for the 20% sample of Arrays 5 or 9 because the 20% search area for these arrays contained too few trackers to meet the control plot establishment guidelines set forth in the *Avian and Bat Fatality Monitoring Plan for the California Valley Solar Ranch* (Appendix A in HTH 2011; the guideline is one control plot [defined in the plan as having the same spatial scale as 2 aggregated tracker blocks, or 12 tracker units] for every 16 tracker blocks [96 tracker units] searched).

For each of Arrays 1, 2, 4, 5, 6, 7, 8, 9, and 11, four evenly spaced segments totaling 20% of the array's perimeter fence were searched by one biologist. Each week, the biologist walked the inside portion of the fence while scanning a 6-m-wide belt centered on the fence.

The Evaporation Pond was surveyed by two biologists. Each week, one searcher walked the perimeter of the pond inside the fenced area while scanning the pond and a 6-m-wide belt centered on the fence. Before entering the fenced area, the searcher also scanned the pond to assess avian activity. The second searcher walked the perimeter of the pond outside the fenced area.

In most cases, missed surveys were not repeated in the same week because they were conducted only on designated days as part of the survey protocol. For estimating the total number of fatalities, the fatality model accounted for search intervals of different lengths due to missed surveys (e.g., if a weekly search day was cancelled because of rain, the search effort would resume the following week and, for that search, the interval was 14 days, not 7 days).

Section 3.0 Results

All Project elements were surveyed weekly, with the following exceptions:

- In observance of the Memorial Day holiday on 26 May 2014, surveys were not conducted for Arrays 6 or 8, or for their associated perimeter fences.
- Surveys were not conducted for the Evaporation Pond on 14 July 2014.
- In observance of the Labor Day holiday on 1 September 2014, surveys were not conducted for Arrays 6 or 8, or their associated perimeter fences.

Twenty-four avian fatalities were counted between 16 May 2014 and 15 August 2014 in the surveyed operational portions of the Project site (Appendix A, Table A-1). Twenty-two (92%) of the avian fatalities were counted from feather spots, and two (8%) were counted from whole carcasses. All fatalities were mapped (Figures 2 through 6), and a summary of the fatality searches was compiled (Table 2). Twelve avian species were represented in the detected fatalities (Appendix A, Table A-2). House finches (*Carpodacus mexicanus*) and horned larks were the most frequent fatalities observed, with four fatalities each (33%). No bat or special-status avian fatalities were observed during this reporting period.

Half the fatalities were recorded along the transmission lines, and half were recorded in the arrays. The Gen-tie Line presented the most fatalities (ten, or 42% of fatalities). No fatalities were recorded in Arrays 5, 7, 8, or 9; the Evaporation Pond; control plots; or associated array perimeter fences, and overall fatality counts were low in the remaining survey areas. More than half of the avian fatalities found were indicated by feather spots. Causes of death were unknown in the arrays, and probably due to powerline collisions along the transmission lines. Of the two carcasses found, one, in an array, did not show signs of illness or injury; the second, along the MVOH Line, had likely been predated.

No incidental fatalities were detected during this reporting period.

Table 2. Results of Avian Fatality Searches Conducted between 16 May and 15 August 2014, and Fatality Totals

				Suspected Cause of Death			
Project Element	**Total Fatalities**	**Fatalities Counted from Feather Spots**	**Fatalities Counted from Whole Carcasses**	**Collision**	**Electrocution**	**Predated**	**Unknown**
Array 1	1	1	0	0	0	0	1
Array 2	2	2	0	0	0	0	2
Array 4	3	2	1	0	0	0	3
Array 6	3	3	0	0	0	0	3
Array 11	3	3	0	0	0	0	3
MVOH Line	2	1	1	1	0	1	0
Gen-tie Line	10	10	0	10	0	0	0
Total Fatalities	**24**	**22**	**2**	**11**	**0**	**1**	**12**

One fatality was counted in Array 1 (Table 2; Figure 2). This fatality was counted from a feather spot. The cause of death for this fatality is unknown.

Two fatalities were counted in Array 2 (Table 2; Figure 2). Both fatalities were counted from feather spots. The causes of death for these fatalities are unknown. No fatalities were observed along the perimeter fence surrounding Arrays 1 and 2.

Three fatalities were counted in Array 4 (Table 2; Figure 3). Two fatalities were counted from feather spots, and the cause of death is unknown. One house finch fatality was counted from a whole carcass. This carcass was completely desiccated and decomposed. It did not show any obvious signs of a panel collision. The cause of death for this whole carcass is unknown. No fatalities were observed along the Array 4 perimeter fence.

No fatalities were observed in Array 5 or along the Array 5 perimeter fence.

Three fatalities were counted in Array 6 (Table 2; Figure 3). All fatalities were counted from feather spots, and the causes of death are unknown. No fatalities were observed along the perimeter fence surrounding Array 6.

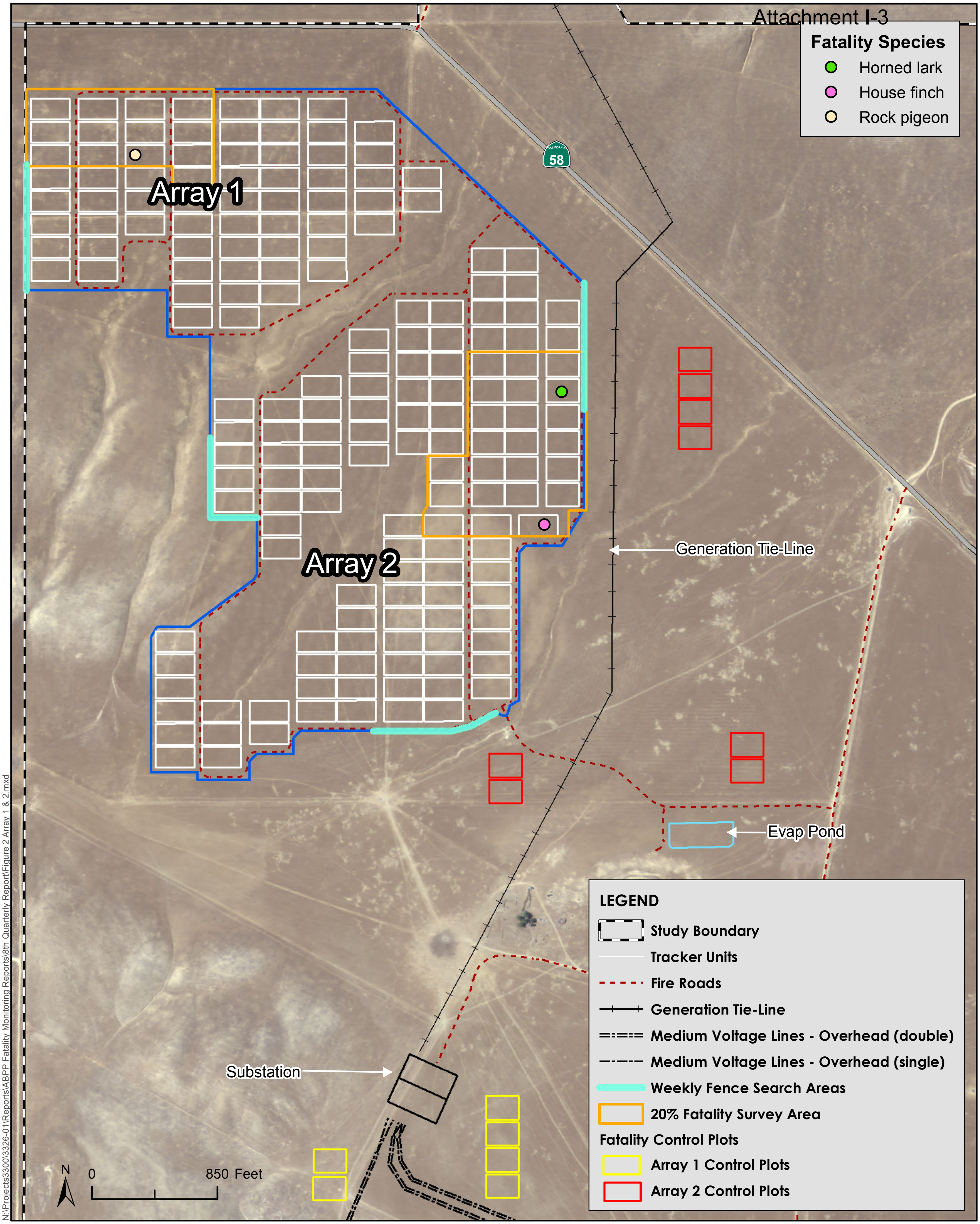
No fatalities were observed in Arrays 7, 8, or 9, or along their associated perimeter fences.

Three fatalities were counted in Array 11 (Table 2; Figure 4). All fatalities were counted from feather spots, and the causes of death are considered to be unknown. No fatalities were observed along the perimeter fence of Array 11.

Two fatalities were counted along the MVOH Line (Table 2; Figure 5). One fatality was counted from a feather spot and one from a whole specimen. The feather spot of a Eurasian collared dove (*Streptopelia decaocto*) was found directly under the powerline, and the source of death was considered to be a powerline collision. The whole specimen, a nestling house sparrow (*Passer domesticus*), was found directly below the powerlines and adjacent to an MVOH utility pole. This carcass exhibited two exterior wounds: on the foot and under the neck. Fatality searchers also observed several other live house sparrows perched on the adjacent utility tower. Although a nest was not observed, house sparrows frequently nest on the MVOH utility poles. If not from the adjacent utility pole, the nestling may have been predated from a nest on another nearby utility pole and then dropped. Therefore, the cause of death was considered to be predation.

Ten fatalities were counted along the Gen-tie Line (Table 2; Figure 6). All of these fatalities were counted from feather spots. More than half of these fatalities consisted of migratory songbirds, comprising an orange-crowned warbler (*Vermivora celata*), a common yellowthroat (*Geothlypis trichas*), a western tanager (*Piranga ludoviciana*), two yellow warblers (*Dendroica petechia*), and a cedar waxwing (*Bombycilla cedrorum*). All fatalities were found directly or nearly directly under the powerlines, and the causes of death were considered to be powerline collisions.

No fatalities were observed in the control plots, at the Evaporation Pond, or along the perimeter fence of the pond.



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\8th Quarterly Report\Figure 2 Array 1 & 2.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

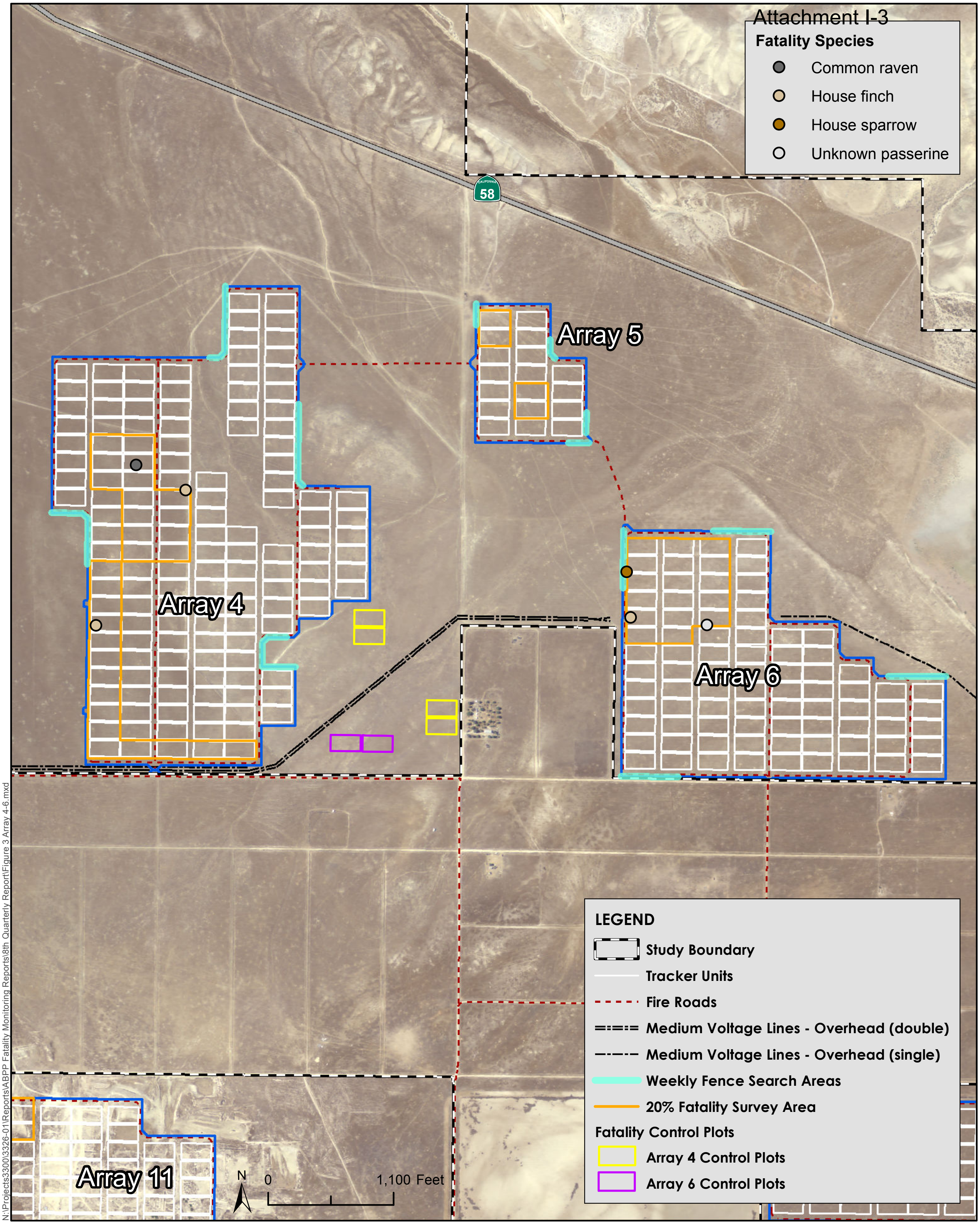
California Valley Solar Ranch

ABPP Eighth Quarterly Postconstruction Fatality Report

Figure 2: Locations and Species of Postconstruction Fatalities Observed in Array 1 and 2 Elements between 16 May 2014 and 15 August 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\8th Quarterly Report\Figure 3 Array 4-6.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

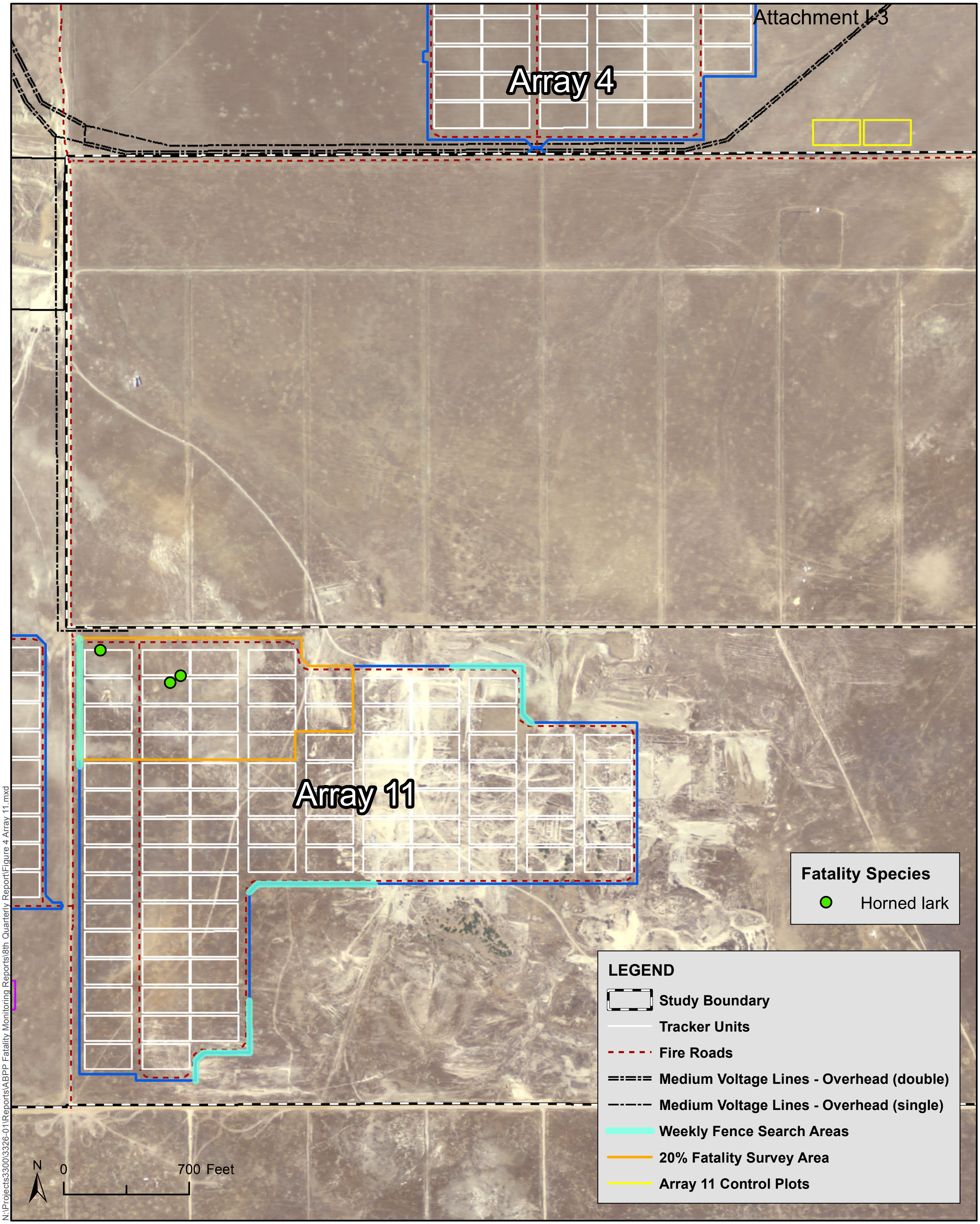
California Valley Solar Ranch

ABPP Eighth Quarterly Postconstruction Fatality Report

Figure 3: Locations and Species of Postconstruction Fatalities Observed in Array 4 and 6 Elements between 16 May 2014 and 15 August 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\8th Quarterly Report\Figure 4 Array 11.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

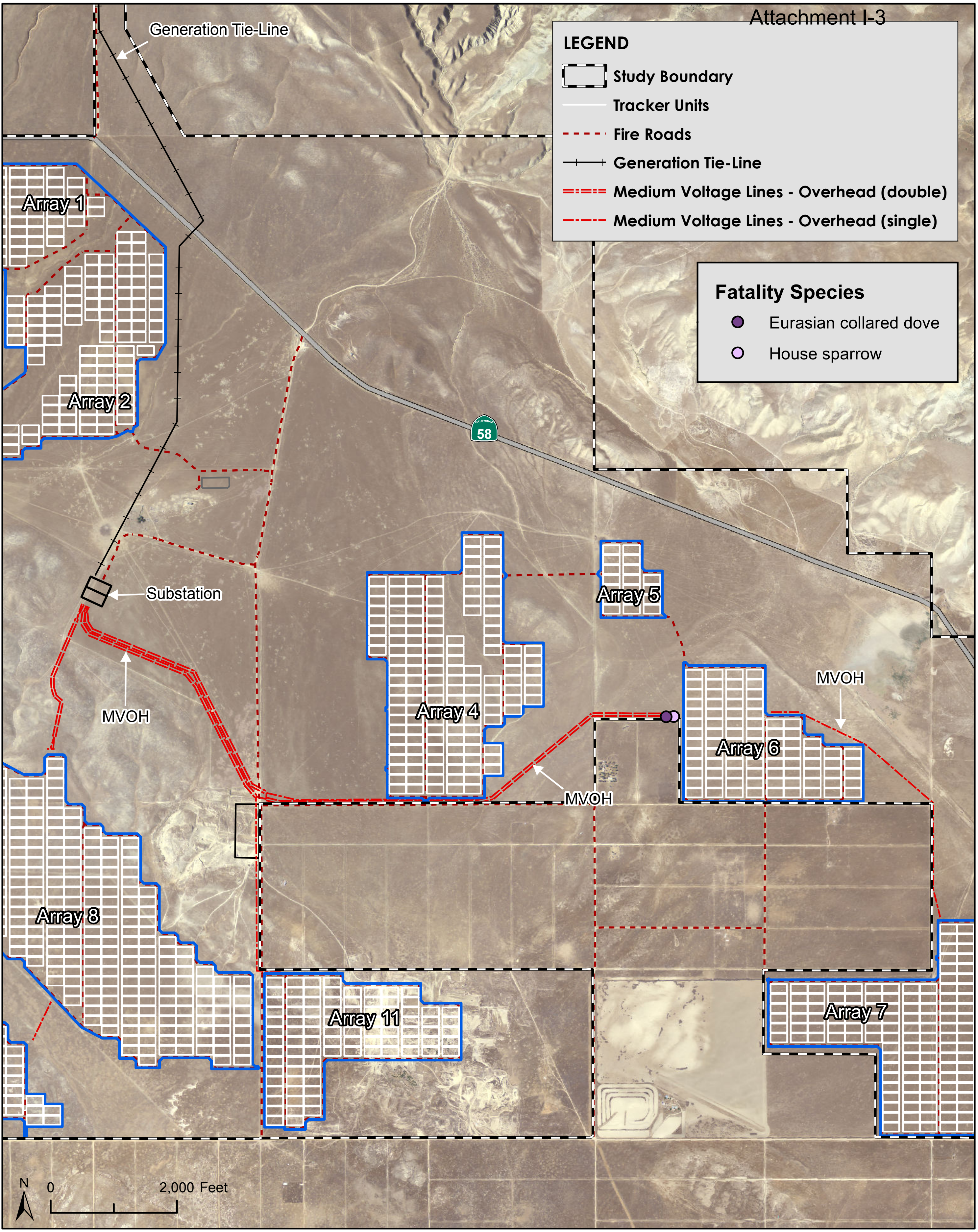
California Valley Solar Ranch

ABPP Eighth Quarterly Postconstruction Fatality Report

Figure 4: Locations and Species of Postconstruction Fatalities Observed in Array 11 Elements between 16 May 2014 and 15 August 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\8th Quarterly Report\Figure 5 MVOH Area.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

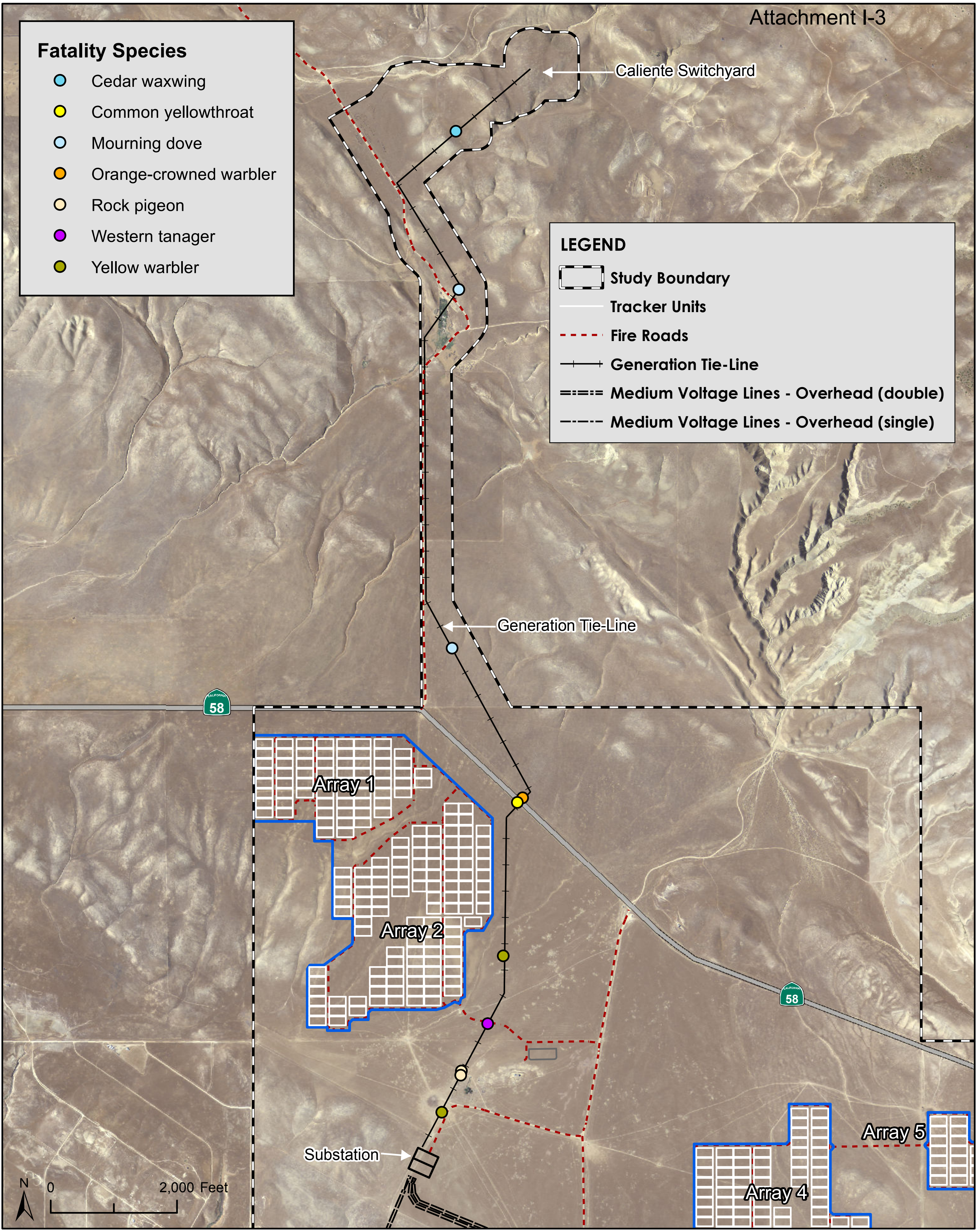
California Valley Solar Ranch

ABPP Eighth Quarterly Postconstruction Fatality Report

Figure 5: Locations and Species of Postconstruction Fatalities Observed along MVOH line between 16 May 2014 and 15 August 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\8th Quarterly Report\Figure 6 Gen-tie Area.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Eighth Quarterly Postconstruction Fatality Report
Figure 6: Locations and Species of Postconstruction Fatalities Observed along Gen-Tie line between 16 May 2014 and 15 August 2014

Section 4.0 Discussion

Overall, fatalities during the eighth quarter were the lowest observed since postconstruction fatality monitoring began in 2012. Likewise, the species that typically dominate our fatality detections at the Project, mourning doves and horned larks, had declined. Unlike in previous quarters, these species were also incidentally observed less frequently. It is possible that lower activity rates and overall lower fatality observations may be attributed to the ongoing drought. In the annual postconstruction fatality report we will examine annual avian point count data from the Project alongside other regional avian activity data to assess whether similar patterns have been observed elsewhere.

Consistent with the trend observed in previous quarters, the majority (92%, or 22 of 24) of postconstruction fatalities detected in the eighth quarter were counted from feather spots, making it difficult to definitively determine causes of death. Of the total number of fatalities, half could be attributed to a known cause (collision or predation) of mortality with a moderate degree of certainty (>50%), whereas the other half could not be attributed to a known cause of mortality.

Resident birds dominated fatality detections in the arrays, corresponding with the general avian species composition and nesting activity incidentally observed during fatality searches this quarter. Of the two resident species (house finches and horned larks) most detected as fatalities in the arrays, nesting activity was most frequently observed for house finches. Between May and July, ten house finch nests were incidentally observed in the torque tubes of the tracker units. Horned larks continued to be observed flocking and roosting among the panels during the eighth quarter. Those species most observed as active in the arrays in some capacity were also the most frequently documented fatalities in the arrays. As noted in previous quarterly reports, fatalities in the arrays are likely attributable to a combination of causes, including predation by resident predators and collisions.

Although overall fatality counts were low, migratory songbirds continue to be the most dominant avian group detected along the Gen-tie Line. During the eighth quarter, migratory songbirds accounted for half the fatalities detected along this power line. As discussed in the seventh quarterly report, we speculate that migratory songbirds interact with the Gen-tie Line more often, possibly because of the height of this structure and its low visibility at night, when most migratory songbirds typically migrate (Farnsworth et. al. 2004; Mabee and Cooper 2004; Watson et. al. 2011). We will provide more discussion and recommendations on this result in the annual postconstruction fatality report.

All feather spots found along the Gen-tie and MVOH Lines were located directly, or nearly directly, under these lines. Although assessing cause of death from feather spots is difficult, the locations of these fatalities suggest that they were caused by powerline collisions, and that the remains found were indicative of scavenging, rather than predation. Nevertheless, resident predators may contribute to some of these fatalities.

Although the full year of fatality searches for all Project elements is not yet complete, it appears that the Evaporation Pond, pond fence, and array perimeter fences contribute little to fatality detections at CVSR as few fatalities have been detected at these Project elements thus far.

Finally, no fatalities were detected in control plots during the eighth quarter. The lack of observed background mortality corresponds with the overall decrease in avian activity observed on the Project site.

Section 5.0 References

Beason, R. C. 1995. Horned lark (*Eremophila alpestris*). No. 195 *in* A. Poole (Editor), The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York. [online]: http://bna.birds.cornell.edu/bna/species/195. Doi:10.2173/bna.195.

[HTH] H. T. Harvey & Associates. 2011. Avian and Bat Protection Plan for the California Valley Solar Ranch Project. Fresno, California.

[HTH] H. T. Harvey & Associates. 2014. California Valley Solar Ranch Project Avian and Bat Protection Plan Annual Postconstruction Fatality Report 16 August 2012–15 August 2013. San Luis Obispo, California.

Farnsworth, A., S. A. Gauthreaux Jr., and D. van Blaricom. 2004. A comparison of nocturnal call counts of migrating birds and reflectivity measurements on Doppler radar. Journal of Avian Biology 35:365–369.

Mabee, T. J., and B. A. Cooper. 2004. Nocturnal bird migration in northeastern Oregon and southeastern Washington. Northwestern Naturalist 85:39–47.

Otis, D. L., J. H. Schulz, D. Miller, R. E. Mirarchi, and T. S. Baskett. 2008. Mourning dove (*Zenaida macroura*). No. 117 *in* A. Poole (Editor), The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York. [online]: http://bna.birds.cornell.edu/bna/species/117.

Scott, S. D., and C. McFarland. 2010. Bird Feathers: A Guide to North American Species. Stackpole Books, Mechanicsburg, Pennsylvania.

Smallwood, K. S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71:2781–2791.

Watson, M. L., J. V. Wells, and R. W. Bavis. 2011. First detection of night flight calls by pine siskins. Wilson Journal of Ornithology 123:161–164.

Appendix A. Fatality Search Results— 16 May to 15 August 2014

Table A-1. Results of Weekly Fatality Searches from 16 May to 15 August 2014

Site	Survey Date	Species Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM[3] Easting	UTM[3] Northing
Array 1	6/5/2014	ROPI	Feather Spot: 15–18 body and/or secondary feathers.	U	n/a	233627	3915666
Array 2	5/20/2014	HOLA	Feather Spot: Nine flight feathers. Approximately 15 body feathers.	U	n/a	234492	3915148
Array 2	5/20/2014	HOFI	Feather Spot: 40 body feathers.	U	n/a	234447	3914875
Array 4	6/4/2014	HOFI	Feather Spot: Six loose flight feathers and approximately 70 body feathers.	U	n/a	235813	3913400
Array 4	6/11/2014	CORA	Feather Spot: Ten body feathers.	U	n/a	235682	3913470
Array 4	8/6/2014	HOFI	Whole Specimen: Very desiccated, keel exposed, internal tissues decomposed.	U	n/a	235565	3913044
Array 6	7/14/2014	Unknown passerine	Feather Spot: 13 body feathers.	U	n/a	237198	3913008
Array 6	7/14/2014	HOFI	Feather Spot: Approximately eight flight feathers and 70 body feathers.	U	n/a	236995	3913033
Array 6	7/14/2014	HOSP	Feather Spot: Approximately 30 body feathers.	U	n/a	236987	3913155

[1] **Species Codes:**

CEDW – Cedar waxwing
CORA – Common raven
COYE – Common yellowthroat
ECDO – Eurasian collared dove
HOFI – House finch
HOLA – Horned lark
HOSP – House sparrow
MODO – Mourning dove
OCWA – Orange-crowned warbler
ROPI – Rock pigeon
WETA – Western tanager
YEWA – Yellow warbler

[2] **Cause of Death:** C = Collision; U = Unknown; P = Predation.

[3] UTM = Universal Transverse Mercator, Zone 11S.

Site	Survey Date	Species Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM[3] Easting	UTM[3] Northing
Array 11	5/27/2014	HOLA	Feather Spot: Three wing partials. Ten loose flight feathers. 70 body feathers.	U	n/a	234943	3911826
Array 11	7/22/2014	HOLA	Feather Spot: Approximately 20 flight feathers and 100 body feathers.	U	n/a	235078	3911778
Array 11	8/12/2014	HOLA	Feather Spot: Partial wing, four coverts, and four flight feathers, all attached.	U	n/a	235060	3911767
Gen-tie Line	5/21/2014	MODO	Feather Spot: One flight feather and approximately 100 body feathers. Within limits of tower pad and directly under powerline.	C	>50	234377	3916198
Gen-tie Line	5/21/2014	OCWA	Feather Spot: 20 flight and approximately 250 body feathers. 3 meters off center of powerline.	C	>50	234682	3915460
Gen-tie Line	5/21/2014	COYE	Feather Spot: Approximately 75 body feathers. Directly under powerline.	C	>50	234667	3915443
Gen-tie Line	5/21/2014	WETA	Feather Spot: 25 flight feathers and approximately 125 body feathers. Directly under powerline.	C	>50	234489	3914380
Gen-tie Line	5/21/2014	ROPI	Feather Spot: Six flight feathers and 40 body feathers. Directly under powerline.	C	>50	234354	3914156

[1]**Species Codes:**

CEDW – Cedar waxwing
CORA – Common raven
COYE – Common yellowthroat
ECDO – Eurasian collared dove
HOFI – House finch
HOLA – Horned lark
HOSP – House sparrow
MODO – Mourning dove
OCWA – Orange-crowned warbler
ROPI – Rock pigeon
WETA – Western tanager
YEWA – Yellow warbler

[2]**Cause of Death:** C = Collision; U = Unknown; P = Predation.

[3]UTM = Universal Transverse Mercator, Zone 11S.

Site	Survey Date	Species Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM[3] Easting	UTM[3] Northing
Gen-tie Line	5/28/2014	YEWA	Feather Spot: Approximately 80 body feathers and six flight feathers. Directly under powerline.	C	>50	234253	3913960
Gen-tie Line	5/28/2014	YEWA	Feather Spot: Approximately 60 body feathers. Directly under powerline.	C	>50	234575	3914705
Gen-tie Line	6/18/2014	CEDW	Feather Spot: 15 primary feathers, approximately 100 body feathers, and five tail feathers. Directly under powerline.	C	>50	234477	3918693
Gen-tie Line	6/18/2014	MODO	Feather Spot: Ten tail and primary feathers, and approximately 200 body feathers. Within limits of tower pad and directly under powerline.	C	>50	234466	3917928
Gen-tie Line	7/30/2014	ROPI	Feather Spot: Feathers spread out over large area (approximately 50 meters) and weathered. Approximately 30 feathers directly under powerline, and remaining spread over 50-meter area.	C	>50	234353	3914146
MVOH Line	7/23/2014	HOSP	Whole Specimen: Fresh intact nestling with small wound on foot and under neck and beak. Directly under powerline and adjacent to utility pole.	P	>50	236924	3913023
MVOH Line	7/30/2014	ECDO	Feather Spot: Clump of five or six body feathers connected by dried blood. Directly under powerline and adjacent to utility pole.	C	>50	236887	3913023

[1] **Species Codes:**

CEDW – Cedar waxwing	HOFI – House finch	OCWA – Orange-crowned warbler
CORA – Common raven	HOLA – Horned lark	ROPI – Rock pigeon
COYE – Common yellowthroat	HOSP – House sparrow	WETA – Western tanager
ECDO – Eurasian collared dove	MODO – Mourning dove	YEWA – Yellow warbler

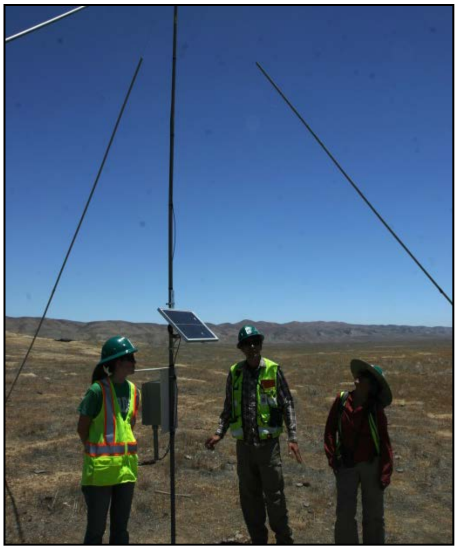
[2] **Cause of Death:** C = Collision; U = Unknown; P = Predation.

[3] UTM = Universal Transverse Mercator, Zone 11S.

Table A-2. Total Number of Fatalities for Each Species Detected during Postconstruction Monitoring between 16 May and 15 August 2014 (Listed Here in Alphabetical Order)[1]

Species	Number of Fatalities
Cedar waxwing	1
Common raven	1
Common yellowthroat	1
Eurasian collared dove	1
House finch	4
Horned lark	4
House sparrow	2
Mourning dove	2
Orange-crowned warbler	1
Rock pigeon	3
Unknown passerine	1
Western tanager	1
Yellow warbler	2
Total	**24**

H. T. HARVEY & ASSOCIATES
Ecological Consultants



California Valley Solar Ranch
Avian and Bat Protection Plan
2014 Annual Bat Report

Prepared for:

HPR II, LLC
California Valley Solar Ranch
13505 Carissa Highway, Highway 58
Santa Margarita, CA 93453

Prepared by:

H. T. Harvey & Associates
Project # 3326-03

Prepared per:

Avian And Bat Protection Plan for the California Valley Solar Ranch Project

U.S. Fish and Wildlife Service
Biological Opinion (81420-2011-F-0511)
San Luis Obispo County
Conditional Use Permit (DRC2008-00097)

February 2015

Table of Contents

Figures

Tables

Appendices

Preparers

Brian Boroski, Ph.D., Vice President and Principal, Wildlife Ecology

Dave Johnston, Ph.D., Project Manager, Associate Wildlife Ecologist and Bat Biologist

Kim Briones, M.S., Wildlife Ecologist

Meredith Jantzen, M.S., Wildlife Ecologist

Ken Lindke, M.S., Quantitative Ecologist

Section 1. Introduction

Through adoption of Resolution #2011-119, the Board of Supervisors of San Luis Obispo County approved the California Valley Solar Ranch (CVSR) Project Conditional Use Permit (DRC 2008-00097) on 19 April 2011. The Conditional Use Permit (CUP) is subject to the Conditions of Approval (COAs) set forth in Exhibit 6 attached to the Resolution. The CUP allows the Applicant (High Plains Ranch II, LLC, and any successor in interest for the life of the CVSR Project) to construct and operate a 250-megawatt photovoltaic solar power plant on an approximately 1896-hectare (4685-acre) site, located mostly south of State Route 58, approximately 6.4 kilometers (4 miles) east of Soda Lake Road, immediately north of the village of California Valley, in the Shandon-Carrizo planning area of San Luis Obispo County.

To help satisfy COA #58 and address concern about possible effects of Project development on migratory and resident birds and bats, an Avian and Bat Protection Plan (ABPP) was developed by H. T. Harvey & Associates (HTH) (2011) in accordance with U.S. Fish and Wildlife Service guidelines (2010). The ABPP provides a framework for monitoring the potential direct and indirect impacts of the CVSR Project on all bat and bird species, with an emphasis on special-status species. For bats, the ABPP specifies using both roost counts in the area surrounding the Project and on-site acoustic monitoring to obtain an in-depth understanding of fluctuations in the local populations of sensitive bat species, as well as how different species are using the Project site and adjacent conservation lands. This document presents the results of bat monitoring conducted for the CVSR Project in 2014.

The Project region is characterized by open, xeric grasslands with rocky outcrops and scattered trees in peripheral areas. The bat species observed in the Carrizo Plain are consistent with those typically found regionally in this type of habitat (Johnston 1998a, 2007). Roosting habitat in the Carrizo Plain is suited primarily to crevice-roosting bats. Habitat for cave-roosting bats is restricted to a few mines and abandoned buildings to the west of the CVSR Project, in the Caliente Mountains where solitary Townsend's big-eared bats (*Corynorhinus townsendii*) occasionally occur. Foliage-roosting bats are not likely to occur in the Project area, except during spring and fall when hoary bats (*Lasiurus cinereus*) migrate through the area. Thus, species expected to reside in and around the CVSR Project throughout the year are the Pacific pallid bat (*Antrozous pallidus pacificus*; hereafter referred to as pallid bats), California mastiff bat (*Eumops perotis californicus*); hereafter referred to as mastiff bats, California myotis *(Myotis californicus*), western small-footed bat (*Myotis ciliolabrum*), canyon bat (*Parastrellus hesperus*), and Mexican free-tailed bat (*Tadarida brasiliensis mexicanus*). The fringed myotis (*Myotis thysanodes*) occurs in the Carrizo Plain National Monument, but is not expected to occur on the Project because suitable forested habitat is lacking. The Townsend's big-eared bat is expected to occur on the project only rarely, if at all, because of the scarcity of potential undisturbed roost habitat in the area. Although not expected to occur naturally, we have records of both big brown bats (*Eptesicus fuscus*) and Yuma myotis (*Myotis yumanensis*), which we have caught while mist-netting in the northern Carrizo Plain. These two species likely only exist in this area as a result of anthropogenic alterations to the landscape (e.g., artificial water sources and buildings), and are expected to occur very rarely on the Project. The pallid bat and California mastiff bat are designated Mammal Species of Special Concern and the Townsend's big-eared bat is designated a Candidate Threatened Species by the State of California (California Department of Fish and Game 2015) (Table 1).

Pursuant to the ABPP, HTH bat ecologists began installing and testing acoustic equipment in June 2012 and started collecting data in July 2012, to evaluate the potential effects on migratory and resident bat species caused by operational components of the Project. Likewise, we began systematic evaluations and monitoring of roost habitat within 10 kilometers (6.2 miles) of the Project in summer 2012. This annual report focuses on bat data collected from 1 January through 31 December 2014, but also includes data collected in 2012 and 2013 for statistical modeling purposes and analysis of trends in roost populations.

Table 1. Conservation Status of Bat Species Found in the CVSR Project Site Region

Species	U.S. Bureau of Land Management	California Department of Fish and Wildlife	U.S. Forest Service	Western Bat Working Group
Pallid bat *Antrozous pallidus*	Sensitive	Species of Special Concern	Sensitive	High Priority
California mastiff bat *Eumops perotis californicus*	Sensitive	Species of Special Concern	No status	High Priority
Mexican free-tailed bat *Tadarida brasiliensis mexicanus*	No status	No status	No status	Low Priority
Hoary bat *Lasiurus cinereus*	No status	No status	No status	Medium Priority
California myotis *Myotis californicus*	No Status	No status	No status	Low Priority
Fringed myotis *Myotis thysanodes*	Sensitive	No status	Sensitive	High Priority
Yuma myotis *Myotis yumanensis*	Sensitive	No status	No status	Low Priority*
Canyon bat *Parastrellus hesperus*	No Status	No status	No status	Low Priority
Big brown bat *Eptesicus fuscus*	No Status	No status	No status	Low Priority
Western small-footed bat *Myotis ciliolabrum*	Sensitive	No status	No status	Medium Priority
Townsend's big-eared bat *Corynorhinus townsendii*	Sensitive	Candidate Threatened (California Endangered Species Act)	Sensitive	High Priority

Source: California Department of Fish and Game 2015.
*Yuma myotis are listed as low priority in California, but medium priority in other ecoregions.

Section 2. Methods

2.1 Acoustic Monitoring

Bats use echolocation calls to detect prey and obstacles as they navigate across different landscapes. Although different species may demonstrate some degree of plasticity in their calls, acoustic parameters such as shape, duration, and minimum frequencies may be used to reliably identify species (Fenton et al. 1995). Today, two primary technologies exist for recording and analyzing bat calls: zero-crossing and full spectrum. Technology for viewing zero-crossing recordings is well developed; it is easy to quickly view and place species labels on thousands of calls at a time. However, full-spectrum technology provides more detail about specific call characteristics, which can sometimes be critical for identifying species with similar call parameters (Fenton 2000). Therefore, to assess relative bat activity in different areas of the CVSR Project, we used both AnaBat SD2s (Titley Scientific, Ballina, NSW, Australia), which are acoustic detectors that use zero-crossing technology, and Song Meter SM2 BATs (Wildlife Acoustics Inc., Concord, MA, USA), which are detectors with full-spectrum recording technology.

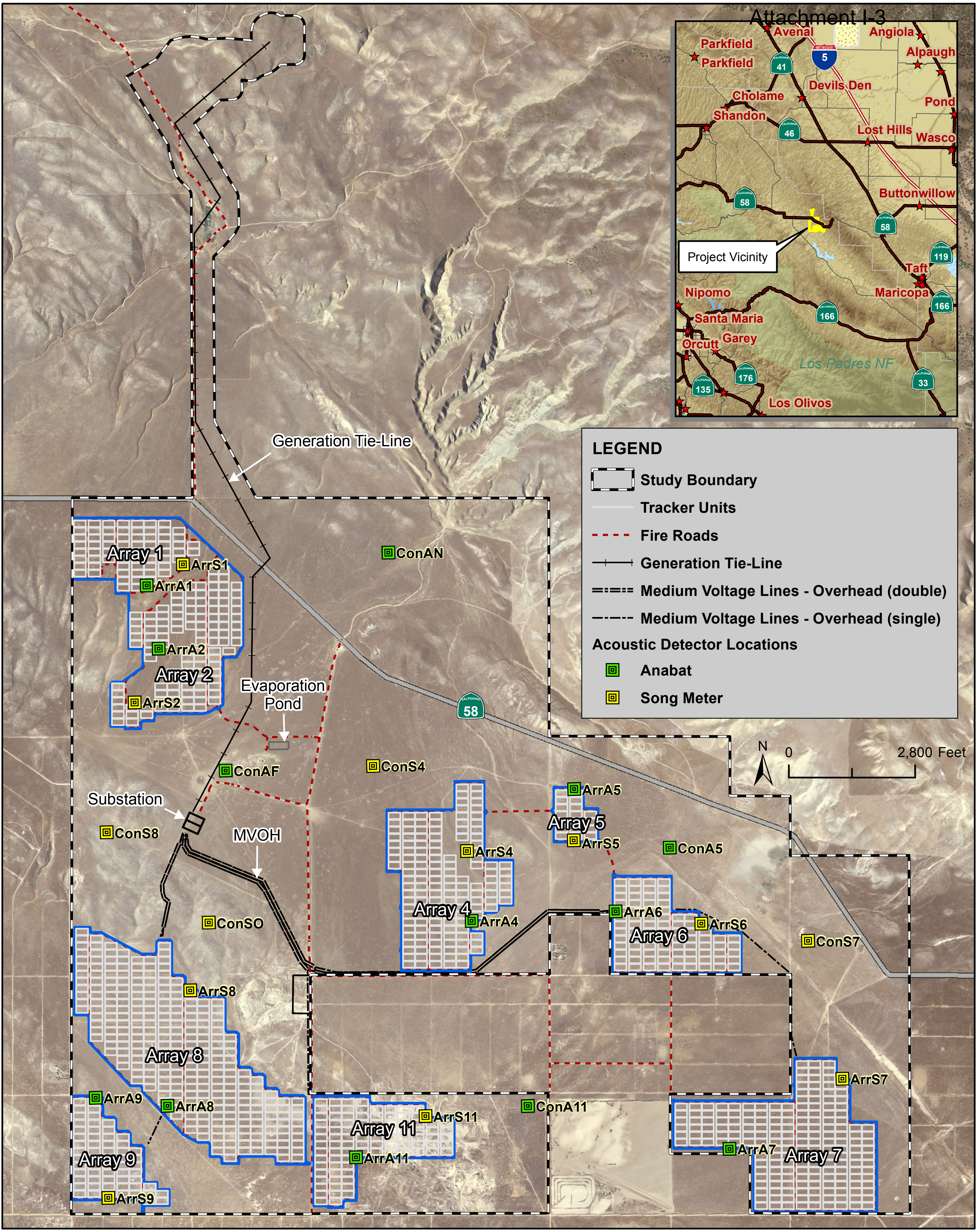
The ABPP monitoring plan was designed to allow for comparison of a year's worth of data between pre- and postconstruction levels of bat activity on the site. As defined by the ABPP, "postconstruction" is considered the period after Project commissioning. However, because the addition of constructed arrays (and even stacks of building material) to the environment during Project construction can affect both insect activity and bat activity by creating favorable windbreaks (Verboom and Huitema 1997; Grindal and Brigham 1999), it is likely that, biologically, this addition of structure, rather than the act of energizing the arrays, marks the distinctive point between pre- and postconstruction conditions. Therefore, for the purposes of our study, we considered individual solar arrays to be in a preconstruction state only before substantial building materials were moved into the area. The timing of construction activities and budgetary considerations prevented us from gathering a full year's worth of preconstruction data in the arrays; therefore, to more accurately record baseline levels of bat activity in natural areas, we installed additional bat detectors in Onsite Conservation Lands (i.e., lands near the arrays conserved as part of Project mitigation).

We deployed two detectors, one AnaBat SD2 (AnaBat), and one Song Meter SM2 BAT (Song Meter), in each of the nine arrays, and we deployed four Song Meters and four AnaBats in Onsite Conservation Lands (Figure 1). We staggered detector deployment across the year, and added new detectors as different construction areas became active (Figure 2). All detectors in Conservation Lands were deployed for at least 1 year (Figure 3). In arrays, we deployed detectors before the start of construction whenever possible, and all detectors were deployed for at least 1 year after the array in which they were located was commissioned.

As a naming convention, we used the prefix Arr to denote detectors in arrays, and the prefix Con to denote detectors in Conservation Lands. We used A or S to indicate which detectors were AnaBats and which were Song Meters. For all detectors in arrays, we included the number of the array at the end of the name to signify each detector's specific location. For detectors in Conservation Lands, we commonly used the number from the closest array, but we deviated from this convention in the following cases: ConAN refers to the AnaBat north of State Route 58, ConSO refers to the Song Meter in Conservation Lands by the operations and maintenance (O&M) facilities, and ConAF refers to the AnaBat next to an abandoned farmhouse. For clarity, we use this naming convention throughout the rest of the document to refer to specific detectors.

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\Bat Report\Fig 1 Acoustic Detectors.mxd

HPR II

H.T. HARVEY & ASSOCIATES

Ecological Consultants

California Valley Solar Ranch

Figure 1. Locations of Acoustic Detectors

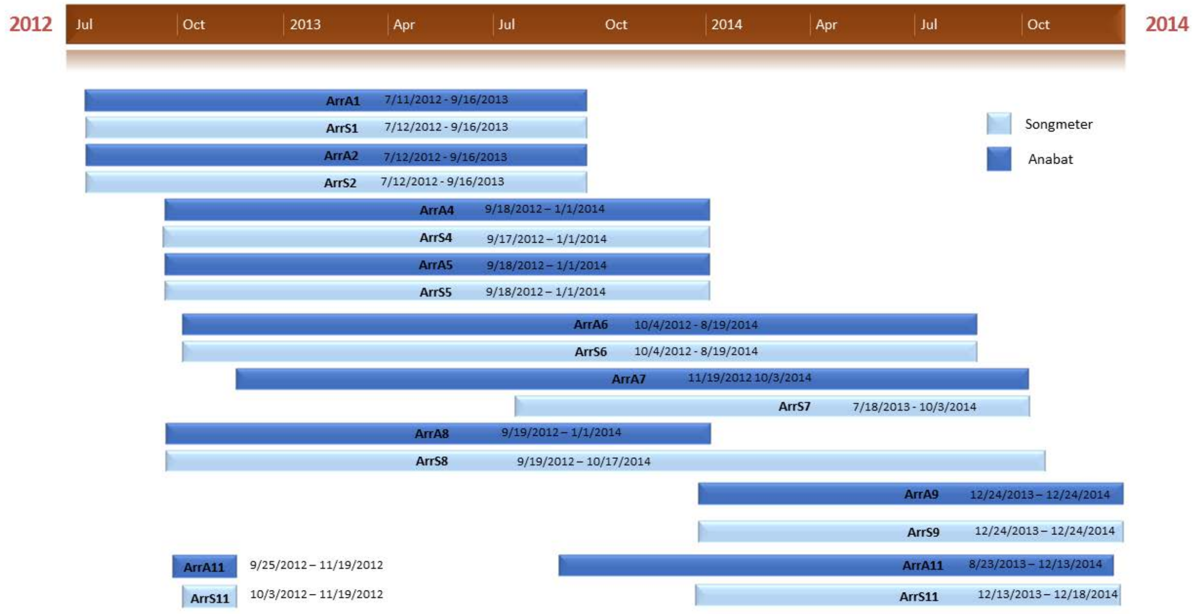


Figure 2. Deployment Dates of Acoustic Bat Detectors in Arrays

[1] Detector naming convention:
- Arr refers to detectors in arrays.
- S and A denote the type of detector, Song Meter or AnaBat.
- The final number indicates the array location.

[2] Preconstruction periods for Array 6 ran from 4 October–12 December 2012.

Preconstruction periods for Array 11 ran from 25 September and 3 October 2012 to 19 November 2012 for ArrA11 and ArrS11, respectively.

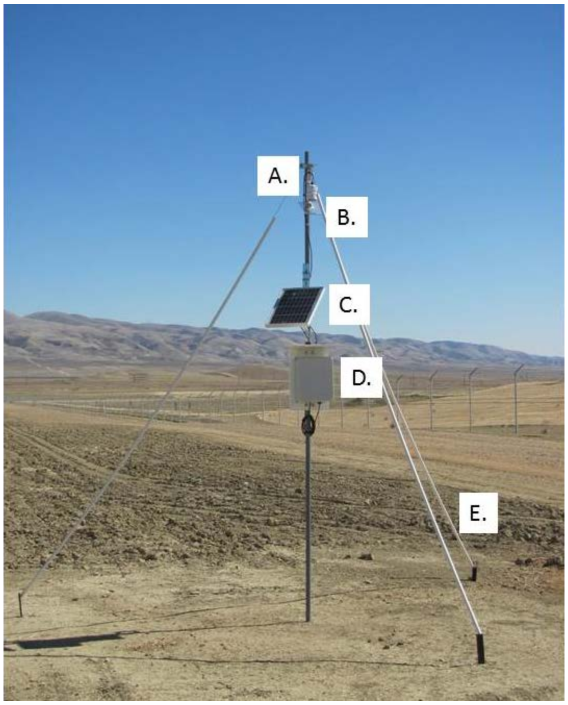
Figure 3. Deployment Dates of Acoustic Bat Detectors in Onsite Conservation Lands

Detector naming convention:
- Con refers to detectors in Conservation Lands.
- S and A denote the type of detector, Song Meter or AnaBat.
- The final character indicates specific location: a number indicates an array location or the nearest landmark for those in Conservation Lands; F refers to an abandoned farmhouse on site; O refers to the O&M facility area; N refers to north of State Route 58.

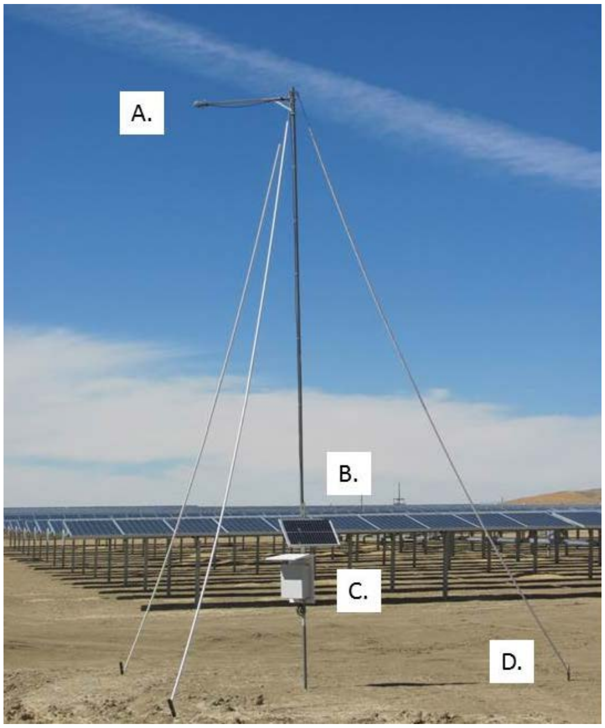
We deployed AnaBat detectors on 10-foot poles, each with a small, 20-watt photovoltaic panel to power the detector. Each pole was tethered to the ground using guy-wires. The wires were covered with PVC piping to make the wires more visible and prevent avian collisions. The AnaBat units were placed inside a weatherproof box and attached to the pole using U-clamps. The AnaBats were powered by solar panels, and both the wire for the solar panel and the wire for the microphones were threaded through the bottom of the weatherproof box. Microphones were positioned facing downward to provide weatherproofing. A reflector plate was angled at 45° from horizontal and placed directly underneath each microphone (Figure 4a). AnaBats were set to record on a nightly basis from 17:00 to 07:00 (5 PM to 7 AM). A subset of detectors (ConA5, ArrA1, ArrA2, and ConAF) was deployed with temperature loggers attached. Each AnaBat in this subset was programmed with its Universal Transverse Mercator (UTM) coordinates, and was set to record from sunset to sunrise, based on location.

We deployed Song Meters on 20-foot poles (Figure 4b). The Song Meters were also set to run on external power supplied by solar panels attached to the poles. Each pole was tethered to the ground using guy-wires. The wires were covered with PVC piping to make the wires more visible and prevent avian collisions. The Song Meter units were placed inside a weatherproof box and attached to the pole using U-clamps. The Song Meters were powered by solar panels, and both the wire for the solar panel and the wire for the microphones were threaded through the bottom of the weatherproof box. We programmed Song Meters according to the default settings provided in the Song Meter SM2 BAT instruction manual. The UTM coordinates were set for each detector, and the Song Meters were set to record from sunset to sunrise, based on their location.

We positioned detectors so that microphones were pointing into the arrays and as close as possible to the edge of each array without casting a shadow onto the panels.



(a) AnaBat SD2. This configuration consisted of: A. microphone; B. reflector plate; C. solar panel; D. AnaBat SD2 and weatherproof case; and E. guy-wire cables and stakes.



(b) Song Meter SM2BAT. This configuration consisted of: A. microphone and bird deterrent caging; B. external solar panel power source; C. Song Meter and weatherproof case; and D. guy-wire cables and stakes.

Figure 4. Monitoring Station Configurations

2.2 Acoustic Analysis

We manually classified all bat acoustic files collected. For the AnaBat data, we used a library of known bat calls to develop a set of automatic filters based on the unique call parameters (e.g., minimum frequency and duration) of different species found in the Carrizo Plain. These filters were used to quickly sort and batch like calls together in AnaLook, v.3.9c (Corben 2011).

Whenever possible, we identified bats to species level based on the acoustic parameters of shape, minimum frequency, duration, and/or critical frequency. Calls that we could not identify to species were classified as unknown. When possible, we classified unknown call files according to the lowest frequency of the calls (i.e., unknown 20-kilohertz [kHz], unknown 30-kHz, and unknown 40-kHz+). When calls in a file were weak or shifted in frequency, we classified them as unknown, with no subcategory.

The first filter we ran was designed to select for files that contained low-frequency calls. We expected Mexican free-tailed bats, pallid bats, and mastiff bats to be included in this group. Because Mexican free-tailed bats were the most abundant of these three bats, we created a filter that was designed to conservatively select only Mexican free-tailed bats. All files that passed the filter were marked and moved into a folder named by species. The remaining files in the low-frequency folder were unknown 20-kHz bats, unknown 30-kHz bats, pallid bats, and a few residual Mexican free-tailed bats.

Likewise, we created a filter designed to filter out files with high-frequency calls. We expected canyon bats, California myotis, and western small-footed bats to be in this group. Because canyon bats and California myotis both have calls with higher minimum frequencies than western small-footed bats, we created a combined filter designed to filter out both California myotis bats and canyon bats. All files that passed this secondary filter were marked and moved into a folder named by species. The remaining files in the high-frequency folder were unknown 40-kHz bats and western small-footed bats.

Once we had created species groups, we manually scanned each group folder and marked noise files for deletion. We also labelled any files that showed poor call quality or indicated species other than the species targeted by a given filter. We deleted all previously marked calls, then marked all labeled calls, and reversed the marks to apply a global header change so that species labels could be attached to all unlabeled files in a folder at one time. We then summed activity levels using the Count Labels tool in AnaLook.

Song Meter data were analyzed in Sonobat v.3.0, US West (Szewczak 2010), callViewer, v.18.0 (Skowronski and Fenton 2008), and AnaLook, v.3.9c (Corben 2011). As a time-saving measure, we converted all Song Meter calls to both zero-crossing and .wav files. This allowed us to move quickly through easily identifiable calls in AnaLook and mark other files for a second look in full-spectrum.

Among the species we analyzed, the echolocation calls of hoary bats and Mexican free-tailed bats are difficult to discriminate because they share similar measurements of minimum frequency and duration. These species also both demonstrate a variety of call shapes, which can be similar to one another; however, some calls may be classified to species through examination of the power spectrum (Skowronski and Fenton 2008), which shows the strength of the signal versus time. This method cannot be used to discriminate species when analyzing zero-crossing AnaBat files, because of constraints associated with this recording technology. Therefore, particularly when looking at AnaBat call files, hoary bat and Mexican free-tailed bat calls are difficult to discriminate. To determine whether or not both species are present on the site, in 2012, we examined 100 Song Meter call files classified as Mexican free-tailed bats/hoary bats from October, when both species are considered migratory, and examined the shape of the power spectrums associated with each Song Meter file to make species discriminations. In this sample, nearly all of the calls were identified as Mexican free-tailed bats and only a few were identified as hoary bats. Hoary bats are a foliage roosting species; therefore, the Carrizo Plain is unlikely to provide suitable habitat for them, and any detections of this bat will likely occur during the spring and fall migratory periods. Because the vast majority of calls from Mexican free-tailed bats and hoary bats overlap, we did not attempt to determine the relative abundance of each species for our analyses. Therefore, throughout the remainder of the report, we will refer to this group as Mexican free-tailed bats, with the understanding that some small number of hoary bats may fall under this label.

Bat calls cannot be used to identify individuals, but the number of calls is commonly used as an index of overall activity at a site (Kunz et al. 1996). We quantified bat activity separately for each species classification by presence/absence within 1-minute periods per night; this method provides more accurate assessments of bat activity than traditional methods of counting individual passes (Miller 2001).

2.3 Roost Observations

To locate bat roosts on and in the vicinity of the CVSR Project, we used both systematic searches and radio telemetry. At each known roost site, we attempted to make a minimum of two counts per summer: one count in early summer during the prevolant period, or before the young of the year are able to fly, and a second count in late summer, during the postvolant period, after the young of the year are able to fly, but before the maternity colonies disperse.

In June–August 2012, we located two potential maternity roosts in rocky outcrops using a combination of radio telemetry and systematic site investigations. One suspected roost was located on U.S. Bureau of Land Management land, but further investigation in 2012 and 2013 revealed that it did not contain a maternity colony. A second roost was found and confirmed on private property. In 2013 and 2014, we went back to the roost on private property. Also in 2013, we received information about a second maternity colony, located in a building, and we monitored this roost through the end of 2014. We used two tally counters each to keep track of (1) how many bats flew out from an emergence spot and (2) how many bats flew back into the same crevice. For the purpose of comparison, we subtracted the number of bats recorded by the second tally counter from the number of bats recorded by the first tally counter.

2.4 Statistical Analysis

For descriptive statistics, we plotted the average number of minutes of activity per night by month for known species for all sites, and relative bat activity for known species or frequency group for the year. These were plotted only for 2014 acoustic data, when arrays were built and fully operational. We refer to Conservation Lands and operational arrays as "preconstruction" and "postconstruction" areas, respectively, to maintain consistency within discussions of parameter estimates.

We conducted all other statistical analyses in R (R v.2.13.1; R Development Core Team 2011). We used both boxplots and Cleveland dotplots to detect outliers. During our initial analysis, it became clear that the AnaBat at the farmhouse recorded significantly more activity than any other detector, likely because trees provide additional habitat structure around this site (Verboom and Huitema 1997; Jantzen and Fenton 2013). Among all the detector sites, trees are unique to this location, so we removed this detector's data from our analysis.

We set all of our explanatory variables (year, month, individual detector location, and construction status) as categorical factors. We expected microphone type to have only a slight effect on the overall interpretation of bat activity, because Song Meters and AnaBats record at similar rates, particularly for lower frequencies (Adams et al. 2012), so we did not include this variable in our analysis.

In total, we ran six models: one for total bat activity on the site, and one model for each species group detected (with hoary bats and Mexican free-tailed bats in one group). Because the data were non-normal and showed signs of heterogeneity, we applied a log transformation (x + 1) to each dataset. We applied generalized least-squares models using the nlme package (Pinheiro et al. 2014). Because the variance of the data differed as a function of individual detector location, we applied an identity variance function to the data to allow the variance to differ by individual detector location. We modeled the activity of each group or species as follows:

Activity = month + construction status + individual detector location + year

We used backward, stepwise selection and removed variables that did not contribute significantly to the model one at a time until all remaining variables were significant.

No calls were recorded from California myotis at ArrS9. This microphone was removed from analysis for this species' model because this is an outlier. Additionally, the model is structured to measure differences in variances among microphones and won't run without some variance.

Section 3. Results

3.1 Acoustic Analysis

In 2014, detectors were operational for 3154 detector nights, ranging from 132 nights recorded at ArrA6 to 357 nights recorded at ConS8. We detected a total of 36,739 minutes (612.3 hours) of bat activity for known species (calls that could be identified to species) and frequency groups. We detected a total of 11,321 minutes (188.7 hours) of bat activity for unknown species. With the exception of western small-footed bats, the average number of minutes of activity for known species was less than 3 minutes per night each month (Figure 5). The average minutes of activity for western small-footed bats peaked at 7.1 minutes per night in August. Likewise, the average number of minutes of activity for California myotis and canyon bats peaked between August and September. Mexican free-tailed bat activity peaked in May and again in September. The average number of calls/minute each month was fairly constant for pallid bats and was never greater than 0.5 minute per night each month. For the year, western small-footed bats accounted for the highest percentage, 38.7%, of total bat activity (Figure 6). Mexican free-tailed bats and canyon bats accounted for 25.6% and 16.4% of the total bat activity, respectively. California myotis and pallid bats accounted for less than 12% of the total activity, and unknown frequency groups/species combined accounted for less than 8% of the total activity for the year.

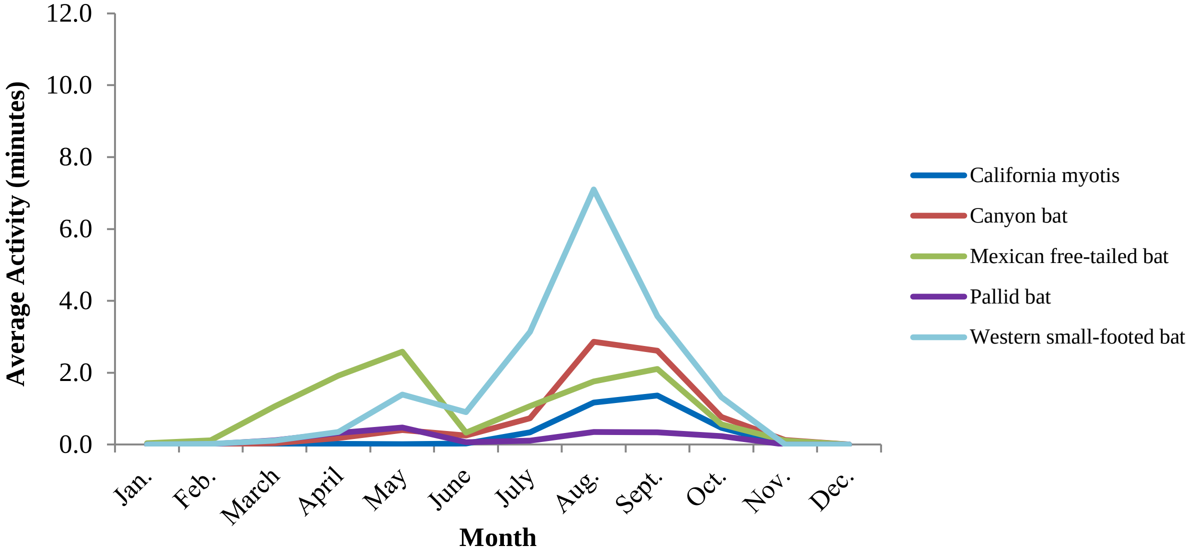


Figure 5. Average Number of Minutes of Activity per Night for Each of Five Species, by Month, in 2014

Total nights of recordings per month are as follows: January = 365, February = 352, March = 362, April = 278, May = 257, June = 277, July = 304, August = 282, September = 242, October = 139, November = 167, and December = 129.

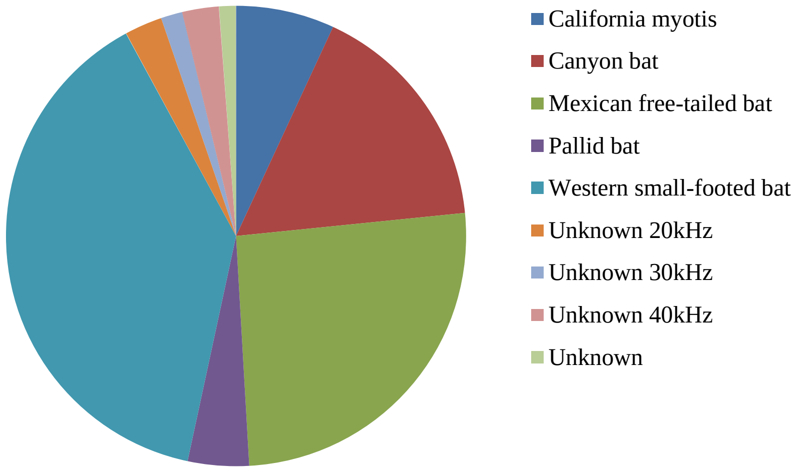


Figure 6. Relative Bat Activity by Species or Frequency Group for 2014

Total minutes recorded for each species or frequency group are as follows: California myotis = 851, canyon bat = 2026, Mexican free-tailed bat = 3159, pallid bat = 526, western small-footed bat = 4759, unknown 20-kHz = 325, unknown 30-kHz = 178, unknown 40-kHz = 316, and unknown = 146.

Total Bat Activity on Site. Total bat activity on site was significantly affected by year, month, and individual detector location ($P<0.05$). Activity was significantly higher in the summer months, compared to the winter months ($P<0.05$). The highest activity occurred in 2012, with significantly decreased activity in 2013 and 2014 (Appendix A, Table A-1).

California Myotis Activity. The activity of California myotis was affected by month and individual detector location ($P<0.05$). Compared to summer months, activity was significantly lower in winter months (Appendix A, Table A-2).

Canyon Bat Activity. Month, individual detector location, year, and construction status all affected the activity of canyon bats ($P<0.05$). Compared to preconstruction areas, canyon bat activity was higher in arrays ($P<0.05$). The activity of these bats was lower in 2013 and 2014 compared to 2012 ($P<0.05$). Compared to most winter months, activity was significantly higher in summer months (Appendix A, Table A-3).

Mexican Free-tailed Bat Activity. Month, individual detector location, and year all affected the activity of Mexican free-tailed bats ($P<0.05$). The activity of these bats was lower in 2013 and 2014 compared to 2012 ($P<0.05$). As a whole, activity was significantly lower in winter months, compared to spring and summer months (Appendix A, Table A-4).

Pallid Bat Activity. The activity of pallid bats was affected by month, individual detector location, year, and construction status ($P<0.05$). The activity of pallid bats was lower in 2013 and 2014, compared to 2012 ($P <$

0.05). In contrast to our findings regarding other bat species, the activity of pallid bats was lower in arrays, compared to preconstruction areas ($P<0.05$). As a whole, activity was significantly lower in winter months, compared to summer months (Appendix A, Table A-5).

Western Small-footed Bat Activity. Month, individual detector location, and year affected the activity of western small-footed bats ($P<0.05$). As a whole, activity was significantly lower in winter months, compared to summer months (Appendix A, Table A-6).

3.2 Roost Counts

3.2.1 Rocky Outcrops on Private Land

Our primary study site consists of a network of rocky outcrops with variable heights (3 – 12 meters) surrounding a private residence on both the east and west sides of the house. The western outcrop is approximately 85 meters (279 feet) wide. The eastern outcrop is more fragmented, but also measures approximately 85 meters wide. Bats are known to inhabit both outcrops.

We observed bats emerging from four areas, which we labeled Roosts A, B, C, and D. These roosts were located in rock outcrops that are within 200 meters of each other. Roost A is located in the western outcrop. Roosts B, C, and D are located in the eastern outcrop, on the east-facing, west-facing, and south-facing sides of this outcrop, respectively. Although roosts were not labeled as such in 2012 or 2013, the defined areas are the same and are used in this report to make clear comparisons across all years (Table 2).

In 2012, we counted bats emerging from Roost A, although the high location of the roost in the rock made it difficult to see individuals at the point of emergence. We counted 68 individuals emerging from this roost on 24 July and 26 individuals emerging on 3 September 2012.

As reported in the 2013 annual bat report (HTH 2014), we conducted roost counts on 29 May, 4 June, and 18 July 2013. On 29 May, we counted no bats emerging from Roost A. We counted 65 bats and 39 bats emerging from Roosts B and C, respectively. The moon phase on 29 May was waning gibbous, so the sky was fairly bright. On 4 June, we did not perform a count at Roost A because bats had not been observed in this area during the recent previous surveys, and it is difficult to get an accurate count from this location, owing to its height. We counted no bats emerging from Roost B, but we counted 26 bats and 23 bats emerging from Roosts C and D, respectively. The moon phase on 4 June was waning crescent, so the sky was fairly dark. On 18 July we did not perform a count at Roost A for reasons cited previously. We counted no bats at Roost B or D. The gibbous moon on 18 July provided for bright conditions.

In 2014, roost count numbers were very low. We conducted emergence counts on 30 June and 29 August 2014. On 30 June, we counted no bats at Roost A or D. We counted three bats each at Roost B and C. On 19 July the sky was fairly bright because the moon was in the gibbous phase. On 29 August we did not survey Roost A. On 29 August, we observed three bats each emerging from Roosts C and D, but no bats were observed emerging from Roost B. The sky was fairly dark because the moon was in the crescent phase on 29 August.

Table 2. Roost Count Results for Rocky Outcrop Roost on Private Land in 2013 and 2014

Date	Location	Number of Bats	Volancy Period	Moon Phase
7/24/2012	Roost A	68	Postvolant	Waxing crescent stage/dark
9/3/2012	Roost A	26	Postvolant	Waning gibbous/bright
5/29/2013	Roost A	0	Prevolant	Waning gibbous stage/bright
5/29/2013	Roost B	65		
5/29/2013	Roost C	39		
6/4/2013	Roost A*	n/a	Prevolant	Waning crescent/dark
6/4/2013	Roost B	0		
6/4/2013	Roost C	26		
6/4/2013	Roost D	23		
7/18/2013	Roost A*	n/a	Postvolant	Waxing gibbous/bright
7/18/2013	Roost B	0		
7/18/2013	Roost C	5		
7/18/2013	Roost D	0		
6/30/2014	Roost A	0	Prevolant	Waning gibbous stage/bright
6/30/2014	Roost B	0		
6/30/2014	Roost C	5		
6/30/2014	Roost D	0		
8/29/2014	Roost A*	n/a	Postvolant	Waxing crescent/dark
8/29/2014	Roost B	0		
8/29/2014	Roost C	3		
8/29/2014	Roost D	3		

Notes:
Roost A = located in western outcrop.
Roost B = located in east-facing side of eastern outcrop.
Roost C = located in west-facing side of eastern outcrop.
Roost D = located in south-facing side of eastern outcrop.
*n/a = Not surveyed.

3.2.2 Building Roost

We first visited this site on 31 May 2013. We counted 47 pallid bats emerging. The moon was in a waning gibbous stage, so the sky was somewhat bright. Because this was not our primary roost study site, we did not return for a postvolant count. We revisited this site on 30 June 2014 for a prevolant count and recorded 46 individuals emerging from this roost. On 28 August 2014, we revisited this site for a postvolant count and recorded 25 bats.

Section 4. Discussion

4.1 Acoustic Analysis

Overall, western small-footed bats were the most frequently detected species, with canyon bats the third most frequently detected species, and slightly less activity for California myotis on the Project in 2014. Western small-footed bats, canyon bats, and California myotis are often common in arid and semiarid habitats, and typically roost in cracks or crevices in rocky outcrops (Holloway and Barclay 2001; Findley and Traut 1970). Given the availability of suitable habitat in the region, our results are consistent with the life history of these two species, and all species that we detected are common and well-documented as occurring in the Carrizo Plain.

We did not detect Yuma myotis or big brown bats on our Project study site, but these are expected to occur only rarely in the Carrizo Plain, and may not occur as far south in the valley as the Project. Although one previous study noted silver-haired bats (*Lasionycteris noctivagans*) occurring in the Carrizo Plain with 95% certainty (Althouse and Mead 2014), big brown bats and silver-haired bats have nearly identical echolocation calls. Reliable discrimination of silver-haired bats often relies on maximum frequencies, which quickly fade out owing to environmental attenuation (Betts 1998). Thus, based on our professional knowledge from previous surveys in the area and of this species' habitat needs, and despite the findings of Althouse and Mead, we consider it unlikely that silver-haired bats occur in the Carrizo Plain.

4.1.1 Annual Changes and Seasonal Trends

Mexican free-tailed bats were the second most frequently detected species in 2014. This species demonstrated peaks in activity in the spring and fall. In the southwest, Mexican free-tailed bats exhibit strong migration patterns in the spring and fall, which is closely tied to winter hibernation and maternity-season activity (Villa and Cockrum 1962; McCracken and Gustin. 1991). Mexican free-tailed bats also migrate short distances from inland areas of California in the summer to more coastal areas of the state in winter (Johnston 1998b). Although these local migration patterns are poorly understood, seasonal movements to coastal areas of California are probably associated with mild winter temperatures there. Although Mexican free-tailed bats are not closely associated with arid habitats, their overall activity levels and seasonal abundance on the Project is likely associated with their migratory movements. At the Project, the detected pulses of Mexican free-tailed bat activity in the spring and fall coincided with the expected timing of these short-distance migrations.

We also found peaks in activity in the fall for California myotis, canyon bats and western small-footed bats. By August, most young are volant and capable of foraging independently, and maternity colonies are beginning to disperse. Peak activity detected during this time likely reflects these general seasonal patterns.

We found that overall activity for pallid bats was low, compared with the other known species, throughout the year. Detections were likely lower because of the hunting strategy used by the species. In contrast to other bat species that locate prey through a quick succession of echolocation pulses referred to as feeding buzzes, pallid bats listen passively for insect vocalizations to locate and isolate their prey (Fuzessery et al. 1993). Although pallid bats still rely on echolocation for navigational purposes, this hunting strategy results in fewer vocalizations, compared with other species. Because acoustic monitoring records echolocation calls, actual pallid bat activity is likely higher than the acoustic data suggests.

We found that all bat species had decreased activity in 2013 and 2014 compared to 2012, and this is likely related to the regional drought. Moderate drought conditions were prevalent in the CVSR Project area by January 2013, extreme drought conditions by January 2014, and exceptional drought conditions by the end of 2014, as defined by the National Drought Monitor (National Drought Mitigation Center 2014). The overall declines in bat populations are mirrored by the trends observed for other species over the past 3 years, including burrowing owls (*Athene cunicularia*), San Joaquin kit foxes (*Vulpes macrotis mutica*), songbirds, and raptors (HTH 2015a, 2015b).

Greif and Siemers (2010) suggested that bats, particularly naïve juveniles, may try to drink from smooth surfaces, such as flat solar panels, that they encounter in the wild. However, over the course of 2 years, no bat fatalities have been found during regular fatality searches of the Project.

4.1.2 Effects of Arrays

We found no relationship between total bat activity and the presence or absence of arrays; however, we found significant increases or declines in specific species' responses to the array areas. As found in previous years, we found increased activity of canyon bats in the Project arrays, compared to preconstruction areas (including Conservation Lands). One explanation for this trend relates to the echolocation call characteristics of this species. Call characteristics help to suit different species of bats to different foraging habitats (Fenton 1990; Schnitzler and Kalko 2001; Müller et al. 2012). Canyon bats have an intermediate call type that combines a frequency-modulated call characteristic, or a call that covers a wide span of frequencies, with a narrowband characteristic, or a call that covers a narrow range of frequencies. These types of calls are commonly seen in species that forage most effectively along edge-type habitats (Fenton 1990), and it is probable that they are using the edges created by the array panels. Several other species, including the California myotis and western small-footed bat, have similar call types but did not exhibit increases in activity in array areas. Perhaps there are unknown nuances in the behaviors of these species that might explain these differences.

We found that the activity of pallid bats decreased in arrays, compared to preconstruction areas (including Conservation Lands), and this likely reflects the foraging habits of this species. Pallid bats typically forage at low heights in the range of 0.5–2.5 meters (1.6–8.2 feet) (O'Shea and Vaughan 1977). Therefore, it is plausible that the fences surrounding the arrays act as a foraging barrier for them (i.e., they change directions when they fly close to a fence rather than flying over the fence.

The relationships between different species and site construction status in 2013 held true in 2014, giving further support to the strength of these relationships. One exception to this, however, was Mexican free-tailed bats, which were previously found to have significantly higher activity inside array (postconstruction) areas, compared to preconstruction areas. The construction status term was dropped from the model in the 2014 analysis because its P-value was >0.05 (*P*=0.051). The exclusion of this term highlights one of the problems of backward step model selection: the arbitrary choice of the level of significance can result in excluding terms that would have been included if an alternative level had been used (i.e., 10% instead of 5%). Although this term likely exerts some influence on bat activity, the effect was not strong enough to include in the full model, and we cannot be sure if the apparent significance of this effect in 2013, and the apparent lack of significance in 2014, is a real change or is an artifact of the model selection process. However, residual analysis did not reveal any trends to indicate that it was a strong effect that should be included, regardless of P-value; therefore, we consider the effect of construction status on activity levels of Mexican free-tailed bats to be borderline.

4.2 Roost Counts

The size and number of boulders in the roost complex located on private land limited the accuracy of our exit counts because we found multiple exit points from multiple outcroppings. Pallid bats are known to switch roosts frequently (Lewis 1996; Johnston et al. 2006), and these particular pallid bats likely switch among multiple roosts that are close to one another, making it difficult to determine net changes in population size.

In contrast, the roost site at the building, which we first visited in 2013, has one controlled access point, and is much more isolated from other potential roosts. Both of these factors make this roost a more reliable location from which to take data—this is shown by the similar numbers of bats recorded for the prevolant counts between 2013 and 2014 (47 and 46, respectively).

The size and number of boulders in the roost complex located on private land limited the accuracy of our exit counts because we found multiple exit points from multiple outcroppings. Pallid bats are known to switch roosts frequently (Lewis 1996; Johnston et al. 2006), and these particular pallid bats likely switch among multiple roosts that are close to one another, making it difficult to determine net changes in population size. In contrast, the roost site at the building, which we first visited in 2013, has one controlled access point, and is much more isolated from other potential roosts. Both of these factors make this roost a more reliable location from which to take data—this is reflected by the steady numbers of the prevolant counts between 2013 and 2014 (47 and 46, respectively).

Besides the apparent overall changes in colony size caused by roost switching, there was a large drop between the prevolant counts that were made at the roost on private land in 2013 and 2014. This drop may have been related, in part, to the timing of the moon phase during the roost counts. While we sought to account for moon phase during all roost counts, it was not always feasible to schedule counts under the same light conditions. Moon phase can affect roost counts, because bat activity tends to be lower on brightly lit nights

(O'Shea and Vaughn 1977). However, we observed higher prevolant numbers during the brightly lit night in 2013 and lower prevolant numbers during the dimly lit night in 2014. Conversely, we observed higher prevolant numbers during the darkly lit night in 2013 than during the brightly lit night in 2014. Therefore, moon phase did not likely affect our roost exit counts greatly, nor is the difference between the counts for 2013 and 2014 likely due to moon phase.

While the timing of the observed decline in roost counts corresponds to the construction of the Project, it is more likely that the drop in counts may be an effect of environmental conditions. The region has experienced a severe drought over the past 2 years. The decreased rainfall has caused trophic-level effects: there was lower vegetative cover in 2014 (HTH 2014b), and fewer insects were observed by many HTH field staff in the region in 2013 and 2014. Drought conditions also may have decreased the survival rates of both adult and subadult bats (Frick et al. 2007, 2010). The effects of the drought, combined with frequent roost switching, and moon phase, made it difficult to determine direct population effects, and what, if any, effects are directly attributable to the Project's construction. The final year of roost counts (2015) will be conducted at this site, as well as at the Building, to hopefully provide more insight on population trends for pallid bats, 3 years after the CVSR Project began.

Section 5. References

5.1 Literature

Adams, A. M., M. K. Jantzen, R. M. Hamilton, and M. B. Fenton. 2012. Do you hear what I hear? Implications of detector selection for acoustic monitoring of bats. Methods in Ecology and Evolution 3(6):992–998.

Althouse and Meade. 2014. Topaz Solar Farms 2013 Fourth Quarter/Second Annual Report for Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. Paso Robles, California.

Betts, B. J. 1998. Effects of interindividual variation in echolocation calls on identification of big brown and silver-haired bats. The Journal of Wildlife Management, 62 (3), 1003-1010.

California Department of Fish and Game. Natural Diversity Database. January 2015. Special Animals List. Periodic publication. 50 pp.http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/spanimals.pdf. Accessed 16 February 2015.

Corben, C. 2011. AnaLook for Windows. [online]: http://users.lmi.net/corben/anabat.htm#Anabat%20 Contents. Accessed December 2013.

Fenton, M. B. 1990. The foraging behavior and ecology of animal-eating bats. Canadian Journal of Zoology 68(3):411–422.

Fenton, M. B., Audet, D., Obrist, M.K., and Rydell, J. 1995. Signal strength, timing, and self-deafening: the evolution of echolocation in bats. Paleobiology. 21:229-242.

Fenton, M. B. 2000. Choosing the 'correct' bat detector. Acta Chiropterologica 2:215–224.

Findley J.S. and G.L. Traut. 1970. Geographic variation in Pipistrellus hesperus. Journal of Mammalogy 51(4): 741-765.

Frick, W. F., W. E. Rainey, and E. D. Pierson. 2007. Potential effects of environmental contamination on Yuma myotis demography and population growth. Ecological Applications 17:1213–1222.

Frick, W. F., D. S. Reynolds, and T. H. Kunz. 2010. Influence of climate and reproductive timing on demography of little brown myotis *Myotis lucifugus*. Journal of Animal Ecology 79:128–136.

Fuzessery, Z.M., P. Buttenhoff, B. Andrews, and J.M. Kennedy. 1993. Passive sound localization of prey by the pallid bat (Antrozous p. pallidus). Journal of Comparative Physiology 171 (6): 767-77

Greif, S., and B. M. Siemers. 2010. Innate recognition of water bodies in echolocating bats. Nature Communications 1(107). [online]: doi:10.1038/ncomms1110 (2010).

Grindal, S. D., and R. M. Brigham. 1999. Impacts of forest harvesting on habitat use by foraging insectivorous bats at different spatial scales. Ecoscience 6(1):25–34.

Holloway, G.L. and R.M.R. Barclay. 2001. Myotis ciliolabrum. Mammalian species: 670 (1-5). American Society of Mammalogists.

[HTH] H. T. Harvey & Associates. 2011. Avian and Bat Protection Plan for the California Valley Solar Ranch Project. Fresno, CA.

[HTH] H. T. Harvey & Associates. 2014a. California Valley Solar Ranch Avian and Bat Protection Plan 2013 Annual Bat Report. Fresno, CA.

[HTH] H. T. Harvey & Associates. 2014b. California Valley Solar Ranch San Luis Obispo County, California Year 2 (2014) On-site Vegetation Monitoring Report. Fresno, CA.

[HTH] H. T. Harvey & Associates. 2015a. CVSR Conservation Lands Habitat Mitigation and Monitoring Plan Year 3 Annual Report. Fresno, California. Administrative Draft

[HTH] H. T. Harvey & Associates. 2015b. California Valley Solar Ranch, San Luis Obispo County, California, Final Avian Activity Surveys Report: October 2011–October 2014. Administrative Draft.

Jantzen, M. K., and M. B. Fenton. 2013. The depth of edge influence among insectivorous bats at forest-field interfaces. Canadian Journal of Zoology 91:287–293.

Johnston, D. 1998a. Carrizo Plain Natural Area Bat Survey Results. HTH Project #1456-01. H. T. Harvey & Associates, Alviso, California. Prepared for the U.S. Bureau of Land Management.

Johnston, D. S. 1998b. [ABS] Population fluctuations in Mexican free-tailed bats (*Tadarida brasiliensis*) in central California. Do some bats migrate? Bat Research News 39:4, p. 172

Johnston, D. 2007. Bat Surveys of the Carrizo Plain Natural Monument. HTH Project #1456-02. H. T. Harvey & Associates, San Jose, California. Prepared for the U.S. Bureau of Land Management, Bakersfield, California.

Johnston, D. S., B. Hepburn, J. Krauel, T. Stewart, and D. Rambaldini. 2006. Winter ecology of pallid bats in central coastal California. Bat Research News 47:115.

Kunz, T. H., C. R. Tidemann, and G. C. Richards. 1996. Small volant mammals. Pages 122–146 D. E. Wilson, F. R. Cole, J. D. Nichols, R. Rudran, and M. S. Foster (Editors), Measuring and Monitoring Biological Diversity; Standard Methods for Mammals. Smithsonian Institution Press, Washington D.C.

Lewis, S. E. 1996. Low roost-site fidelity in pallid bats: Associated factors and effect on group stability. Behavioral Ecology and Sociobiology 39(5):335–344.

McCracken, G.F., and M.K. Gustin. 1991. Nursing behavior in Mexican free-tailed bat maternity colonies. Ethology 89: 305-321.

Miller, B. W. 2001. A method for determining relative activity of free flying bats using a new activity index for acoustic monitoring. Acta Chiropterologica 3(1):93–105.

Müller, J., M. Mehr, C. Bässler, M. B. Fenton, T. Hothorn, H. Pretzsch, H. J. Klemmt, and R. Brandl. 2012. Aggregative response in bats: Prey abundance versus habitat. Oecologia 169(3):673–684.

National Drought Mitigation Center. 2014. United States drought monitor weekly comparison. Lincoln, Nebraska. [online]: http://droughtmonitor.unl.edu/MapsAndData/WeeklyComparison.aspx. Accessed December 2014.

O'Shea, T. J., and T. A. Vaughan. 1977. Nocturnal and seasonal activities of the pallid bat, *Antrozous pallidus*. Journal of Mammalogy 58(3):269–284.

Pinheiro J, Bates D, DebRoy S, Sarkar D and R Core Team (2014). _nlme: Linear and Nonlinear Mixed Effects Models_. R package version 3.1-118, <URL: http://CRAN.R-project.org/package=nlme>.

R Development Core Team. 2011. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.

Schnitzler, H., and E. K. V. Kalko. 2001. Echolocation by insect-eating bats. Bioscience 51(7):557–569.

Skowronski, M. D., and M. B. Fenton. 2008. Model-based automated detection of echolocation calls using the link detector. Journal of the Acoustical Society of America 124(1):328–336. [online]: doi:10.1121/1.2924122.

U.S. Fish and Wildlife Service. 2010. Region 8 Interim Guidelines for the Development of a Project-specific Avian and Bat Protection Plan for Solar Energy Plants and Related Transmission Facilities. Region 8, Sacramento, California.

Verboom, B., and H. Huitema. 1997. The importance of linear landscape elements for the pipistrelle *Pipistrellus pipistrellus* and the serotine bat *Eptesicus serotinus*. Landscape Ecology 12(2):117–125. [online]: doi: 10.1007/BF02698211.

Villa, R.B., and E.L. Cockrum. 1962. Migration in the guano bat Tadarida brasiliensis Mexican (Saussure). Journal of Mammalogy 43 (1): 43-64.

Appendix A. Parameter Estimates for Bat Activity on Site

Table A-1. Parameter Estimates for Total Bat Activity on Site

The reference case (represented as the intercept) is for January 2013 at detector ArrA1. All other parameter estimates, standard errors, and p-values correspond to adjustments to this reference case for a given factor level. Note that model predictions based on these parameter estimates are on the scale of the transformed response variable (log(x +1)).

Parameter	Estimate	Standard Error	P-value
Intercept	-0.25	0.07	$P < 0.05$
Month			
February	0.08	0.06	0.18
March	1.04	0.06	$P < 0.05$
April	2.03	0.06	$P < 0.05$
May	2.03	0.06	$P < 0.05$
June	1.55	0.06	$P < 0.05$
July	2.03	0.06	$P < 0.05$
August	3.05	0.06	$P < 0.05$
September	2.63	0.06	$P < 0.05$
October	1.52	0.06	$P < 0.05$
November	0.25	0.06	$P < 0.05$
December	-0.12	0.06	0.05
Year			
2012	0.08	0.04	$P < 0.05$
2014	-0.18	0.04	$P < 0.05$
Detector			
ArrA2	0.03	0.08	0.66
ArrA4	0.33	0.08	$P < 0.05$
ArrA5	0.35	0.07	$P < 0.05$
ArrA6	0.56	0.07	$P < 0.05$
ArrA7	0.61	0.07	$P < 0.05$
ArrA8	0.57	0.07	$P < 0.05$
ArrA9	0.57	0.09	$P < 0.05$
ArrA11	0.78	0.08	$P < 0.05$
ArrS1	0.51	0.09	$P < 0.05$
ArrS2	0.57	0.10	$P < 0.05$
ArrS4	0.04	0.08	0.66
ArrS5	0.95	0.08	$P < 0.05$
ArrS6	-0.04	0.09	0.63

Parameter	**Estimate**	**Standard Error**	**P-value**
ArrS7	0.32	0.11	$P < 0.05$
ArrS8	0.70	0.08	$P < 0.05$
ArrS9	-0.38	0.09	$P < 0.05$
ArrS11	0.67	0.09	$P < 0.05$
ConA5	0.67	0.09	$P < 0.05$
ConA11	0.67	0.08	$P < 0.05$
ConS4	-0.24	0.09	$P < 0.05$
ConS7	0.56	0.08	$P < 0.05$
ConS8	-0.39	0.09	$P < 0.05$
ConSO	0.55	0.11	$P < 0.05$
ConAN	0.23	0.08	$P < 0.05$

Table A-2. Parameter Estimates for California Myotis Activity on Site

The reference case (represented as the intercept) is for January at detector ArrA1. All other parameter estimates, standard errors, and P-values correspond to adjustments to this reference case for a given factor level. Note that model predictions based on these parameter estimates are on the scale of the transformed response variable (log(x +1)).

Parameter	Estimate	Standard Error	*P*-value
Intercept	-0.04	0.01	$P < 0.05$
Month			
February	0.00	0.01	0.79
March	0.01	0.01	0.57
April	0.01	0.01	0.13
May	0.02	0.01	0.06
June	0.02	0.01	0.11
July	0.04	0.01	$P < 0.05$
August	0.12	0.01	$P < 0.05$
September	0.14	0.01	$P < 0.05$
October	0.03	0.01	$P < 0.05$
November	-0.01	0.01	0.42
December	-0.00	0.01	0.77
Detector			
ArrA2	0.02	0.01	$P < 0.05$
ArrA4	0.04	0.01	$P < 0.05$
ArrA5	0.03	0.01	$P < 0.05$
ArrA6	0.09	0.01	$P < 0.05$
ArrA7	0.10	0.01	$P < 0.05$
ArrA8	0.13	0.01	$P < 0.05$
ArrA9	0.16	0.02	$P < 0.05$
ArrA11	0.24	0.02	$P < 0.05$
ArrS1	0.00	0.01	0.87
ArrS2	0.05	0.01	$P < 0.05$
ArrS4	0.05	0.01	$P < 0.05$
ArrS5	0.12	0.01	$P < 0.05$
ArrS6	0.02	0.01	$P < 0.05$
ArrS7	0.12	0.03	$P < 0.05$
ArrS8	0.09	0.01	$P < 0.05$
ArrS9*	n/a	n/a	n/a
ArrS11	0.23	0.04	$P < 0.05$
ConA5	0.09	0.02	$P < 0.05$
ConA11	0.22	0.02	$P < 0.05$
ConS4	0.03	0.01	$P < 0.05$

Parameter	**Estimate**	**Standard Error**	**P-value**
ConS7	0.20	0.02	$P < 0.05$
ConS8	0.03	0.01	$P < 0.05$
ConSO	0.00	0.01	0.68
ConAN	0.04	0.01	$P < 0.05$

Note: ArrS9 was excluded from the model for this dataset, because no calls from this species were recorded.

Table A-3. Parameter Estimates for Canyon Bat Activity on Site

The reference case (represented as the intercept) is for January 2013 at detector ArrA1, in a postconstruction phase. All other parameter estimates, standard errors, and P-values correspond to adjustments to this reference case for a given factor level. Note that model predictions based on these parameter estimates are on the scale of the transformed response variable (log(x +1)).

Parameter	Estimate	Standard Error	P-value
Intercept	-0.10	0.02	$P < 0.05$
Construction Status			
Preconstruction	-0.08	0.04	$P < 0.05$
Month			
February	0.00	0.02	0.93
March	0.01	0.02	0.47
April	0.06	0.02	$P < 0.05$
May	0.09	0.02	$P < 0.05$
June	0.09	0.02	$P < 0.05$
July	0.20	0.02	$P < 0.05$
August	0.51	0.02	$P < 0.05$
September	0.41	0.02	$P < 0.05$
October	0.11	0.02	$P < 0.05$
November	0.00	0.02	0.81
December	-0.04	0.02	$P < 0.05$
Year			
2012	0.09	0.01	$P < 0.05$
2014	0.07	0.01	$P < 0.05$
Detector			
ArrA2	0.02	0.02	0.33
ArrA4	0.13	0.02	$P < 0.05$
ArrA5	0.13	0.02	$P < 0.05$
ArrA6	0.19	0.02	$P < 0.05$
ArrA7	0.10	0.02	$P < 0.05$
ArrA8	0.05	0.02	$P < 0.05$
ArrA9	0.08	0.03	$P < 0.05$
ArrA11	0.25	0.03	$P < 0.05$
ArrS1	0.08	0.03	$P < 0.05$
ArrS2	0.10	0.03	$P < 0.05$
ArrS4	0.13	0.02	$P < 0.05$
ArrS5	0.28	0.03	$P < 0.05$
ArrS6	0.07	0.02	$P < 0.05$
ArrS7	0.05	0.03	0.07

Parameter	Estimate	Standard Error	P-value
ArrS8	0.12	0.02	$P < 0.05$
ArrS9	-0.01	0.02	0.59
ArrS11	0.13	0.04	$P < 0.05$
ConA5	0.32	0.05	$P < 0.05$
ConA11	0.21	0.05	$P < 0.05$
ConS4	0.15	0.05	$P < 0.05$
ConS7	0.52	0.06	$P < 0.05$
ConS8	0.00	0.05	0.96
ConSO	0.19	0.05	$P < 0.05$
ConAN	0.30	0.05	$P < 0.05$

Table A-4. Parameter Estimates for Hoary Bat and Mexican Free-tailed Bat Activity on Site

The reference case (represented as the intercept) is for January 2013 at detector ArrA1. All other parameter estimates, standard errors, and P-values correspond to adjustments to this reference case for a given factor level. Note that model predictions based on these parameter estimates are on the scale of the transformed response variable (log(x +1)).

Parameter	**Estimate**	**Standard Error**	**P-value**
Intercept	0.08	0.04	0.06
Month			
February	0.03	0.03	0.38
March	0.46	0.03	$P < 0.05$
April	1.02	0.03	$P < 0.05$
May	0.80	0.03	$P < 0.05$
June	0.28	0.03	$P < 0.05$
July	0.33	0.03	$P < 0.05$
August	0.52	0.03	$P < 0.05$
September	0.70	0.03	$P < 0.05$
October	0.53	0.03	$P < 0.05$
November	0.11	0.04	$P < 0.05$
December	-0.03	0.04	0.34
Year			
2012	0.07	0.03	$P < 0.05$
2014	-0.06	0.02	$P < 0.05$
Detector			
ArrA2	-0.05	0.05	0.27
ArrA4	0.00	0.05	0.94
ArrA5	-0.09	0.04	$P < 0.05$
ArrA6	0.00	0.04	0.99
ArrA7	0.03	0.04	0.52
ArrA8	0.21	0.05	$P < 0.05$
ArrA9	0.19	0.06	$P < 0.05$
ArrA11	0.2	0.05	$P < 0.05$
ArrS1	0.43	0.06	$P < 0.05$
ArrS2	0.42	0.07	$P < 0.05$
ArrS4	-0.01	0.05	0.88
ArrS5	0.25	0.06	$P < 0.05$
ArrS6	-0.07	0.05	0.15
ArrS7	-0.12	0.05	$P < 0.05$
ArrS8	0.37	0.05	$P < 0.05$
ArrS9	-0.23	0.05	$P < 0.05$

Parameter	**Estimate**	**Standard Error**	**P-value**
ArrS11	0.19	0.06	$P < 0.05$
ConA5	-0.22	0.05	$P < 0.05$
ConA11	-0.04	0.05	0.36
ConS4	-0.16	0.05	$P < 0.05$
ConS7	-0.26	0.04	$P < 0.05$
ConS8	-0.18	0.05	$P < 0.05$
ConSO	0.51	0.08	$P < 0.05$
ConAN	-0.16	0.05	$P < 0.05$

Table A-5. Parameter Estimates for Pacific Pallid Bat Activity on Site

The reference case (represented as the intercept) is for January 2013 at detector ArrA1 in a post-construction phase. All other parameter estimates, standard errors, and P-values correspond to adjustments to this reference case for a given factor level. Note that model predictions based on these parameter estimates are on the scale of the transformed response variable (log(x +1)).

Parameter	Estimate	Standard Error	P-value
Intercept	-0.02	0.01	0.14
Construction Status			
Preconstruction	0.07	0.02	$P < 0.05$
Month			
February	0.01	0.01	0.56
March	0.05	0.01	$P < 0.05$
April	0.15	0.01	$P < 0.05$
May	0.12	0.01	$P < 0.05$
June	0.06	0.01	$P < 0.05$
July	0.04	0.01	$P < 0.05$
August	0.10	0.01	$P < 0.05$
September	0.14	0.01	$P < 0.05$
October	0.14	0.01	$P < 0.05$
November	-0.03	0.02	0.08
December	-0.04	0.02	$P < 0.05$
Year			
2012	0.06	0.01	$P < 0.05$
2014	-0.02	0.01	$P < 0.05$
Detector			
ArrA2	0.00	0.02	0.81
ArrA4	0.09	0.02	$P < 0.05$
ArrA5	0.05	0.02	$P < 0.05$
ArrA6	0.07	0.02	$P < 0.05$
ArrA7	0.06	0.02	$P < 0.05$
ArrA8	0.06	0.02	$P < 0.05$
ArrA9	0.14	0.03	$P < 0.05$
ArrA11	0.14	0.02	$P < 0.05$
ArrS1	-0.01	0.02	0.51
ArrS2	-0.02	0.02	0.31
ArrS4	-0.00	0.02	0.91
ArrS5	0.07	0.02	$P < 0.05$
ArrS6	-0.02	0.02	0.29
ArrS7	0.01	0.02	0.53

Parameter	Estimate	Standard Error	P-value
ArrS8	0.10	0.02	$P < 0.05$
ArrS9	0.06	0.02	$P < 0.05$
ArrS11	0.21	0.03	$P < 0.05$
ConA5	-0.03	0.03	0.46
ConA11	-0.02	0.03	0.52
ConS4	-0.10	0.03	$P < 0.05$
ConS7	-0.02	0.03	0.54
ConS8	0.01	0.03	0.83
ConSO	-0.01	0.04	0.71
ConAN	-0.06	0.03	$P < 0.05$

Table A-6. Parameter Estimates for Western Small-footed Bat Activity on Site

The reference case (represented as the intercept) is for January 2013 at detector ArrA1. All other parameter estimates, standard errors, and P-values correspond to adjustments to this reference case for a given factor level. Note that model predictions based on these parameter estimates are on the scale of the transformed response variable (log(x +1)).

Parameter	Estimate	Standard Error	P-value
Intercept	-0.16	0.03	$P < 0.05$
Month			
February	0.01	0.03	0.71
March	0.09	0.03	$P < 0.05$
April	0.33	0.03	$P < 0.05$
May	0.56	0.03	$P < 0.05$
June	0.50	0.03	$P < 0.05$
July	0.81	0.03	$P < 0.05$
August	1.47	0.03	$P < 0.05$
September	1.03	0.03	$P < 0.05$
October	0.18	0.03	$P < 0.05$
November	0.03	0.03	0.26
December	0.00	0.03	0.88
Year			
2012	-0.11	0.02	$P < 0.05$
2014	-0.14	0.02	$P < 0.05$
Detector			
ArrA2	0.09	0.03	$P < 0.05$
ArrA4	0.14	0.04	$P < 0.05$
ArrA5	0.38	0.04	$P < 0.05$
ArrA6	0.42	0.04	$P < 0.05$
ArrA7	0.54	0.04	$P < 0.05$
ArrA8	0.29	0.03	$P < 0.05$
ArrA9	0.34	0.04	$P < 0.05$
ArrA11	0.45	0.04	$P < 0.05$
ArrS1	0.44	0.05	$P < 0.05$
ArrS2	0.13	0.04	$P < 0.05$
ArrS4	0.06	0.03	0.08
ArrS5	0.60	0.05	$P < 0.05$
ArrS6	0.12	0.05	$P < 0.05$
ArrS7	0.5	0.07	$P < 0.05$
ArrS8	0.29	0.03	$P < 0.05$
ArrS9	-0.01	0.04	0.87
ArrS11	0.44	0.05	$P < 0.05$

Parameter	**Estimate**	**Standard Error**	**P-value**
ConA5	0.74	0.06	$P < 0.05$
ConA11	0.60	0.05	$P < 0.05$
ConS4	-0.02	0.04	0.68
ConS7	0.48	0.04	$P < 0.05$
ConS8	-0.06	0.04	0.11
ConSO	0.01	0.05	0.91
ConAN	0.22	0.04	$P < 0.05$

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch Project
Avian and Bat Protection Plan
Final Postconstruction
Fatality Report

Prepared for:

HPR II, LLC
California Valley Solar Ranch
13505 Carissa Highway, Highway 58
Santa Margarita, CA 93453

Prepared by:

H. T. Harvey & Associates
Project # 3326-03

Prepared per:

Avian and Bat Protection Plan for the California Valley Solar Ranch Project

U.S. Fish and Wildlife Service
Biological Opinion (81420-2011-F-0511)
San Luis Obispo County
Conditional Use Permit (DRC2008-00097)

4 March 2015

Executive Summary

Project Overview

The California Valley Solar Ranch Project (CVSR Project) is a 250-megawatt solar photovoltaic energy facility located within an approximately 4685-acre site (Project site) in eastern San Luis Obispo County, California (Figure 1). The facility is owned and operated by High Plains Ranch II, LLC (HPR II). The Conditional Use Permit for the CVSR Project required that an Avian and Bat Protection Plan be prepared and implemented to monitor the impacts of the CVSR Project on birds and bats after construction. In compliance with the resultant Avian and Bat Protection Plan, avian and bat fatality searches were conducted from 6 June 2012 through 17 November 2014. This report represents the final avian and bat fatality report, and covers the monitoring results of searcher-efficiency trials, carcass-persistence trials, repeat fatality searches, regular weekly fatality searches, and incidental observations of fatalities from 16 August 2013 to 17 November 2014.

Methods

H. T. Harvey & Associates (HTH) biologists conducted weekly surveys in the following CVSR Project elements: Arrays 1, 2, 4, 5, 6, 7, 8, 9, 11, and in 20% of all associated perimeter fence areas, the Medium-voltage Overhead (MVOH) Line, the Generation-tie (Gen-tie) Line, and the Evaporation Pond. During the reporting period, all arrays were surveyed each week at 20% of their total area, with the exception of Arrays 1 and 2, which were surveyed with 100% coverage through the end of December 2013, at which time they too were surveyed at 20% of their total area. Additionally, to help identify the proportion of fatalities found that could be attributed to natural mortality rates, we surveyed control plots, located in Conservation Lands surrounding the CVSR Project site.

All fatalities were classified as either carcasses or feather spots. Feather spots consisted of groups of feathers composed of at least two or more primary flight feathers, five or more tail feathers, or 10 or more feathers of any type concentrated together in an area 1 square meter (m^2) or smaller (Smallwood 2007); feathers with significant skin or flesh, or with any bone attached, were considered fatality detections but were not necessarily considered feather spots.

In addition to performing weekly searches, HTH biologists conducted a series of repeat searches: 5-day repeats, in which biologists searched the same subset of a Project element for 5 consecutive days, and 1-day repeat searches, in which biologists searched a subset of an area that was searched 1 day previously by either 5-day repeat searchers or weekly searchers. The purpose of these repeat searches was to check the efficiency of searchers and evaluate the consistency of results; however, as reported herein, not all of the repeat searches proved necessary, and they were discontinued at the end of December 2013.

To estimate the rate of avian and bat fatalities occurring on the site, we used Huso's Fatality Estimator (2011). In formulating a fatality estimate, it was necessary to determine (1) the rate of scavenging that occurs on the site, and (2) how well searchers find different-size carcasses in different amounts of vegetation cover. These determinations were made by (1) planting fresh carcasses of birds of various sizes and placing camera traps on them to identify scavenger species and the exact time of carcass removal, and (2) planting both carcasses and feather spots of different sizes in different vegetation classes while regular weekly and repeat searches were taking place. Searcher-efficiency and carcass-removal rates were then used to adjust the annual count of fatalities to arrive at a site-wide fatality estimate.

We used background fatality rates estimated from searches of control plots within onsite Conservation Lands to adjust fatality rates within arrays. This enabled us to estimate mean background-adjusted fatality rates for the CVSR Project that represent fatalities that cannot be explained by background fatalities alone. This estimate was substantially less than the total unadjusted fatality rates within arrays. Our method used bootstrap resampling of observed data to estimate the mean and 90% confidence intervals for background-adjusted per-tracker unit fatality rates.

Results and Discussion

During the period of 16 August 2013 to 17 November 2014, a total of 453 avian fatalities, of 36 identified species and 5 unknown species groups, were detected. A total of 364 fatalities were found during standardized weekly searches. This number includes four clearance fatalities (fatalities found on the initial search of an area, which cannot be reliably aged or attributed to Project-related causes). A total of 54 fatalities were found during standardized 5-day and 1-day repeat searches. This number includes 18 clearance fatalities. A total of 35 fatalities were found incidentally. Two of the incidental fatalities were found in onsite Conservation Lands, and these, along with the four weekly clearance and 18 repeat clearance fatalities, were not used in any analyses in this report. That left an effective sample size of 429 fatalities that were used for analyses in this report.

Of the 429 fatalities found in Project elements and control plots during this reporting period, the cause of death for the majority (80.9%) could not be reliably discerned. Seventy-three (17.0%) were believed to have died as a result of a collision (65 with powerlines, 7 with solar panels, and 1 with a perimeter fence). Two deaths were believed to be caused by electrocution (0.5%). Six (1.4%) were believed to have been caused by predation, and one (0.2%) was believed to have been caused by disease.

Across Project elements, the majority (85.3%) of all fatalities were of resident species. The highest number of fatalities of migrants was found along the Gen-tie Line, where migratory species accounted for 21.5% of all fatalities. Seasonal variation was apparent in the pattern of fatalities found in both the arrays and along the Gen-tie Line. Fatalities found in the arrays peaked in the winter, whereas Gen-tie Line fatalities peaked in the late summer and fall.

For both carcass-persistence and searcher-efficiency trials, data were grouped over the entire postconstruction period to create a more robust sample size for the purposes of using the Fatality Estimator. One specimen was placed for each persistence or searcher efficiency trial. Between 15 October 2012 and 11 March 2014, we conducted carcass-persistence trials with 206 specimens. Eleven trial carcasses were excluded because the persistence data collected were insufficient (i.e., carcasses were collected by staff after the initial scavenging event), leaving an effective sample size of 195 carcasses. The carcass-persistence trials included 96 small carcasses and 99 large carcasses. Assuming conservatively that carcasses would not persist past the 6-week trial period, mean carcass persistence over the entire year was 9.3 days for small carcasses and 22.2 days for large carcasses.

In total, we planted 434 fatalities for searcher-efficiency trials. Three fatality plants were removed by scavengers, leaving an effective sample size of 431 (113 small and 98 large feather spots and 113 small and 107 large carcasses). Overall searcher efficiency was 50.8%, but varied from 57.3% to 44.5% in easy and moderate-visibility areas, respectively. Searcher efficiency also varied by size and fatality type: 72.9% of all large carcasses were found and 41.6% of all small carcasses were found, whereas 65.3% of all large feather spots were found and only 26.5% of all small feather spots were found.

During the period of 7 November 2013 to 6 November 2014 (the period used in the Fatality Estimator, representing one full year where weekly fatality searches occurred across all Project elements), there were an estimated 126 fatalities from known causes that occurred on the Project site (90% confidence interval: 106–155). There were not enough fatalities with known or suspected causes of death in the arrays to run a fatality estimate reflecting cause of death (N=2), but the estimate of fatalities per tracker in the arrays, for fatalities with unknown or natural causes of death, was 2.24 (90% confidence interval: 1.83–2.87). In the control plots, this estimate was 1.72 (90% confidence interval: 1.05–2.68).

For this same period, we estimated the mean background-adjusted per-tracker fatality rate to be 0.51 (90% confidence interval:-0.83-1.81) for one full year. The mean annual background-adjusted fatality estimate within arrays encompassing approximately 1176 acres at the CVSR project containing 1032 tracker units for the period of 7 November 2013 to 6 November 2014 was 526 fatalities (0.51 fatalities per tracker unit x 1032 tracker units).

Recommendations

During the course of this fatality monitoring study, we have identified areas where further research is needed to guide the design of future fatality monitoring studies at utility-scale solar facilities. The following recommendations outline research areas and measures that we believe are important.

- Background mortality should be assessed using a spatially balanced study employing control plots similar in size, layout, and overall total area to the developed project site.
- Focused research on the causes of feather spots and the average number of feather spots created from a single fatality should be considered.

- If site-wide fatality monitoring is deemed necessary, monitoring should start once the full project becomes operational and for at least one year. Fatality monitoring survey design, including spatial coverage requirements and survey frequency can be optimized after the collection of preliminary data.
- Intensive daily repeat fatality surveys are not necessary to conduct fatality estimates and are only recommended when required to link timing of fatalities to specific events (e.g., weather patterns or operational changes).
- Avian use studies should consider bird census techniques that are potentially more effective in documenting species richness and relative abundance of birds in project areas that will be covered by arrays, such as line transect methods.
- Projects incorporating high-tension powerlines should assess whether the project site is located in an important route for migratory songbirds.
- To assess fatalities along linear project features such as powerlines, study designs should incorporate linear controls, to provide background mortality rates for such features.
- To the extent practicable, powerlines should not be placed over wetland features, where large numbers of birds may roost and nest.
- We recommend that necropsies be performed on a subsample of carcasses to provide confirmation of the cause of the fatality.
- The use of scent dogs should be considered to increase the likelihood of detecting rare events and increase the accuracy and narrow the confidence level of fatality estimates, especially in areas with high density vegetation.
- Feather spots should be incorporated into bias-trial protocols to produce more robust fatality estimates and to provide more comparable industry-wide fatality estimates, especially for studies with longer search intervals.

Table of Contents

Figures

Tables

Appendices

Contributors

Brian B. Boroski, Ph.D., Vice President and Principal in Charge, Wildlife Ecology

David Johnston, Ph.D., Project Manager, Associate Wildlife Ecologist

Doug Drynan, B.S., Project Manager, Senior Wildlife Ecologist

Kim M. Briones, M.S., Wildlife Ecologist

Meredith K. Jantzen, M.S., Wildlife Ecologist

Gabe A. Reyes, M.A. Candidate., Wildlife Ecologist

Ken Lindke, M.S., Quantitative Ecologist

Heather Ogston, B.A., Technical Editor

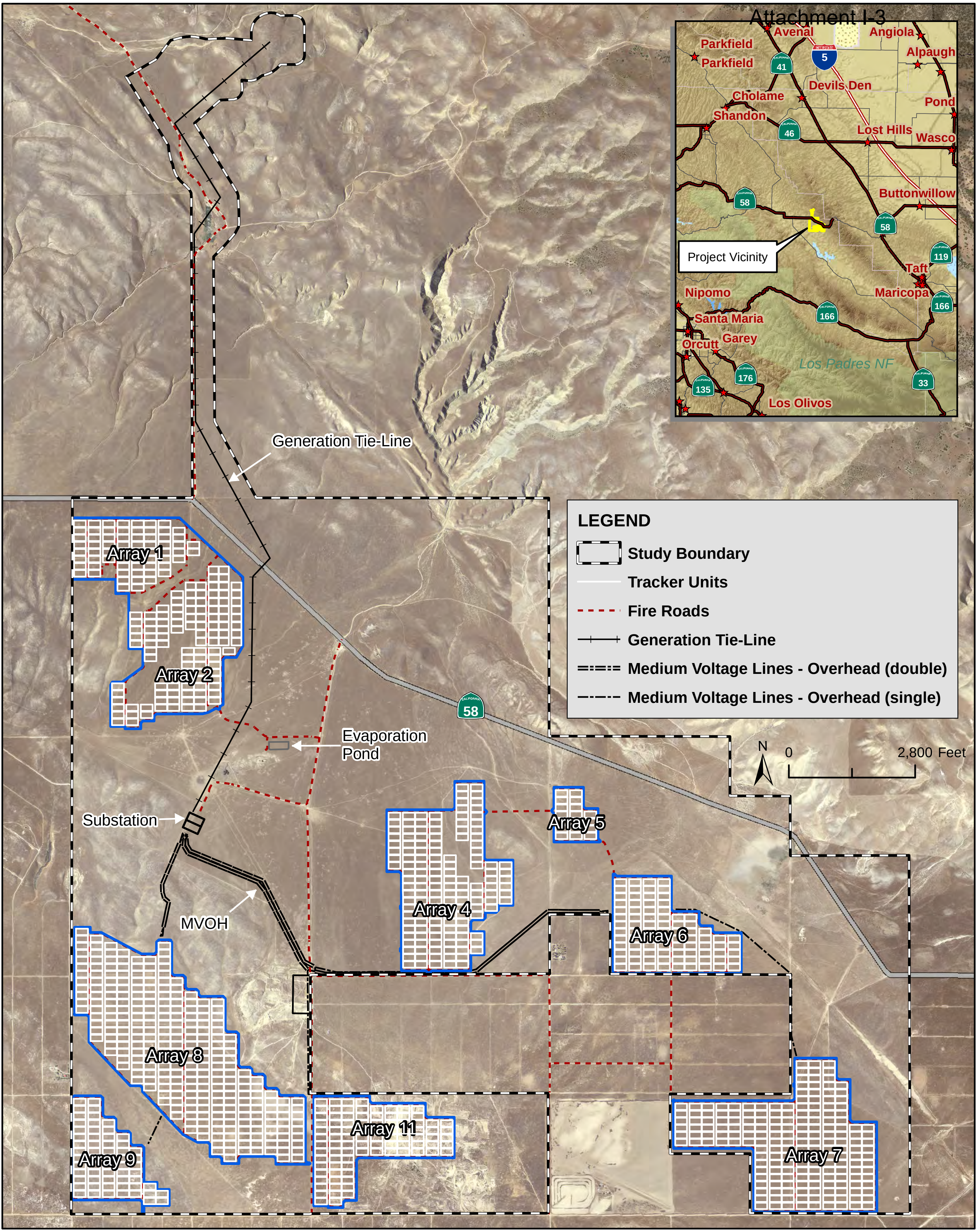
Section 1.0 Introduction

On 19 April 2011, through adoption of Resolution #2011-119, the Board of Supervisors of San Luis Obispo County (the County) approved the California Valley Solar Ranch Project (CVSR Project) Conditional Use Permit (DRC 2008-00097). The CVSR Project is a 250-megawatt solar photovoltaic energy facility located within an approximately 4685-acre site (Project site) in eastern San Luis Obispo County, California (Figure 1). The facility is owned and operated by High Plains Ranch II, LLC (HPR II).

Before construction of the Project, there were concerns about the anticipated impacts that the Project might have on birds and bats. In particular, it was predicted that obligate waterbirds may mistake the panels for water and be attracted to the solar arrays; waterbirds are sometimes found in black-top parking lots or on roads, and some solar facilities have reported finding waterbird fatalities (Horvath et al. 2009; Grippo et al. 2014; Kagan et al. 2014). There was also concern that birds and bats could collide with panels (McCrary et al. 1986; Grippo et al. 2014). Although bird and bat mortality has been well documented at wind energy projects (Arnett et al. 2008; Baerwald and Barclay 2009), the level of CVSR's probable impacts was not certain. Therefore, H. T. Harvey & Associates (HTH) developed an Avian and Bat Protection Plan (ABPP) (HTH 2011) for the Project as required by the County as part of its Conditions of Approval (COAs), set forth in Exhibit 6 attached to the Resolution. As elements of the Project became operational, and continuing after the full completion of construction, HTH ecologists have implemented the *Avian and Bat Fatality Monitoring Plan for the California Valley Solar Ranch* (Fatality Monitoring Plan) (Appendix A in HTH 2011), conducting weekly fatality searches and additional searches to document impacts on birds and bats.

As required in COA #58, HTH, on behalf of HPR II, has submitted one annual report and eight quarterly reports detailing all Project-related bird or bat deaths or injuries detected during the monitoring study defined by the Fatality Monitoring Plan. This document represents the final fatality report for the Project. As required in the Fatality Monitoring Plan, this Final Postconstruction Fatality Report documents the results of postconstruction monitoring for 1 full year after completion of the Project. It summarizes the results of fatalities found since the end of the first annual reporting period (15 August 2013), integrating results from the most recent quarter of monitoring, and discusses the complete study period for the Project, where appropriate.

One of the main goals of the monitoring effort was to estimate the numbers of fatalities associated with different Project elements. In addition to performing regular weekly searches, we conducted searcher-efficiency trials to estimate the percentage of fatalities of different sizes found by searchers in both short and tall vegetation. To calculate the persistence of fatalities in the environment, we also conducted carcass-persistence trials. The values we derived from both types of trial were used in tandem with the results of the weekly searches to estimate ranges of fatalities associated with different Project elements. Additionally, to obtain an estimate of background mortality levels, we conducted controlled searches in control plots located on onsite Conservation Lands. We calculated levels of fatalities associated with various Project elements, using the Fatality Estimator (Huso 2011) to extrapolate from our survey data to the entire Project. The date range for all fatality estimates is based on one full year where weekly fatality searches occurred across all Project elements, from 7 November 2013 to 6 November 2014.



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 1 Project Site.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report

Figure 1. Project Site with Gen-tie Line, MVOH Line, Evaporation Pond, Arrays, and Control Plots

This Final Postconstruction Fatality Report is organized as follows:

- Section 2 describes our field and statistical methods.
- Section 3 presents the results of weekly and repeat fatality searches, describes trends and patterns in the monitoring results; and provides estimates of fatalities by Project element and cause of death.
- Section 4 draws comparisons between our results and the results of fatality searches conducted in other regions and industries.
- Section 5 lists recommendations for future studies.
- Section 6 lists the references cited in this report.
- Appendices A and B list avian species used in the searcher-efficiency and carcass-persistence trials.
- Appendix C presents data from weekly fatality searches for the period of 16 August 2013 to 17 November 2014.
- Appendices D and E present data from repeat searches for the period of 16 August 2013 to 31 December 2013 (after which repeat searches were discontinued).
- Appendix F lists fatalities that were incidentally observed in the period of 16 August 2013 to 17 November 2014.
- Appendix G includes errata for data reported in the first annual postconstruction fatality report (HTH 2014a); revisions were made to correct errors, erroneous omissions, or any other changes that were made to the dataset. Notes are included summarizing the reason for the change.

Section 2.0 Methods

This section presents the methods we used to conduct weekly and repeat fatality searches, collect data from incidental observations, and perform carcass-removal and searcher-efficiency trials. Project elements searched as part of this study were the Generation-tie (Gen-tie) Line; the Medium-voltage Overhead (MVOH) Line; Arrays 1, 2, 4, 5, 6, 7, 8, 9, and 11; the array perimeter fences; control plots; and the Evaporation Pond.

2.1 Field Methods

2.1.1 Weekly Fatality Searches

To estimate the total number of fatalities associated with different Project elements, we conducted a series of weekly fatality searches on different Project elements. Because the construction of different Project elements was completed at different times, fatality searches began at varying times of year, depending on the Project element searched (Table 1).

2.1.1.1 Field Search Methods

Weekly fatality searches were performed for the Gen-tie Line; MVOH Line; Evaporation Pond; Arrays 1, 2, 4, 5, 6, 7, 8, 9, and 11; and the associated control plots and fences for each array. The study design involved sampling 100% of the Gen-tie Line, MVOH Line, and Evaporation Pond. Twenty percent of Arrays 4, 5, 6, 7, 8, 9, and 11 were sampled, as was 20% of their respective fences. Arrays 1 and 2 and their associated fences were searched at 100% for the first year of fatality searches, after which (beginning in January 2014) they were searched at 20%, and four control plots were removed to reflect the decreased search effort in these areas. Each week, we selected random start locations for each Project element using a random number generator. Random selection was based on tower numbers (for the Gen-tie Line), line segment (for the MVOH Line), numbered array corners (for the solar arrays), and numbered fence corners (for the array perimeter fences).

A team of two biologists searched a 30-meter (m)-wide transect centered under the complete length of the Gen-tie Line. Because of the relatively shorter height of the MVOH Line, it was assumed that carcasses would have less potential to distribute over a wide area (HTH 2011); therefore, the transect area along the entire length of the MVOH Line was only 18 m wide. Each person searched half the transect width and half the tower or pole radial areas for both the Gen-tie and MVOH Lines. On the Gen-tie Line, each person searched a 15-m-wide transect for large birds and a 6-m-wide transect for small birds and bats. On the MVOH Line, each person searched a 9-m-wide transect for small and large birds.

Table 1. Fatality Search Commencement Dates by Project Element

Project Element	Date Fatality Searches Began
Gen-tie Line	6 June 2012
Array 1[1]	20 September 2012
Array 2 (Serengeti portion only)[2]	25 September 2012
Array 1 and 2 fence[1]	25 September 2012
Array 2 control plots	30 October 2012
Array 1 control plot	1 November 2012
Array 2 North (including Serengeti) and South[1, 2]	27 November 2012
Array 8 (20% sample)	7 January 2013
Array 4 (20% sample)	9 January 2013
Array 5 and fence (20% sample)	9 January 2013
Array 4 fence (20% sample)	16 January 2013
MVOH Line	30 January 2013
Array 8 control plots	4 February 2013
Array 4 control plots	6 February 2013
Array 8 fence (20% sample)	20 May 2013
Array 6 and fence (20% sample) and control plots	30 September 2013
Array 7 and fence (20% sample) and control plots	10 October 2013
Array 9 and fence (20% sample)	6 November 2013
Array 11 and fence (20% sample), and control plots	6 November 2013
Evaporation Pond	11 November 2013

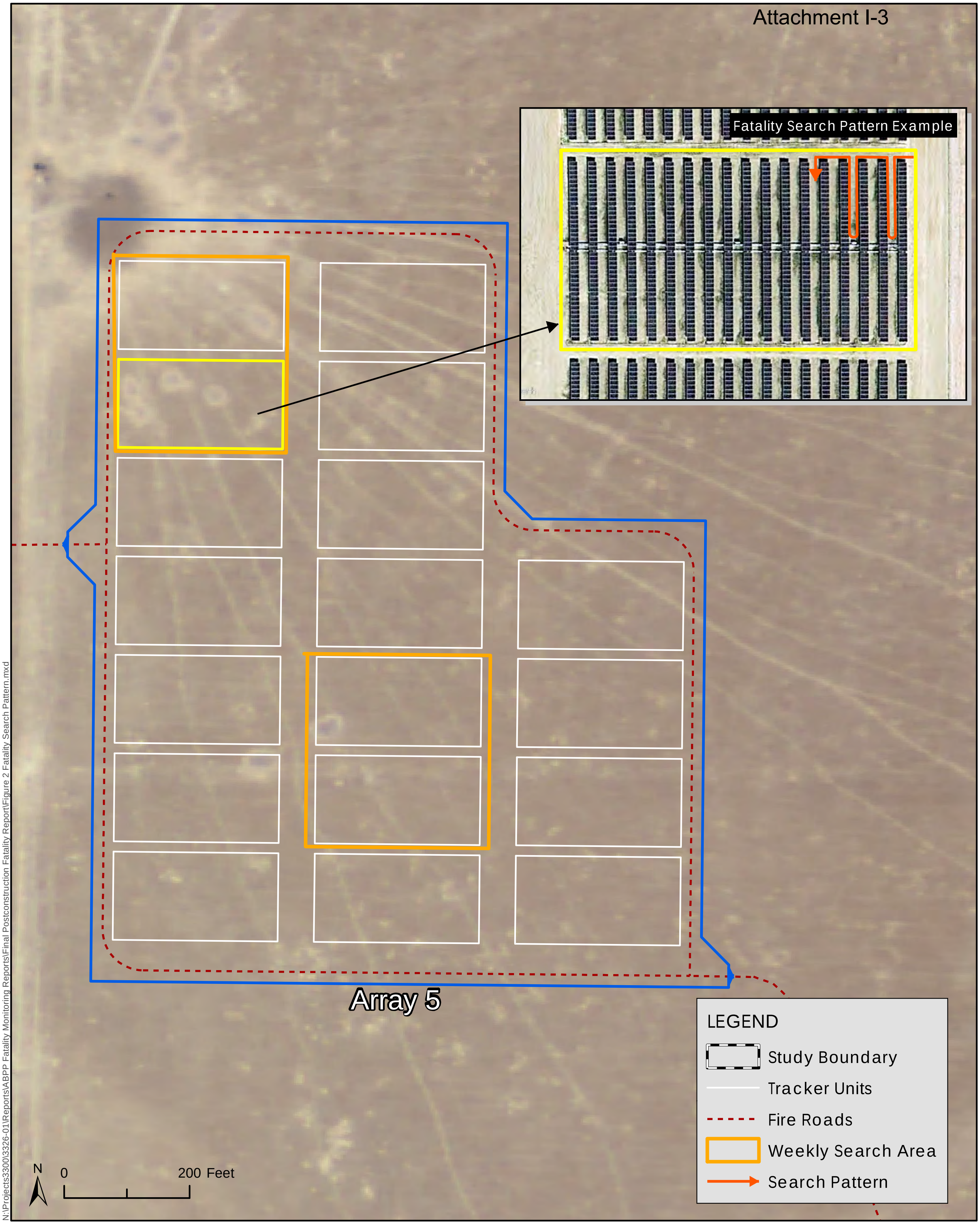
Notes:
[1] Sampling reduced to 20% of total array area (starting 2 January and 7 January 2014 for Arrays 2 and 1, respectively).
[2] The Serengeti portion of Array 2 was searched separately only until 27 November 2012 (3 days).

In the arrays, biologists searched tracker units in teams of two. In each tracker unit, biologists walked into every other row of panels and visually scanned both the row walked and each adjacent row. To avoid crossing the drive arms of the tracker units, searchers turned around upon reaching the drive arm, and continued to scan the next row as they proceeded out of the row. Thus, although searchers walked only every other row, they visually scanned adjacent rows to ensure full coverage (Figure 2).

Control plots were randomly placed in adjacent onsite Conservation Lands to measure the level of background mortality. Control plots were designed specifically for comparing background fatality rates to fatality rates within arrays by making them equivalent to the size of a typical SunPower Oasis tracker unit (i.e., equivalent to 18 rows of solar panels, with 40 panels to a row), which measures approximately 79.9 m by 42.8 m (3416 m^2). Six aggregated tracker units comprise a typical tracker block that generates 1.5 megawatts. We used pin flags or wooden stakes to delineate mock panel trackers on the control plots, and searchers followed the same pattern and procedure used for searching the arrays. We did not establish control plots for the 20% sample of Arrays 5, 6, and 9 because the 20% search area for these arrays contained too few trackers to meet the control plot establishment guidelines set forth in the Fatality Monitoring Plan (Appendix A in HTH 2011; the guideline is one control plot [defined in the plan as having the same spatial scale as 2 aggregated tracker blocks, or 12 tracker units] for every 16 tracker blocks [96 tracker units] searched).

Twenty percent of the total fence length was surveyed by one biologist. Each week, the biologist walked the inside portion of the fence while scanning a 6-m-wide belt centered on the fence. In some cases, the fences were not completely built until after weekly searches had already commenced. In these instances, fences were included as part of the regular search routine only after they were completely installed.

Because searches were conducted only on designated days as a part of the search protocol, make-up searches were not conducted if the search day was missed because of inclement weather, holidays, or maintenance work. In estimating the total number of fatalities, the fatality model accounted for search intervals of different lengths due to missed searches (e.g., if a weekly search day was cancelled because of rain, the search effort would resume the following week, and for that search, the interval was 14 days, not 7 days).



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 2 Fatality Search Pattern.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report
Figure 2: Fatality Search Pattern

2.1.1.2 Data Collection

We documented a fatality event each time a carcass or a feather spot was found. We considered a feather spot a fatality if it had at least two or more primary flight feathers, five or more tail feathers, or ten or more feathers of any type concentrated together in an area 1 square meter (m^2) or smaller (Smallwood 2007). We defined the number of feathers required to constitute a fatality using definitions employed in other fatality studies at wind farms (e.g., Gruver et al. 2009; Erickson 2009; Smallwood et al. 2010). Additionally, feather spots not meeting these requirements but containing flesh, blood, or bone were also considered fatalities.

During fatality searches, we occasionally encountered avian roost areas where signs of preening and molting were evident. Preening and molting spots typically have fewer feathers and are more spread out than feather spots associated with fatalities. Also, roosting areas rarely contain primary or secondary feathers, but are often dotted with droppings. In the solar arrays, we regularly observed flocks of mourning doves (*Zenaida macroura*) and horned larks (*Eremophila alpestris*) roosting. Mourning doves exhibit a complex molt strategy that can occur year-round and includes preformative, prealternate, and definitive prebasic molts (Otis et al. 2008). Likewise, horned lark adults and first-year birds undergo a definitive prebasic molt at the end of the breeding season (typically the end of July) (Beason 1995). Searchers used their biological knowledge to determine whether or not feathers from mourning doves, horned larks, or other species known to be in a molt period should be recorded as a fatality. No data were taken on molt or roost-spot feathers.

When a fatality was detected, we assigned the fatality a unique incident number and recorded data on the fatality and the substrate in which it was found. Incident numbers were written as follows: YYYYMMDD-##, consisting of the year, month, day, and a unique number assigned to each searcher. Each searcher recorded a unique set of numbers, so data can be traced back to individual searchers. To verify species identifications, we took photographs of each fatality and, when necessary, consulted Scott and McFarland's *Bird Feathers: A Guide to North American Species* (2010). We also consulted our feather reference collection, prepared from positively identified fatalities collected on the site over the course of Project monitoring. For each fatality, we recorded location (using Universal Transverse Mercator [UTM] coordinates), time found, taxon, four-letter alpha code, carcass condition, parts found, number and types of feathers, suspected cause of death, and estimated time since death. Whenever possible, we recorded information about the age and sex of the fatality, as well as scavenger type. Additionally, we gathered information on the size and spread of the feather spot and the surrounding substrate, vegetation height, and percent vegetation cover, as well as whether the fatality occurred in an array row walked by a searcher, or in a neighboring row (for fatalities found in the arrays). All carcasses and feather spots discovered by regular weekly searchers were removed.

The suspected cause of death was assessed for all fatalities and assigned to one of the following classes: collision, electrocution, predation, disease, or unknown. It was then further assigned a "Level of Certainty for Suspected Cause" category, as defined in the Migratory Bird Special Purpose Utility Salvage Permit (SPUT) for the Project (issued by the U.S. Fish and Wildlife Service [USFWS] on 10 March 2014 [permit number MB02733B-0]). Level of certainty was assigned as follows: Observed = 100%; Valid = >90%; Probable = >50%; Possible = <50%; or

Unknown/Not Applicable. To make the assessment, searchers examined all carcasses for signs of injury or illness, and assigned a cause of death using the following assumptions:

- Possible solar panel or powerline collision: If fatalities were found in arrays or under powerlines, we assigned collision as the cause of death with >90% certainty if carcasses had injuries consistent with an impact. We assigned collision as the cause of death with >50% certainty if feather spots or carcasses had no noticeable injuries but were found within 10 feet of powerlines. In arrays, we assigned collision as the cause of death with <50% certainty if feathers or flesh were stuck to solar panels, or if smudge marks or imprints, as from an impact, were observed on a panel.

- Electrocution: For fatalities near the MVOH Line, we assigned electrocution as the cause of death with >90% certainty if carcasses had visible injuries consistent with electrocution (e.g., singed feathers, burns on feet, or curled leg scales). Likewise, we assigned the same cause of death and level of certainty to a few fatalities based on circumstantial evidence (e.g., a breaker tripped during a recent rain event for an unknown reason, and a bird nesting on an overhead wire pole was found dead shortly afterward).

- Predation: We assigned predation as the cause of death with >90% certainty if birds were found impaled on tumbleweeds, fence lines or other structures. For decapitated carcasses found in any Project element, we assigned predation as the cause of death with <50% certainty. Fatalities found at sites regularly used by predators (e.g., at a plucking post), as indicated by old remains, were assumed to be predated with >50% certainty.

- Disease: We assigned this cause of death with >50% certainty if a carcass was emaciated or otherwise appeared unhealthy (e.g., if it had growths typical of avian pox).

- Unknown: Fatalities were assigned the designation of unknown cause of death when there was no compelling evidence to indicate how these fatalities occurred (e.g., carcasses had no obvious signs of injuries or illness, or body parts or entrails were present on solar panels but there were no visible imprints or smudge marks that allowed us to distinguish between predation and collision).

2.1.2 Repeat Searches

A series of repeat searches was designed to provide a verification of the results of weekly searches. Repeat searches were designed to create a shorter search interval that would allow carcasses with a short scavenging time to be more readily found and identified. Because repeat searches were intensive, they covered less area than the regular weekly searches. After the first annual report, it became apparent that avian fatalities, particularly long-lasting feather spots, accounted for the bulk of the findings. Likewise, the low number of trackers that were searched during each 5-day repeat search caused confidence intervals on these independent fatality estimates to be greatly inflated, compared to the estimates produced using weekly search data. For these reasons, the utility of repeat searches was greatly reduced, and the decision was made to cease all repeat searches (both 5-day and 1-day repeat searches) from 1 January 2014 onward. The methods used for the repeat searches, conducted before 1 January 2014, are summarized below.

2.1.2.1 5-Day Repeat Searches

Five-day repeats were conducted on all Project elements subject to regular weekly searches, with the exception of the Gen-tie Line, which was not included in the 5-day repeat searches because small birds and bats were assumed to be unlikely to strike high-tension powerlines. All other Project elements were subjected to 5-day repeat searches once every 4 weeks.

During each 5-day repeat search period, searchers covered a quarter of the total area covered during regular weekly searches (i.e., 25% of Arrays 1, 2, and the MVOH Line, and 5% of Arrays 4, 5, 6, 7, 8, 9, and 11), and the same areas were searched for 5 consecutive days. Because of the small size of the Evaporation Pond, searchers walked the entire perimeter of the pond during repeat searches. However, due to the large size of Array 2, 5-day repeat searches of Array 2 Serengeti were conducted separately from those of Array 2 North and South.

When possible, 5-day repeat searches were conducted in areas separate from regular weekly searches, to keep the search interval at a constant span of 7 days for all weekly search areas. In Arrays 1 and 2, however, overlapping search areas were unavoidable because weekly searches encompassed 100% of the arrays.

The first day of each 5-day repeat search was treated as a clearance search, and all fatalities found on the first day were removed from further analysis. Data for fatalities was collected in the same way as weekly search data, with the following exception: feather spots and scavenged carcasses were monitored throughout the search period, and notes were made regarding persistence. All remaining feather spots were collected on the fifth day of the 5-day repeats. For intact carcasses, cameras traps were placed near the carcasses to monitor persistence past the 5-day span of the repeat searches, with the intention of collecting additional data for carcass-persistence trials; however, due to technical issues, camera traps did not function properly during these trials and the data could not be incorporated.

2.1.2.2 1-Day Repeat Searches

One-day repeat searches covered a randomly selected block representing 25% of all elements (i.e., arrays, fences, and control plots) searched in the original weekly or 5-day repeat searches. Blocks were searched on the day following regular weekly searches, every other week (semimonthly), and after each 5-day repeat search, on either the last day of the 5-day search or 1 day after its completion.

2.1.3 Incidental Fatalities

Fatalities were sometimes found outside of regularly searched areas, both by CVSR Project personnel and HTH biologists. When this happened, fatality data were recorded and the fatality was collected in the same manner as if it were found during a weekly search. These fatalities could not be included in the site-wide fatality estimate, however, because the lack of a regular search interval made it impossible to accurately quantify the search effort for the area and the probability of finding the fatality. Nonetheless, all incidental fatalities are reported here, in the SPUT reports, and in reports for other Project salvage collection permits.

2.1.4 Carcass-persistence Trials

Carcasses decompose at rates that are influenced by environmental conditions, and carcasses and feather spots are also moved and dispersed by wind and scavengers. To calculate the number of fatalities that might be available for searchers to find in a given period, it is necessary to estimate the total persistence rates of carcasses. Scavenger species and density vary by region, so site-specific carcass-persistence trials must be conducted to accurately estimate fatality rates.

For our carcass-persistence trials, we acquired avian carcasses from the onsite fatality searches and a local wildlife rehabilitation center. We also collected them opportunistically (e.g., we collected road-killed birds) under State and federal salvage permits. Whenever possible, we used species that naturally occur on the site or in the surrounding area, and limited the handling of carcasses to reduce transfer of foreign scents. We categorized all carcasses into one of two sizes: small (≤100 grams [g]) and large (>100 g). For the purposes of the descriptive statistics and fatality estimates provided in this report, trial data from the first year and second year (between 15 October 2012 and 11 March 2014) are grouped together to provide a more robust fatality estimate. Of the 206 carcasses that we placed for carcass-persistence trials, 101 were large and 105 were small (Appendix B).

To avoid “scavenger swamping” (saturating our study area with more carcasses than resident scavengers are able to remove) (Smallwood et al. 2010), we limited the number of carcasses present in a search area at one time to four. We dropped carcasses from shoulder height and allowed them to fall naturally to the ground. We recorded each carcass location with a Global Positioning System (GPS) unit, and noted the direction and distance to the nearest tower (when carcasses were placed along the Gen-tie Line) or tracker number (when carcasses were placed in arrays). We placed Bushnell Trophy Cameras (Model 119436) within 1–1.5 m of the carcass on a t-post, facing north to avoid allowing sunlight to shine directly into the camera lens. We programmed cameras to take three date- and time-stamped photographs in quick succession after each trigger event; each camera had a 1-second refractory period between pictures.

We checked each carcass and the camera batteries and memory storage cards at least once per week, for up to 6 weeks or until the carcass was scavenged. We classified the carcass as “removed” if the carcass could not be located, or if there were fewer than ten feathers of any type or fewer than two primary feathers remaining. To classify feather spots, we used criteria similar to those used by the regular weekly searchers. Therefore, we classified the scavenging outcome as “not removed” if there were ten or more feathers of any type, two or more primary feathers, or any flesh or bone remaining. If the carcass was no longer in front of the camera and was not readily apparent, we searched the surrounding area using a spiral search pattern. We started the search at the camera’s location and spiraled out to 30 m from the camera. If the carcass had been moved to a new location within the search area, but was intact, we repositioned the camera on the carcass in its new location.

During the first year of our study, we collected all remaining feathers and signs of the carcass after the initial scavenging event. However, after the first annual report, it became apparent that, because of the high proportion of feather spots found on site, it was necessary to estimate the full persistence time for carcasses, rather than the time to scavenging (in this report, use of the term *carcass persistence* rather than *carcass removal* reflects this broader focus). Therefore, in this document we report the time to scavenging as the time to the last scavenging event, and for scavenger species, we report the scavenger that resulted in the carcass's removal or conversion to a feather spot. In nine trials, carcasses were collected after the initial scavenging event, when partial or nearly whole carcasses remained behind. We exclude the results of these trials because they lack complete persistence data and we have no basis for estimating the time to the last scavenging event. Additionally, to accurately estimate total persistence, we conducted 30 feather spot persistence trials, in different vegetation heights, to determine appropriate adjustment factors to add to the persistence time of carcasses that were scavenged but left feather spots behind. We monitored each feather spot on a weekly basis for up to 4 weeks. To calculate the adjustment factor, we took the midpoint from the time between the last check when the feather spot was present and the first check when the feather spot was absent. We averaged these persistence times by vegetation class and added them to the total persistence time for all carcasses that left feather spots behind after scavenging.

For 28 of the carcasses that were removed and left no feather spot, the time of scavenging was not captured on camera. For the purpose of our descriptive statistics, we calculated the midpoint between the last photograph in which the carcass was present and the first photograph in which it was absent, and used that as the time of scavenging, to yield the total persistence time.

2.1.5 Searcher-efficiency Trials

Not all fatalities deposited in a search area are observed by searchers because detection is inherently imperfect, being influenced by topography, vegetation, fatality size and type, and the number of fatalities removed by scavengers (Thompson 1994). To determine how efficient searchers are at detecting fatalities, we conducted a series of searcher-efficiency trials, in which we placed trial fatalities (*fatality plants*) throughout the fatality search areas and calculated the average number of trial fatalities found by searchers.

For the purposes of the descriptive statistics and fatality estimates provided in this report, trials from the first year and second year are grouped together to provide a more robust fatality estimate. Therefore, we report on a total of 52 days of searcher-efficiency trials, starting 5 September 2012 and ending 31 July 2014, and representing the entire postconstruction study period.

We used both carcasses and feather spots in various amounts of vegetation cover throughout the year to characterize separate rates of searcher efficiency for fatality size (large or small), fatality type (carcass or feather spot), and visibility. Trial fatalities included specimens of common species found on the CVSR Project site and suitable proxy specimens salvaged from a local wildlife rehabilitation center (Appendix A). To avoid harming scavengers, euthanized specimens were not used for bias trials. In total, we planted 434 fatalities for searcher efficiency trials. Three fatality plants were removed by scavengers, leaving an effective sample size of 431 (113 small and 98 large feather spots, and 113 small and 107 large carcasses).

We assigned each species of carcass to one of two sizes (small or large) based on weight (i.e., small = ≤100 g; large = >100 g), as defined in *The Sibley Guide to Birds* (Sibley 2000). We also assigned a size to each feather spot based on spread of feathers. A small feather spot was defined as feathers from a small or large bird, scattered in a ≤20-square-centimeter (cm^2) area; a large feather spot was defined as feathers from a small or large bird scattered in an area >20 cm^2. In total, we classified all fatality plants into one of four size classes: (small feather spot, large feather spot, small carcass, or large carcass).

We originally categorized visibility into one of three classes: Easy, Moderate, or Difficult, based on a combination of vegetation height and percent vegetation cover (Table 2; Figure 3) within a 1-m^2 area surrounding each fatality plant. However, because the Difficult visibility class was rarely present (N=5), for all analyses, we lumped Moderate and Difficult visibility classes together in the High vegetation height category.

Table 2. Visibility Classifications Assigned to Categories of Vegetation Height and Percent Cover

Vegetation Height (Low <25 cm, Medium 25-50 cm, High >50)	Vegetation Cover (%)	Visibility Classification
Low	0–50	**Easy**
Low	50–100	**Moderate**
Medium	0–25	**Easy**
Medium	25–100	**Moderate**
High	0–50	**Moderate**
High	50–100	**Difficult**

In the field, we used a combination of haphazard and random, stratified sampling to determine the placement of each fatality plant. Haphazard sampling was incorporated to ensure that a representative number of trial fatalities were placed in all visibility classifications. We marked each fatality plant discreetly with tape or flagging so that searchers would know to report their findings as part of the controlled searcher-efficiency trial. We arrived approximately 1 hour in advance of the searchers so that we could set out fatality plants without alerting searchers that they were being tested. We recorded a GPS point for each fatality plant, and assigned it to a visibility group. Searchers contacted the efficiency-trial biologist as they discovered trial plants, and all plants were removed from the field once the fatality search was completed.

a) Easy Visibility **b) Moderate Visibility**

Figure 3. Photographic Examples of Easy (a) and Moderate (b) Visibility Classes for Feather Spots (Top Two Panels) and Carcasses (Bottom Two Panels), Based on Vegetation Height and Percent Cover

2.2 Statistical Methods

Animals die at an unknown rate, which must be inferred from regular searches of a site. Secondly, fatalities persist for varying amounts of time and are imperfectly detected by searchers. For these reasons, it is often inappropriate to draw conclusions based on the raw number of fatalities in an open system. The need to accurately estimate fatalities given these variables has driven the development of several fatality estimation statistical methods (e.g., see Johnson et al. 2003; Smallwood 2007; and Huso 2011). All of these fatality estimation models are based around several common themes; in particular, all such models are designed to infer information about the total number of fatalities or total fatality "population" based on fatalities that are found. In an open system, the true total number of fatalities is unknown and cannot be determined, but fatality estimators use information based on average scavenging times and average searcher efficiency to form a number range (confidence interval) that likely contains the true number of total fatalities for a given site. The interval can be broadened or constrained based on the level of confidence desired. For this report, we use 90% confidence intervals for all fatality estimates. This means there is a 90% probability, based on our sample size that the true number of fatalities falls within our estimated range.

Because fatality estimates are based on the total number of fatalities found, there is an inherent bias when low numbers of fatalities are discovered. This is often referred to as *sampling bias*; it refers to the fact that small sample sizes may include outliers that are not representative of the wider population (in this case, the total number of fatalities that occur). As the number of fatalities found grows larger, the number, size, and species of fatalities should become more representative of the population, and fatality estimates become more accurate. Throughout this report, we urge caution in the interpretation of estimates based on small sample sizes; also, we did not calculate estimates based on data representing fewer than five fatalities.

As mentioned above, fatality estimation methods share a similar underlying premise. Generally, the fatality estimation formula for a given site may be written as:

$$F = C/rp,$$

where the number of fatalities, F, is the quotient of the number of carcasses found, C, over the product of carcasses left unscavenged, r, and the proportion that an observer sees, p (Huso 2011).

The inputs for r and p are estimated in subgroups of covariates that influence the detectability and persistence of each carcass, such as carcass size, vegetation height, and stage of decay or scavenging (i.e., feather spot versus carcass). Given the tendency for many fatality estimation models to underestimate site-wide fatalities, we chose to use a fatality estimator written by Huso (2011), which was shown to outperform previously developed models by more accurately accounting for imperfect detectability. This model, the Fatality Estimator, was developed to estimate fatalities primarily for wind energy projects; however, it can be applied to other types of sites, including powerlines and solar projects (Huso 2011). The Fatality Estimator uses the conceptual framework of fatalities, combined with bootstrapping from models of r and p, to calculate variances and confidence intervals for the estimate of total fatalities. (*Bootstrapping* is a statistical method used to create a distribution to assign measures of variance to estimates when the underlying distribution of data is either unknown or cannot be represented algebraically (Efron and Tibshirani 1986)—bootstrapping resamples the data, by taking a subsample of the entire data set several thousand times to create a distribution that may be used to infer information about the sample mean).

2.2.1 Estimating Carcass-persistence Rates

Measurements of carcass-persistence rates, r, typically include one or more censoring values. A *censoring value* is used in statistics when a value is only partially known. For example, if a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing, then the date of scavenging is unknown, and an interval censor would be used. Because we used camera traps, the majority of scavenging times were known precisely, and the data were not censored. However, when cameras failed to record the moment of scavenging, we applied interval censoring. Likewise, because feather spots were collected after scavenging events, a right censor was applied to trial carcasses that resulted in feather spots (right censors are typically used when the carcass or feather spot is collected prior to the end of the trial). Finally, owing to camera malfunctions, no photographs were taken of some carcasses prior to scavenging. In these cases, the carcasses and all evidence of the fatalities were removed before the first field observation. The time to scavenging and total persistence time for these carcasses was calculated as the midpoint from the time of placement to the time of the first field check, and a left censor was applied in the model.

There are four commonly used survival model distributions that can be used in the Fatality Estimator for a value of *r:* exponential, Weibull, loglogistic, and lognormal. These four distributions have different rates and shapes of decay curves that attempt to model the survival of carcasses over a given search interval. Because the time of death for detected fatalities is usually unknown, the probability of persistence cannot be calculated exactly for each carcass, but it can be estimated from the selected survival model and bootstrapped to obtain a range of estimates of *r* for each carcass.

We modeled our data using a series of models based on each of these four distributions. For each distribution, we compared models with and without explanatory variables. (An *explanatory variable* is any data set of interest that may have an influential relationship on the dependent variable, or measured outcome, of a study.) Specifically, for each distribution, we compared the following possible models: the null model, which contains no explanatory variables, a model controlling for season as an explanatory variable, a model controlling for size as an explanatory variable, and a model controlling for both season and size as explanatory variables. This resulted in four models for each distribution, for a total of 16 models.

To rank the fit of each survival model to our carcass-persistence trial data, we used Akaike's Information Criterion adjusted for sample size (AICc) (Akaike 1973). AIC and AICc are typically used to compare the relative fit of different models to a dataset. Although the absolute value of AICc may vary, the difference in AICc values among models provides information about which model is most statistically supported. The model with the lowest AICc value is typically held to be most supported by the data, but any model with a change in AICc values of less than 2 from the "best model" is considered to have strong evidence supporting it (Burnham and Anderson 2004).

2.2.2 Estimating Searcher-efficiency Rates

Searcher efficiency, or the proportion of fatalities that an observer sees, *p*, is represented most simply by the following equation:

$$p = \frac{NumberObserved}{NumberAvailable}$$

We compared four models for this dataset: the null model, a model containing size class as an explanatory variable, a model containing visibility class as an explanatory variable, and a model containing both size class and visibility class as explanatory variables.

2.2.3 Estimating Fatalities on the Project Site

The Fatality Estimator bootstrapping procedure calculates an adjusted fatality value for every fatality found based on the search interval, searcher efficiency, and carcass persistence. Because fatalities of different species and different-size feather spots are found in different vegetation heights and percent cover, fatality estimates based on different data sets with the same number of total fatalities can yield very different results. Fatalities found in tall grass, for example, are considered more difficult to find, based on the searcher-efficiency rates calculated at the CVSR Project. Therefore, fatalities found in tall grass are weighted more heavily in the overall estimate.

Within the Fatality Estimator, the bootstrapped values are automatically summed, and a total estimate and 90% confidence intervals are calculated for the Project element and each covariate combination assigned. The Fatality Estimator was developed for wind energy projects, and used individual wind turbines as the sample unit of replication. To apply this tool to the CVSR Project, we used tracker units instead of turbines as the sample unit. For the overhead lines, for which the entire length was sampled, we set the entire feature as the sample unit. For the fences, we made an estimate from the 6411.2-m length searched during weekly fatality searches as a unit, and extrapolated from the estimate to represent the total fence length of 32056 m.

Although the majority of fatalities were included in the fatality estimates, some did not meet the underlying assumptions of the fatality estimate model. Fatalities deemed older than the search interval (i.e., fatalities missed during previous searches) were not included in the Fatality Estimator because rates of imperfect efficiency (i.e., <100%) are already accounted for in the model, and including these old fatalities would falsely inflate estimates. Likewise, incidental fatalities were not included in the Fatality Estimator because they were found outside the defined search effort. Clearance fatalities more than 1 day old (>24 hours) were also excluded from estimates because time since death could not be reliably established.

When possible, we calculated fatality estimates by fatality class [a size designation of small ≤100g, or large >100 g. based on average size of species as defined in *The Sibley Guide to Birds* (Sibley 2000)], season, and cause of death; however, small sample sizes (N<5) sometimes did not allow for estimates to be calculated for all of these explanatory variables.

The date range for all fatality estimates is based on one full year where weekly fatality searches occurred across all Project elements, from 7 November 2013 to 6 November 2014. Although Arrays 1 and 2 were searched at 100% until the end of December 2013, fatalities found in trackers outside the 20% area that was established in January 2014 were excluded from all estimates.

2.2.4 Applying Control Plot Data to Adjust Fatality Rates

If we assume that control plots adequately represent background mortality that could be expected if the CVSR Project did not exist, then we should be able to estimate the mortality rates related to the presence of the Project as the difference between rates within the arrays and rates in the control plots within Conservation Lands. Any such evaluation requires that fatality rates between array areas and Conservation Lands be evaluated and applied on the same spatial and temporal scale. Control plots were designed specifically for this purpose by making them equivalent to the size of a typical tracker unit. This allowed us to calculate a per-tracker unit fatality rate for array areas, and a per-control plot fatality rate for Conservation Lands that represents the same spatial scale. Because the focus of the fatality survey effort was to develop an overall fatality rate for the Project with a certain level of precision, more effort was spent surveying tracker units within arrays than control plots within Conservation Lands. Approximately one control plot was established for every eight tracker units surveyed within the arrays. The larger sample size of tracker-unit sized plots within the arrays versus those in Conservation Lands resulted in higher precision in estimating fatality rates in the array areas as compared to Conservation Lands.

To estimate the fatality rate related to the CVSR Project, we used bootstrap methods and the results from the Fatality Estimator to estimate the mean and 90% confidence intervals of the difference between per-tracker fatality rates within array areas and per-control plot fatality rates within Conservation Lands.. In an attempt to account for differences in sample sizes between array areas and Conservation Lands, we subsampled array areas at a sample size equal to the number of control plots. By applying this method to the results from the Fatality Estimator, we adjusted the individual fatalities to account for imperfect detection due to searcher efficiency and carcass persistence rates.

Definitions:

N_C = Total number of control plots within Conservation Lands that were surveyed for the entire study period,
N_T = Total number of tracker units surveyed within array areas during the study period,
n_c = number of randomly sampled control plots,
n_t = number of randomly sampled tracker units,
F_C = Total estimated fatalities across all n_c over the study period,
F_T = Total estimated fatalities across all n_t over the study period,
F_{con} = estimated background fatality rate based upon control plots over the study period,
F_{trac} = estimated per-tracker unit fatality rate within arrays over the study period,
$F_{b.adj}$ = estimated per-tracker unit fatality rate that is adjusted by subtracting background fatality rates, and
m = the number of bootstrap iterations.
Note that $n_c = n_t = N_C$.

The bootstrap process proceeded as follows:

1. Randomly sample n_c control plots, with replacement, from the N_C control plots at the study site. Note that because we are sampling with replacement, an individual control plot may be represented more than once.
2. Based on the new random sample of n_c control plots, estimate the total fatality rate for control plots, F_C, using the Fatality Estimator .
3. Estimate the per-control plot fatality rate, which equates in spatial scale to the per-tracker unit fatality rate: $F_{con} = F_C / N_C$.
4. Randomly sample n_t tracker units, with replacement, from the N_T tracker units in the study area.
5. Based on the new random sample of n_t tracker units, estimate the total fatality rate for tracker units sampled, F_T, using the Fatality Estimator. Note that we are estimating total fatalities for N_C number of tracker units, and not for the entire facility or the N_T number of tracker units surveyed.
6. Estimate the per-tracker fatality rate: $F_{trac} = F_T / N_C$.
7. Calculate the adjusted, per-tracker fatality rate as the difference between the per-control plot fatality rates and the per-tracker fatality rates from 3 and 6, above ($F_{b.adj} = F_{trac} - F_{con}$).
8. Do this m number of times, yielding m values of $F_{b.adj}$. ($m = 2000$).
9. Estimate the adjusted, per-tracker fatality rate as the mean of the m values of $F_{b.adj}$, and the 90% confidence intervals as the 0.05 and 0.95 quantiles of those values.

Sampling only N_C trackers from the much larger N_T trackers that were actually surveyed at the site is intended to simulate a balanced paired design, as if we had sampled an equal amount of area in the arrays and within the onsite Conservation Lands. If we had not done so, our degree of confidence in the mean per-tracker unit fatality rate for array areas would be much higher than the mean control plot fatality rate in Conservation Lands due to the relatively low sample size of control plots, which could result in biased estimates. It should be noted that when we applied this analysis to results from the Fatality Estimator, we did not account for uncertainty in searcher efficiency and carcass persistence sub-models; and therefore, we invoke an assumption that the parameters of those models are known without error. Consequently, the results of this bootstrap analysis only represent error associated with the random and incomplete sampling of tracker units within arrays and control plots within onsite Conservation Lands (i.e., sampling error).

Section 3.0 Results

3.1 Weekly Searches

A total of 360 avian fatalities were found during weekly fatality searches of Project elements and control plots between 16 August 2013 and 17 November 2014 (Figures 4–11; Appendix C). An additional four clearance fatalities were also found during weekly searches. However, because time since death cannot be reliably established, we do not include clearance fatalities in any further discussion in this section. No bat fatalities were found during the current reporting period.

Of the 360 fatalities found during weekly searches, the majority (65%) was found in arrays, and 307 (85%) fatalities were year-round avian residents (Table 3).

Table 3. Number of Fatalities Found at Each Project Element, by Residency Status

	Migrant	Resident	Winter Resident	Unknown[1]	Total
Arrays	5	217	9	3	234
Control plots	1	16	0	0	17
Evaporation Pond	0	4	0	0	4
Fences	0	11	1	2	14
Gen-tie Line	14	38	11	2	65
MVOH Line	0	21	2	3	26
Total	20	307	23	10	360

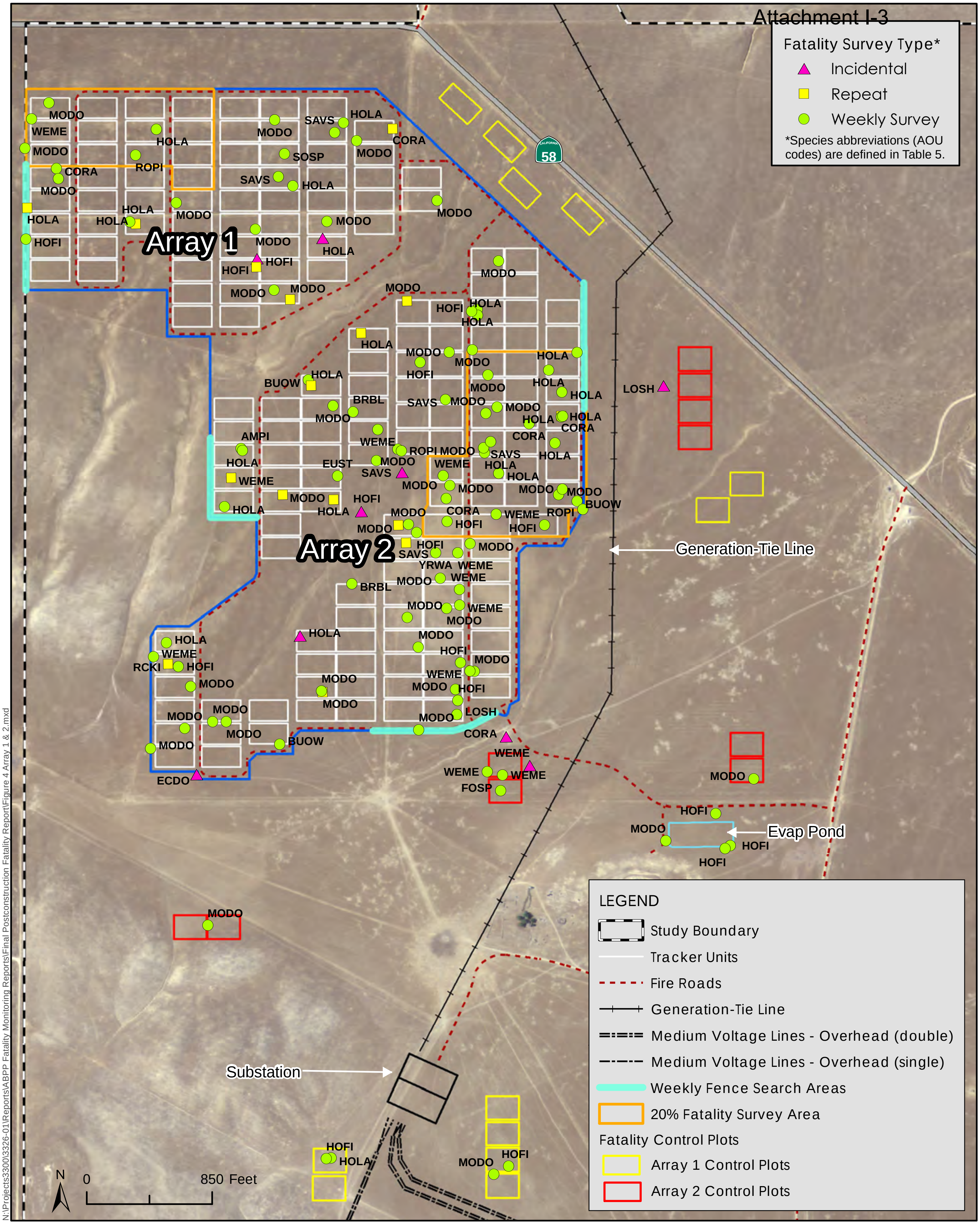
Note:
[1] Unidentified species among the fatalities were grouped as having Unknown residency status.

To assess the effect of season on fatalities, we excluded fatalities from Arrays 1 and 2 that were detected outside the reduced 20% search areas before January 2014. Additionally, one fatality found in a control plot was excluded; this control plot was removed in January 2014 to coincide with the reduced search effort in Arrays 1 and 2. Inclusion of these data would inflate seasonal numbers for these areas, because a greater search effort occurred before January. However, we excluded these data only for the analysis presented here, in Section 3.1. All subsequent sections include all available data from this reporting period.

There was seasonal variation in fatalities across the different Project elements (Table 4; Figures 12-16). The arrays and Gen-tie Line showed the most variation in the numbers of fatalities found across seasons (Figures 12 and 15). The largest number of fatalities in the arrays occurred in winter, accounting for 48.3% of all array fatalities (Table 4). There was a steady decline in fatalities in the arrays after winter, and this decline carried into fall 2014. Also, array fatalities were lower in fall 2014 compared with fall 2013. The largest number of fatalities along the Gen-tie Line occurred in fall 2013, accounting for 39.06% of all Gen-tie Line fatalities. Gen-tie Line fatalities declined after fall 2013 but remained fairly constant. Like array fatalities, Gen-tie Line fatalities in fall 2014 were lower than in fall 2013. There was also a slight spike in fatalities in the winter along the MVOH Line, but overall numbers for this Project element were too low to establish trends. Likewise, fatalities found along the fences and at the Evaporation Pond and control plots were too few to establish trends.

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



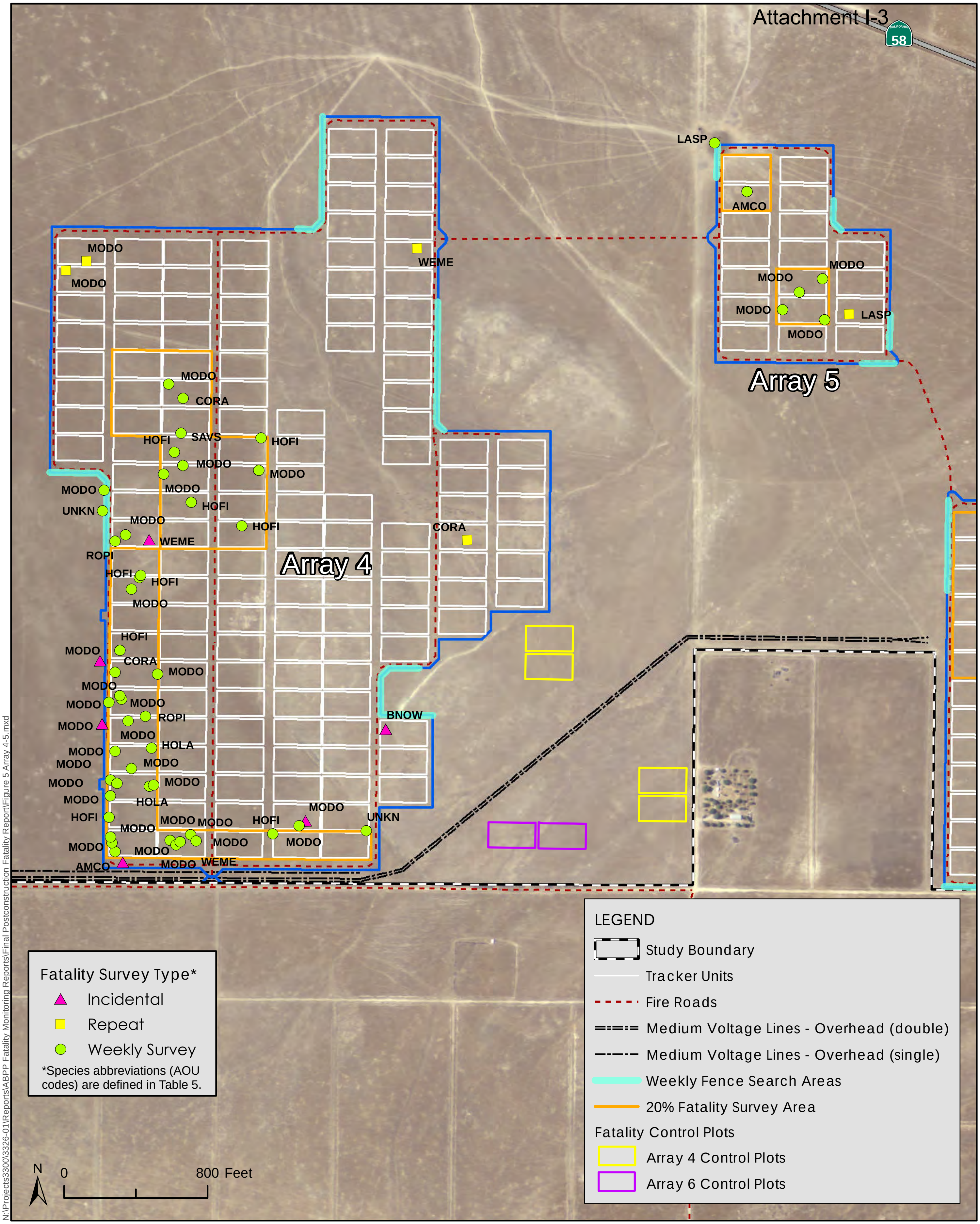
N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 4 Array 1 & 2.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report
Figure 4: Locations and Species of Postconstruction Fatalities Observed in Array 1 and 2 and Evaporation Pond Elements between 16 August 2013 and 17 November 2014

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 5 Array 4-5.mxd

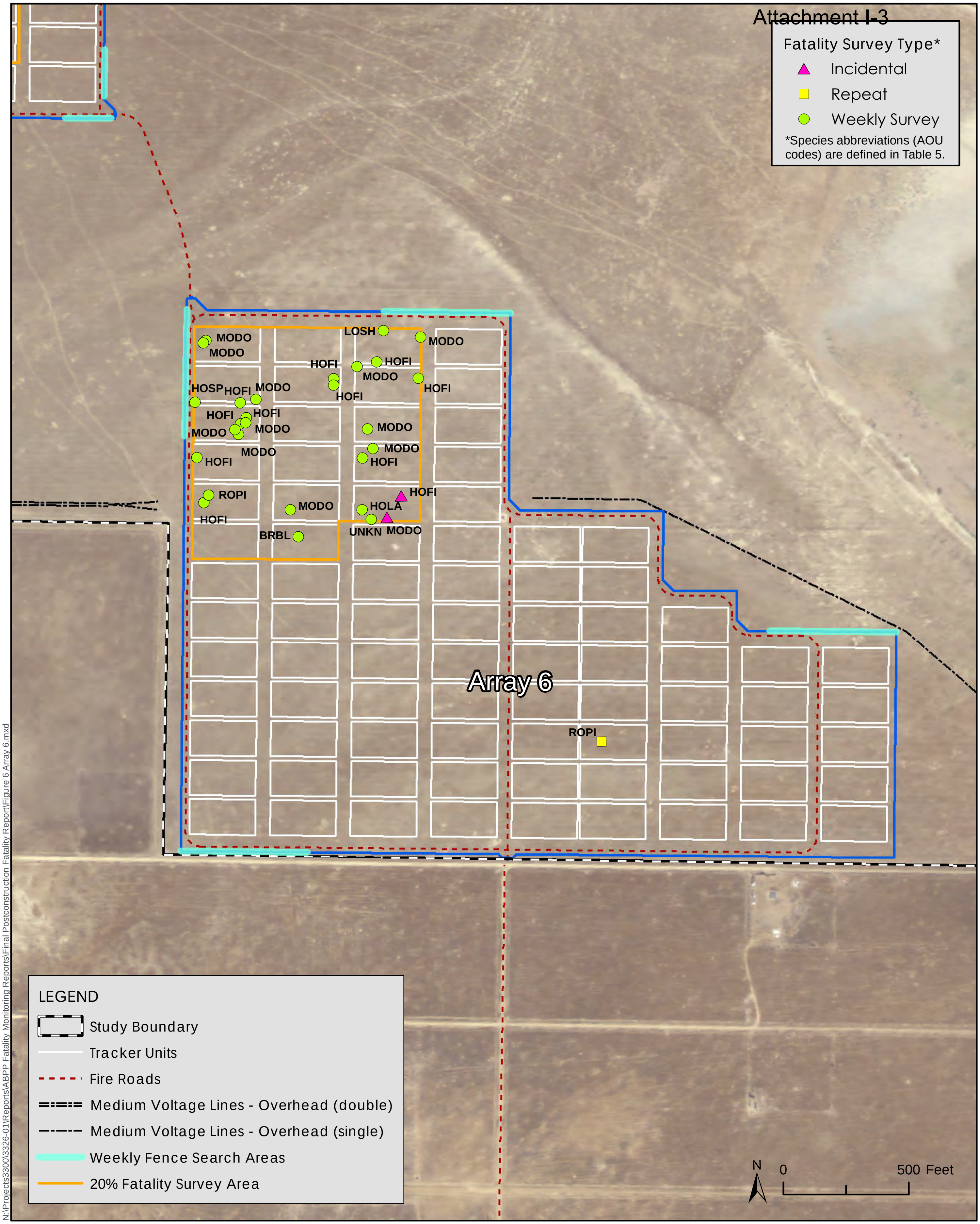
HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report
Figure 5: Locations and Species of Postconstruction Fatalities Observed in Array 4 and 5 Elements between 16 August 2013 and 17 November 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 6 Array 6.mxd

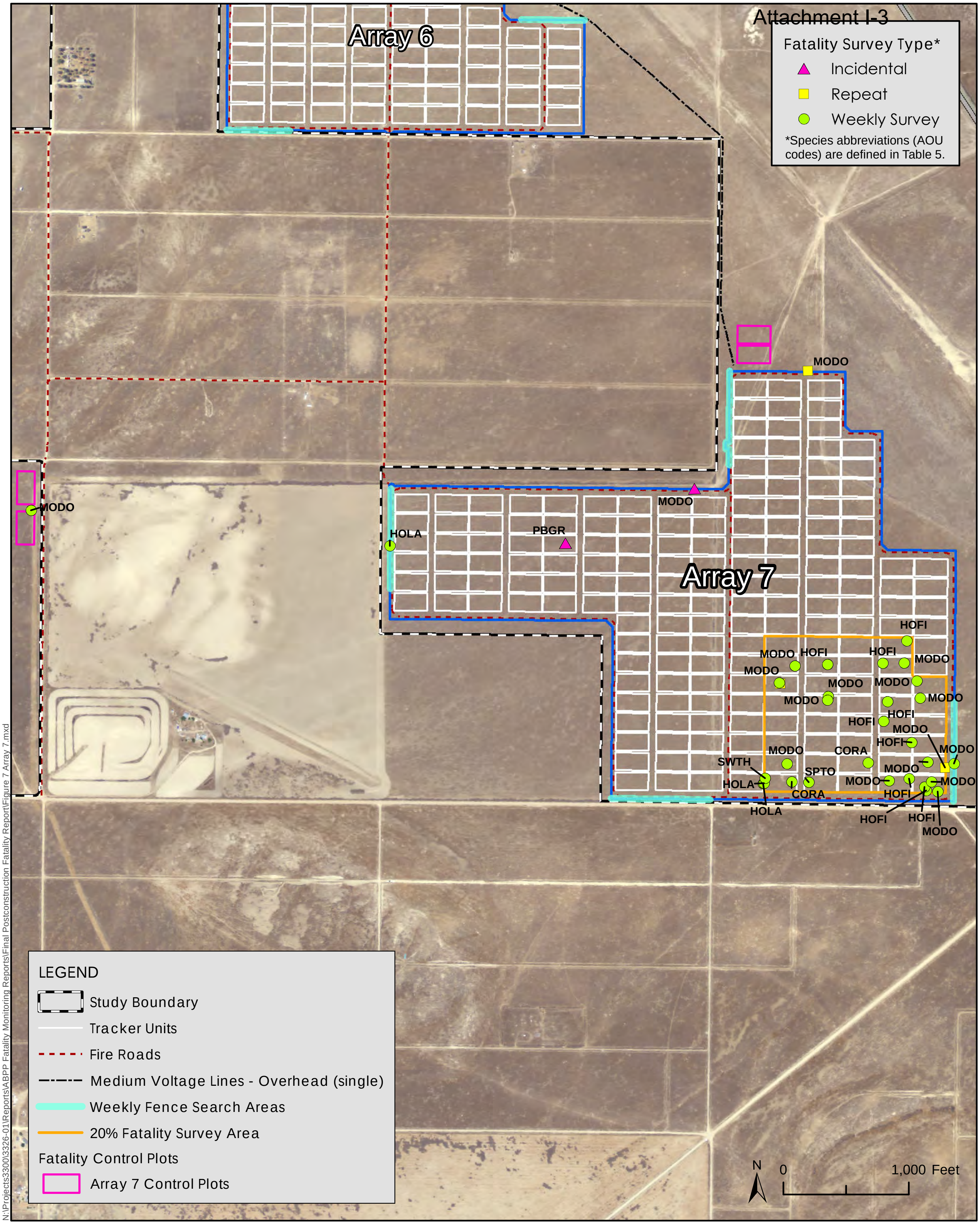
HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report
Figure 6: Locations and Species of Postconstruction Fatalities Observed in Array 6 Elements between 16 August 2013 and 17 November 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 7 Array 7.mxd

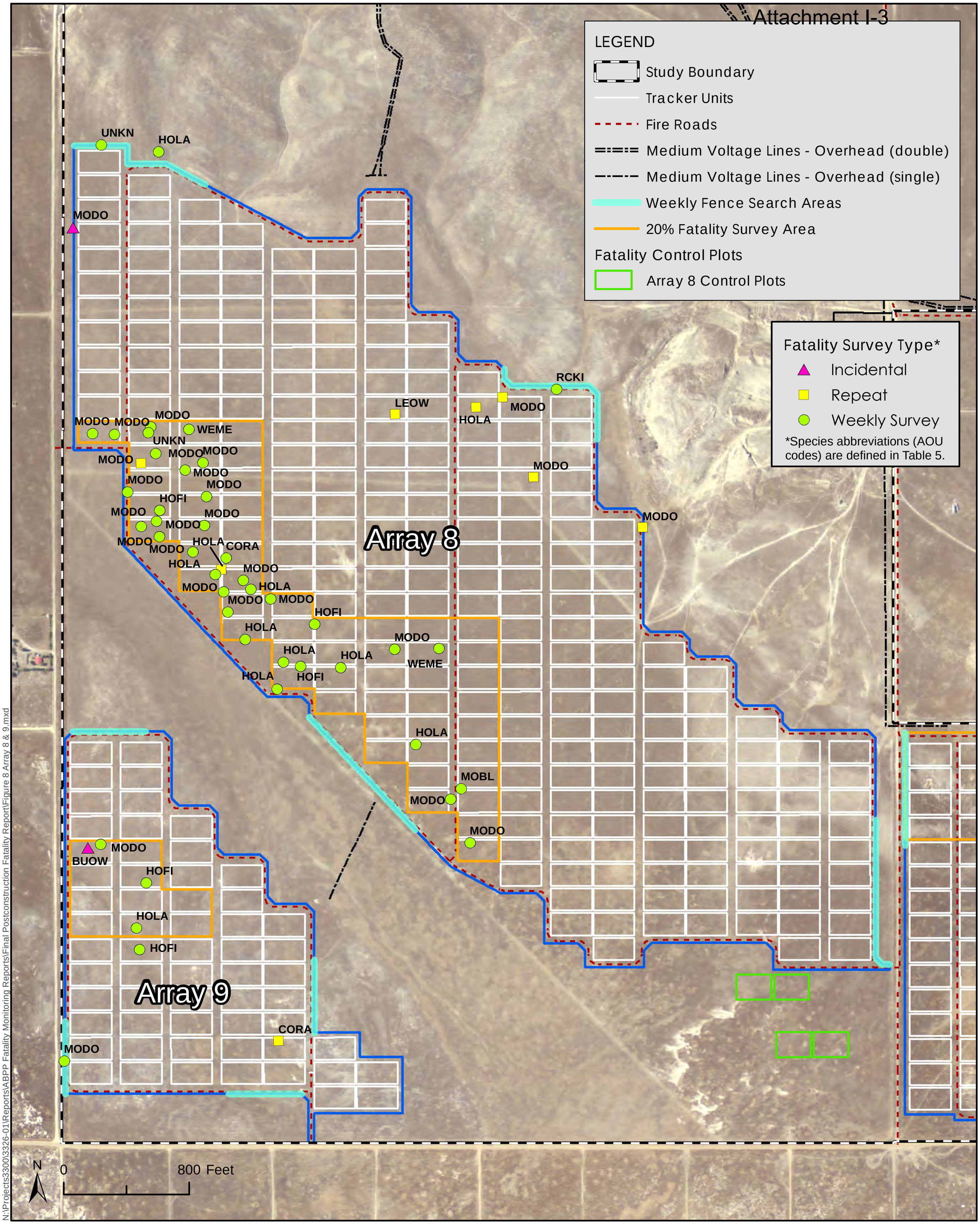
HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report
Figure 7: Locations and Species of Postconstruction Fatalities Observed in Array 7 Elements between 16 August 2013 and 17 November 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



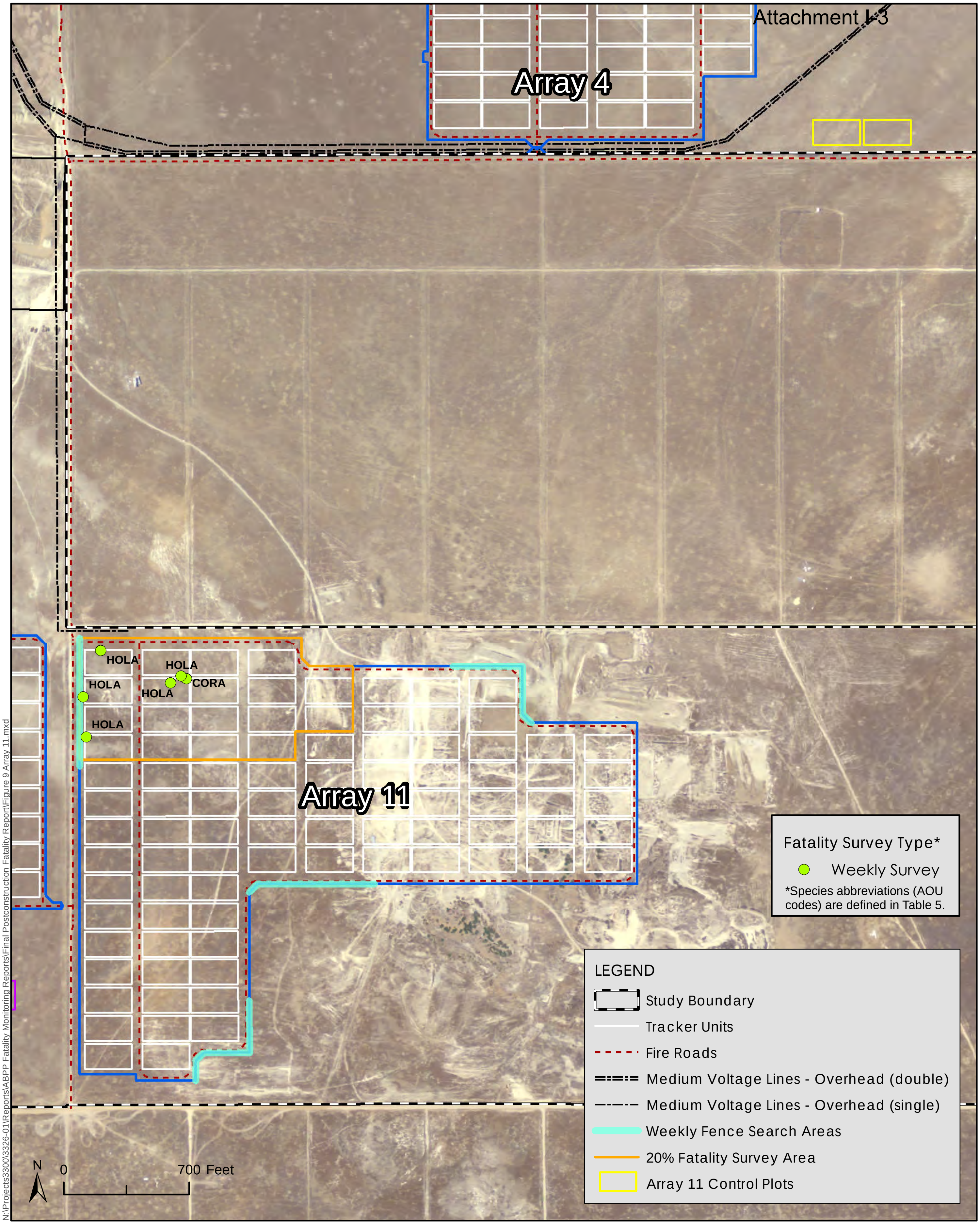
N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 8 Array 8 & 9.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report

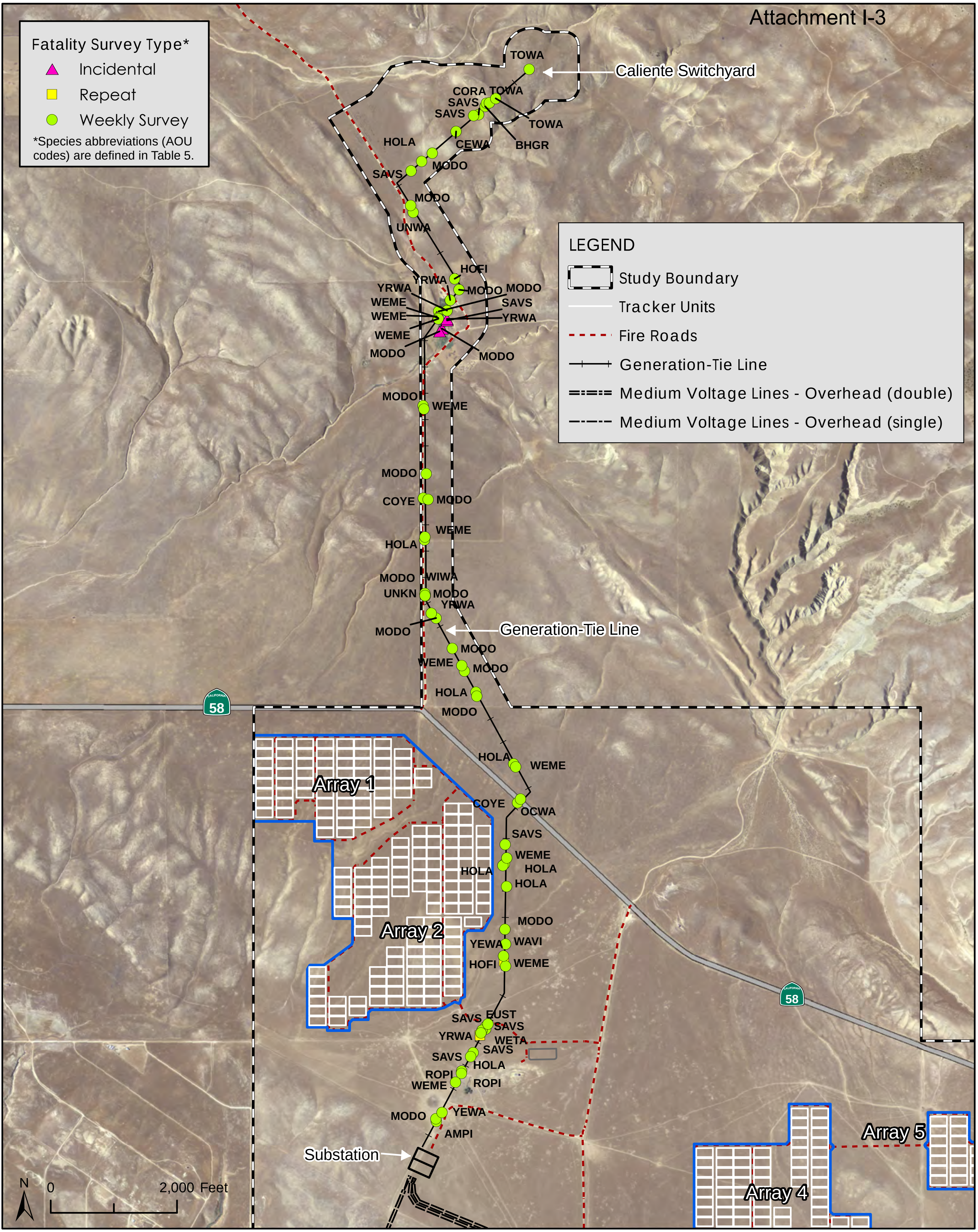
Figure 8: Locations and Species of Postconstruction Fatalities Observed in Array 8 and 9 Elements between 16 August 2012 and 17 November 2014



HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report
Figure 9: Locations and Species of Postconstruction Fatalities Observed in Array 11 Elements between 16 August 2013 and 17 November 2014



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 10 Gen-tie Area.mxd

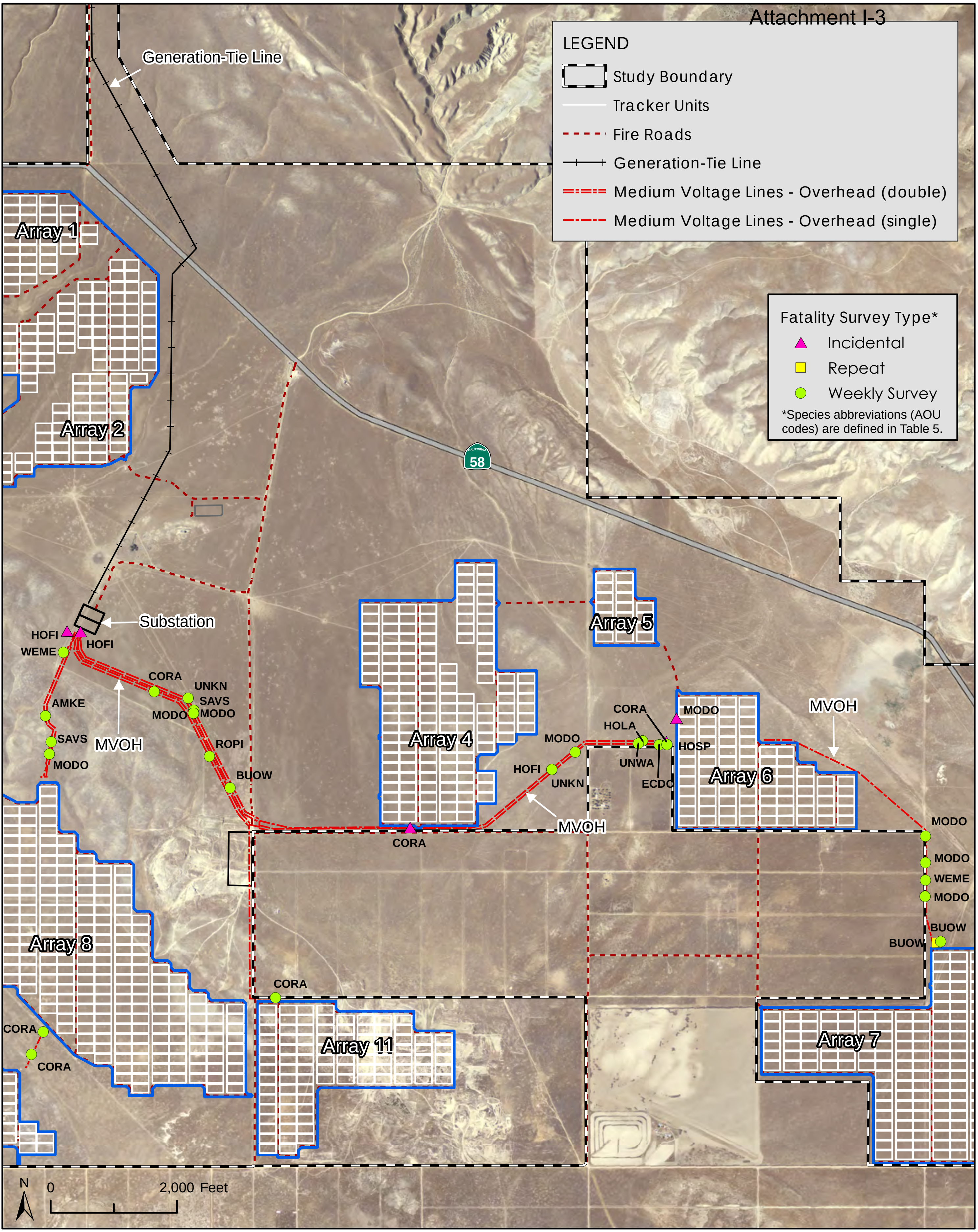
HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report
Figure 10: Locations and Species of Postconstruction Fatalities Observed along Gen-Tie Line between 16 August 2013 and 17 November 2014

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Final Postconstruction Fatality Report\Figure 11 MVOH Area.mxd

HPR II

H.T. HARVEY & ASSOCIATES
Ecological Consultants

California Valley Solar Ranch
ABPP Final Postconstruction Fatality Report
Figure 11: Locations and Species of Postconstruction Fatalities Observed along MVOH Line between 16 August 2013 and 17 November 2014

Table 4. Number (a) and Percentage (b) of Fatalities Found at Each Project Element, by Season (N=300) [1]

(a) Location	Number of Fatalities				
	Fall 2013	Winter	Spring	Summer	Fall 2014
Arrays	27	85	31	12	21
Control plots	2	7	4	0	3
Evaporation Pond	0	4	0	0	0
Fences	3	8	2	0	1
Gen-tie Line	25	9	11	10	9
MVOH Line	6	11	6	2	1
Total	63	124	54	24	35

(b) Location	Percentage (%) of Fatalities				
	Fall 2013	Winter	Spring	Summer	Fall 2014
Arrays	15.34	48.30	17.61	6.82	11.93
Control plots	12.50	43.75	25.00	0.00	18.75
Evaporation Pond	0.00	100.00	0.00	0.00	0.00
Fences	21.43	57.14	14.29	0.00	7.14
Gen-tie Line	39.06	14.06	17.19	15.63	14.06
MVOH Line	23.08	42.31	23.08	7.69	3.85
Total	21.00	41.33	18.00	8.00	11.67

Note:
[1] Fatalities in non-20% areas of Arrays 1 and 2 found between 16 August 2013 and 31 December 2013 are excluded

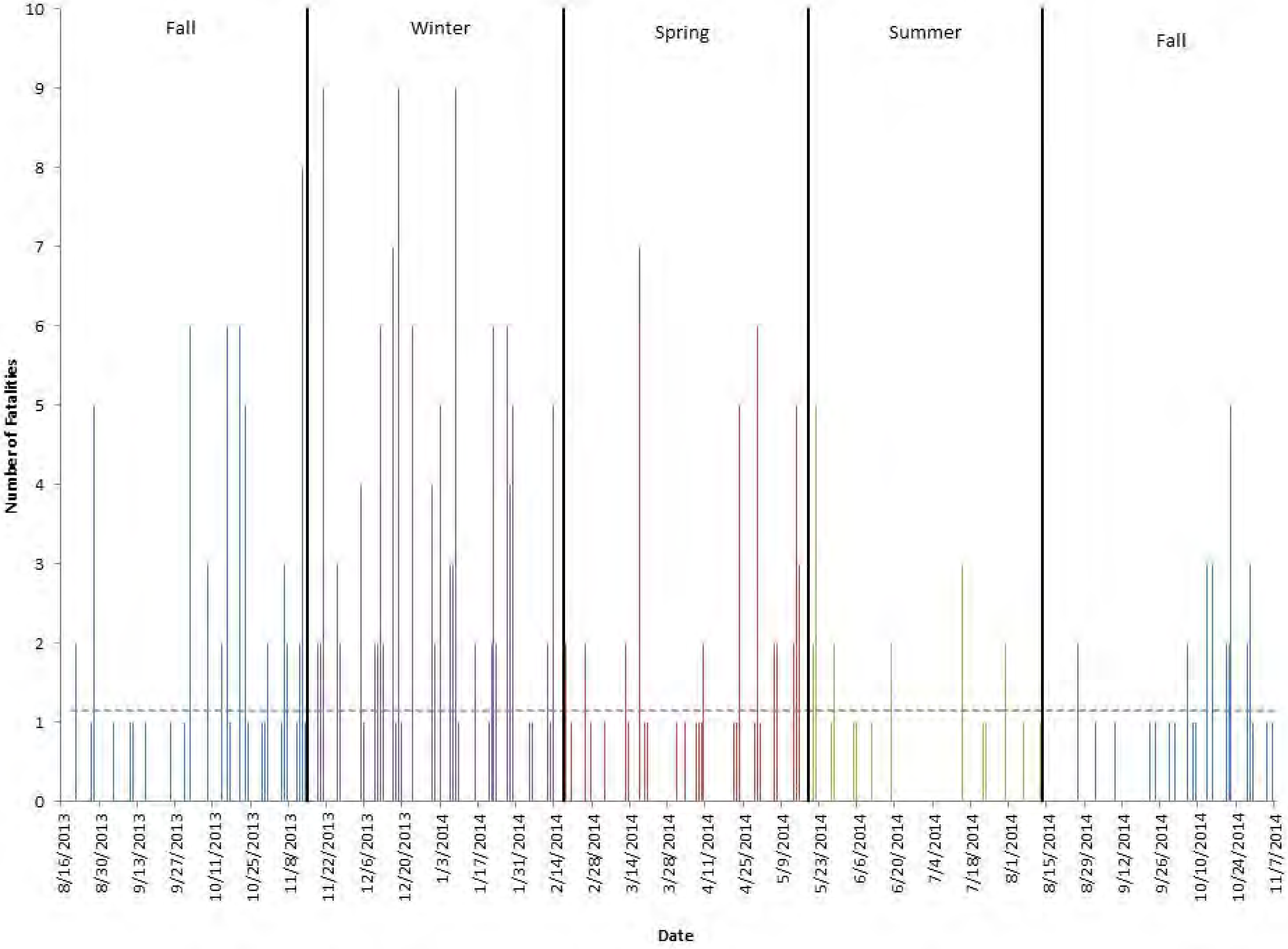


Figure 12. Seasonal Variation in Fatalities Found in Arrays

Note: Fatalities in non-20% areas in Arrays 1 and 2 found between 16 August 2013 and 31 December 2013 are excluded.

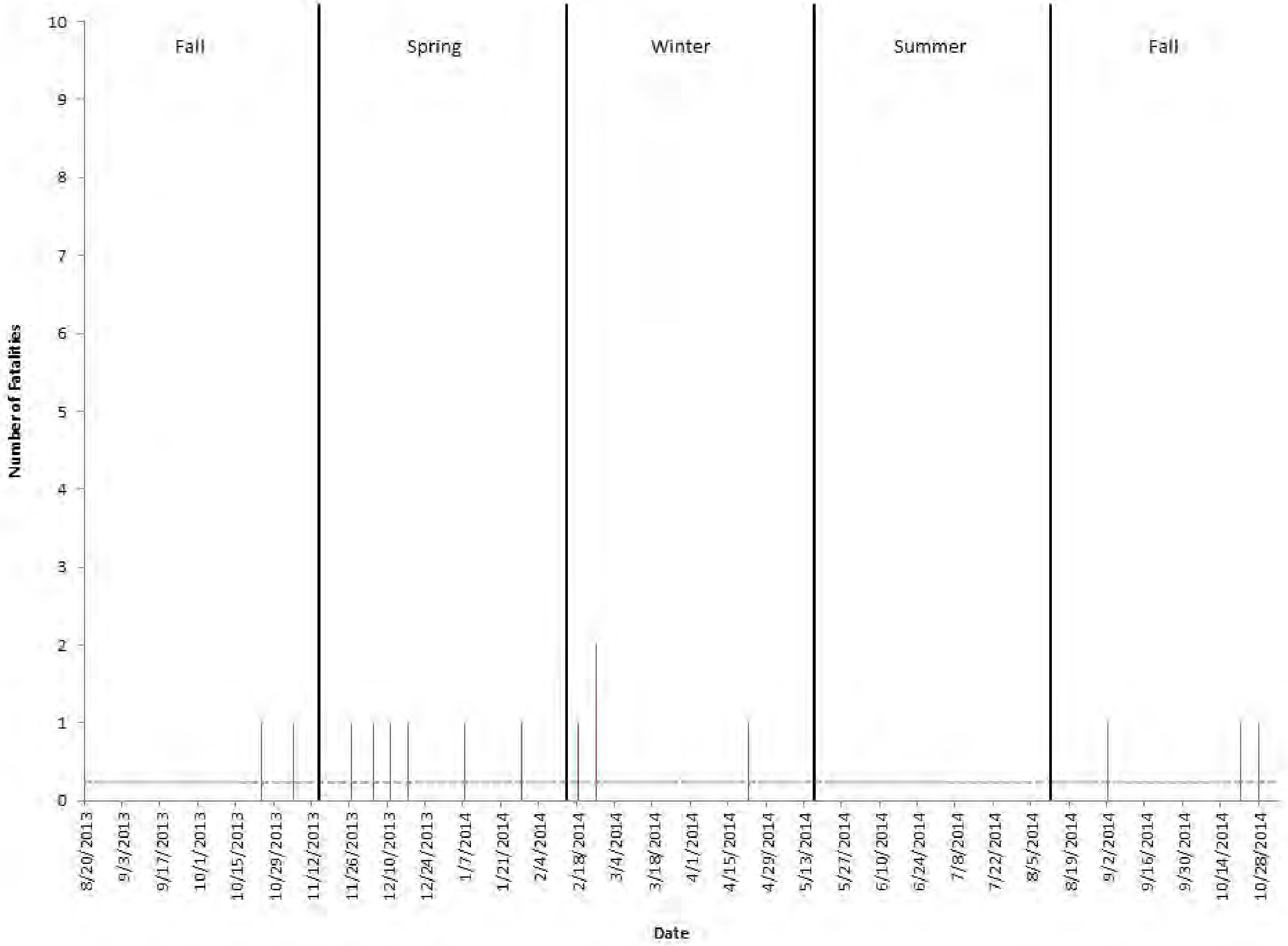


Figure 13. Seasonal Variation in Fatalities Found in Control Plots

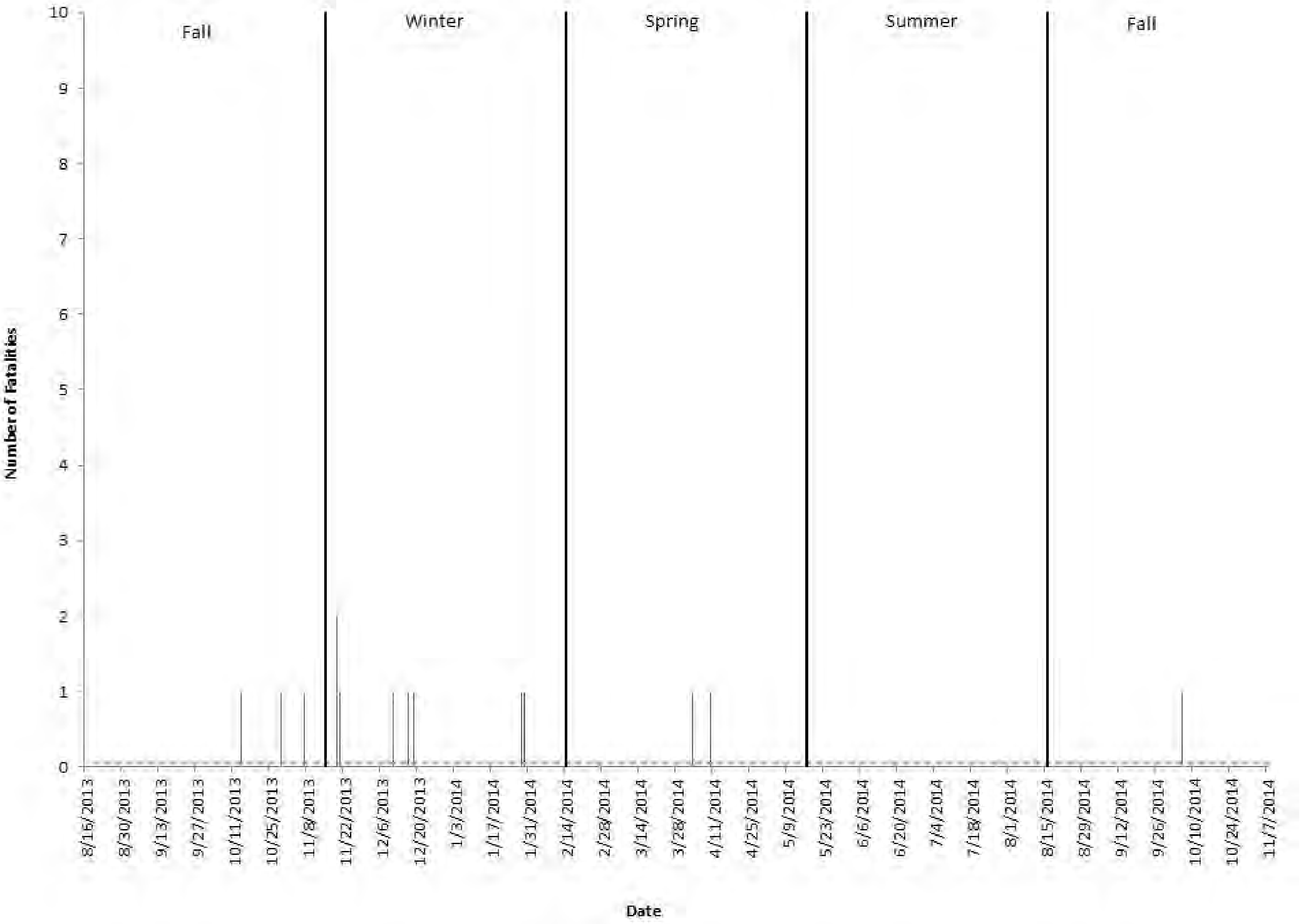


Figure 14. Seasonal Variation in Fatalities Found along Fences

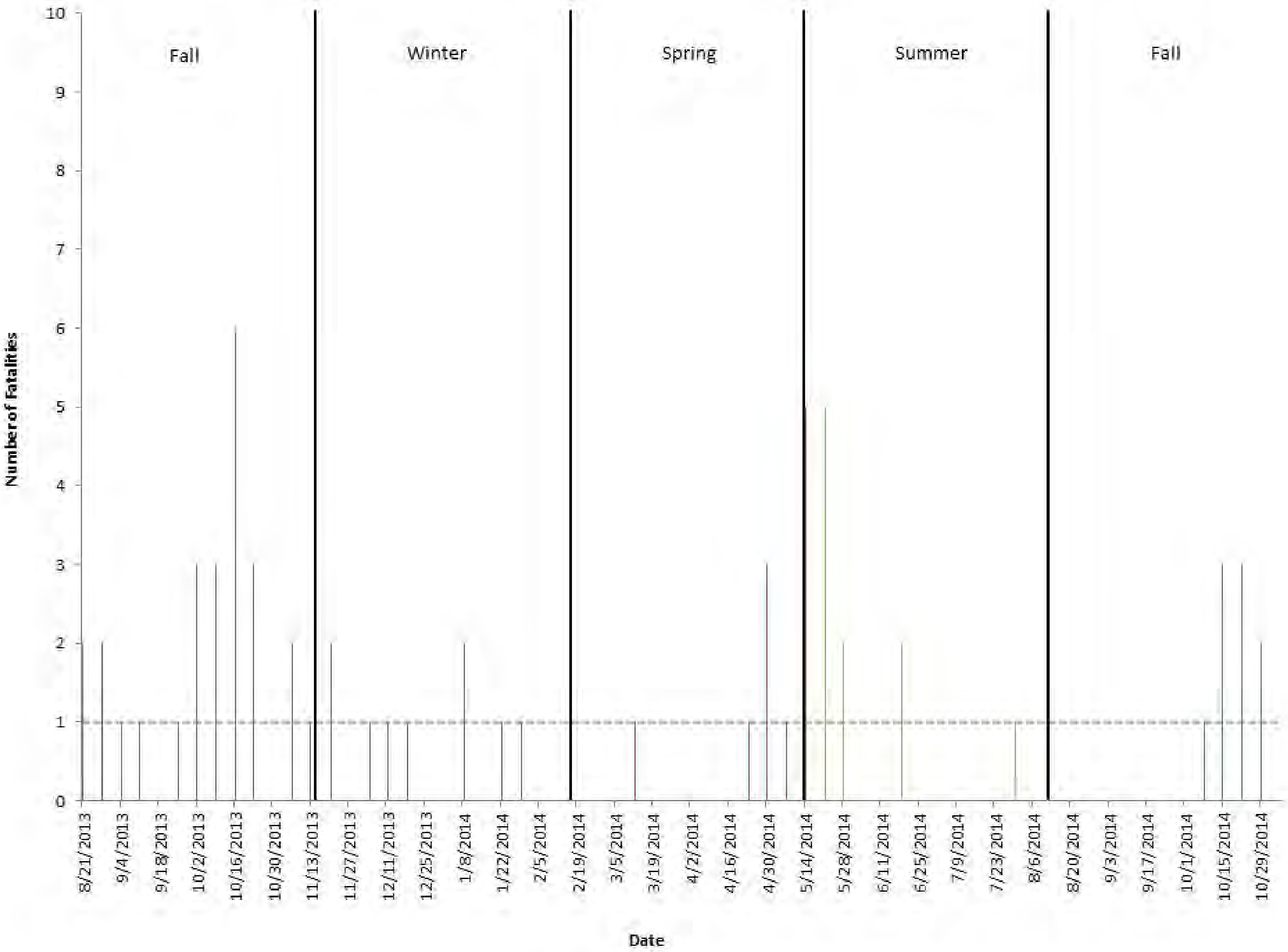


Figure 15. Seasonal Variation in Fatalities Found along Gen-tie Line

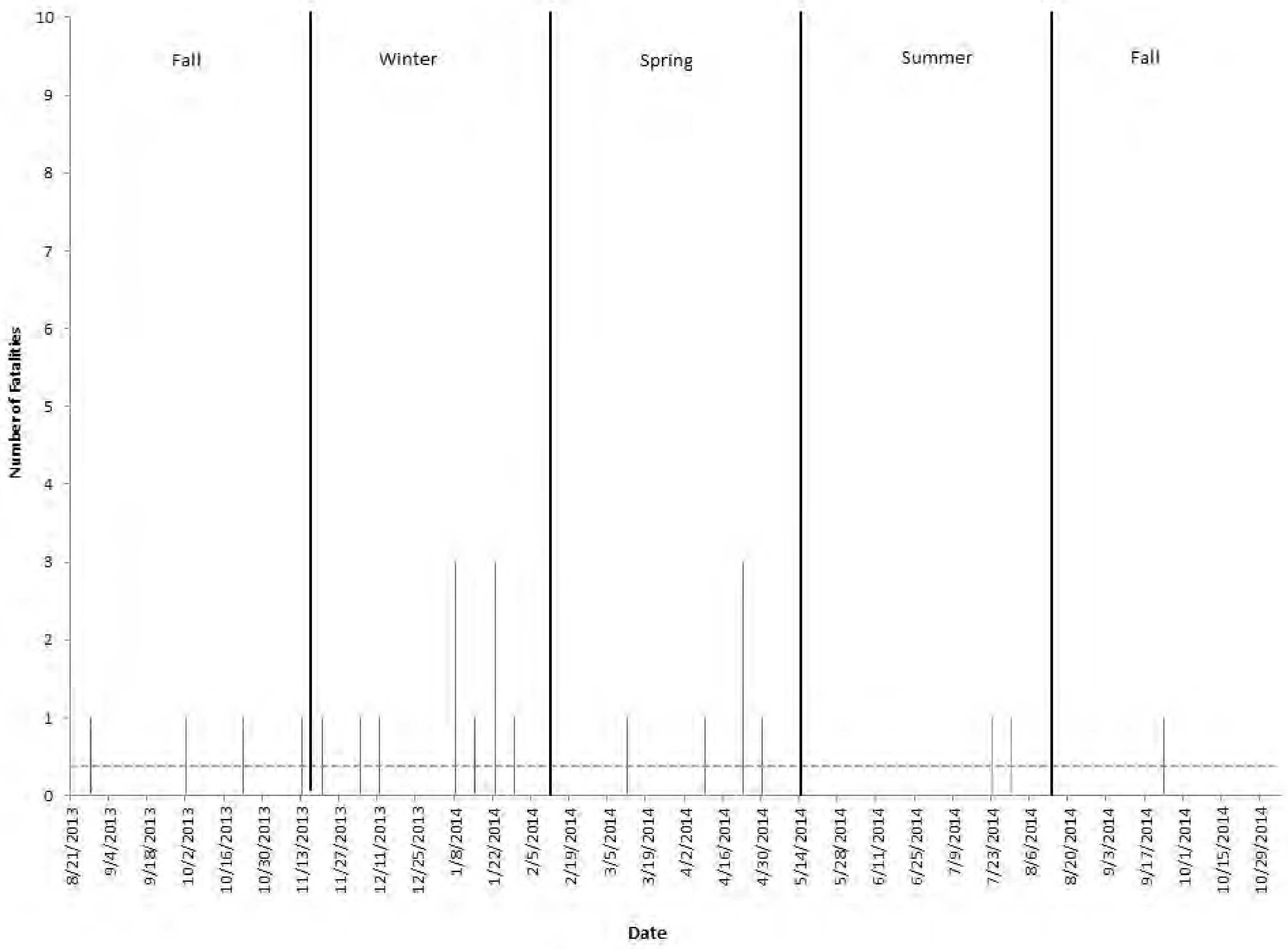


Figure 16. Seasonal Variation in Fatalities Found along MVOH Line

3.2 Repeat Searches

This section presents the results of all repeat searches, which (in the final year of monitoring) were conducted from 16 August through 31 December 2013. For reasons discussed in Section 2.1.2, we did not calculate fatality estimates based on the results of the 5-day repeat searches or the 1-day repeat searches in 5-day search areas for this report. However, because the 1-day repeat searches of weekly search areas affected the search interval for weekly searches and occurred in overlapping areas, these results were included in total fatality estimates (consistent with the first annual report [HTH 2014a]).

In total, 54 fatalities were detected during repeat searches across all Project elements and control plots. Eighteen of these fatalities were clearance fatalities and are not discussed further, for reasons described earlier. Therefore, the effective sample size for repeat searches was 36 fatalities. Combining the results of all repeat searches, the largest percentage (83.3%) of fatalities was found in the arrays. Details of fatalities found during each type of repeat search are presented below.

3.2.1 5-Day Repeat Searches

Nineteen fatalities were found during 5-day repeat searches between 16 August and 31 December 2013. An additional 18 clearance fatalities were found but not used in any analyses. One of these fatalities was found directly under the MVOH Line, suggesting collision as the cause of death (>50% certainty, or Probable). The cause of death for the remainder of fatalities was unknown.

3.2.2 1-Day Repeat Searches of Weekly Search Areas

Fifteen fatalities were found during 1-day repeat searches of weekly search areas during this annual reporting period. Two feather spots were found directly under the Gen-tie Line and were considered to have >50% probability of death by collision (Probable). The carcass of a mourning dove was found in Array 2. This carcass had bruising on its right foot and signs of trauma to its right shoulder and chest, suggesting that collision was a Valid (>90% certainty) cause of death. The cause of death for the remainder of fatalities was unknown.

3.2.3 1-Day Repeat Searches of 5-Day Repeat Search Areas

Two fatalities were found during 1-day repeat searches of 5-day repeat search areas between 16 August and 31 December 2013. One was the feather spot of a mourning dove, found along the fence in Array 8 on 18 October. The second was the feather spot of a common raven (*Corvus corax*), found in Array 9 on 8 November. The causes of death could not be discerned for these fatalities.

3.3 Incidental Fatalities

Thirty-five incidental fatalities were found between 16 August 2013 and 17 November 2014. This number includes two fatalities that were found in onsite Conservation Lands. Of the total number of fatalities found incidentally, 46.8% were found in arrays. Only one fatality was found and reported by CVSR Project staff.

Two ravens were found in separate events and both were suspected to have died from electrocution. A pied-billed grebe (*Podilymbus podiceps*) was observed being consumed by a coyote (*Canis latrans*), but because grebes are obligate waterbirds, collision was assigned as the cause of death. A mourning dove was also assumed to have died from collision after a smudge mark was discovered on an otherwise clean panel above a feather spot.

3.4 Trends in Total Fatalities

The subsections that follow present combined counts of fatalities found during weekly searches, repeat searches, and incidental detections. The purpose of combining these counts is to use all available data to help illustrate possible trends associated with Project elements and species.

Overall, 453 fatalities were found during weekly and repeat searches of Project elements, and incidentally. Twenty two of these fatalities were clearance fatalities, and 2 of the incidentally discovered fatalities were found on onsite Conservation Lands. In this section, we do not include any further discussion of clearance fatalities or fatalities found on Conservation Lands outside of control plots. Therefore, the effective sample size discussed for all Project elements in this section is 429 fatalities. The majority of these fatalities were found in arrays (Figure 17).

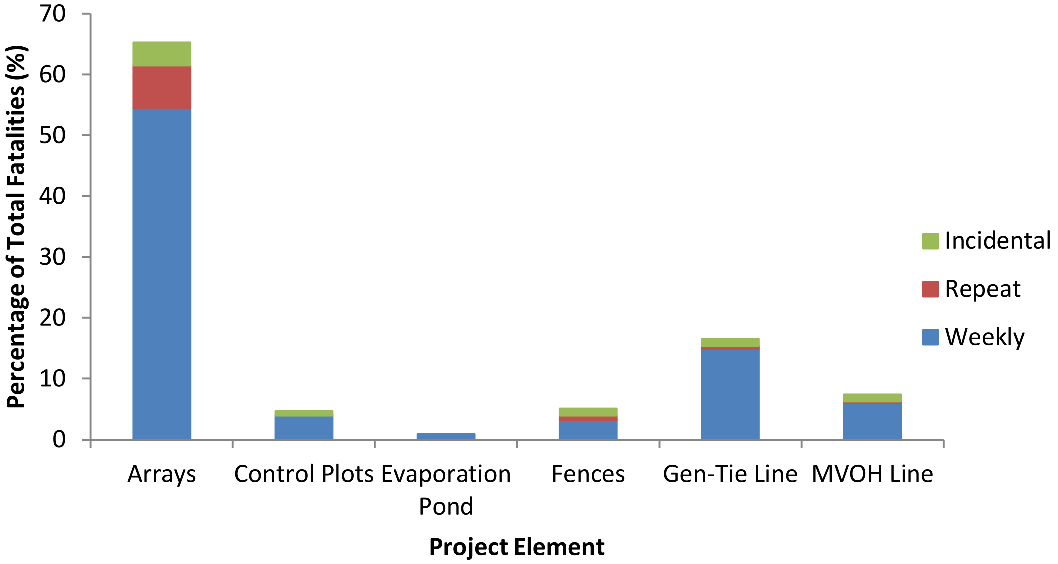


Figure 17. Percentage of Total Fatalities Found during Weekly Searches, Repeat Searches, and Incidentally at All Project Elements (N=429)

Note: Incidental fatalities found in onsite Conservation Lands, and clearance fatalities, are not included.

3.4.1 Cause of Death

Of the 429 fatalities found in Project elements and control plots, the cause of death for the majority (80.9%) could not be reliably discerned. Seventy-three (17.0%) were believed to have died as a result of a collision (50 on the Gen-tie Line, 15 on the MVOH Line, 7 with solar panels, and 1 with a perimeter fence). Two fatalities were believed to be electrocuted (0.5%). Six (1.4%) were believed to have been killed by predators, and one (0.2%) was believed to have died from disease.

Both electrocution deaths occurred along the MVOH Line (Figure 18). Although none of the fatalities found in control plots had a known cause of death, >45% of the fatalities found along the Gen-tie Line and MVOH Line were believed to be the result of collision. This determination was based primarily on the location of fatalities directly or nearly directly under the lines. Only eight fatalities found in arrays were linked to known causes of death (seven panel collisions and one predation event), and the remaining 97.1% of fatalities found in arrays were assigned an unknown cause of death.

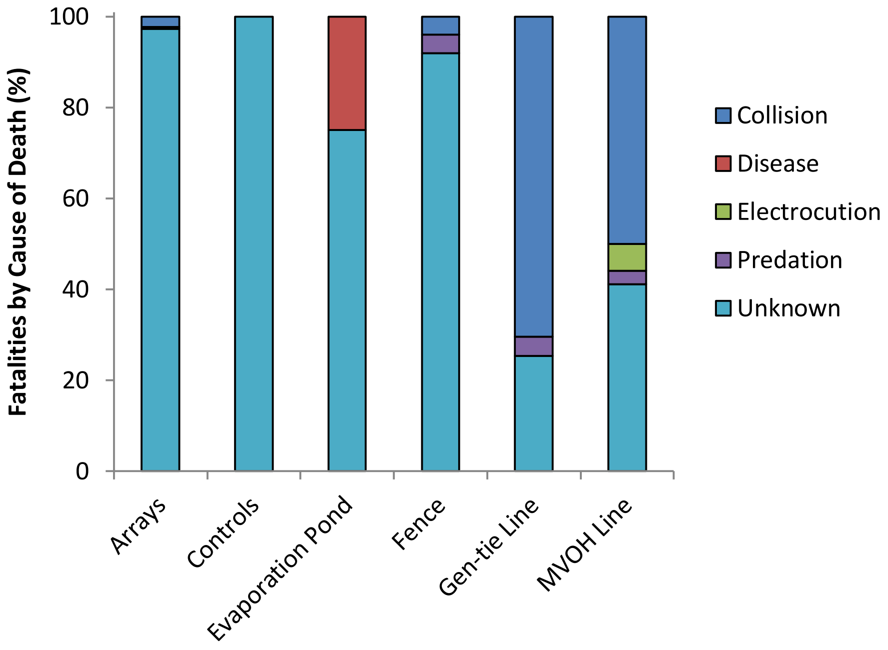


Figure 18. Cause of Death by Project Element

3.4.2 Fatalities by Species

In total, we found fatalities from 36 known avian species and 5 fatalities that did not provide enough information to assign them to a species (Table 5). With the exception of two American coots (*Fulica americana*) found in Arrays 4 and 5, and one pied-billed grebe found in Array 7, all known fatalities were terrestrial avian species.

Mourning doves accounted for the greatest percentage of fatalities (38.9%) found, with horned larks and house finches (*Carpodacus mexicanus*) composing the second (13.5%) and third (13.1%) most frequently observed fatalities, respectively. Fatalities from three special-status species, burrowing owl (*Athene cunicularia*), loggerhead shrike (*Lanius ludovicianus*), and yellow warblers (*Setophaga petechial*) were detected during weekly searches, but combined, these fatalities accounted for only about 3% of the total number of fatalities found during weekly searches.

Table 5. Number of Fatalities Found, by Species

Species	Scientific Name	AOU Code[4]	Fatalities Recorded
Mourning dove[2]	*Zenaida macroura*	MODO	167
Horned lark[1]	*Eremophila alpestris*	HOLA	58
House finch[1]	*Haemorhous mexicanus*	HOFI	56
Western meadowlark[1]	*Sturnella neglecta*	WEME	30
Common raven[2]	*Corvus corax*	CORA	21
Savannah sparrow[1]	*Passerculus sandwichensis*	SAVS	18
Rock pigeon[2]	*Columba livia*	ROPI	11
Burrowing owl[2]	*Athene cunicularia*	BUOW	7
Yellow-rumped warbler[1]	*Dendroica coronata*	YRWA	6
Eurasian collared-dove[2]	*Streptopelia decaocto*	EUCD	4
Unknown passerine[3]		UNKN	4
Brewer's blackbird[1]	*Euphagus cyanocephalus*	BRBL	3
Loggerhead shrike[1]	*Lanius ludovicianus*	LOSH	3
Townsend's warbler[1]	*Dendroica townsendii*	TOWA	3
Unknown large bird[2]		UNKN	3
American coot[2]	*Fulica americana*	AMCO	2
American pipit[1]	*Anthus rubescens*	AMPI	2
Common yellowthroat[1]	*Geothlypis trichas*	COYE	2
European starling[1]	*Sturnus vulgaris*	EUST	2
House sparrow[1]	*Passer domesticus*	HOSP	2
Lark sparrow[1]	*Chondestes grammacus*	LASP	2
Ruby-crowned kinglet[1]	*Regulus calendula*	RCKI	2
Warbler species[1]		UNWA	2
Yellow warbler[1]	*Setophaga petechia*	YEWA	2
American kestrel[2]	*Falco sparverius*	AMKE	1
Black-headed grosbeak[1]	*Pheucticus melanocephalus*	BHGR	1
Barn owl[2]	*Tyto alba*	BANO	1
Cedar waxwing[1]	*Bombycilla cedrorum*	CEDW	1
Fox sparrow[1]	*Passerella iliaca*	FOSP	1

Species	Scientific Name	AOU Code[4]	Fatalities Recorded
Long-eared owl[2]	*Asio otus*	LEOW	1
Mountain bluebird[1]	*Sialia currucoides*	MOBL	1
Orange-crowned warbler[1]	*Vermivora celata*	OCWA	1
Pied-billed grebe[2]	*Podilymbus podiceps*	PBGR	1
Song sparrow[1]	*Melospiza melodia*	SOSP	1
Spotted towhee[1]	*Pipilo maculatus*	SPTO	1
Swainson's thrush[1]	*Catharus ustulatus*	SWTH	1
Unknown raptor[2]		UNKN	1
Unknown small bird[1]		UNKN	1
Warbling vireo[1]	*Vireo gilvus*	WAVI	1
Western tanager[1]	*Piranga ludoviciana*	WETA	1
Wilson's warbler[1]	*Wilsonia pusilla*	WIWA	1
Total			**429**

Notes:

[1] Denotes species modeled as small birds in the Fatality Estimator.

[2] Denotes species modeled as large birds in the Fatality Estimator.

[3] These unidentifiable species were examined and determined to be large or small birds for the purposes of the Fatality Estimator on a case-by-case basis.

[4] Codes designated by the American Ornithologists' Union (AOU) Check-list of North American Birds (AOU 2015). Codes for unknown species are not designated by the AOU. For purposes of this report, unidentifiable large birds, small birds, raptors, or passerines are designated as UNKN. Unidentifiable warblers are designated as UNWA.

3.4.3 Fatalities by Residency Group

When comparing migrants (transient species traveling between summer breeding grounds and wintering grounds), residents (species living in the region year-round), and winter residents (species present in the region only in the winter), across all Project elements, residents accounted for the highest proportion of fatalities in arrays (70.46%), compared with all other Project elements (Table 6). Migrants and winter residents accounted for the highest number of fatalities along the Gen-tie Line (63.64% and 51.85%, respectively), compared with all other Project elements.

Table 6. Percent of Residency Group Fatalities across Project Elements (N=429)

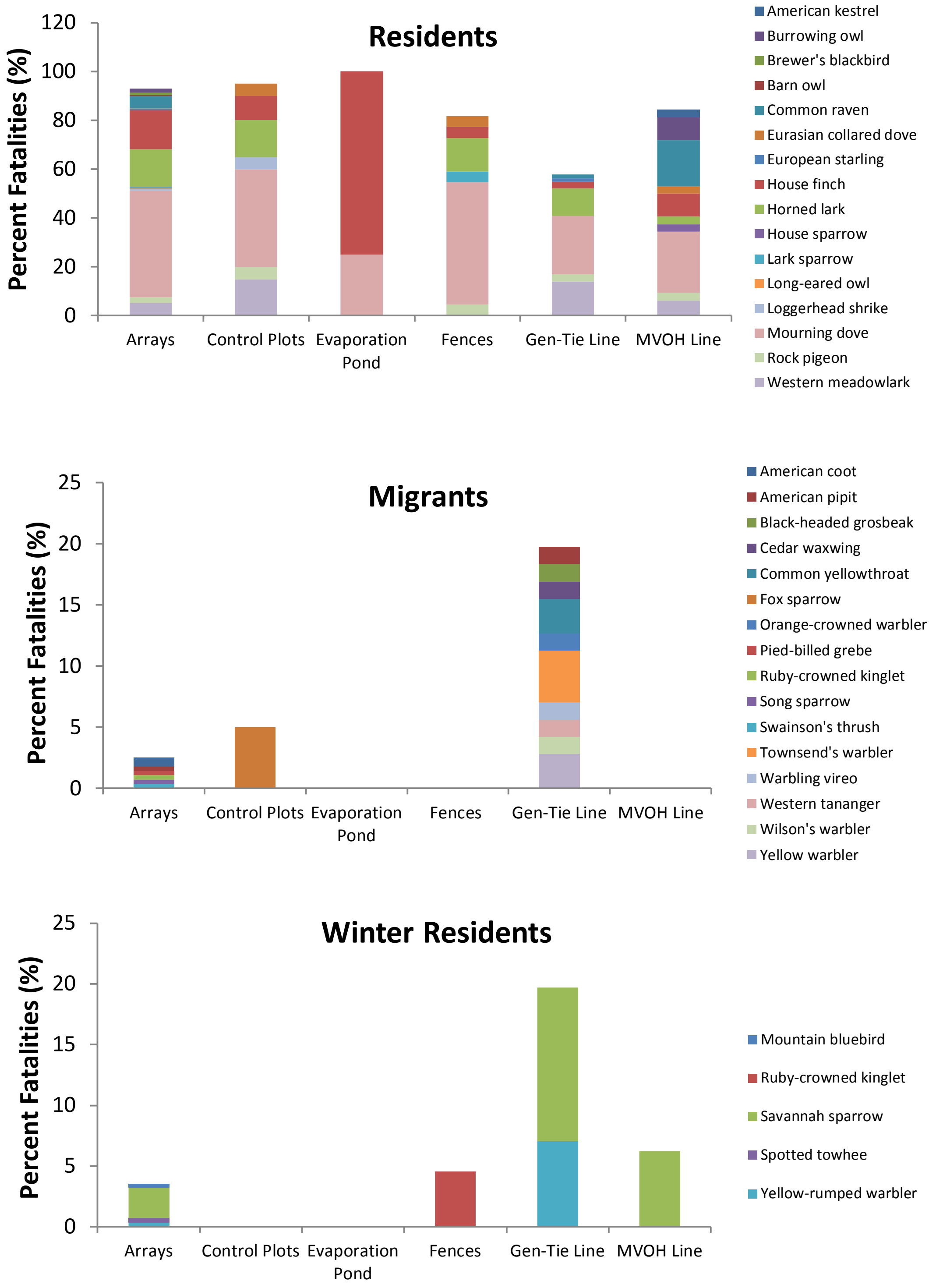
	Percent (%) of Fatalities			
Project Element	**Migrant**	**Resident**	**Winter Resident**	**Unknown**
Arrays	31.82	70.46	37.04	27.27
Control plots	4.55	5.15	0.00	0.00
Evaporation Pond	0.00	1.08	0.00	0.00
Fences	0.00	4.88	3.70	27.27
Gen-Tie Line	63.64	11.11	51.85	18.18
MVOH Line	0.00	7.32	7.41	27.27
Residency Group Total	100	100	100	100

Within each Project element, avian resident fatalities accounted for the highest percentage of fatalities (Table 7, Figure 19). Migrant and winter resident fatalities accounted for the second highest percentage of fatalities (19.72% and 19.72%), but only with the Gen-tie Line.

Table 7. Percent of Residency Group Fatalities within Project Elements (N=429)

	Percent (%) of Fatalities in Each Project Element				
Project Element	**Migrant**	**Resident**	**Winter Resident**	**Unknown**	**Total Percent Fatalities**
Arrays	2.50	92.86	3.57	1.07	100
Control plots	5.00	95.00	0.00	0.00	100
Evaporation Pond	0.00	100.00	0.00	0.00	100
Fences	0.00	81.82	4.55	13.64	100
Gen-tie Line	19.72	57.75	19.72	2.82	100
MVOH Line	0.00	84.38	6.25	9.38	100

Within each Project element, the highest species richness of fatalities was found in the arrays and along the Gen-tie Line, but the overall species composition of fatalities for these Project elements differed. The MVOH line had the third highest species richness of fatalities. In contrast, no migratory species fatalities were found along the MVOH line. The lowest species richness of fatalities was found in control plots, fences and the Evaporation Pond.



Notes: Residency status is based on knowledge of species typically found on the Project site at different times of the year. Unknown species (N=11) are not included in this figure.

Figure 19. Fatalities, by Species and Residency Group, as Percentages of the Total Fatalities in Each Project Element (N=418)

3.4.4 Gen-tie Line Trends by Elevation

Both overhead lines (the Gen-tie and the MVOH Lines) had a high percentage of fatalities with known causes of death. However, the seasonal graphs of the Gen-tie Line monitoring results demonstrate peaks that could be associated with migratory activity, whereas the MVOH Line data did not. The Gen-tie Line is unique among the other Project elements in several ways: it is the only Project element that has a variety of elevations along its length, it crosses over a tamarisk wetland in the area north of State Route 58, and the powerlines are higher above the ground than those associated with the MVOH Line.

To help determine what factor had the largest effect on the differences in fatality rates and species richness of fatalities found along the two lines, we assessed the numbers of fatalities along the Gen-tie Line by elevation. Although elevation consistently increases as the tower numbers increase from the substation (Tower 1) to the Caliente switching station (Tower 23), the number of fatalities found between towers does not indicate a pattern (Figure 20). Similarly, the number of species found at different areas along the Gen-tie Line did not increase with elevation, and did not cluster around the tamarisk wetland located between Gen-tie Line towers 17 and 18 (Figure 21).

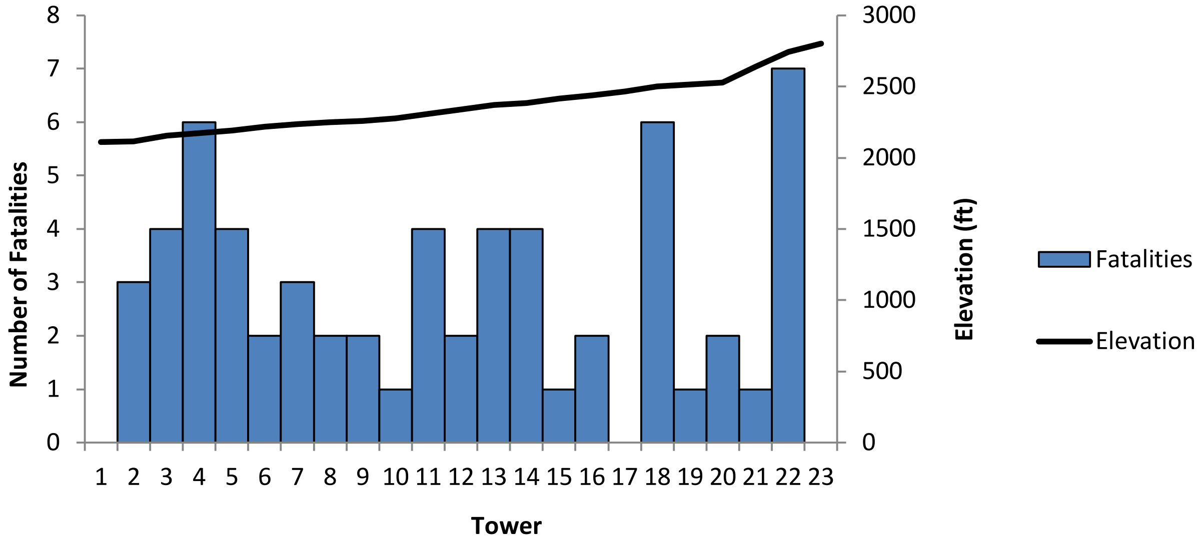


Figure 20. Number of Fatalities along the Gen-tie Line, by Elevation and Tower Number

Note: Fatalities are grouped from tower to tower (e.g., all fatalities found between the substation and Tower 1 are graphed under Tower 1).

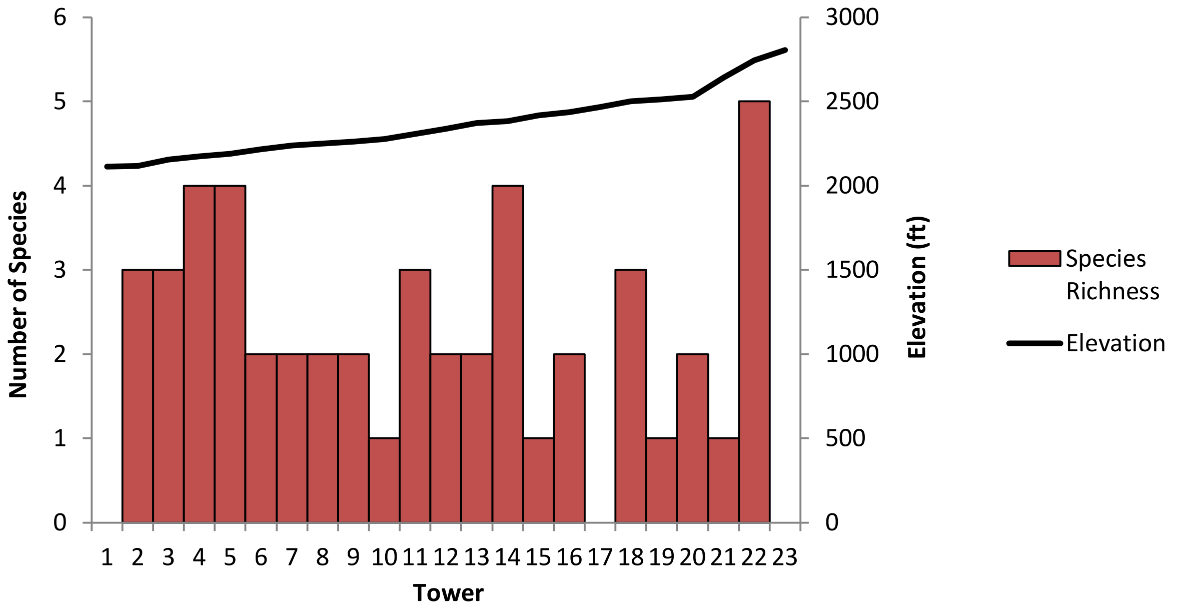


Figure 21. Species Richness of Fatalities Found along the Gen-tie Line, by Elevation and Tower Number

Note: Fatalities are grouped from tower to tower (e.g., all fatalities found between the substation and Tower 1 are graphed under Tower 1. The tamarisk wetland is located between Towers 17 and 18).

3.5 Fatality Estimates

3.5.1 Carcass-persistence Rates

3.5.1.1 Overall Project Site Persistence Rates

Between 15 October 2012 and 11 March 2014, we conducted carcass-persistence trials using 206 fatality plants. Eleven fatality plants were excluded because full persistence data were not collected (i.e., carcasses were collected by staff after the initial scavenging event). One-hundred and five carcasses were placed after the first annual reporting period, but because the results of both years were used to inform persistence times in the Fatality Estimator, the results of all trials are presented here.

From our 30 feather spot persistence trials, we calculated that feather spots persisted an average of 18 days on bare ground, 35 days in low grass (≤25 cm), and 45 days in medium or high grass (>25 cm). We applied these values as adjustment factors for all feather spots that persisted after scavenging, and these are the values we report below, unless otherwise noted. Feather spots that were left on low grass with <50% cover in a 1-m^2 area were assigned the same adjustment factor as those on bare ground.

3.5.1.2 Persistence Rates by Explanatory Variables

Observed scavenger species included common ravens, which scavenged 46.2% of all planted fatalities; San Joaquin kit foxes (*Vulpes macrotis mutica)*, which scavenged 22.1% of all planted fatalities; coyotes, which scavenged 5.6% of all planted fatalities; and one of each of the following: a turkey vulture (*Cathartes aura*), a prairie falcon

(*Falco mexicanus*), and a red-tailed hawk (*Buteo jamaicensis*) (Figure 22). Two planted carcasses, a great horned owl (*Bubo virginianus*) and a red-tailed hawk, remained mostly intact for the full 6-week monitoring period, so no final scavenger species was assigned to these carcasses. Unknown scavengers accounted for 23.6% of all scavenging events.

After 7 days, only 10.8% of all small carcasses remained unscavenged. However, 25.0% of all small carcasses and resultant feather spots remained in place (Figure 23). This effect was even more dramatic for large carcasses: whereas only 25.3% of all carcasses remained after a week, more than half (65.7%) of all large carcasses either remained in place or left feather spots behind.

Figure 22. Scavenger Species Documented in Carcass-persistence Trials

Notes: Clockwise from top left, recorded scavenger species were as follows: common raven, San Joaquin kit fox, turkey vulture, red-tailed hawk, prairie falcon, and a coyote.

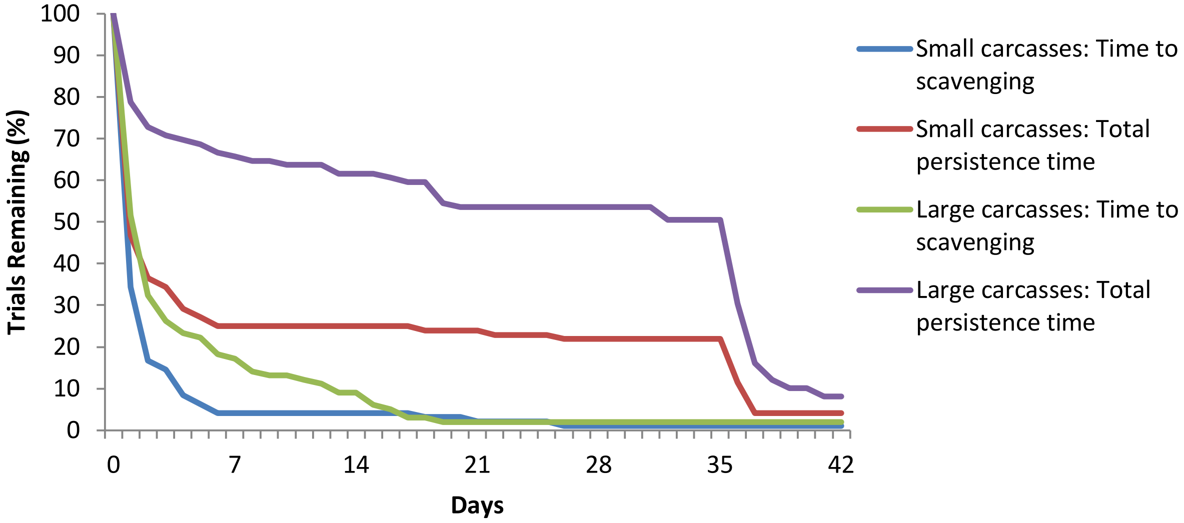


Figure 23. Percent of All Carcasses and Resultant Feather Spots Remaining Over Time (N=195)

Time to scavenging was longest for both large and small carcasses in the winter. Assuming conservatively that carcasses would not persist past the 6-week trial period, mean carcass persistence over the entire year was 9.3 days for small carcasses and 22.2 days for large carcasses. Total persistence times did not exhibit a clear seasonal pattern, but clearly varied by carcass size (Table 8).

Table 8. Average Time to Scavenging and Average Total Persistence, by Size and Season

Season	Carcass Size	N	Average Time to Scavenging (days)	Average Total Persistence (days)
Fall	Small	29	1.52	11.91
	Large	28	2.77	17.80
Winter	Small	29	3.56	9.87
	Large	30	5.16	17.27
Spring	Small	22	1.62	4.30
	Large	28	4.03	30.51
Summer	Small	16	1.08	12.02
	Large	13	2.53	27.34

3.5.1.3 Model Selection for Carcass-persistence Decay Curve

Based on the carcass-persistence data, we compared 16 possible models. The model with the lowest AICc had a lognormal distribution and controlled for carcass size but not season (Table 9). Because the ΔAICc is >2 between this model and the next ranked model, this model alone has substantial support, and we used this model in the fatality estimates.

Table 9. AICc Values for Each of 16 Models of Carcass Persistence

Distribution	Model Formula	AICc	Shape
Exponential	Null	1012.0	1.0
Exponential	Season	1010.7	1.0
Exponential	Size	946.6	1.0
Exponential	Season + Size	949.4	1.0
Loglogistic	Null	680.1	2.41
Loglogistic	Season	684.1	2.39
Loglogistic	Size	637.2	2.06
Loglogistic	Season + Size	639.8	2.04
Lognormal	Null	671.7	3.92
Lognormal	Season	675.7	3.89
Lognormal	**Size**	**631.8**	**3.45**
Lognormal	Season + Size	634.4	3.41
Weibull	Null	699.3	3.21
Weibull	Season	702.3	3.19
Weibull	Size	659.2	2.96
Weibull	Season + Size	663.1	2.95

Notes: AICc = Akaike's Information Criterion, adjusted for sample size. Lognormal model in **bold** is best supported. "Null" indicates models with no explanatory variables.

3.5.2 Searcher-efficiency Rates

Between 5 September 2012 and 31 July 2014, we conducted 434 searcher-efficiency trials in all operational Project elements throughout the site. Three trial specimens (two large carcasses and one small carcass) were removed by scavengers and not used in analysis. Therefore, we used a total of 431 fatality trial specimens: 113 small and 98 large feather spots, and 113 small and 107 large carcasses. Fatality plants were placed in areas with various combinations of vegetation height and percent cover.

Overall searcher efficiency was 50.8% (Table 10). When accounting for size and visibility class, each on their own, searchers were most effective at detecting large carcasses, large feather spots, and fatality plants placed in the Easy visibility class. When accounting for size and visibility class together, searcher efficiency for large carcasses and large feather spots in the Easy visibility class was 80% and 77.1%, respectively. Searcher efficiency was slightly lower for large carcasses in the Moderate visibility class, at 66.7%, and was 50.9% for small carcasses in the Easy visibility class. At 25.5%, searchers were least effective at finding small feather spots in the Moderate visibility class.

Table 10. Results from Searcher-efficiency Trials, September 2012 through July 2014

Category	Detection Rate (%)	N
Overall	50.8	431
Size Class		
Large carcass	72.9	107
Small carcass	41.6	113
Large feather spot	65.3	98
Small feather spot	26.5	113
Visibility Class		
Easy visibility	57.3	211
Moderate visibility	44.5	220
Size Class and Visibility Class		
Large carcass, Easy visibility	80.0	50
Large carcass, Moderate visibility	66.7	57
Small carcass, Easy visibility	50.9	55
Small carcass, Moderate visibility	32.8	58
Large feather spot, Easy visibility	77.1	48
Large feather spot, Moderate visibility	54.0	50
Small feather spot, Easy visibility	27.6	58
Small feather spot, Moderate visibility	25.5	55

3.5.2.1 Model Selection

Based on the searcher-efficiency trial data, we compared four possible models. The model with the lowest AICc controlled for both visibility class and size class (Table 11). Because the ΔAICc is >2 between this model and the next ranked model, this model alone has substantial support, and we used this model in the fatality estimates.

Table 11. AICc Ranking of Searcher-efficiency Models

Model	AICc
Null	599.39
Visibility	594.33
Size Class	543.89
Size Class + Visibility	**536.23**

Notes: AICc = Akaike's Information Criterion, adjusted for sample size.
Model in **bold** is best supported.

3.5.3 Fatality Estimates for Known Causes

After determining the proper model structure for both searcher-efficiency and carcass-persistence trials, we ran a series of fatality estimates. We report fatality estimates only for areas and categories in which more than five fatality detections occurred, because using the Fatality Estimator with five or fewer detections produces highly biased values due to the small sample size.

Fatality estimates were calculated separately for each Project element, with the exception of the Evaporation Pond, where a low sample size precluded running a fatality estimate. Estimates are first provided for fatalities where the cause of death was determined based on direct evidence of collision or electrocution. Following these estimates, we provide estimates for fatalities where the cause of death could not be determined or was natural (i.e., cause of death was disease or predation) (Section 3.5.4).

3.5.3.1 Total Fatality Estimates for Known Causes

Of the 53 fatalities for which the cause of death could be determined, 40 were included in the fatality estimate models (Table 12). Two from the arrays were excluded from the model but then added, unadjusted, to the estimator output, to produce the total fatality estimate for known causes. Eleven fatalities with evidence of electrocution or collision were not included in the fatality estimates: four were excluded because they were found incidentally, five were excluded because they were older than the search interval, and two were excluded because they were found in Array 1 and 2 outside of the 20% search areas established in January 2014.

Table 12. Number of Detections Based on Known Causes in Each Project Element, and Number Included in Fatality Estimates, 7 November 2013 to 6 November 2014

	Fatalities Detected		
Project Element	**Number Included**	**Number Excluded**	**Total Found**
Arrays	0	6[1,2]	6
Control plots	0	0	0
Evaporation Pond	0	0	0
Fences	0	0	0
Gen-tie Line	29	5[3]	34
MVOH Line	11	2[4]	13
Total	**40**	**13**	**53**

Notes:
[1] Two fatalities were excluded because they were incidentals and two fatalities were excluded because they were found outside of the 20% areas for Array 1 and 2 prior to January 2014.
[2] No estimate was provided for this element because of the low sample size; the remaining two fatalities (see Note 1) were added unadjusted to the overall estimator output.
[3] Five fatalities were excluded because they were older than the search interval.
[4] Two electrocuted fatalities were excluded because they were found incidentally.

During the period of 7 November 2013 to 6 November 2014, an estimated 126 birds died from electrocution- or collision-related causes (90% confidence interval: 106–155) at the Project site (Table 13).

Table 13. Estimates of Total Fatalities with Known Causes, 7 November 2013 to 6 November 2014

Project Element	Number of Fatalities Included in Model	Estimate of Fatalities (with Lower and Upper 90% Confidence Limits)
Arrays	0	n/a[1]
Control plots	0	n/a[2]
Evaporation Pond	0	n/a[2]
Fences	0	n/a[2]
Gen-tie Line	29	99 (83, 123)
MVOH Line	11	25 (21, 30)
Total for Project site[1]	**40**	**126 (106, 155)[1]**

Notes:
[1] The two fatalities in the arrays were added unadjusted to the total fatality estimate for the site.
[2] n/a = not applicable; no fatalities caused by electrocution or collision were found in these elements.

3.5.3.2 Fatality Estimates by Project Element

No fatalities that were found in control plots, at the Evaporation Pond, or along fences provided direct evidence of electrocution or collision, so we do not provide a fatality estimate for known causes based on fatalities found in these project elements. Likewise, due to the low number of fatalities found with known causes of death in the array areas, we do not provide a fatality estimate for the array areas.

The overhead powerlines were the only areas for which we estimated the number of fatalities caused by collision or electrocution. Ninety-nine fatalities were estimated to have occurred as a result of collision along the Gen-tie Line (90% confidence interval: 83–123; Table 14). Seasonal estimates were not made for the Gen-tie Line by cause of death because very few fatalities were found in the winter (N=4).

Table 14. Fatality Estimates for the Gen-tie Line, by Cause of Death (Electrocution or Collision), and Fatality Class, 7 November 2013 to 6 November 2014

	Number of Fatalities Included in Model	Estimated Total Number of Fatalities[1]	Lower and Upper 90% Confidence Limits
Cause of Death			
Electrocution	0	0	n/a[1,2]
Collision	29	99	83, 123
Fatality Class			
Large	7	19	15, 24
Small	22	81	65, 104

Notes:

[1] The bootstrap methods used to produce the fatality estimate produce estimates for the entire dataset that differ slightly from the sum of estimates for constituent subgroups of the data.
[2] n/a= not applicable; no electrocution-related fatalities were found in the Gen-tie Line area.

An estimated 25 fatalities occurred along the MVOH Line as a result of collision between 7 November 2013 and 6 November 2014 (90% confidence interval: 21–30; Table 15). Seasonal estimates for the MVOH Line were not calculated due to low sample sizes in the summer, fall, and winter (N=1, N=2, and N=2, respectively). Estimates by size also were not calculated, because of a low sample size for small birds (N=2).

Table 15. Fatality Estimates for the MVOH Line by Cause of Death (Electrocution or Collision), 7 November 2013 to 6 November 2014

	Number of Fatalities Included in Model	Estimated Total Number of Fatalities	Lower and Upper 90% Confidence Limits
Cause of Death			
Electrocution	0[1]	0	n/a[2]
Collision	11	25	21, 30

Notes:
[1] Two electrocution-related fatalities were excluded from the model because they were found incidentally.
[2] n/a = not applicable; no electrocution-related fatalities found along the MVOH Line were included in the model.

3.5.4 Fatality Estimates for Unknown and Natural Causes of Death

For the purposes of these estimates, fatalities with suspected natural causes of death (i.e., predation or disease) are included in this section, along with fatalities for which cause of death could not be determined. We did not calculate separate estimates for predation or disease; instead, these fatalities are grouped in with the total estimates for fatalities with unknown causes of death. Of the 251 fatalities for which the cause of death was natural or could not be determined, 186 were included in the fatality estimate models (Table 16). Of the excluded fatalities, four each from the Evaporation Pond and Gen-tie Line were later added unadjusted to the estimator output, to produce the total fatality estimate for unknown causes. There were 65 fatalities with an unknown or natural cause of death that were not included in the fatality estimates; 20 were excluded because they were found incidentally, 9 were excluded because they were older than the search interval, 1 was excluded because it was found in a control plot that was removed in January 2014 when the search areas for Arrays 1 and 2 were reduced to 20%, and 27 were excluded because they were found in Array 1 and 2 outside of the 20% search areas established in January 2014.

Table 16. Number of Unknown-cause and Natural Fatalities Detected in Each Project Element, and Number Included in Fatality Estimates, 7 November 2013 to 6 November 2014

	Fatalities Detected		
Project Element	**Number Included**	**Number Excluded**	**Total Found**
Arrays	150	45[1]	195
Control plots	14	4[2]	18
Evaporation Pond	0	4[3]	4
Fences	11	4[4]	15
Gen-tie Line	0	4[5]	4
MVOH Line	11	4[6]	15
Total	**186**	**65**	**251**

Notes:

[1] Seven fatalities were excluded because they were older than the search period, 11 fatalities were excluded because they were found incidentally, and 27 were excluded because they were found outside of the 20% search areas for Arrays 1 and 2 prior to January 2014.

[2] Three fatalities were excluded because they were found incidentally, and one fatality was excluded because it was in a control plot that was removed when the search areas for Array 1 and 2 were reduced to 20%.

[3] No estimate was provided for these elements because of the low sample size; however, these detections were later added unadjusted to the estimator output.

[4] Three fatalities were excluded because they were found incidentally, and one fatality was excluded because it was older than the search interval.

[5] No estimate was provided for these elements because of the low sample size; however, these detections were later added unadjusted to the estimator output.

[6] Three fatalities were excluded because they were found incidentally, and one fatality was excluded because it was older than the search interval.

During the period of 7 November 2013 to 6 November 2014, an estimated 2597 birds died from unknown causes (90% confidence interval: 2116-3334) at the Project site (Table 17).

Table 17. Estimates of Unknown-cause and Natural Fatalities, 7 November 2013 to 6 November 2014

Project Element	Number of Fatalities Included in Model	Estimate of Fatalities (with Lower and Upper 90% Confidence Limits)
Arrays	150	2314 (1890, 2965)
Control plots	14	52 (31, 81)
Evaporation Pond	0[1]	n/a[2]
Fences	11	185 (155, 230)
Gen-tie Line	0[1]	n/a[2]
MVOH Line	11	39 (32, 50)
Total for Project site[1]	**186**	**2598 (2116, 3334)**[1]

Notes:

[1] In total, eight fatalities with unknown or natural causes of death were found in the Evaporation Pond area and the Gen-tie Line area. These were added, unadjusted, to the total fatality estimate for the site.

[2] n/a = not applicable; there were fewer than five fatalities in this group. However, the unadjusted numbers were added to the fatality estimates and confidence intervals.

3.5.4.1 Fatality Estimates by Project Element

Because few fatalities were found in the Evaporation Pond and few with unknown causes of death were found along the Gen-tie Line, we do not provide fatality estimates for these fatalities here.

An estimated 2314 fatalities (90% confidence interval: 1890–2965) occurred in the arrays from unknown or natural causes in the year 7 November 2013 to 6 November 2014 (Table 18). The estimated number of fatalities per tracker in the arrays was 2.24 (90% confidence interval: 1.83–2.87), whereas in the control plots it was 1.72 (90% confidence interval: 1.05–2.68; Table 19).

Table 18. Fatality Estimates for the Arrays, by Cause of Death (Unknown), Fatality Class and Season, 7 November 2013 to 6 November 2014

	Number of Fatalities Included in Model	Estimate of Fatalities per Tracker[1]	Lower and Upper 90% Confidence Limits	Estimated Total Number of Fatalities[1]	Lower and Upper 90% Confidence Limits
Cause of Death					
Unknown	150	2.24	1.83, 2.87	2314	1890, 2965
Fatality Class					
Large	84	0.89	0.69, 1.17	920	712, 1209
Small	66	1.34	0.97, 1.89	1385	1002, 1953
Season					
Fall	28	0.32	0.2, 0.46	331	206, 476
Winter	85	1.24	0.94, 1.69	1281	971, 1746

Spring	27	0.47	0.27, 0.77	486	278, 796
Summer	10	0.21	0.07, 0.42	217	72, 434

Note:
[1] The bootstrap methods used to produce the fatality estimate produce estimates for the entire dataset that differ slightly from the sum of estimates for constituent subgroups of the data.

Table 19. Fatality Estimates for the Control Plots, by Cause of Death (Unknown), Fatality Class, and Season, 7 November 2013 to 6 November 2014

	Number of Fatalities Included in Model	Estimate of Fatalities per Tracker[1]	Lower and Upper 90% Confidence Limits	Estimated Total Number of Fatalities[1,2]	Lower and Upper 90% Confidence Limits
Cause of Death					
Unknown	14	1.72	1.05, 2.68	52	31, 81
Fatality Class					
Large	6	0.66	0.27, 1.23	20	8, 37
Small	8	1.06	0.33, 2.0	32	9, 60

Notes:
[1] The bootstrap methods used to produce the fatality estimate produce estimates for the entire dataset that differ slightly from the sum of estimates for constituent subgroups of the data.
[2] Estimated total is for 30 control plots.

An estimated 185 fatalities (90% confidence interval range: 155–230; Table 20) occurred along the fenceline between the dates of 7 November 2013 to 6 November 2014. An estimated 39 fatalities occurred (90% confidence interval range: 32–50) along the MVOH Line that could be attributed to unknown or natural causes (Table 21).

Table 20. Fatality Estimates for the Fences[1], by Cause of Death (Unknown) and Fatality Class, 7 November 2013 to 6 November 2014

	Number of Fatalities Included in Model	Estimated Total Number of Fatalities[2]	Lower and Upper 90% Confidence Limits
Cause of Death			
Unknown	11	185	155, 230
Fatality Class			
Large	6	85	65, 105
Small	5	105	80, 135

Notes:
[1] Estimates were made from 6411.2-m area searched during regular fatality searches and extrapolated to represent total fence area of 32,056 m.
[2] Bootstrap methods used to produce the fatality estimate produce estimates for the entire dataset that differ slightly from the sum of estimates for constituent subgroups of the data.

Table 21. Fatality Estimates for the MVOH Line, by Cause of Death (Unknown), 7 November 2013 to 6 November 2014

	Number of Detections Included in Model	Estimated Total Number of Fatalities	90% Confidence Intervals
Cause of Death			
Unknown	11	39	32, 50

3.6 Annual Background-Adjusted per-Tracker Unit Fatality Rates

The mean annual per-tracker unit fatality rate within arrays (F_{trac}), and per-control plot fatality rate within Conservation Lands (F_{con}), based on bootstrap samples were 2.24 (90% confidence interval range: 1.32 – 3.28) and 1.73 (90% confidence interval range: 0.86 – 2.74), respectively. Note that these bootstrapped estimates and confidence intervals differ slightly from those of the observed data, and are only presented here to give context for the background-adjusted estimate. The mean annual background-adjusted per-tracker unit fatality rate ($F_{b.adj}$) was 0.51 (90% confidence interval range: -0.83-1.81). The mean annual background-adjusted estimate of the number of fatalities within arrays was 526 for the period of 7 November 2013 to 6 November 2014.

Table 22. Resampled Fatality Estimates for the Control Plots, Project Plots, and Background Adjusted Fatality Estimates, 7 November 2013 to 6 November 2014. Based on 2000 iterations

Site	Mean Bootstrapped Fatality/Plot Estimate	Lower and Upper 90% Confidence Limits
Array Tracker Unit Plots	2.24	1.32, 3.28
Control Plots	1.73	0.86, 2.74
Adjusted Fatality Estimate	0.51	-0.83, 1.81[1]

[1] Negative values occur when control plot estimates exceed array tracker unit plot estimates.

Section 4.0 Discussion

This section discusses the patterns observed through monitoring, provides descriptive statistics of trends, and relates these patterns and trends to avian use of the site, and current and future research on comparable topics.

4.1 Patterns Observed in Fatality Detection Efforts

4.1.1 Avian Abundance

Fatalities in the arrays and Gen-tie Line exhibited the most seasonal variation, with definitive spikes in winter and fall 2013, respectively. Overall fatality trends in the arrays from fall 2013 through fall 2014 appear to parallel avian abundance during the same period, which was quantified during avian activity surveys conducted throughout the site and in adjacent offsite areas, as part of ABPP implementation. Avian abundance was moderately low in fall 2013, increased in winter 2013, and then steadily declined from spring to summer, with a small spike again in fall 2014 (HTH 2015). Although we cannot say definitively what the cause of death was for many of the array avian fatalities, it appears that these fatalities mirror trends in abundance; in other words, when birds are more abundant, so are array fatalities. For instance, Columbid activity (i.e., mourning doves) showed a strong seasonal pattern, with average detection rates during point counts highest in winter (HTH 2015). In contrast, although there was a spike in fatalities in fall 2013 along the Gen-tie Line, fatalities there did not parallel avian abundance seasonally in the region.

As defined by the National Drought Monitor (National Drought Mitigation Center 2014), the onset of prolonged drought translated to moderate drought conditions in the Project area by January 2013, extreme drought conditions by January 2014, and exceptional drought conditions by the end of 2014. The results of fatality monitoring may have been influenced by the three-year drought that the Project site is experiencing. The annual average precipitation at the Project site is 10.11 inches, and the site received 8.44 inches in 2011-2012, 4.01 inches in 2012-2013, and 3.43 inches in 2013-2014 (San Luis Obispo County Public Works 2014). Drought conditions were responsible for low vegetative cover in 2014 at areas within the Project site that had been revegetated, as well as undisturbed reference sites (HTH 2014b). Lower vegetative cover likely resulted in decreased food abundance, and may have contributed to declines in overall avian abundance in the Project vicinity. Therefore, overall fatality counts should be interpreted with caution, as they could differ under non-drought conditions.

4.1.2 Utility of Repeat Searches

Repeat searches were originally designed to capture higher numbers of fatalities, especially taxa like bats that are less likely to leave sign behind after scavenging, and to provide verification of the results found in weekly searches. Because it was not practical to conduct repeat searches for any more than 5% of most arrays and 5% of the fences, repeat data from these small areas sampled from our previous year resulted in large sampling bias when extrapolated to the much larger Project elements. Furthermore, after conducting fatality searches for more than a year, it became apparent that avian fatalities accounted for >99% of all fatality finds, and that a sufficient proportion of fatalities (22.6% of all small carcasses and 63.6% of all large carcasses) persisted past the weekly search interval. Together, these reasons led to the decision to cease repeat searches at the CVSR Project.

Despite our decision to stop repeat searches at CVSR, short-interval searches could potentially play an important role in areas with higher scavenging rates and at sites where a large proportion of animals could be scavenged without leaving sign. Also, at sites with higher rates of fatalities, a lower number of searched trackers may be sufficient for accurately estimating site-wide fatalities. However, this method should be implemented only after assessing fatality rates through reconnaissance searches.

4.1.3 Utility of Incidental Detections

Of the 35 fatalities found during this reporting period, only one was found by CVSR operations staff. Fatalities were rarely found in high-traffic areas such as roads, suggesting that data gathered from future incidental reporting will be very limited for analytical purposes. On their own, incidental detections are unlikely to provide enough data to allow tracking of trends in species found, seasonal variations, or trends across Project elements. Despite this limitation, ongoing reporting of these detections may yet assist in identifying and remediating major wildlife hazards on the Project site. The fatality that was discovered by CVSR Project staff during this reporting period was likely caused by electrocution, highlighting the role of the incidental detection protocol.

4.2 Fatality Trends: Cause of Death by Project Element

4.2.1 Fatalities by Cause of Death

4.2.1.1 Arrays

Among avian species expected to be affected by development of the Project, waterbirds were of particular concern. Because waterbirds are sometimes attracted to black-top parking lots or roads, and some solar facilities have reported finding high proportions of waterbirds (Horvath et al. 2009; Grippo et al. 2014; Kagan et al. 2014), obligate waterbirds could potentially be at risk at and near solar arrays. However, during the current year reporting period, only three waterbirds were detected in arrays at CVSR.

It is difficult to discern if waterbird fatalities were low because waterbirds were less attracted to the region during the drought, the birds didn't perceive the arrays as water, or for some other reason. Extreme drought conditions have led to longer-than-normal dry lake conditions in Soda Lake, approximately 2 miles (3 km) south of the Project site. This dry lake supports standing water only during wet years, when it is a major attractant for waterbirds to the region.

Except for the Evaporation Pond (where several waterbird species have been observed by HTH biologists), the Project site lacks aquatic habitats suitable for waterbirds. Therefore, the three waterbirds likely had confused the arrays for water bodies and either collided with a panel or landed in the array. Pied-billed grebes are obligate waterbirds and have difficulty taking flight from land because of the posterior position of their feet (Miller 1942;

Johnsgard 1987). American coots also spend a majority of their lives in water, but they are also capable of making short-distance movements on land. Considering the life history of these species and the lack of suitable habitat on site, the three fatalities were considered collisions; these individuals may have died from predation after they landed in the arrays and were unable to take off, or died from trauma stemming from collision.

A total of ten carcasses were found in the arrays during this reporting period. Of these, the probable cause of death could be established for only three. Previous studies of birds that have died from window collisions suggest that birds rarely have broken necks or other visible skeletal fractures, but intercranial hemorrhaging is almost always present (Klem 1991). Because we did not perform necropsies on whole carcasses found in the field, we were not able to definitively rule out collision as a possible cause of death. Cause of death determinations are further complicated by the possibility that survivors of collisions may be temporarily stunned, and made more susceptible to predation. Given these factors, the cause of death for whole carcasses found without signs of injury or disease were categorized as unknown.

4.2.1.2 Gen-tie Line and MVOH Line

The majority of fatalities found along the Gen-tie and MVOH Lines were located directly or nearly directly under these lines. This pattern suggests that many of these fatalities were caused by powerline collisions, and that the remains were indicative of scavenging, rather than predation. Brown and Drewien (1995) and many others have documented that high-tension powerlines contribute to avian mortality, and especially to the mortality of larger birds such as waterfowl. However, few large carcasses were detected during fatality searches of the Gen-tie and MVOH Lines. Instead, the majority of fatalities found were passerines, possibly reflecting the greater proportion of passerines that occur on the site. Nevertheless, these results suggest that the avian flight diverters installed on the Gen-tie Line may greatly reduce the risk of collisions with larger birds, but are not effective at diverting smaller birds.

In contrast to the fatalities found along the MVOH Line, fatalities found along the Gen-tie Line showed strong seasonal peaks in fall and late spring. Also, Gen-tie Line fatalities included migrant passerines not typically observed on the Project site or expected in the area. The Gen-tie Line and MVOH Line differ from each other in several respects: the Gen-tie Line follows a large elevational change, the lines are higher above the ground than the MVOH Line, and several bird species breed at a pond with tamarisk trees located directly below the Gen-tie Line. To help determine potential differences in fatality patterns between the two types of overhead lines, we produced graphs relating fatality number and species richness to tower number and elevation. These graphs did not suggest any clear linear trends or clustering near the tamarisk pond; fatalities were more or less equally distributed along the Gen-tie Line. Therefore, the differences in height between these two structures may be the main factor effecting differences in fatality rates and species richness of fatalities. The avian flight diverters on the Gen-tie Line appear to be largely ineffective in deterring these migrant and winter resident passerines, possibly because these birds are less apt to see overhead lines during nocturnal movements.

The tamarisk pond was not searched directly for the full year, to avoid disturbing nesting birds during the breeding season. In the fall, dense saltbush (*Atriplex* sp.) made some areas between the pond and Tower 17 impassable. Although the lack of fatality clustering on towers to either side of the tamarisk pond suggests that the higher avian use at the tamarisk pond does not result in a detectable increase in collision in the vicinity of the pond.

It is difficult to study how the mortality of large and small birds along the overhead lines compares with background mortality rates without having a linear control in the landscape. We know of no studies that control for background mortality rates along a linear corridor without an actual linear structure. Instead, most avian mortality studies of high-tension powerlines typically compare fatality rates of powerlines with or without avian flight-diverting structures (Brown and Drewien 1995; Janss and Ferrer 1998). Given that more passerine fatalities were documented along the CVSR Project powerlines than expected, and very few raptor fatalities were documented, a linear control would be useful in understanding how these fatality rates compare with background fatality rates for large and small avian groups in the Project area.

4.2.1.3 Control Plots

The control plots were designed as a way to quantify background levels of mortality on the Project site. All fatalities found in control plots were assigned an unknown cause of death, and all of these fatalities were included in a total fatality estimate that was used to define an adjustment factor for the site. For other research sites where preconstruction surveys are not a viable option, on-site control plots may provide similar data that could not otherwise be obtained. At CVSR, cause of death could not be determined for most array fatalities, so data from the control plots was useful in elucidating what percentage of array fatalities may be assigned to background (natural) causes, rather than indirect or direct Project-related causes.

4.2.1.4 Evaporation Pond

The Evaporation Pond represented a concern because evaporation ponds in xeric environments can attract birds and exposethem to elevated selenium and toxic salt levels. Additionally, the perimeter fence surrounding the pond was considered to represent a collision risk. However, the Evaporation Pond had the lowest number of fatalities during this reporting period, and all fatalities were found on the same day.

The only bird considered to have died from disease during this reporting period was found along the fence of the Evaporation Pond. Because this bird was extremely emaciated, disease seemed to be the plausible cause of death.

During the entire postconstruction monitoring period, Evaporation Pond levels were relatively low. Nonetheless, passerines and waterbirds were occasionally observed in and around the pond before searchers conducted fatality searches. As part of CVSR operations, a bird deterrence protocol (hazing and use of automated deterrence devices) was in place at the Evaporation Pond throughout the designated shorebird nesting season (February through July). These efforts likely resulted in less use of the pond by birds. Given that so few fatalities were detected at the pond, especially during time periods were active deterrence devices were not in use, risk of fatalities occurring at the pond appears to be low.

4.2.1.5 Fences

Few fatalities were detected along array perimeter fences, and only one was attributed to collision. Given the low number of fatalities found at this Project element, risk of fence collision as a whole appears to be low.

4.3 Fatality Estimates

4.3.1 Estimated Fatalities on the CVSR Project Site

During the period of 7 November 2013 to 6 November 2014 (the period used in the Fatality Estimator), there were an estimated 126 fatalities from known causes that occurred on the Project site (90% confidence interval: 106–155).

There were an estimated 2.24 fatalities per tracker (90% confidence interval: 1.83–2.87) from unknown or natural causes of death in the arrays. In control plots, there were an estimated 1.72 fatalities per control plot (90% confidence interval: 1.05–2.68). The confidence intervals for controls are considerably wider in part because fewer trackers were searched in control areas than in array areas for the year.

The confidence interval is much smaller this year, compared to the confidence interval of 3.09 fatalities per tracker reported last year, when we provided a fatality estimate for just Array 1 from nearly 1 year of data. Because we grouped all of the arrays' data, thus creating a larger sample size for a single fatality estimate, we more accurately estimated a fatality rate for the site as a whole. Additionally, by combining 2 years of carcass-persistence and searcher-efficiency data, we decreased the amount of uncertainty in our modeling parameters, which in turn decreased the amount of uncertainty in the fatality estimate as a whole.

Large-scale fatality searches at solar facilities have been a subject of interest since as early as the 1980s (e.g., Wagner et al. 1983), but the methods still vary in search intensity and regularity, fatality estimation methods used, and methods used for determining cause of death (e.g., Althouse and Meade 2014; HTH 2014a). Because of the differences among studies, comparison among rates of fatalities reported remains difficult. Although fatality rates per megawatt are often reported as a useful tool to compare rates among industrial sites and across energy types (Arnett et al. 2008; Smallwood 2013), it is easy to draw incorrect conclusions if the underlying methods differ and if different panel technologies are involved (e.g., a tracker unit generating 0.5 megawatts more than an alternative type may only be 7% larger).

4.3.2 Adjusting Fatality Rates on the CVSR Project Site

Observed fatalities within arrays that could be attributed to collision were limited (N=6 in 2013-2014); thus, fatality estimates at CVSR are primarily based upon fatalities where the cause of death or injury could not be determined. Adjusting these avian fatality rates by background fatality rates measured within control plots substantially reduced the estimated fatality rate that may be related to the CVSR Project. Whether placed within the context of per-acre of arrays or per-acre of tracker units, an annual mean background-adjusted fatality estimate of 526 fatalities indicates that there may be one fatality per 2.3 acres per year that cannot currently be explained by background fatality rates as measured in control plots.. These could be fatalities resulting from collision that leave no evidence of collision (or are moved away from the site of collision by scavengers), or increased fatality rates due to differential rates of avian use and/or predation within the arrays compared to the control plots.

We observed an increase of some avian species within the arrays. Mourning doves were the most common fatality in solar arrays, followed by horned larks and house finches, which combined accounted for 66% of all fatalities. During the first year of study, there were 44 point count detections of seven species perched on the developing arrays of solar panels. After the second year of study, the numbers had increased to 210 total detections of 13 species, including a merlin (*Falco columbarius*). After the third year of study, the numbers had increased to 578 total detections of 15 species; however, 81% of the tally consisted of house finches and mourning doves. Observations of horned larks during avian use surveys averaged higher in the array and Gen-tie survey areas than in the offsite survey areas throughout the study period, especially in winter (HTH 2015).

Modeling results indicated that activity rates for mourning doves increased in construction areas and remained high as the Project moved into the operational phase, suggesting a lasting attraction for these species (HTH 2015). Ninety-nine percent of the observations of mourning doves within the solar generation facility occurred in the arrays, either on the ground or perched on array structures (HTH 2015). Mourning doves are among the most widespread and abundant species in the country; Seamans and Sanders (2014) estimated that there are approximately 275 million mourning doves in the country, and their abundance appears to be stable in the West.

Surveyors at the CVSR Project documented use by scavenger/ predatory birds and mammals (San Joaquin kit fox [*Vulpes macrotis mutica*] and coyote [*Canis latrans*]). A merlin was observed perching and hunting in the developed solar arrays; also observed were a foraging red-tailed hawk and a foraging ferruginous hawk (*Buteo regalis*). Merlins eat mostly sparrow-sized to dove-sized birds (Warkentin et al. 2005) often specializing on hunting a couple of the most abundant species in an area, which would include horned larks, house finches, and mourning doves in the Project area. Each merlin can prey on 2.2 to 2.5 birds per day (Page and Whitacre 1975; Warkentin et al. 2005). They are known to flush flocks to take advantage of the confusion, which surveyors at CVSR have hypothesized may result in strikes with array infrastructure. Differential use of the arrays by avian species combined with predation by raptors, foxes, and coyotes could explain the current estimated difference between fatality rates within arrays and control plots.

We should point out that the sample size for control plots is low, and the number of fatalities within those control plots is even lower. Low sample size can easily lead to biases due to sampling error. Conducting bootstrap analysis on observed data inherently invokes an assumption that the observed data adequately represents the true state of the system. For example, in this case we must assume that the 14 fatalities detected in the 30 control plots (for the 2013/14 survey period) adequately represent fatality rates across all onsite Conservation Lands. Since the 30 control plots only cover a very small fraction of Conservation Lands, this assumption is tenuous. Furthermore, even though N_C trackers are sampled for each bootstrap iteration, they are drawn from the much larger N_T "population" of surveyed trackers (which represents approximately 20% of all trackers). As a result, we effectively sampled a large portion of the total number of trackers over the many bootstrap iterations, but the area over which we sampled control plots remains fixed and small. Therefore, some bias and imbalance remains in the bootstrapped results. We believe that these methods make the best use of the available data to control for background fatality in estimating fatality rates attributable to the CVSR Project and quantifying the uncertainty in those estimates.

In addition to the imbalance in sample area between control and array plots, there are several other factors that may influence these results. The proximity of control plots to arrays should be advantageous because we are comparing similar underlying habitats. However it is possible that fatality rates in lands immediately adjacent to the Project could be affected by their proximity to the Project, and thus would not adequately represent the background fatality rate of the area if the Project was absent all together. The large difference in estimated fatality rates between this year, and the 2013 annual report likely represents a reduction in avian use as continued drought widely impacted bird populations and nesting behavior (Section 4.1.1). Noting this difference among years stresses the importance of comparing fatality rates during the same time periods over successive years, because changes in bird population abundance and behavior may greatly affect analysis results.

More research is needed to address the issue of background fatality rates versus fatality rates attributable to solar photovoltaic projects. Study designs that include avian use studies within arrays and control plots, and studies that balance sample sizes within arrays and control plots would address many of the limitations of this analysis.

4.3.3 Carcass-persistence Rates

Although previous studies have monitored the overall persistence of carcass sign (e.g., feather spots), the practice has not been universally adopted (Balcomb 1986; Hager et al. 2012). Nevertheless, we chose to focus on overall persistence times, rather than time to scavenging alone, because feather spots represent an important source of data for fatality searches. Although some information is lost after scavenging, feather spots may still provide some degree of certainty about cause of death, by their location (e.g., directly under a powerline) and species identification (e.g., feather spots from waterbirds species may lend credibility to the idea that individuals of the species mistake the arrays for water). The results of our carcass-persistence trials revealed that, whereas average scavenging times were less than a week for both small and large carcasses across seasons, average persistence times ranged from 5 days to 30 days. The results also suggest that, although season has a strong influence on scavenging time, it has considerably less influence on overall persistence time. Instead, size seems to have a strong impact on persistence time: small carcasses are much more likely to be removed completely during scavenging, whereas large carcasses tend to leave feather spots behind.

In our study, we were careful to avoid scavenger swamping. Although some previous studies (e.g., Wagner et al. 1983, Ponce et al. 2010, and Derby et al. 2007) likely overloaded the capacity of local scavengers to effectively dispose of placed carcasses (Smallwood et al. 2010), the smaller numbers of carcasses we placed each week helped to ensure that we recorded accurate scavenging times. Still, several carcasses were visited several times before they were scavenged. Kit foxes are one of the few scavenger species present in the area that is capable of food caching (Clark pers. comm.), but they too sometimes visited carcasses without attempting to remove them. Because we made a concerted effort to use fresh carcasses, we feel that this pattern simply highlights the highly opportunistic nature of scavenging.

Our results suggest that, although scavenging times may differ by 1–2 days by season, persistence time of feather spots is most affected by the vegetation height and density where the carcass is placed. Although this may seem self-evident, the effects of vegetation height on carcass persistence has received limited attention in previous studies of carcass persistence or fatality estimates, and it may have significant implications for fatality estimates at sites where ground vegetation is cleared or purposely kept short, particularly when search intervals are longer than a week.

4.3.4 Searcher-efficiency Rates

Overall searcher-efficiency rates between 2012 and 2014 were comparable to efficiency rates at other wind and solar energy facilities, where rates have ranged from 32% to 67% (Nicholson et al. 2005; Derby et al. 2007; Leslie et al. 2012; Johnston et al. 2013; Martin et al. 2013).

Our study incorporated feather spots along with carcasses in the searcher-efficiency trial design. Feather spots are rarely incorporated into fatality studies, but many fatality studies report a majority of fatalities from feather spots (Derby et al. 2007; WEST 2004; Johnston et al. 2013; Martin et al. 2013; Althouse and Meade 2014), either because scavenging is rapid or because there are longer search intervals. Thus, visibility associated with the condition of the fatality is rarely representative of true conditions and could affect fatality estimates. In our study, fatality searchers were most effective at finding large carcasses and large feather spots in easy visibility conditions, and least effective at finding small feather spots in both easy and moderate visibility conditions, and at finding small carcasses in moderate visibility conditions. When attempting to recover a missed trial specimen in one of the latter three classes, and even when standing within a few feet of the specimen, searchers often had difficulty visually locating it. Undoubtedly, these fatality types were difficult to detect because they blend in with vegetation, even when vegetation height is low. The large differences in detectability between carcasses and feather spots point to the importance of incorporating feather spots into studies, to yield more robust fatality estimates.

Section 5.0 Recommendations

During the course of this fatality monitoring study, we have identified areas where further research is needed to guide the design of future fatality monitoring studies at utility-scale solar facilities. The following recommendations outline research areas and measures that we believe are important.

- Projects covering large amounts of area may have a significant portion of fatalities from natural background mortality. To determine the contribution of background mortality, a spatially balanced study employing control plots similar in size, layout, and overall total area, should be used to estimate background fatality rates with comparable accuracy to the developed project site.

- Focused research on the causes of feather spots and the average number of feather spots created from a single fatality should be considered.

- If site-wide fatality monitoring is deemed necessary and the primary goal is to determine annual operational fatality rates, then site-wide fatality monitoring should be started once the full project becomes operational and for at least one year. Fatality searches phased in as portions of the project become operational can be used to document fatalities prior to site-wide searches, and to conduct searcher efficiency and carcass persistence trials to develop the survey design. Fatality monitoring survey design, including spatial coverage requirements and survey frequency can be optimized after the collection of preliminary data.

- Intensive daily repeat fatality surveys are not necessary to conduct fatality estimates. The reduced spatial and temporal coverage of these intensive surveys may lead to less precise estimates when extrapolated to obtain site-wide annual estimates, and are only recommended when required to link timing of fatalities to specific events (e.g., weather patterns or operational changes).

- Avian use studies should consider bird census techniques that are potentially more effective in documenting species richness and relative abundance of birds in project areas that will be covered by arrays. Typical point count study designs may not be effective at detecting birds that tend to remain concealed under panels during counts. Line transect methods may provide a better index of avian use before and after construction. Birds under panels will likely be more visible from line transects oriented perpendicular to the array tracker rows than they would be from fixed-location point count sites located outside the arrays. If possible, line transect survey intervals should mirror fatality search intervals, to assess whether fatality rates correspond with bird activity levels. If survey intervals cannot mirror fatality search intervals, we recommend a minimum of monthly avian activity searches using line transects to determine relative abundance and trends in populations during periods of avian fatality monitoring.

- Projects incorporating high-tension powerlines should assess whether the project site is located in an important route for migratory songbirds. Because many migratory songbirds fly at night, typical deterrence devices that have been successful with raptors may not be as effective at preventing collisions by songbirds.

- To assess fatalities along linear project features such as powerlines, study designs should incorporate linear controls, to provide background mortality rates for such features.

- To the extent practicable, powerlines should not be placed over wetland features, where large numbers of birds may roost and nest. Wetland features, such as the tamarisk wetland along the Gen-tie Line, provide habitat for common and sensitive species, such as the tricolored blackbird (*Agelaius tricolor*), now emergency-listed under the California Endangered Species Act.

- We recommend that necropsies be performed on a subset of carcasses when practicable, especially when external injuries are not present; birds that have died because of collisions may not have external signs of injury, but typically exhibit intercranial hemorrhaging that can be identified during a necropsy. Performing necropsies on a subsample of carcasses may lead to more information about the cause of death.

- The use of scent dogs in fatality monitoring efforts should be considered to increase the accuracy and narrow the confidence level of fatality estimates, especially in areas with high density vegetation. Scent dogs have been shown to be more efficient at detecting some fatality classes than human searchers and have a higher likelihood of detecting rare events than humans, given equal levels of survey effort (HTH, unpublished data). Studies on sites with varying topography, complex habitat features, and dense vegetation may benefit from scent dog searches because the dogs rely on olfactory, rather than visual, cues.

- Feather spots should be incorporated into bias-trial protocols to produce more robust fatality estimates and to provide more comparable industry-wide fatality estimates, especially for studies with longer search intervals.

Section 6.0 References

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 *in* B. N. Petran and F. Csaki (Editors), 2nd International Symposium on Information Theory Akademiai Kiado, Budapest, Hungary.

Althouse and Meade. 2014. Topaz Solar Farms 2013 Fourth Quarter/Second Annual Report for Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. Paso Robles, California.

[AOU] American Ornithologists' Union. 2015. The AOU Check-list of North American Birds, 7th Edition [online]: http://www.aou.org/checklist/north/print.php. Accessed 16 January 2015.

Arnett, E. B., W. Brown, and W. P. Erickson. 2008. Patterns of bat fatalities at wind energy facilities in North America. Journal of Wildlife Management 72(1):61–78.

Baerwald, E. F., and R. M. R. Barclay, 2009. Geographic variation in activity and fatality of migratory bats at wind energy facilities. Journal of Mammalogy 90(6):1341–1349.

Balcomb, R. 1986. Songbird carcasses disappear rapidly from fields. Auk 103(4):817–820.

Beason, R. C. 1995. Horned lark (*Eremophila alpestris*). No. 195 i*n* A. Poole (Editor), The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York.
[online]: http://bna.birds.cornell.edu/bna/species/195. Doi:10.2173/bna.195

Brown, W. M., and R. C. Drewien. 1995. Evaluation of two power line markers to reduce crane and waterfowl collision mortality. Wildlife Society Bulletin 23(2):217–227.

Burnham, K. P., and D. R. Anderson. 2004. Understanding AIC and BIC in Model Selection. Sociological Methods & Research 33(2):261-304.

Clark, H. O., Jr. Senior Wildlife Ecologist. H. T. Harvey & Associates. 10 October 2013-email correspondence with Meredith Janzen of H. T. Harvey & Associates, regarding food caching by San Joaquin kit fox.

Derby, C., A. Dahl, W. Erickson, K. Bay, and J. Hoban. 2007. Postconstruction Monitoring Report for Avian and Bat Mortality at the NPPD Ainsworth Wind Farm. 27 February. Prepared for Nebraska Public Power District. Prepared by Western Ecosystems Technology, Inc.

Efron, B, and R. Tibshirani. 1986. Bootstrap methods for standard errors, confidence intervals and other measures of statistical accuracy. Statistical Science 1:54–77.

Erickson, W. 2009. Avian and Bat Monitoring Plan at Martinsdale Wind Farm. Draft. Prepared by WEST, Inc. [online]: http://dnrc.mt.gov/trust/wind/martinsdale/EIS/AppendixcMonitoring%20Protocol.pdf.

Grippo, M., J. W. Hayse, and B. L. O'Conner. 2014. Solar energy development and aquatic ecosystems in the Southwestern United States: Potential impacts, mitigation, and research needs. Environmental Management. Doi: 1007/s00267-014-0384-x.

Gruver, J., M. Sonnenburg, K. Bay, and W. Erickson. 2009. Post-construction bat and bird fatality study at the Blue Sky Green Field Wind Energy Center, Fond du Lac County, Wisconsin final report. Prepared by WEST, Inc. [online]: http://city.milwaukee.gov/ImageLibrary/Groups/cityGreenTeam/ documents/birdbatblueskygrfieldstudy.pdf.

Hager, S. B., B. J. Cosentino, and K. J. McKay. 2012. Scavenging affects persistence of avian carcasses resulting from window collisions in an urban landscape. Journal of Field Ornithology 83(2):203–211.

Horváth, G., G. Kriska, P. Malik, and B. Robertson. 2009. Polarized light pollution: A new kind of ecological photopollution. Frontiers of Ecology and Environment 7(6):317–325.

[HTH] H. T. Harvey & Associates. 2011. Avian and Bat Protection Plan for the California Valley Solar Ranch Project. Fresno, California.

[HTH] H. T. Harvey & Associates. 2014a. California Valley Solar Ranch Project Avian and Bat Protection Plan Annual Postconstruction Fatality Report 16 August 2012–15 August 2013. San Luis Obispo, California.

[HTH] H. T. Harvey & Associates. 2014b. California Valley Solar Ranch San Luis Obispo County, California Year 2 (2014) On-site Vegetation Monitoring Report. Fresno, California.

[HTH] H. T. Harvey & Associates. 2015. California Valley Solar Ranch, San Luis Obispo County, California, Final Avian Activity Surveys Report: October 2011–October 2014.

Huso, M. 2011. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. Doi: 10.1002/env.1052.

Janss, G. F. E., and M. Ferrer. 1998. Rate of bird collision with power lines: Effects of conductor-marking and static wire-marking. Journal of Field Ornithology 69:8–17.

Johnsgard, P. A. 1987. 3 comparative egocentric and locomotory behaviors. Paper 5 *in* Johnsgard, P. A., Diving Birds of North America.

Johnson, G. D., W. P. Erickson, M. D. Strickland, M. F. Sheperd, D. A. Sheperd, and S. A. Sarappo. 2003. Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota. American Midland Naturalist 150:332–342.

Johnston, D. S., J. A. Howell, S. B. Terrill, N. Thorngate, J. Castle, J. P. Smith, T. J. Mabee, J. H. Plissner, N. A. Schwab, P. M. Sanzenbacher, and C. M. Grinnell. 2013. Bird and Bat Movement Patterns and Mortality at the Montezuma Hills Wind Resource Area. CEC-500-2013-015. California Energy Commission.

Kagan, R. A., T. C. Viner, P. W. Trail, and E. O. Espinosa. 2014. Avian mortality at solar energy facilities in southern California: A preliminary analysis. National Fish and Wildlife Forensics Laboratory. [online]: http://docketpublicenergy.ca/gov/PublicDocuments/09-AFC-07C/TN201977_20140407T161504_Center_Supplemental_Opposition_to_Motion.pdf

Klem, D., Jr. 1991. Bird injuries, cause of death, and recuperation from collisions with windows. Journal of Field Ornithology 61(1):115–119.

Leslie, D., J. Schwartz, and B. Karas. 2012. Altamont Pass Wind Resource Area Bird Fatality Study, Bird Years 2005-2010. November. M87. ICF 00904.08. Prepared for Alameda County Community Development Agency, Hayward, California. Prepared by ICF International, Sacramento, California.

Martin, C., E. Arnett, and M. Wallace. 2013. Evaluating Bird and Bat Post-construction Impacts at the Sheffield Wind Facility, Vermont; 2012 Annual Report. Department of Natural Resources Management, Texas Tech University, Lubbock, Texas.

McCrary, M. D., R. L. McKernan, R. W. Schreiber, W. D. Wagner, and T. C. Sciarrotta. 1986. Avian mortality at a solar energy power plant. Journal of Field Ornithology 57:135–141.

Miller, R. F. 1942. The pied-billed grebe, a breeding bird of the Philadelphia region. Cassinia 32:22–34.

National Drought Mitigation Center. 2014. United States drought monitor weekly comparison. Lincoln, Nebraska. [online]: http://droughtmonitor.unl.edu/MapsAndData/WeeklyComparison.aspx. Accessed December 2014.

Nicholson, C. P., R. D. Tankersley Jr., J. K. Fiedler, and N. S. Nicholas. 2005. Assessment and Prediction of Bird and Bat Mortality at Wind Energy Facilities in the Southeastern United States: Final Report, 2005. Tennessee Valley Authority, Knoxville, Tennessee.

Otis, D. L., J. H. Schulz, D. Miller, R. E. Mirarchi, and T. S. Baskett. 2008. Mourning dove (*Zenaida macroura*). No. 117 *in* A. Poole (Editor), The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York. [online]: http://bna.birds.cornell.edu/bna/species/117.

Ponce, C., J. C. Alonso, G. Argandoña, and M. Carrasco. 2010. Carcass removal by scavengers and search accuracy affect bird mortality estimates at power lines. Animal Conservation 13:603–612.

San Luis Obispo County Public Works. 2014. Volunteer Precipitation Gauge Station Monthly Precipitation Report: California Valley CDF # 175. [online]: http://slocountywater.org. Accessed October 2014.

Scott, S. D., and C. McFarland. 2010. Bird Feathers: A Guide to North American Species. Stackpole Books, Mechanicsburg, Pennsylvania.

Shuford , W.D., and Gardali, T., editors. 2008. California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field of Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento.

Sibley, D. A. 2000. The Sibley Guide to Birds. Alfred A. Knopf, New York, New York.

Smallwood, K. S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71:2781–2791.

Smallwood, K. S. 2013. Comparing bird and bat fatality rates among North American wind-energy projects. Wildlife Society Bulletin 37:19–33.

Smallwood, K. S., D. A. Bell, S. A. Snyder, and J. E. Didonato. 2010. Novel scavenger removal trials increase wind turbine-caused avian fatality estimates. Journal of Wildlife Management 74(5):1089–1097.

Thompson, S.K., and G.A. Seber. 1994. Detectability in conventional and adaptive sampling. Biometrics, 50(3): 712-724.

Wagner, W. D., R. L. McKernan, P. A. Flanagan, and R. W. Schreiber. 1983. Wildlife Interactions at Solar One Facility, Daggett, California: Fall 1982 Interim Report.

Warkentin, I.G., N.S. Sodhi, R.H.M. Espie, A.F. Poole, L.W. Oliphant and P. C. James. 2005. Merlin (*Falco columbarius*). In The Birds of North America Online, No. 44 (A. Poole, Ed.). Cornell Lab of Ornithology, Ithaca, New York.

[WEST] Western Ecosystems Technology, Inc. 2004, Stateline Wind Project Wildlife Monitoring Final Report. Cheyenne, Wyoming, and Walla Walla, Washington, and Northwest Wildlife Consultants, Inc., Pendleton, Oregon.

Appendix A. Avian Species Used in Searcher-efficiency Trials, September 2012 to November 2014 (N = 434)

Species	Carcass Size	Number of Fatality Plants Placed[1]
Acorn woodpecker (*Melanerpes formicivorus*)	Large	1[2]
America coot (*Fulica americana*)	Large	9
American crow (*Corvus brachyrhynchos*)	Large	11
American kestrel (*Falco sparverius*)	Large	1
Band-tailed pigeon (*Patagioenas fasciata*)	Large	6
Barn owl (*Tyto alba*)	Large	5
Black-crowned night heron (*Nycticorax nycticorax*)	Large	1
Black-headed grosbeak (*Pheucticus melanocephalus*)	Small	1
Brewer's blackbird (*Euphagus cyanocephalus*)	Small	4
Brown-headed cowbird (*Molothrus ater*)	Small	6
Burrowing owl (*Athene cunicularia*)	Large	1
California quail (*Callipepla californica*)	Large	12
California towhee (*Melozone crissalis*)	Small	1
Cedar waxwing (*Bombycilla cedrorum*)	Small	1
Chestnut-backed chickadee (*Poecile rufescens*)	Small	1
Cliff swallow (*Petrochelidon pyrrhonota*)	Small	8[2]
Common raven (*Corvus corax*)	Large	16
Common yellowthroat (*Geothylpis trichas*)	Small	1
Cooper's hawk (*Accipiter cooperii*)	Large	12
Eared grebe (*Podiceps nigricollis*)	Large	1
Eurasian collared-dove (*Streptopelia decaocto*)	Large	7
European starling (*Sturnus vulgaris*)	Small	2
Great horned owl (*Bubo virginianus*)	Large	16
Greater roadrunner (*Geococcyx californianus*)	Large	4
Green heron (*Butorides virescens*)	Large	2
Horned lark (*Eremophila alpestris*)	Small	36
House finch (*Carpodacus mexicanus*)	Small	53
House sparrow (*Passer domesticus*)	Small	17
Lark sparrow (*Chondestes grammacus*)	Small	2
Lesser goldfinch (*Spinus psaltria*)	Small	1
Lincoln sparrow (*Melospiza lincolnii*)	Small	3
Long-eared owl (*Asio otus*)	Large	3
Mourning dove (*Zenaida macroura*)	Large	70
Red-shouldered hawk (Buteo lineatus)	Large	30[2]
Red-tailed hawk (*Buteo jamaicensis*)	Large	2
Rock pigeon (*Columba livia*)	Large	15

Species	Carcass Size	Number of Fatality Plants Placed[1]
Savannah sparrow (*Passerculus sandwichensis*)	Small	7
Sharp-shinned hawk (*Accipiter striatus*)	Large	1
Short-eared owl (*Asio flammeus*)	Large	1
Swainson's thrush (*Catharus ustulatus*)	Small	2
Unknown small	Small	3
Unknown large	Large	1
Unknown raptor	Large	3
Unknown songbird	Small	3
Varied thrush (*Ixoreus naevius*)	Small	1
Warbling vireo (*Vireo gilvus*)	Small	1
Western meadowlark (*Sturnella neglecta*)	Small	25
Western scrub-jay (*Aphelocoma californica*)	Small	2
White-crowned sparrow	Small	2
White-tailed kite (*Elanus leucurus*)	Large	1
Yellow warbler (*Setophaga petechia*)	Small	9
Yellow-billed magpie (*Pica nuttalli*)	Large	7
Yellow-rumped warbler (*Dendroica coronata*)	Small	3

Notes:
[1] Numbers represent both carcasses and feather spots placed
[2] One individual was removed by a scavenger

Appendix B. Avian Species Used in Carcass-persistence Trials (N=206)

Species	Carcass Size	Number Placed
Acorn woodpecker (*Melanerpes formicivorus*)	Small	6
American coot (*Fulica americana*)	Large	4
American crow (*Corvus brachyrhynchos*)	Large	18†
American goldfinch (*Spinus tristis*)	Small	2
American kestrel (*Falco sparverius*)	Large	3
American robin (*Turdus migratorius*)	Large	3
Anna's hummingbird (*Calypte anna*)	Small	3
Band-tailed pigeon (*Patagioenas fasciata*)	Large	3†
Barn owl (*Tyto alba*)	Large	5†
Black turnstone (*Arenaria melanocephala*)	Large	1
Brewer's blackbird (*Euphagus cyanocephalus*)	Small	6
Blackbird sp.	Small	1
Bullock's oriole (*Icterus bullockii*)	Small	1
Bushtit (*Psaltriparus minimus*)	Small	2
California gull (*Larus californicus*)	Large	1
California thrasher (*Toxostoma redivivum*)	Small	1
California quail (*Callipepla californica*)	Large	2*
California towhee (*Melozone crissalis*)	Small	4
Cedar waxwing (*Bombycilla cedrorum*)	Small	2
Cliff swallow (*Petrochelidon pyrrhonota*)	Small	4
Common raven (*Corvus corax*)	Large	2
Cooper's hawk (*Accipiter cooperii*)	Large	1
Eurasian collared-dove (*Streptopelia decaocto*)	Large	7
European starling (*Sturnus vulgaris*)	Small	4
Great horned owl (*Bubo virginianus*)	Large	9
Greater roadrunner (*Geococcyx californianus*)	Large	2
Hermit thrush (*Catharus guttatus*)	Small	1
Horned grebe (*Podiceps auritus*)	Large	2
Horned lark (*Eremophila alpestris*)	Small	3
House finch (*Haemorhous mexicanus*)	Small	16
House sparrow (*Passer domesticus*)	Small	6†
House wren (*Troglodytes aedon*)	Small	2
Lesser goldfinch (*Spinus psaltria*)	Small	2
Lincoln's sparrow (*Melospiza lincolnii*)	Small	1
Mourning dove (*Zenaida macroura*)	Large	11*
Northern flicker (*Colaptes auratus*)	Large	2
Northern fulmar (*Fulmarus glacialis*)	Large	1
Northern mockingbird (*Mimus polyglottos*)	Small	5

Species	Carcass Size	Number Placed
Nuttall's woodpecker (*Picoides nuttallii*)	Small	3
Peregrine falcon (*Falco peregrinus*)	Large	1
Pine siskin (*Spinus pinus*)	Small	1
Red-necked phalarope (*Phalaropus lobatus*)	Small	1†
Red-shouldered hawk (*Buteo lineatus*)	Large	7†
Red-tailed hawk (*Buteo jamaicensis)*	Large	9†
Red-winged blackbird (*Agelaius phoeniceus*)	Small	2
Rock dove/pigeon (*Columba livia*)	Large	4
Ruby-crowned kinglet (*Regulus calendulai*)	Small	1
Savannah sparrow (*Passerculus sandwichensis*)	Small	2
Sharp-shinned hawk (*Accipiter striatus*)	Large	1†
Song sparrow (*Melospiza melodia*)	Small	1
Western bluebird (*Sialia mexicana*)	Small	1
Western meadowlark (*Sturnella neglecta*)	Large	1
Western screech-owl (*Megascops kennicottii*)	Large	5
Western scrub-jay (*Aphelocoma californica*)	Small	9
White-crowned sparrow (*Zonotrichia leucophrys*)	Small	4
White-tailed kite (*Elanus leucurus*)	Large	2†
Yellow-rumped warbler (*Setophaga coronata*)	Small	2

Notes:
* = Reclassified:
- One California quail was a nestling and was classified as a small carcass.
- Two mourning doves were juveniles and were classified as small carcasses.

† Excluded from analysis:
- Two American crows were excluded from analysis because full persistence data were lacking.
- One band-tailed pigeon was excluded from analysis because full persistence data were lacking.
- One barn owl was excluded from analysis because full persistence data were lacking.
- One house sparrow was excluded from analysis due to removal by biologist prior to scavenging.
- One red-necked phalarope was excluded from analysis due to camera malfunctioning.
- One red-shouldered hawk was excluded from analysis because full persistence data were lacking.
- Two red-tailed hawks were excluded from analysis because full persistence data were lacking.
- One sharp-shinned hawk was excluded from analysis because full persistence data were lacking.
- One white-tailed kite was excluded from analysis because full persistence data were lacking.

Appendix C. Weekly Fatality Search Results: 16 August 2013 to 17 November 2014

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20130828-41	34.5kV Line	8/28/2013	UNWA	Feather spot: 16 primaries and secondaries, four tail, and 40+ contour feathers from unknown warbler.	C	>50	11S	236786	3913033
20131002-51	34.5kV Line	10/2/2013	SAVS	Whole carcass: no obvious sign of injury but feathers falling out of chest from possible collision point.	C	>90	11S	234643	3913250
20131023-46	34.5kV Line	10/23/2013	AMKE	Feather spot: all feather types. At least >100 body feathers and >12 wing and tail feathers.	C	>50	11S	233929	3913261
20131113-41	34.5kV Line	11/13/2013	MODO	Feather spot: 5-6 contours in clumps	U	n/a	11S	238157	3912540
20131113-106	34.5kV Line	11/13/2013	MODO	Feather spot: 50 body and 3 primary feathers.	C	>50	11S	234646	3913264
20131113-107	34.5kV Line	11/13/2013	CORA	Feather spot: 30 body feathers.	U	n/a	11S	234458	3913361
20131120-91	34.5kV Line	11/20/2013	MODO	Feather spot: 3 Tail feathers. 9 body feathers found clumped	U	n/a	11S	234645	3913250
20131204-26	34.5kV Line	12/4/2013	BUOW	Feather spot: 50+ body feathers	U	n/a	11S	238214	3912029
20131211-41	34.5kV Line	12/11/2013	WEME	Feather spot: Three flight feathers (all tail) and 15 to 20 body feathers.	C	>50	11S	238150	3912327
20140108-124	34.5kV Line	1/8/2014	BUOW	Feather spot: 10+ flight and body feathers.	U	n/a	11S	234808	3912884
20140108-125	34.5kV Line	1/8/2014	MODO	Feather spot: 100+ body and flight feathers.	U	n/a	11S	238146	3912249

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140108-126	34.5kV Line	1/8/2014	MODO	Feather spot: 3 secondary, 1 primary, and 10 body feathers.	C	>50	11S	236480	3913001
20140115-36	34.5kV Line	1/15/2014	HOLA	Feather spot: 15 body feathers.	U	n/a	11S	236807	3913045
20140122-36	34.5kV Line	1/22/2014	UNKN	Feather spot: 15 body feathers from unknown large bird.	U	n/a	11S	234620	3913324
20140122-37	34.5kV Line	1/22/2014	UNKN	Feather spot: 20 body feathers from unknown raptor.	U	n/a	11S	236364	3912921
20140122-38	34.5kV Line	1/22/2014	HOFI	Feather spot: Five flight and 40+ body feathers.	U	n/a	11S	236364	3912921
20140129-56	34.5kV Line	1/29/2014	WEME	Feather spot: 10 flight feathers and 15 - 20 body feathers.	U	n/a	11S	234025	3913564
20140312-101	34.5kV Line	3/12/2014	CORA	Feather spot: 11 body feathers.	C	>50	11S	233867	3911735
20140409-56	34.5kV Line	4/9/2014	MODO	Feather spot: 80 + body feathers.	C	>50	11S	233941	3913077
20140423-101	34.5kV Line	4/23/2014	CORA	Feather spot: 11 body feathers.	C	>50	11S	234994	3911864
20140423-102	34.5kV Line	4/23/2014	CORA	Feather spot: 20 body feathers.	C	>50	11S	233807	3911629
20140423-36	34.5kV Line	4/23/2014	ROPI	Partial Carcass: 40 + body and wing feathers attached to bone	C	>50	11S	234714	3913039
20140430-56	34.5kV Line	4/30/2014	MODO	Feather spot: Eight flight and four body feathers.	C	>50	11S	238153	3912412
20140723-21	34.5kV Line	7/23/2014	HOSP	Whole carcass: Fresh intact nestling with small wound on foot and under neck and beak. Directly under powerline and adjacent to utility pole.	P	>50	11S	236924	3913023

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140730-21	34.5kV Line	7/30/2014	ECDO	Feather spot: Clump of five or six body feathers connected by dried blood. Directly under powerline and adjacent to utility pole.	C	>50	11S	236887	3913023
20140924-101	34.5kV Line	9/24/2014	SAVS	Whole carcass: Beak open and lower mandible broken.	C	>50	11S	233952	3913134
20130822-56	Array 1	8/22/2013	CORA	Feather spot: cluster of body feathers.	U	n/a	11S	233463	3915644
20130829-41	Array 1	8/29/2013	HOLA	Feather spot: approximately 20 body feathers.	U	n/a	11S	233950	3915592
20130829-86	Array 1	8/29/2013	MODO	Feather spot: 40+ contour feathers, two rectrices, some coverts and scapulars.	U	n/a	11S	233466	3915623
20130919-47	Array 1	9/19/2013	HOLA	Feather spot: 12 flight feathers (primary, secondary, and tail). More than 20 contour feathers.	U	n/a	11S	234059	3915719
20130919-16	Array 1	9/19/2013	MODO	Feather spot: 100+ body feathers, five tail feathers and two flight feathers.	U	n/a	11S	234018	3915516
20130919-17	Array 1	9/19/2013	MODO	Feather spot: 60+ body feathers, two tail feathers, and two wing coverts.	U	n/a	11S	233904	3915378
20130926-41	Array 1	9/26/2013	MODO	Feather spot: 100+ body feathers, 16+ flight feathers (primaries, secondaries, and retrices).	U	n/a	11S	233708	3915565
20131010-67	Array 1	10/10/2013	SAVS	Feather spot: ten Flight and 75 body feathers (breast, coverts) .	U	n/a	11S	233921	3915612
20131010-91	Array 1	10/10/2013	SAVS	Feather spot: 150 body feathers (belly breast mantle coverts) and 20 flight feathers (primary, secondary, tail).	U	n/a	11S	234040	3915699
20131017-101	Array 1	10/17/2013	HOLA	Partial carcass: partial wing with bone and few contour feathers.	U	n/a	11S	233611	3915529
20131017-102	Array 1	10/17/2013	SOSP	Feather spot: three wing and 75 contour feathers.	U	n/a	11S	233935	3915659

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131017-41	Array 1	10/17/2013	HOLA	Feather spot: 500+ body feathers.	U	n/a	11S	233672	3915718
20131107-106	Array 1	11/7/2013	MODO	Feather spot: One wing and 20 body feathers.	U	n/a	11S	233870	3915505
20131205-66	Array 1	12/5/2013	MODO	Feather spot: 24 body feathers and two secondary feathers with dried blood.	U	n/a	11S	234085	3915681
20140102-101	Array 1	1/2/2014	MODO	Feather spot: 10 flight and 25 body feathers.	U	n/a	11S	234247	3915552
20140102-122	Array 1	1/2/2014	MODO	Feather spot: 20+ body and three primary feathers.	U	n/a	11S	233452	3915780
20140605-41	Array 1	6/5/2014	ROPI	Feather spot: 15–18 body and/or secondary feathers.	U	n/a	11S	233627	3915666
20141009-21	Array 1	10/9/2014	WEME	Feather spot: Approximately 30 body feathers in several clumps.	U	n/a	11S	233415	3915748
20141030-101	Array 1	10/30/2014	MODO	Feather spot: Three tail feathers, one primary, and approximately 30 body feathers.	U	n/a	11S	233917	3915729
20140304-56	Array 11	3/4/2014	HOLA	Feather spot: 100 body feathers, four wing parts, and 15 flight feathers.	U	n/a	11S	234910	3911748
20140506-56	Array 11	5/6/2014	HOLA	Feather spot: 25 flight and 15 body feathers.	U	n/a	11S	234913	3911680
20140527-21	Array 11	5/27/2014	HOLA	Feather spot: Three wing partials. Ten loose flight feathers. 70 body feathers.	U	n/a	11S	234943	3911826
20140722-91	Array 11	7/22/2014	HOLA	Feather spot: 20+ flight feathers, 100+ body feathers.	U	n/a	11S	235078	3911778
20140812-101	Array 11	8/12/2014	HOLA	Partial carcass: Partial wing, four coverts, and four flight feathers, all attached.	U	n/a	11S	235060	3911767
20140909-121	Array 11	9/9/2014	CORA	Feather spot: One secondary feather and approximately body feathers.	U	n/a	11S	235087	3911773

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131029-1	Array 1-2 Fence	10/29/2013	ROPI	Feather spot: 20 contour feathers.	U	n/a	11S	234527	3914904
20131119-36	Array 1-2 Fence	11/19/2013	MODO	Feather spot: 200+ feathers including body, tail, wing, and contour feathers	U	n/a	11S	233399	3915688
20131119-37	Array 1-2 Fence	11/19/2013	MODO	Feather spot: 15 contour, 3 tail feathers	U	n/a	11S	233618	3914440
20131210-56	Array 1-2 Fence	12/10/2013	MODO	Feather spot: 12-15 body feathers.	U	n/a	11S	234173	3914460
20140128-21	Array 1-2 Fence	1/28/2014	HOFI	Feather spot: 20+ flight and 150+ body feathers.	U	n/a	11S	233395	3915500
20140107-123	Array 2	1/7/2014	HOFI	Feather spot: 100+ body feathers.	U	n/a	11S	234246	3914889
20140121-112	Array 2	1/21/2014	MODO	Feather spot: Two flight and 40 body feathers.	U	n/a	11S	234478	3914936
20140121-113	Array 2	1/21/2014	MODO	Feather spot: Four flight and 70 body feathers. Heavily clumped body feathers.	U	n/a	11S	234326	3915038
20140128-41	Array 2	1/28/2014	MODO	Feather spot: Five to six flight and 15+ body feathers. Some skin connected to the downy feathers.	U	n/a	11S	234357	3915121
20140128-42	Array 2	1/28/2014	WEME	Feather spot: 10 flight and 100+ body feathers.	U	n/a	11S	234348	3914900
20140211-21	Array 2	2/11/2014	MODO	Feather spot: 10 body feathers; two loose and eight attached to single piece of skin.	U	n/a	11S	234340	3915188
20140211-22	Array 2	2/11/2014	BUOW	Feather spot: 20 flight and 100 body feathers.	U	n/a	11S	234516	3914922
20140408-66	Array 2	4/8/2014	HOLA	Feather spot: Approximately 20 body feathers.	U	n/a	11S	234474	3915043
20140429-91	Array 2	4/29/2014	HOLA	Feather spot: Feathers of right wing and 50+ body feathers. Possibly from same as 20140506-	U	n/a	11S	234466	3915194

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
				36.					
20140506-36	Array 2	5/6/2014	HOLA	Feather spot: 20 body feathers and left wing. Possibly from same as 20140429-91.	U	n/a	11S	234526	3915229
20140513-41	Array 2	5/13/2014	HOLA	Feather spot: Eight flight feathers.	U	n/a	11S	234356	3914984
20140513-42	Array 2	5/13/2014	CORA	Feather spot: Approximately 30 body feathers.	U	n/a	11S	234246	3914936
20140520-101	Array 2	5/20/2014	HOLA	Feather spot: Nine flight feathers. Approximately 15 body feathers.	U	n/a	11S	234492	3915148
20140520-66	Array 2	5/20/2014	HOFI	Feather spot: 40 body feathers.	U	n/a	11S	234447	3914875
20140826-101	Array 2	8/26/2014	HOLA	Feather spot: Approximately 200 body and flight feathers.	U	n/a	11S	234328	3915028
20140826-126	Array 2	8/26/2014	MODO	Feather spot: Approximately 30 body feathers and four secondary feathers.	U	n/a	11S	234333	3915109
20141021-41	Array 2	10/21/2014	HOLA	Feather spot: Five primary and approximately 25 contour feathers.	U	n/a	11S	234489	3915097
20141028-101	Array 2	10/28/2014	CORA	Feather spot: Approximately 30 body feathers.	U	n/a	11S	234422	3915085
20141104-21	Array 2	11/4/2014	MODO	Feather spot: Clump of 10 body feathers with blood and piece of bone.	U	n/a	11S	234486	3914947
20131105-11	Array 2 Control	11/5/2013	MODO	Feather spot: wing and feathers, bone, and heart. Twenty primaries and secondaries, one wing, 10 tail, and 100+ body feathers.	U	n/a	11S	234298	3913537
20131112-63	Array 2 Control	11/12/2013	MODO	Feather spot: 20 body feathers	U	n/a	11S	233665	3914133

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131126-101	Array 2 Control	11/26/2013	WEME	Feather spot: 10-15 body feathers. 2 tail feathers.	U	n/a	11S	234312	3914369
20131210-107	Array 2 Control	12/10/2013	HOFI	Feather spot: 11 body feathers	U	n/a	11S	233953	3913581
20131217-111	Array 2 Control	12/17/2013	HOLA	Feather spot: 200 body feathers, skin	U	n/a	11S	233963	3913582
20130827-21	Array 2 North	8/27/2013	HOLA	Partial carcass: right wing with exposed bone and dried muscle tendons/ligaments.	U	n/a	11S	234323	3915324
20130827-26	Array 2 North	8/27/2013	MODO	Feather spot: seven tail feathers, 30 body feathers, one primary feather.	U	n/a	11S	234310	3915241
20130903-57	Array 2 North	9/3/2013	HOLA	Feather spot: five tail, five primary, three secondary, and 100+ body feathers.	U	n/a	11S	234323	3915312
20130910-37	Array 2 North	9/10/2013	HOLA	Partial carcass: two wings, five tail feathers and 30+ body feathers.	U	n/a	11S	234492	3915098
20130924-51	Array 2 North	9/24/2013	ROPI	Feather spot: five secondary feathers and one clump of five body feathers.	U	n/a	11S	234156	3915037
20130924-11	Array 2 North	9/24/2013	BUOW	Feather spot: approximately 50 contour feathers and 12 primaries. Secondary larger feather spot on adjacent Conservation Land.	U	n/a	11S	233969	3915190
20131008-41	Array 2 North	10/8/2013	AMPI	Feather spot: eight primary feathers in two clumps.	U	n/a	11S	233825	3915053
20131015-36	Array 2 North	10/15/2013	SAVS	Feather spot: partial wing (10 primary and secondary feathers), three tail feathers, five wing coverts and 15 breast feathers. Some fresh blood on feathers and feathers with fresh blood also found on panel above fatality.	U	n/a	11S	234251	3915140
20131015-106	Array 2 North	10/15/2013	HOLA	Feather spot: two secondaries and few coverts attached by small amount of flesh.	U	n/a	11S	233828	3915049

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131015-41	Array 2 North	10/15/2013	EUST	Feather spot: five to eight tail feathers, five to ten wing feathers, and 50+ contour feathers.	U	n/a	11S	234023	3914990
20131022-51	Array 2 North	10/22/2013	MODO	Feather spot: 20 contour feathers.	U	n/a	11S	234262	3915238
20131022-52	Array 2 North	10/22/2013	MODO	Feather spot: two wing feathers (secondaries).	U	n/a	11S	234149	3915041
20131112-81	Array 2 North	11/12/2013	WEME	Feather spot: 1 primary feather. 30 belly, breast and mantle feathers.	U	n/a	11S	234109	3915083
20131112-41	Array 2 North	11/12/2013	HOFI	Feather spot: 200-300 body feathers. 3-4 wing feathers.	U	n/a	11S	234201	3915219
20131112-42	Array 2 North	11/12/2013	HOFI	Feather spot: 5 primaries attached together with very dried skin.	U	n/a	11S	234311	3915321
20131126-111	Array 2 North	11/26/2013	SAVS	Whole carcass: Carcass, body without head. Impaled on tumbleweed.	P	<90	11S	234341	3915050
20131217-38	Array 2 North	12/17/2013	HOLA	Feather spot: Partial wing, with 200 body feathers and 20+ primary, secondary, and tail feathers.	U	n/a	11S	233787	3914934
20131217-51	Array 2 North	12/17/2013	MODO	Feather spot: 10 flight and 30 body feathers	U	n/a	11S	234370	3915423
20131231-16	Array 2 North	12/31/2013	MODO	Feather spot: 15+ flight and 200+ body feathers. Dried blood on feathers.	U	n/a	11S	234254	3914963
20131231-41	Array 2 North	12/31/2013	SAVS	Feather spot: 12 flight and 40+ body feathers.	U	n/a	11S	234104	3915019
20131231-42	Array 2 North	12/31/2013	WEME	Feather spot: 20+ flight and 200+ body feathers.	U	n/a	11S	234241	3914983
20131231-43	Array 2 North	12/31/2013	BRBL	Feather spot: 50+ body and ~12 flight feathers.	U	n/a	11S	234059	3915121
20131231-26	Array 2 North	12/31/2013	MODO	Feather spot: Five flight and 50 body feathers.	U	n/a	11S	234018	3915135

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20130910-52	Array 2 South	9/10/2013	LOSH	Feather spot: 30 flight feathers and 20 body feathers.	U	n/a	11S	234253	3914489
20130917-21	Array 2 South	9/17/2013	MODO	Feather spot: 30+ breast/body feathers, two secondaries, one tail feather and one primary feather.	U	n/a	11S	233705	3914565
20131029-37	Array 2 South	10/29/2013	MODO	Feather spot: 15+ wing feathers and 300 body feathers.	U	n/a	11S	233690	3914479
20131029-38	Array 2 South	10/29/2013	BRBL	Feather spot: 50+ body feathers. 6 contour and tail feathers.	U	n/a	11S	234045	3914766
20131029-56	Array 2 South	10/29/2013	MODO	Feather spot: two clumps of body feathers with six feathers in each clump.	U	n/a	11S	233776	3914490
20131105-61	Array 2 South	11/5/2013	YRWA	Feather spot: five tail feathers, ten or more primary and secondary feathers, 15+ rump feathers and 50+ mantle, belly, and breast feathers.	U	n/a	11S	234220	3914825
20131112-61	Array 2 South	11/12/2013	WEME	Feather spot: 4 secondaries. 50+ breast and belly feathers. 30+ mantle feathers	U	n/a	11S	234266	3914715
20131112-56	Array 2 South	11/12/2013	WEME	Feather spot: 2 primaries. 50+ breast, belly, and mantle feathers	U	n/a	11S	234266	3914823
20131119-61	Array 2 South	11/19/2013	WEME	Feather spot: 6 tail. 10 secondaries. 5+ primaries. 75+ breast body and mantle feathers.	U	n/a	11S	234267	3914747
20131119-62	Array 2 South	11/19/2013	MODO	Feather spot: 6 flight feathers. 25 body feathers	U	n/a	11S	234292	3914841
20131126-36	Array 2 South	11/26/2013	HOFI	Feather spot: 20 breast feathers attached to a piece of skin	U	n/a	11S	233681	3914607
20131126-37	Array 2 South	11/26/2013	HOFI	Feather spot: 100+ body feathers and 15+ flight feathers	U	n/a	11S	234182	3914868
20131126-46	Array 2 South	11/26/2013	MODO	Feather spot: 150+ body feathers, 15+ remiges, and 4+ retrices.	U	n/a	11S	233748	3914491

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131210-26	Array 2 South	12/10/2013	BUOW	Feather spot: Mostly body and wing feathers. One wing with bone attached, apparently plucked from carcass. Feathers and feather dust smudge on panel.	C	>50	11S	233885	3914440
20131210-27	Array 2 South	12/10/2013	MODO	Feather spot: Multiple tail and untertail coverts and body feathers.	U	n/a	11S	234178	3914631
20131217-26	Array 2 South	12/17/2013	MODO	Feather spot: 15 body feathers connected by skin.	U	n/a	11S	234292	3914577
20131217-113	Array 2 South	12/17/2013	HOLA	Feather spot: beak with flight feathers and 500 body feathers.	U	n/a	11S	233658	3914657
20131217-112	Array 2 South	12/17/2013	MODO	Feather spot: 1 flight and 60 body feathers	U	n/a	11S	234228	3914772
20131217-101	Array 2 South	12/17/2013	WEME	Feather spot: 25 body feathers	U	n/a	11S	234283	3914578
20131231-91	Array 2 South	12/31/2013	HOFI	Feather spot: 300 body and 20 flight feathers.	U	n/a	11S	234264	3914596
20131231-93	Array 2 South	12/31/2013	MODO	Feather spot: 20 flight and 100+ body feathers in several clumps.	U	n/a	11S	233975	3914547
20131231-94	Array 2 South	12/31/2013	MODO	Feather spot: 10 body feathers clumped.	U	n/a	11S	234239	3914709
20131231-95	Array 2 South	12/31/2013	MODO	Feather spot: 30 body and one flight feather.	U	n/a	11S	234157	3914693
20131231-112	Array 2 South	12/31/2013	HOFI	Feather spot: 70 body feathers.	U	n/a	11S	234256	3914518
20131231-126	Array 2 South	12/31/2013	WEME	Feather spot: Eight flight and 100 body feathers. Long smudge of body fluids along two trackers and panels with approximately ten feathers attached.	C	<50, >0	11S	233630	3914629

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131231-111	Array 2 South	12/31/2013	MODO	Feather spot: 10 flight and 200 body feathers.	U	n/a	11S	234252	3914541
20131231-127	Array 2 South	12/31/2013	MODO	Feather spot: 30 body feathers and four flight feathers.	U	n/a	11S	234166	3914885
20130828-38	Array 4	8/28/2013	HOFI	Feather spot: approximately 40 body feathers tightly clumped.	U	n/a	11S	235818	3912726
20131002-66	Array 4	10/2/2013	MODO	Feather spot: nine flight and body feathers.	U	n/a	11S	235580	3912843
20131002-81	Array 4	10/2/2013	WEME	Feather spot: ten body feathers.	U	n/a	11S	235660	3912716
20131023-101	Array 4	10/23/2013	MODO	Feather spot: three contour and 10-15 clumped body feathers.	U	n/a	11S	235566	3912961
20131030-36	Array 4	10/30/2013	MODO	Feather spot: 50+ body feathers and six contour and tail feathers.	U	n/a	11S	235544	3912717
20131106-82	Array 4	11/6/2013	ROPI	Feather spot: four tail feathers and 75+ body feathers.	U	n/a	11S	235561	3913230
20131113-108	Array 4	11/13/2013	MODO	Feather spot: 300 body and 10 wing feathers	U	n/a	11S	235658	3913495
20131113-61	Array 4	11/13/2013	MODO	Feather spot: Partial wing with clumps of wing coverts. Body feathers.	U	n/a	11S	235542	3912727
20131113-62	Array 4	11/13/2013	MODO	Feather spot: 4 secondary and 20 body feathers.	U	n/a	11S	235587	3913148
20131113-91	Array 4	11/13/2013	MODO	Feather spot: 2 primaries. 20 body feathers- some clumped	U	n/a	11S	235643	3912719
20131120-77	Array 4	11/20/2013	MODO	Feather spot: 4 tail and 30 body feathers	U	n/a	11S	235646	3913342
20131120-108	Array 4	11/20/2013	MODO	Feather spot: 30 body feathers. 1 secondary feather.	U	n/a	11S	235543	3912797

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131120-101	Array 4	11/20/2013	HOFI	Feather spot: Severn to eight feathers and 50 body feathers. Some with blood on feathers.	U	n/a	11S	235665	3913379
20131204-51	Array 4	12/4/2013	MODO	Feather spot: 24 body feathers connected with tissue.	U	n/a	11S	235863	3912739
20131211-56	Array 4	12/11/2013	MODO	Feather spot: Five+ flight (two primary feathers) and 50+ body feathers.	U	n/a	11S	235544	3912824
20131211-106	Array 4	12/11/2013	MODO	Feather spot: 15 flight and 150 body feathers.	U	n/a	11S	235544	3912956
20131211-107	Array 4	12/11/2013	MODO	Feather spot: 10 flight and 150 body feathers.	U	n/a	11S	235553	3912873
20131211-51	Array 4	12/11/2013	MODO	Feather spot: Body and flight feathers.	U	n/a	11S	235678	3912728
20131218-36	Array 4	12/18/2013	MODO	Feather spot: 50+ contour/body feathers and 15 flight feathers	U	n/a	11S	235808	3913345
20131218-37	Array 4	12/18/2013	MODO	Feather spot: 25 body feathers, including two clumps of 10 feathers each.	U	n/a	11S	235563	3912967
20131218-41	Array 4	12/18/2013	SAVS	Feather spot: 100+ body and 20 flight feathers.	U	n/a	11S	235677	3913411
20131218-42	Array 4	12/18/2013	MODO	Feather spot: 2 flight and 30+ contour feathers	U	n/a	11S	235628	3913002
20131218-38	Array 4	12/18/2013	HOLA	Feather spot: 200+ body feathers and 10 unidentified feathers.	U	n/a	11S	235610	3912812
20131218-39	Array 4	12/18/2013	MODO	Feather spot: 100 body and 2 flight feathers.	U	n/a	11S	235555	3912818
20131218-26	Array 4	12/18/2013	MODO	Feather spot: 30+ body and 5 flight feathers.	U	n/a	11S	235687	3912717
20140108-56	Array 4	1/8/2014	MODO	Feather spot: One wing covert, one tail feather, and 40 body feathers.	U	n/a	11S	235617	3912814

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140108-127	Array 4	1/8/2014	HOFI	Feather spot: 2 flight and 30+ body feathers and partial beak.	U	n/a	11S	235540	3912761
20140115-91	Array 4	1/15/2014	HOFI	Feather spot: 100 body and three flight feathers.	U	n/a	11S	235601	3913167
20140122-101	Array 4	1/22/2014	UNKN	Feather spot: piece of wing with feathers connected by skin, five flight and four covert feathers from unknown passerine.	U	n/a	11S	235977	3912728
20140122-104	Array 4	1/22/2014	HOFI	Feather spot: beak, organs, blood, and feathers. 20 flight and 200 body feathers.	U	n/a	11S	235777	3913251
20140129-41	Array 4	1/29/2014	HOFI	Feather spot: Three flight and 75 body feathers.	U	n/a	11S	235603	3913171
20140212-56	Array 4	2/12/2014	HOFI	Feather spot: wing clump, 15+ flight and 100 body feathers, across length of tracker row.	U	n/a	11S	235692	3913293
20140319-56	Array 4	3/19/2014	MODO	Feather spot: 10+ body feathers.	U	n/a	11S	235576	3912924
20140423-111	Array 4	4/23/2014	CORA	Feather spot: Approximately 30 body feathers.	U	n/a	11S	235556	3913007
20140430-57	Array 4	4/30/2014	HOLA	Feather spot: Wing segments - 50 flight and 40 body feathers.	U	n/a	11S	235615	3912877
20140507-91	Array 4	5/7/2014	MODO	Feather spot: 20 flight and 250 body feathers.	U	n/a	11S	235579	3913240
20140604-21	Array 4	6/4/2014	HOFI	Feather spot: Six loose flight feathers and approximately 70 body feathers.	U	n/a	11S	235813	3913400
20140611-56	Array 4	6/11/2014	CORA	Feather spot: Ten body feathers.	U	n/a	11S	235682	3913470
20140806-91	Array 4	8/6/2014	HOFI	Whole carcass: Very desiccated, keel exposed, internal tissues decomposed.	U	n/a	11S	235565	3913044

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20141001-56	Array 4	10/1/2014	AMCO	Feather spot: 10 flight feathers and approximately 200 body feathers.	U	n/a	11S	235549	3912702
20141022-44	Array 4	10/22/2014	MODO	Feather spot: Three tail feathers, five secondaries, and approximately 200 body feathers.	U	n/a	11S	235653	3912711
20141022-21	Array 4	10/22/2014	MODO	Feather spot: 15 body feathers in three distinct clumps.	U	n/a	11S	235679	3913356
20141029-93	Array 4	10/29/2014	ROPI	Feather spot: 10 flight feathers and 10 body feathers.	U	n/a	11S	235606	3912931
20131218-21	Array 4 Fence	12/18/2013	MODO	Feather spot: 100+ body and five tail feathers. Feathers found in several distinct clumps.	U	n/a	11S	235544	3913317
20140129-82	Array 4 Fence	1/29/2014	UNKN	Feather spot: 100 body feathers, four wing parts,15 flight feathers from unknown large bird.	U	n/a	11S	235541	3913282
20131120-37	Array 5	11/20/2013	MODO	Feather spot: 40+ body feathers. ~12 Secondaries. 3 Tail feathers	U	n/a	11S	236776	3913579
20131120-38	Array 5	11/20/2013	MODO	Feather spot: 20 body, 3 tail, and 6 contour feathers found in several clumps.	U	n/a	11S	236734	3913627
20140108-41	Array 5	1/8/2014	MODO	Feather spot: Eight to ten flight and 15+ body feathers.	U	n/a	11S	236705	3913598
20140129-81	Array 5	1/29/2014	AMCO	Feather spot: Approximately 100 body feathers.	U	n/a	11S	236649	3913800
20140205-91	Array 5	2/5/2014	MODO	Feather spot: Three clumped feathers attached to skin.	U	n/a	11S	236774	3913649
20131120-36	Array 5 Fence	11/20/2013	LASP	Feather spot: 100 body and contour feathers. 20+ wing and tail feathers. Beak with attached feathers.	U	n/a	11S	236596	3913884
20130930-21*	Array 6	9/30/2013	BUOW	Feather spot: two body feathers, four flight feathers (1 primary, 3 secondaries).	U	n/a	11S	237124	3913027

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20130930-22*	Array 6	9/30/2013	HOLA	Feather spot: 40 body feathers, two secondary feathers, several distinct clumps of 5-10 body feathers.	U	n/a	11S	237161	3913037
20131021-41	Array 6	10/21/2013	HOLA	Feather spot: wing parts, 30+ body, four tail, and 12-15 wing feathers. Some feathers clumped together with wing parts.	U	n/a	11S	237187	3913020
20131125-36	Array 6	11/25/2013	HOFI	Feather spot: 15 primary and secondary feathers. 30+ body and contour feathers.	U	n/a	11S	237209	3913199
20131216-36	Array 6	12/16/2013	MODO	Feather spot: 2 tail, 5 contour and 20 body feathers	U	n/a	11S	237100	3913022
20131216-37	Array 6	12/16/2013	MODO	Feather spot: 2 tail, 20 contour, and 30 body feathers	U	n/a	11S	237002	3913230
20131230-41	Array 6	12/30/2013	LOSH	Feather spot: 20 flight (wing and tail) and 100+ body feathers. Feathers were on the north side of the panel in a large area at the edge of the array. Some feathers and fluids were on the nearby panel.	C	<50, >0	11S	237218	3913237
20131230-42	Array 6	12/30/2013	HOFI	Feather spot: 10 flight and 30 body feathers.	U	n/a	11S	237156	3913180
20131230-43	Array 6	12/30/2013	MODO	Feather spot: six flight and two body feathers.	U	n/a	11S	237202	3913094
20131230-44	Array 6	12/30/2013	HOFI	Feather spot: 20+ flight feathers and 300+ body feathers	U	n/a	11S	237189	3913083
20140106-112	Array 6	1/6/2014	MODO	Feather spot: Six flight and 40 body feathers.	U	n/a	11S	237048	3913129
20140106-67	Array 6	1/6/2014	HOFI	Feather spot: 200+ body, four primary, and 10+ secondary feathers. Beak with fresh blood.	U	n/a	11S	237042	3913153
20140127-56	Array 6	1/27/2014	HOFI	Feather spot: 50+ body and 25+ flight feathers.	U	n/a	11S	236988	3913088

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140127-57	Array 6	1/27/2014	HOFI	Feather spot: 100+ body feathers.	U	n/a	11S	237049	3913135
20140127-58	Array 6	1/27/2014	HOFI	Whole carcass: found inside the "C" piles head first on ground below the cable trays. Carcass in rigor but no obvious broken dens-neck and keel bone intact. Eyes intact-fluid filled. Ceres present.	U	n/a	11S	237042	3913128
20140127-59	Array 6	1/27/2014	HOFI	Feather spot: 25 flight and 100 body feathers.	U	n/a	11S	237259	3913178
20140127-60	Array 6	1/27/2014	HOFI	Feather spot: 10 flight and 15+ body feathers.	U	n/a	11S	237156	3913172
20140204-66	Array 6	2/4/2014	MODO	Feather spot: 200+ body and 40 flight feathers.	U	n/a	11S	237039	3913115
20140218-111	Array 6	2/18/2014	MODO	Feather spot: One tail feather and 40 body feathers connected by skin.	U	n/a	11S	237035	3913121
20140317-2	Array 6	3/17/2014	MODO	Feather spot: Approximately 100 body feathers.	U	n/a	11S	237185	3913194
20140317-39	Array 6	3/17/2014	MODO	Feather spot: 30 body and 4 four flight feathers.	U	n/a	11S	237061	3913157
20140317-21	Array 6	3/17/2014	MODO	Feather spot: 80+ body and 16 wing and tail feathers. One partial wing clump with dried skin and blood.	U	n/a	11S	237196	3913118
20140421-36	Array 6	4/21/2014	BRBL	Feather spot: Approximately 15 body feathers; some are connected to one another.	U	n/a	11S	237109	3912989
20140714-11	Array 6	7/14/2014	UNKN	Feather spot: 13 body feathers from unknown passerine.	U	n/a	11S	237198	3913008
20140714-41	Array 6	7/14/2014	HOFI	Feather spot: Approximately eight flight feathers and 70 body feathers.	U	n/a	11S	236995	3913033

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140714-42	Array 6	7/14/2014	HOSP	Feather spot: Approximately 30 body feathers.	U	n/a	11S	236987	3913155
20140922-21	Array 6	9/22/2014	ROPI	Feather spot: Six primaries, six secondaries and 10 body feathers.	U	n/a	11S	237001	3913042
20141013-122	Array 6	10/13/2014	MODO	Feather spot: Approximately 20 body feathers and two secondary feathers connected with tissue.	U	n/a	11S	237263	3913228
20141020-21	Array 6	10/20/2014	MODO	Feather spot: 15 body feathers, two secondary feathers, and two tail feathers.	U	n/a	11S	236999	3913227
20131010-101*	Array 7	10/10/2013	MODO	Feather spot: ten body feathers.	U	n/a	11S	238673	3911160
20131010-26*	Array 7	10/10/2013	WEME	Feather spot: clump of eight body feathers attached by skin.	U	n/a	11S	238462	3911291
20131031-36	Array 7	10/31/2013	MODO	Feather spot: 50 body feathers and six tail feathers.	U	n/a	11S	238532	3910993
20131031-71	Array 7	10/31/2013	MODO	Feather spot: 100 body feathers and 15 flight feathers - some clumped.	U	n/a	11S	238635	3910988
20131107-76	Array 7	11/7/2013	MODO	Feather spot: Approximately 30 feathers found on the solar panel. One flight feather found on the ground.	U	n/a	11S	238612	3911192
20131114-91	Array 7	11/14/2013	SPTO	Feather spot: 10+ tail, 5+ primary and secondary, and 50+ body feathers.	U	n/a	11S	238337	3910994
20131205-47	Array 7	12/5/2013	HOFI	Feather spot: 10 flight and 50 body feathers	U	n/a	11S	238522	3911138
20131212-56	Array 7	12/12/2013	HOFI	Feather spot: 100+ body feathers and 10+ flight feathers.	U	n/a	11S	238533	3911185
20131212-57	Array 7	12/12/2013	HOFI	Feather spot: 120+ body feathers and 20+ flight feathers. Found tangled with tumbleweed against cable tray.	U	n/a	11S	238523	3911279

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131219-56	Array 7	12/19/2013	HOFI	Feather spot: 80+ body and 15+ flight feathers tangled in tumbleweed.	U	n/a	11S	238389	3911279
20140102-11	Array 7	1/2/2014	HOFI	Whole carcass: no sign of injury or illness.	U	n/a	11S	238622	3910967
20140102-12	Array 7	1/2/2014	HOFI	Feather spot: Approximately 25 primary feathers, 400 body feathers, and some fresh organs.	U	n/a	11S	238618	3910976
20140102-126	Array 7	1/2/2014	MODO	Feather spot: Six primary and ~15 body feathers.	U	n/a	11S	238310	3911277
20140102-127	Array 7	1/2/2014	MODO	Feather spot: One flight and 10+ body feathers.	U	n/a	11S	238627	3911036
20140109-102	Array 7	1/9/2014	HOFI	Feather spot: Five to ten flight and 150 body feathers.	U	n/a	11S	238589	3911085
20140123-36	Array 7	1/23/2014	MODO	Feather spot: 40+ body and one flight feather.	U	n/a	11S	238605	3911234
20140123-101	Array 7	1/23/2014	HOFI	Feather spot: Seven flight and 50 to 100 body feathers.	U	n/a	11S	238581	3910997
20140213-101	Array 7	2/13/2014	MODO	Feather spot: 15 body feathers clumped.	U	n/a	11S	238650	3910964
20140213-102	Array 7	2/13/2014	MODO	Feather spot: 40 body and one tail feather.	U	n/a	11S	238271	3911237
20140213-103	Array 7	2/13/2014	HOFI	Feather spot: 12 flight feathers and 100+ body feathers.	U	n/a	11S	238583	3911332
20140213-66	Array 7	2/13/2014	MODO	Feather spot: 16 body and two flight feathers.	U	n/a	11S	238575	3911278
20140220-125	Array 7	2/20/2014	MODO	Feather spot: 200+ body feathers and 30+ flight feathers.	U	n/a	11S	238389	3911201
20140227-41	Array 7	2/27/2014	MODO	Feather spot: Five flight and 30+ body feathers.	U	n/a	11S	238387	3911192

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140313-41	Array 7	3/13/2014	MODO	Feather spot: One wing covert and 12 body feathers.	U	n/a	11S	238285	3911040
20140320-36	Array 7	3/20/2014	CORA	Feather spot: 15 body feathers.	U	n/a	11S	238482	3911038
20140410-36	Array 7	4/10/2014	CORA	Feather spot: Approximately 30 body feathers.	U	n/a	11S	238296	3910996
20140501-111	Array 7	5/1/2014	HOLA	Feather spot: Approximately 30 flight and 50 body feathers.	U	n/a	11S	238226	3910993
20140515-36	Array 7	5/15/2014	SWTH	Feather spot: Approximately 200 body feathers and five flight feathers.	U	n/a	11S	238231	3911006
20140515-37	Array 7	5/15/2014	HOLA	Feather spot: Approximately 50 body feathers and five flight feathers.	U	n/a	11S	238228	3910994
20131107-41	Array 7 Fence	11/7/2013	MODO	Feather spot: Part of wing. Flight, secondary, and body feathers.	U	n/a	11S	238691	3911031
20140410-101	Array 7 Fence	4/10/2014	HOLA	Feather spot: 13 flight feathers.	U	n/a	11S	237332	3911591
20131024-41	Array 7 Control	10/24/2013	MODO	Feather spot: one tail feather, five or six wing feathers, and 20+ contour feathers.	U	n/a	11S	236462	3911697
20130916-72	Array 8 Circuit 2	9/16/2013	UNKN	Feather spot: wing held together by flesh, and approximately 100 body feathers from unknown passerine.	U	n/a	11S	233456	3912480
20130930-81	Array 8 Circuit 2	9/30/2013	MODO	Feather spot: hundreds of feathers of multiple types.	U	n/a	11S	234055	3911662
20131014-41	Array 8 Circuit 2	10/14/2013	WEME	Feather spot: 50+ body feathers, and six contour and tail feathers.	U	n/a	11S	233535	3912484
20131021-21	Array 8 Circuit 2	10/21/2013	HOFI	Feather spot: 18 body feathers, and single clump of 10+ body feathers and additional loose feathers.	U	n/a	11S	233737	3912016

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131021-22	Array 8 Circuit 2	10/21/2013	MODO	Feather spot: two tail feathers, 15+ coverts and 50+ body feathers in several clumps.	U	n/a	11S	233592	3912166
20131021-91	Array 8 Circuit 2	10/21/2013	MODO	Feather spot: one wing feather, two contour, and seven body feathers.	U	n/a	11S	233565	3912352
20131021-107	Array 8 Circuit 2	10/21/2013	MODO	Feather spot: 50-100 body feathers.	U	n/a	11S	233599	3912126
20131021-106	Array 8 Circuit 2	10/21/2013	HOFI	Feather spot: approximately 15 wing and approximately 30 body feathers.	U	n/a	11S	233767	3912097
20131111-106	Array 8 Circuit 2	11/11/2013	MODO	Feather spot: One wing attached to two contour feathers. Few more body feathers	U	n/a	11S	233436	3912298
20131118-106	Array 8 Circuit 2	11/18/2013	MODO	Feather spot: 50 body, 2 tail, and 2 wing feathers	U	n/a	11S	233683	3912149
20131118-107	Array 8 Circuit 2	11/18/2013	MODO	Feather spot: 27 body and 1 tail feathers	U	n/a	11S	233559	3912296
20131125-106	Array 8 Circuit 2	11/25/2013	MODO	Feather spot: 1 tail feather, 100 body feathers, and one wing feather. Clump of body feathers attached and blood on one feather.	U	n/a	11S	233560	3912418
20131125-41	Array 8 Circuit 2	11/25/2013	HOLA	Feather spot: 9 - 10 body feathers	U	n/a	11S	233631	3912072
20131209-106	Array 8 Circuit 2	12/9/2013	MODO	Feather spot: 20 body and 3 flight feathers	U	n/a	11S	233469	3912439
20131209-91	Array 8 Circuit 2	12/9/2013	MODO	Feather spot: 10 flight and numerous body feathers	U	n/a	11S	233390	3912479
20131216-67	Array 8 Circuit 2	12/16/2013	MODO	Feather spot: 18 body feathers and five primary feathers.	U	n/a	11S	233466	3912307
20131216-59	Array 8 Circuit 2	12/16/2013	MODO	Feather spot: 19 body feathers and one flight feather.	U	n/a	11S	233461	3912491

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131216-106	Array 8 Circuit 2	12/16/2013	HOLA	Feather spot: 10 flight and 300 body feathers.	U	n/a	11S	233645	3912169
20131216-66	Array 8 Circuit 2	12/16/2013	MODO	Feather spot: 45 body and 4 primary feathers. Clump of body feathers attached.	U	n/a	11S	233921	3912043
20131223-101	Array 8 Circuit 2	12/23/2013	WEME	Feather spot: 250+ body and 30 flight feathers	U	n/a	11S	234007	3912042
20131223-56	Array 8 Circuit 2	12/23/2013	MODO	Feather spot: two distinct clumps: One with 20+ grey and white body feathers and a second clump of 25 brown and grey body feathers.	U	n/a	11S	233412	3912366
20140106-36	Array 8 Circuit 2	1/6/2014	HOLA	Feather spot: 200+ body and three flight feathers and beak.	U	n/a	11S	233704	3912025
20140120-41	Array 8 Circuit 2	1/20/2014	HOLA	Feather spot: One flight and 10-15 contour feathers.	U	n/a	11S	233577	3912200
20140127-111	Array 8 Circuit 2	1/27/2014	MOBL	Feather spot: 4 flight and 25 body feathers clumped together	U	n/a	11S	234041	3911768
20140317-36	Array 8 Circuit 2	3/17/2014	HOFI	Whole carcass: Possible panel collision. Beak keratin damaged/uplifted slightly, indicating possible blunt force trauma.	C	>90	11S	233473	3912328
20140317-1	Array 8 Circuit 2	3/17/2014	HOLA	Whole carcass: No sign of injury or illness.	U	n/a	11S	233815	3912011
20140317-37	Array 8 Circuit 2	3/17/2014	HOLA	Feather spot: 20 body and two flight feathers.	U	n/a	11S	233690	3911973
20140317-38	Array 8 Circuit 2	3/17/2014	HOLA	Partial carcass: partial wing (eight flight feathers). Assorted body feathers all attached at joint.	U	n/a	11S	233956	3911857
20140331-36	Array 8 Circuit 2	3/31/2014	MODO	Feather spot: Approximately 50 body feathers.	U	n/a	11S	233525	3912405

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140407-101	Array 8 Circuit 2	4/7/2014	MODO	Feather spot: Eight body feathers and two clumps of body feathers with connected tissue.	U	n/a	11S	233535	3912245
20140929-21	Array 8 Circuit 2	9/29/2014	CORA	Feather spot: Approximately 20 body feathers.	U	n/a	11S	233599	3912231
20141006-126	Array 8 Circuit 2	10/6/2014	MODO	Feather spot: Approximately body feathers and four secondaries.	U	n/a	11S	233631	3912187
20141013-1	Array 8 Circuit 2	10/13/2014	MODO	Feather spot: Eight flight feathers and approximately 40 contour feathers.	U	n/a	11S	233347	3912482
20141013-121	Array 8 Circuit 2	10/13/2014	MODO	Feather spot: Three tail feathers and approximately 60 contour feathers.	U	n/a	11S	233471	3912277
20141020-41	Array 8 Circuit 2	10/20/2014	MODO	Feather spot: 10-12 body feathers.	U	n/a	11S	234020	3911748
20131014-106	Array 8 Fence	10/14/2013	RCKI	Whole carcass: no obvious sign of injury.	C	>50	11S	234252	3912538
20131216-56	Array 8 Fence	12/16/2013	HOLA	Feather spot: 100+ body and 10 flight feathers, leg and thigh, and one inch diameter skin. Some parts found impaled on tumbleweed. Likely a loggerhead shrike kill.	P	>90	11S	233494	3913025
20141006-41	Array 8 Fence	10/6/2014	UNKN	Feather spot: Approximately body feathers from unknown small bird.	U	n/a	11S	233383	3913042
20140108-111	Array 9	1/8/2014	HOFI	Feather spot: 30 flight and 200+ body feathers.	U	n/a	11S	233406	3911476
20140213-56	Array 9	2/13/2014	HOFI	Feather spot: 100+ breast feathers, two parts of upper wing, and 20 individual flight feathers.	U	n/a	11S	233423	3911605
20140515-22	Array 9	5/15/2014	HOLA	Whole carcass: No sign of injury or illness.	U	n/a	11S	233401	3911518
20141106-41	Array 9	11/6/2014	MODO	Feather spot: Approximately 25 body feathers.	U	n/a	11S	233337	3911683

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140403-51	Array 9 Fence	4/3/2014	MODO	Feather spot: 100 body feathers and four flight feathers.	U	n/a	11S	233252	3911264
20131204-52	Controls	12/4/2013	MODO	Feather spot: 20 flight and tail feathers. 200 body feathers.	U	n/a	11S	236280	3912639
20140107-91	Controls	1/7/2014	WEME	Feather spot: 10 flight and 50+ body feathers.	U	n/a	11S	234343	3914361
20140107-66	Controls	1/7/2014	ECDO	Feather spot: 20 flight and 150+ body feathers.	U	n/a	11S	236446	3912721
20140128-111	Controls	1/28/2014	MODO	Feather spot: 30+ body feathers matted and connected to skin and blood.	U	n/a	11S	234862	3914336
20140218-66	Controls	2/18/2014	MODO	Feather spot: 30 body feathers.	U	n/a	11S	236475	3911690
20140225-101	Controls	2/25/2014	HOLA	Feather spot: 50+ body and ~20 flight feathers.	U	n/a	11S	236464	3911592
20140225-102	Controls	2/25/2014	HOFI	Feather spot: ~15 flight and 40+ body feathers.	U	n/a	11S	234329	3913553
20140422-56	Controls	4/22/2014	HOLA	Feather spot: 10 body feathers.	U	n/a	11S	236467	3911647
20140902-21	Controls	9/2/2014	ROPI	Feather spot: Three body feathers and one secondary feather clumped together with blood. Several feathers are together in a sheath.	U	n/a	11S	236446	3911574
20141021-101	Controls	10/21/2014	MODO	Feather spot: Approximately 200 body feathers, four primary and nine secondary feathers.	U	n/a	11S	238328	3912064
20141028-1	Controls	10/28/2014	FOSP	Feather spot: Approximately 150 body feathers.	U	n/a	11S	234338	3914329
20131223-36	Evaporation Pond	12/23/2013	HOFI	Feather spot: 100+ body feathers and 20+ flight feathers (partial wing); feathers mostly clumped. Found at the north end of the	U	n/a	11S	234781	3914267

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
				pond.					
20131223-16	Evaporation Pond	12/23/2013	HOFI	Whole carcass: found at southeast corner of fence. No rigor mortis and the keel bone could be felt. Carcass appeared malnourished. Feathers around cloaca are matted with feces. Dried blood around edges of the beak.	D	>50	11S	234809	3914200
20131223-57	Evaporation Pond	12/23/2013	HOFI	Feather spot: 10+ body feathers and one flight feather.	U	n/a	11S	234798	3914194
20131223-58	Evaporation Pond	12/23/2013	MODO	Feather spot: Majority of tail segment. 10 flight and eight body feathers. Found at southwest corner outside pond fence.	U	n/a	11S	234676	3914214
20130821-21	Gen-tie Line	8/21/2013	MODO	Feather spot: three tail feathers, 15+ flight feathers, 50+ breast and body feathers.	C	>50	11S	234284	3916921
20130821-23	Gen-tie Line	8/21/2013	MODO	Feather spot: fewer than flight feathers, and 30+ breast and body feathers.	C	>50	11S	234279	3917046
20130828-36	Gen-tie Line	8/28/2013	UNKN	Feather spot: about 15 body feathers from unknown passerine.	C	>50	11S	234254	3916454
20130828-37	Gen-tie Line	8/28/2013	HOLA	Feather spot: about 50 body feathers and two secondary feathers.	C	>50	11S	234595	3915151
20130904-61	Gen-tie Line	9/4/2013	MODO	Feather spot: three primaries, two secondaries, approximately 20 body feathers.	C	>50	11S	234487	3915964
20130911-72	Gen-tie Line	9/11/2013	HOLA	Feather spot: 75 body feathers, one tail, three primary, and four secondary feathers.	U	n/a	11S	234601	3915040
20130925-52	Gen-tie Line	9/25/2013	UNWA	Partial carcass: clump of small body feathers attached to spinal bone fragments from unknown warbler.	C	>50	11S	234246	3918342
20131002-71	Gen-tie Line	10/2/2013	SAVS	Whole carcass: found with broken neck.	C	>90	11S	234254	3918510

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131002-36	Gen-tie Line	10/2/2013	SAVS	Feather spot : 100 body feathers (breast, mantle, rump, coverts), and partial wing (15 primary and secondary feathers).	U	n/a	11S	234478	3914356
20131002-73	Gen-tie Line	10/2/2013	SAVS	Feather spot: 100+ body feathers (belly, breast, mantle, rump, coverts), and 20 flight feathers (primary and secondary).	C	>50	11S	234459	3914349
20131009-66	Gen-tie Line	10/9/2013	SAVS	Whole carcass: no visible external injuries.	C	>50	11S	234601	3915243
20131009-106	Gen-tie Line	10/9/2013	HOFI	Feather spot: 15 primaries and 150 body feathers.	U	n/a	11S	234447	3917982
20131009-107	Gen-tie Line	10/9/2013	YRWA	Partial carcass: half carcass impaled by loggerhead shrike.	P	>90	11S	234405	3917830
20131016-109	Gen-tie Line	10/16/2013	HOLA	Feather spot: four wing feathers and 30+ contour feathers.	C	>50	11S	234260	3916727
20131016-107	Gen-tie Line	10/16/2013	WEME	Feather spot: ten wing, 150 body, and few tail feathers.	U	n/a	11S	234361	3917795
20131016-108	Gen-tie Line	10/16/2013	WEME	Feather spot: ten wing, few tail, and 300+ body feathers	C	>50	11S	234262	3916740
20131016-110	Gen-tie Line	10/16/2013	WEME	Feather spot: partial wing, plus 20 wing, a few tail, and 100 contour feathers.	U	n/a	11S	234664	3915616
20131016-41	Gen-tie Line	10/16/2013	EUST	Feather spot: four or five wing feathers, two or three tail feathers, and 100-200 contour feathers.	U	n/a	11S	234479	3914368
20131016-42	Gen-tie Line	10/16/2013	SAVS	Whole carcass: no obvious sign of injury.	U	n/a	11S	234589	3918770
20131023-91	Gen-tie Line	10/23/2013	YRWA	Feather spot: four wing feathers and 20 body feathers.	C	>50	11S	234422	3917880
20131023-94	Gen-tie Line	10/23/2013	YRWA	Whole carcass: no obvious sign of injury.	U	n/a	11S	234281	3916371

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131023-95	Gen-tie Line	10/23/2013	CORA	Feather spot: 15 wing feathers and a few body feathers.	C	>50	11S	234628	3918824
20131106-101	Gen-tie Line	11/6/2013	MODO	Feather spot: 30 body and wing feathers.	U	n/a	11S	234359	3918593
20131106-102	Gen-tie Line	11/6/2013	MODO	Feather spot: 15 body feathers, clumped.	C	>50	11S	234432	3916086
20131113-81	Gen-tie Line	11/13/2013	SAVS	Feather spot: 15+ flight feathers found in two distinct clumps attached by dried skin. 80 mantle, breast, and rump feathers.	C	>50	11S	234564	3918767
20131120-106	Gen-tie Line	11/20/2013	WEME	Feather spot: 150 body and 20 wing and tail feathers.	U	n/a	11S	234323	3914104
20131120-107	Gen-tie Line	11/20/2013	HOLA	Feather spot: 200 body and 4 wing feathers	U	n/a	11S	234586	3915142
20131204-66	Gen-tie Line	12/4/2013	WEME	Feather spot: 12 body feathers	C	>50	11S	234420	3916114
20131211-92	Gen-tie Line	12/11/2013	WEME	Feather spot: 100 body feathers and 10+ flight feathers (primary, secondary, and tail).	C	>50	11S	234278	3917359
20131218-57	Gen-tie Line	12/18/2013	MODO	Feather spot: 15+ body feathers. 1 Tail feather.	C	>50	11S	234586	3914835
20140108-101	Gen-tie Line	1/8/2014	MODO	Feather spot: 15+ flight and 200+ body feathers. Dried blood on feathers.	U	n/a	11S	234257	3918309
20140108-102	Gen-tie Line	1/8/2014	WEME	Feather spot: Four flight, approximately 18 body, and 2 covert feathers.	C	>50	11S	234607	3915178
20140122-16	Gen-tie Line	1/22/2014	WEME	Feather spot: Clump of five flight feathers held together with skin and loose flight feathers, and 30+ body feathers.	C	>50	11S	234362	3917791
20140129-111	Gen-tie Line	1/29/2014	HOLA	Feather spot: Approximately 10 flight, 50 body feathers.	C	>50	11S	234484	3915983

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140312-36	Gen-tie Line	3/12/2014	HOLA	Feather spot: Approximately 100 body and 20 flight feathers.	C	>50	11S	234654	3915632
20140423-56	Gen-tie Line	4/23/2014	BHGR	Whole carcass: found directly under powerline. Left wing appears to be dislocated.	C	>50	11S	234622	3918809
20140430-101	Gen-tie Line	4/30/2014	MODO	Feather spot: Approximately 100 body and 12 flight feathers.	C	>50	11S	234254	3916463
20140430-36	Gen-tie Line	4/30/2014	MODO	Feather spot: Approximately 50 body feathers and 15 flight feathers.	C	>50	11S	234303	3916347
20140430-37	Gen-tie Line	4/30/2014	TOWA	Whole carcass: Directly under powerline. Right wing appears to be dislocated at shoulder.	C	>50	11S	234642	3918826
20140507-36	Gen-tie Line	5/7/2014	WAVI	Feather spot: Six flight and 200+ body feathers.	C	>50	11S	234587	3914762
20140514-91	Gen-tie Line	5/14/2014	TOWA	Whole carcass: Directly under powerline. Signs of blunt-force trauma to right abdomen. Organs exposed.	C	>90	11S	234674	3918846
20140514-92	Gen-tie Line	5/14/2014	TOWA	Whole carcass: Directly under powerline. Signs of blunt-force trauma to right abdomen. Organs exposed.	C	>50	11S	234908	3919061
20140514-95	Gen-tie Line	5/14/2014	WIWA	Feather spot: Approximately 80 body feathers and 25 flight feathers.	C	>50	11S	234253	3916458
20140514-93	Gen-tie Line	5/14/2014	COYE	Feather spot: Ten flight and 15 body feathers.	C	>50	11S	234261	3916928
20140514-94	Gen-tie Line	5/14/2014	MODO	Feather spot: Five flight feathers and 30 body feathers.	C	>50	11S	234253	3916468
20140521-41	Gen-tie Line	5/21/2014	MODO	Feather spot: One flight feather and approximately 100 body feathers. Within limits of tower pad and directly under powerline.	C	>50	11S	234377	3916198
20140521-42	Gen-tie Line	5/21/2014	OCWA	Feather spot: 20 flight and approximately 250 body feathers. 3 meters off center of powerline.	C	>50	11S	234682	3915460

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140521-43	Gen-tie Line	5/21/2014	COYE	Feather spot: Approximately 75 body feathers. Directly under powerline.	C	>50	11S	234667	3915443
20140521-44	Gen-tie Line	5/21/2014	WETA	Feather spot: 25 flight feathers and approximately 125 body feathers. Directly under powerline.	C	>50	11S	234489	3914380
20140521-45	Gen-tie Line	5/21/2014	ROPI	Feather spot: Six flight feathers and 40 body feathers. Directly under powerline.	C	>50	11S	234354	3914156
20140528-56	Gen-tie Line	5/28/2014	YEWA	Feather spot: Approximately 80 body feathers and six flight feathers. Directly under powerline.	C	>50	11S	234253	3913960
20140528-57	Gen-tie Line	5/28/2014	YEWA	Feather spot: Approximately 60 body feathers. Directly under powerline.	C	>50	11S	234575	3914705
20140618-11	Gen-tie Line	6/18/2014	CEDW	Feather spot: 15 primary feathers, approximately 100 body feathers, and five tail feathers. Directly under powerline.	C	>50	11S	234477	3918693
20140618-12	Gen-tie Line	6/18/2014	MODO	Feather spot: Ten tail and primary feathers, and approximately 200 body feathers. Within limits of tower pad and directly under powerline.	C	>50	11S	234466	3917928
20140730-41	Gen-tie Line	7/30/2014	ROPI	Feather spot: Feathers spread out over large area (approximately 50 meters) and weathered. Approximately 30 feathers directly under powerline, and remaining spread over 50-meter area.	C	>50	11S	234353	3914146
20141008-56	Gen-tie Line	10/8/2014	AMPI	Feather spot: Approximately 60 body feathers and 20 flight feathers. Directly under line.	C	>50	11S	234224	3913918
20141015-101	Gen-tie Line	10/15/2014	SAVS	Feather spot: Two flight feathers and approximately 100 body feathers. Directly under line.	C	>50	11S	234400	3914225
20141015-102	Gen-tie Line	10/15/2014	MODO	Feather spot: Approximately 10 flight feathers and 100 body feathers. Directly under line.	C	>50	11S	234223	3913930

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Incident ID	Site	Search Date	AOU Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20141015-103	Gen-tie Line	10/15/2014	MODO	Feather spot: Approximately 40 flight feathers and a partial wing.	U	n/a	11S	234364	3917827
20141022-41	Gen-tie Line	10/22/2014	HOLA	Partial carcass: Headless carcass and approximately 200 body feathers. Directly under line.	P	<50, >0	11S	234306	3918554
20141022-42	Gen-tie Line	10/22/2014	WEME	Feather spot: Approximately 200 body feathers, three primary feathers. Directly under line.	C	>50	11S	234583	3914657
20141022-43	Gen-tie Line	10/22/2014	HOLA	Feather spot: Approximately 100 body feathers. Directly under line.	C	>50	11S	234413	3914244
20141029-91	Gen-tie Line	10/29/2014	MODO	Feather spot: Approximately 100 body feathers. Directly under line.	C	>50	11S	234274	3917374
20141029-92	Gen-tie Line	10/29/2014	YRWA	Feather spot: Approximately 100 body feathers and 25 flight feathers. Directly under line.	C	>50	11S	234454	3914337

Notes: UTM = Universal Transverse Mercator.

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Appendix D. 5-Day Repeat Fatality Search Results: 16 August 2013 to 31 December 2013

Fatality ID	Area	Date Detected	Number of Days Fatality Persisted	Species[1]	Observation Details	Cause of Death[2]	% Certainty	Easting	Northing
20130925-16R	Array 1	9/25/2013	3	MODO	Feather spot: Two tail feathers and 14 body feathers.	U	n/a	233937	3915357
20130925-36R	Array 1	9/25/2013	3	HOFI	Feather spot: Partial wing and 50 body feathers, scattered contour feathers, secondaries, and primaries.	U	n/a	233869	3915427
20131023-36R	Array 1	10/23/2013	3	CORA	Feather spot: 15 contour feathers.	U	n/a	234160	3915427
20131119-41R*	Array 1	11/19/2013	3	HOFI	Feather spot: 300+ body feathers, 5+ wing feathers, and three tail feathers from an adult male.	U	n/a	234008	3915554
20131023-71R	Array 1-2 fence	10/23/2013	3	CORA	Feather spot: 15 contour feathers.	U	n/a	234160	3915703
20130826-56R*	Array 2 Serengeti	8/26/2013	n/a	MODO	Feather spot: Five primaries, two secondaries, and 16+ body feathers.	U	n/a	234458	3915140
20131001-101R	Array 2 North	10/1/2013	4	HOLA	Feather spot: Three flight feathers.	U	n/a	234178	3915346
20131001-41R	Array 2 North	10/1/2013	4	HOLA	Feather spot: Six flight feathers and 30 body feathers.	U	n/a	233974	3915178

Notes:

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Fatality ID	Area	Date Detected	Number of Days Fatality Persisted	Species[1]	Observation Details	Cause of Death[2]	% Certainty	Easting	Northing
20131002-106R	Array 2 North	10/2/2013	2	HOLA	Whole carcass: Adult male. No sign of injury or illness. Found directly under panel.	U	n/a	234081	3915283
20130902-81R*	Array 2 South	9/2/2013	n/a	HOLA	Feather spot: 11 flight feathers.	U	n/a	234293	3914596
20130902-86R*	Array 2 South	9/2/2013	n/a	HOLA	Feather spot: 20+ flight feathers and 100+ body feathers. Adult male.	U	n/a	234027	3914724
20131101-106R	Array 2 South	11/1/2013	n/a	MODO	Feather spot: Four tail feathers and more than one hundred body feathers.	U	n/a	233977	3914544
20131016-46R	Array 4	10/16/2013	3	CORA	Feather spot: 17 contour feathers.	U	n/a	236160	3913218
20131114-101R	Array 4	11/14/2013	2	WEME	Feather spot: 100+ body feathers and 15+ wing and tail feathers. Feathers present on solar panel, indicating either panel strike or avian scavenging.	U	n/a	236086	3913716
20131210-38R*	Array 4	12/10/2013	n/a	WEME	Feather spot: > 20 body feathers and >20 primary and secondary feathers.	U	n/a	235592	3913712
20131212-114R	Array 4	12/12/2013	2	MODO	Feather spot: Five flight feathers and 60 body feathers	U	n/a	235523	3913707
20131213-39R	Array 4	12/13/2013	n/a	MODO	Feather spot: 75+ body feathers, 12+ tail feathers	U	n/a	235488	3913692
20131210-102R*	Array 4 Fence	12/10/2013	n/a	MODO	Feather spot: Approximately 30 feathers.	U	n/a	235654	3913759

Notes:

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Fatality ID	Area	Date Detected	Number of Days Fatality Persisted	Species[1]	Observation Details	Cause of Death[2]	% Certainty	Easting	Northing
20130821-86R	Array 5	8/21/2013	3	LASP	Feather spot: Seven flight feathers and approximately 100 body feathers. Adult.	U	n/a	236818	3913588
20131111-36R*	Array 5	11/11/2013	n/a	HOFI	Feather spot: 20 primary and secondary feathers, 100+ body feathers, bill.	U	n/a	236620	3913535
20131210-103R*	Array 5	12/10/2013	n/a	MODO	Feather spot: 3 tail feathers, 2 flight feathers, and 15 body feathers.	U	n/a	235544	3913728
20131108-56R	Array 6	11/8/2013	n/a	ROPI	Feather spot: 150+ belly, rump, and scapular feathers, five tail feathers, and ten or more primary and secondary feathers.	U	n/a	237422	3912732
20131210-113R*	Array 6	12/10/2013	n/a	MODO	Feather spot: 10 primary feathers and 40 body feathers.	U	n/a	235536	3913664
20131210-112R*	Array 7	12/10/2013	n/a	MODO	Feather spot: 50 body feathers and 4 flight feathers.	U	n/a	235713	3913580
20130821-41R	Array 8	8/21/2013	2	HOLA	Feather spot: 15+ contour feathers.	U	n/a	234095	3912508
20130822-42R	Array 8	8/22/2013	2	LEOW	Feather spot: 20 contour and breast feathers.	U	n/a	233937	3912500
20131111-46R*	Array 8	11/11/2013	n/a	WEME	Feather spot: 200+ breast and body feathers.	U	n/a	233768	3912809
20131209-101R*	Array 8	12/09/2013	n/a	MODO	Feather spot: 5-10 flight feathers and 30 body feathers.	U	n/a	234381	3912071

Notes:

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Fatality ID	Area	Date Detected	Number of Days Fatality Persisted	Species[1]	Observation Details	Cause of Death[2]	% Certainty	Easting	Northing
20131209-102R*	Array 8	12/09/2013	n/a	MODO	Feather spot: 2 tail feathers, 2 flight feathers, and 50 body feathers.	U	n/a	234371	3912219
20131209-36R*	Array 8	12/9/2013	n/a	MODO	Feather spot: 200 + body feathers and 20+ primary feathers.	U	n/a	234156	3912315
20131210-37R	Array 8	12/10/2013	3	MODO	Feather spot: 50+ body feathers and 30+ flight and tail feathers.	U	n/a	234202	3912369
20131014-46R*	Array 8 fence	10/14/2013	n/a	MODO	Feather spot: 30 + contour feathers.	U	n/a	234050	3912692
20121111-101R*	Array 8 fence	11/11/2013	n/a	MODO	Feather spot: 30 body feathers and one flight feather.	U	n/a	233369	3912447
20131210-101R	Array 8 fence	12/10/2013	3	MODO	Feather spot: Ten to fifteen flight feathers and 30 body feathers.	U	n/a	234411	3912264
20131203-56R	MVOH	12/3/2013	3	BUOW	Feather spot: 20 body feathers.	C	>50	238194	3912024
20131007-81R*	MVOH	10/7/2013	n/a	WEME	Feather spot: 100+ body feathers and flight feathers.	C	>50	234591	3913326
20131007-82R*	MVOH	10/7/2013	n/a	WEME	Feather spot: Approximately 15 feathers and tail feathers.	C	>50	234781	3912925

Notes:

[1] Codes are designated by the American Ornithologists' Union (AOU) Check-list of North American Birds, and are defined in Table 5.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

* = Clearance fatality

Appendix E. 1-Day Repeat Search Results: 16 August 2013 to 31 December 2013

Fatality ID	Area	Date Detected	Species[1]	Observation Details	Cause of Death[2]	% Certainty	Easting	Northing
1-day repeat searches of regular weekly search areas								
20131018-61R	Array 1	10/18/2013	HOLA	Feather spot: One covert feather and 15 flight feathers.	U	n/a	233623	39155240
20131009-36R	Array 2 North	10/8/2013	HOLA	Feather spot: Approximately 30 contour feathers.	U	n/a	234013	3914941
20131218-111R	Array 2 North	12/18/2013	MODO	Whole carcass: Trauma to right shoulder and chest. Bruising on right foot. Trauma appears to have partially healed. Found directly under panel, but no mark on panel.	C	>90	233908	3914955
20131218-11R	Array 2 North	12/18/2013	WEME	Feather spot: Seven flight feathers and 200+ body feathers. Presence of loose clumps of feathers on flat solar panels suggests that the bird was very recently scavenged by a raven.	U	n/a	233803	3914993
20130911-36R	Array 2 South	9/11/2013	MODO	Feather spot: Approximately 15 breast and contour feathers.	U	n/a	234145	3914884
20131106-81R	Array 2	11/6/2013	RCKI	Feather spot: 100+ feathers.	U	n/a	233660	3914613
20131204-36R	Array 2 South	12/4/2013	SAVS	Feather spot: 100+ body feathers, 12 primaries and secondaries.	U	n/a	234160	3914847
20131211-06R	Array 2 Serengeti	12/11/2013	CORA	Feather spot: Approximately 20 body feathers.	U	n/a	234489	3915098

Notes:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

Fatality ID	Area	Date Detected	Species[1]	Observation Details	Cause of Death[2]	% Certainty	Easting	Northing
20131231-76R	Array 6	12/31/2013	MODO	Feather spot: 20 body feathers and five contour feathers.	U	n/a	235570	3913160
20131108-61R	Array 7	11/08/2013	MODO	Feather spot: Partial wing and ten body feathers.	U	n/a	238669	3911022
20131220-1R	Array 7	12/20/2013	ECDO	Feather spot: Two tertiary feathers and 18 body feathers in two clumps.	U	n/a	237717	3912921
20130917-47R	Array 8	9/17/2013	MODO	Feather spot: Approximately 30 body feathers. Likely preen spot.	U	n/a	233440	3912421
20131112-26R	Array 8	11/12/2013	HOLA	Feather spot: 30 body feathers.	U	n/a	233589	3912209
20131024-61R	Gen-tie Line	10/24/2013	HOFI	Feather spot:	C	>50	238669	3911022
20131205-21R	Gen-tie Line	12/5/2013	SAVS	Feather spot: 16 flight and 50+ body feathers.	C	>50	234448	3914325
1-day repeat searches of 5-day repeat search areas								
20131018-01R	Array 8 fence	10/18/2013	MODO	Feather spot: Approximately 15 body feathers.	U	n/a	234147	3912526
20131108-01R	Array 9	11/8/2013	CORA	Feather spot: Seven contour feathers in a clump. Feathers were sheared at the base, indicating mammalian scavenging.	U	n/a	233670	3911290

Notes:
[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5.
[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

Appendix F. Incidental Fatalities: 16 August 2013 to 17 November 2014

Incident ID	Site	Search Date	Species Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20140129-67	MVOH line	1/29/2014	MODO	Feather spot: 20+ flight and 150+ body feathers. Blood on ground near feather spot and on some flight and body feathers. Time of death probably 48 hours due to fresh blood.	U	n/a	11S	236973	3913150
20140203-91	MVOH line	2/3/2014	HOFI	Feather spot: Beak (upper and lower), approximately 200 body and 30+ flight feathers.	U	n/a	11S	234046	3913667
20140416-106	MVOH line	4/16/2014	CORA	Whole carcass: Bird found dead on nest. Nest material in mouth. Maggots present on carcass. No visible signs of electrocution.	E	<50%, >0	11S	236922	3913037
20140512-106	MVOH line	5/12/2014	CORA	Whole carcass: Bird found dead at base of power pole with one singed wing. Found by operations and maintenance crew, and bird was scavenged before it could be recovered by a biologist.	E	>90%	11S	235671	3912665
20140313-91	Array 1	3/13/2014	HOFI	Feather spot: 50+ body and 15+ flight feathers	U	n/a	11S	233871	3915444
20140313-11	Array 1	3/13/2014	HOLA	Partial carcass: One wing and dried torso; chest cavity open and organs absent. No head. One foot attached.	U	n/a	11S	234008	3915482
20140121-111	Array 1-2 Fence	1/21/2014	ECDO	Feather spot: 30 body feathers and one secondary feather.	U	n/a	11S	233711	3914383
20130924-101	Array 2 North	9/24/2013	MODO	Feather spot: five clumped body feathers; ten body feathers total. Two clumps of feathers as though plucked, and one feather in sheath (so not molted).	U	n/a	11S	234156	3914993
20130927-101	Array 2 North	9/27/2013	CORA	Feather spot: three primary feathers, one secondary feather.	U	n/a	11S	234353	3914440
20140306-111	Array 2	3/6/2014	HOFI	Feather spot: 200 body and 50 flight feathers. Bill (in two pieces) with attached feathers.	U	n/a	11S	234069	3914915
20140319-41	Array 2	3/19/2014	HOLA	Feather spot: 8 tail, 10 wing, and 100 body feathers	U	n/a	11S	233934	3914662
20131217-61	Array 2 Control	12/17/2013	WEME	Feather spot: 50 body and 15 flight feathers	U	n/a	11S	234400	3914379

Notes:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

Incident ID	Site	Search Date	Species Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20131217-36	Array 2 Control	12/17/2013	LOSH	Feather spot: Partial wing, seven primaries and 30+ body feathers.	U	n/a	11S	234702	3915154
20131107-36	Array 4	11/7/2013	BANO	Feather spot: 20+ primary/wing and 30+ body/contour feathers.	U	n/a	11S	236014	3912900
20131119-67	Array 4	11/19/2013	MODO	Feather spot: 200+ body feathers. 11 large feathers (primary and secondary). Dirty panels with clean spot.	C	<50%, >0	11S	235874	3912747
20131218-101	Array 4	12/18/2013	MODO	Feather spot: Three tail, 15 flight, and 30 body feathers.	U	n/a	11S	235562	3912684
20140122-103	Array 4	1/22/2014	WEME	Feather spot: Two flight (Primaries) and approximately 100 body feathers.	U	n/a	11S	235619	3913231
20131211-121	Array 4 Fence	12/11/2013	MODO	Feather spot: 200 body and few flight feathers	U	n/a	11S	235531	3913027
20140122-94	Array 4 Fence	1/22/2014	MODO	Feather spot: 200 body and 30 flight feathers.	U	n/a	11S	235532	3912920
20140106-66	Array 6	1/6/2014	HOFI	Feather spot: 200+ body, one primary, and three secondary feathers.	U	n/a	11S	237235	3913036
20140106-111	Array 6	1/6/2014	MODO	Feather spot: 100+ body feathers.	U	n/a	11S	237217	3913010
20140122-91	Array 7	1/22/2014	MODO	Whole carcass: Whole carcass + 40 body feathers near fence and 30 clumped body feathers about 30 ft. away.	U	n/a	11S	238075	3911713
20140410-21	Array 7	4/10/2014	PBGR	Feather spot: Approximately 500 body feathers and 30 flight feathers with fresh blood. Coyote observed consuming bird in morning. Unclear if predation or scavenging event; however, it was determined that the death was indirectly caused by the array, because the grebe likely perceived the array as a body of water, and once it landed on the ground was unable to take flight again.	C	<50%, >0	11S	237759	3911588
20131118-108	Array 8 Control	11/18/2013	MODO	Feather spot: 200 body and 20 wing feathers	U	n/a	11S	234339	3913452
20130916-71	Array 8 Fence	9/16/2013	UNKN	Partial Carcass: Headless body and wing with a few feathers stuck to fence from unknown large bird.	U	n/a	11S	234825	3912821
20140224-67	Array 8 Fence	2/24/2014	MODO	Feather spot: 200+ body feathers and flight feathers.	U	n/a	11S	233323	3912883
20131119-68	Array 9	11/19/2013	BUOW	Feather spot: 10 contour feathers	U	n/a	11S	233283	3917787
20140226-201	Conservation Land	2/26/2014	MODO	Feather spot: 22 flight feathers and many contour feathers.	U	n/a	11S	235386	3911179

Notes:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

Incident ID	Site	Search Date	Species Code[1]	Observation Details	Cause of Death[2]	% Certainty	UTM Zone	Easting	Northing
20141030-1	Conservation Land	10/30/2014	MODO	Feather spot: 14 flight feathers and approximately 50 contour feathers.	U	n/a	11S	235467	3913108
20140326-201	MVOH	3/26/2014	HOFI	Feather spot: Approximately 20 body feathers connected by flesh.	U	n/a	11S	234111	3913663
20131002-72	Gen-tie Line	10/2/2013	SAVS	Feather spot: 75 body feathers, 15 flight feathers, and some wing bits.	U	n/a	11S	234404	3917782
20131016-106	Gen-tie Line	10/16/2013	YRWA	Feather spot: 15-20 wing feathers and 100+ body feathers.	U	n/a	11S	234403	3917789
20131023-92	Gen-tie Line	10/23/2013	MODO	Feather spot: 30 body feathers.	U	n/a	11S	234378	3917743
20131023-93	Gen-tie Line	10/23/2013	WEME	Feather spot: 15 body feathers.	U	n/a	11S	234354	3917803
20131211-91	Gen-tie Line	12/11/2013	MODO	Feather spot: Five flight feathers (all tail feathers) and five body feathers. Found in Tamarisk wetland at suspected predatory bird feeding spot.	P	>50	11S	234365	3917730

Notes:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN. Unknown warblers are designated as UNWA.

[2] Causes of death: C = collision; D = disease; E = electrocution; P = predation; U = unknown.

Appendix G. Fatality Data Errata for CVSR ABPP Annual Postconstruction Fatality Report, 16 August 2012 to 15 August 2013

Incident ID	Site	Search Date	Species Code[1]	UTM Zone	Easting	Northing	Observation Details	Errata Notes
20120927-1	Array 1	9/27/2012	MODO	11S	233981	3915723	Feather spot: >10 body feathers	Later determined to be feathers from roosting and preening mourning doves. Remove from the record.
20121127-103	Array 2 North	11/27/2012	MODO	11S	234496	3915315	Feather spot: Ten body feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-104	Array 2 North	11/27/2012	HOLA	11S	234475	3915069	Feather spot: Ten+ body, five secondary, eight covert, and six primary feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-102	Array 2 North	11/27/2012	MODO	11S	234372	3915321	Feather spot: ten + body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-101	Array 2 North	11/27/2012	MODO	11S	234368	3915324	Feather spot: Body feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-1	Array 2 North	11/27/2012	LEOW	11S	234062	3915269	Feather spot: ten + body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-300	Array 2 North	11/27/2012	HOLA	11S	234407	3914929	Feather spot: ten primary and ten+ body feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-200	Array 2 North	11/27/2012	WEME	11S	234484	3915273	Feather spot: ten+ body and four primary feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-201	Array 2 North	11/27/2012	HOLA	11S	234384	3915103	Feather spot: approximately 25 flight feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-11	Array 2 South	11/27/2012	MODO	11S	233636	3914428	Feather spot: two tail feathers and several body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.

Note:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN.

Incident ID	Site	Search Date	Species Code[1]	UTM Zone	Easting	Northing	Observation Details	Errata Notes
20121127-3	Array 2 South	11/27/2012	MODO	11S	234115	3914603	Feather spot: >10 body feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-2	Array 2 South	11/27/2012	MODO	11S	233967	3914604	Feather spot: >10 body feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-6	Array 2 South	11/27/2012	MODO	11S	234182	3914887	Feather spot: >10 body feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-7	Array 2 South	11/27/2012	MODO	11S	234166	3914885	Feather spot: >10 body feathers	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-8	Array 2 South	11/27/2012	UNKN	11S	234174	3914646	Feather spot: two primary feathers and approximately ten body feathers from unknown RODO-sized bird.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121127-9	Array 2 South	11/27/2012	MODO	11S	234071	3914509	Feather spot: body feathers and three primaries	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121204-16	Array 2 South	12/4/2012	MODO	11S	233692	3914434	Feather spot: 15+ body and two tail feathers, and one secondary feather,	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121204-21	Array 2 South	12/4/2012	MODO	11S	234074	3914506	Feather spot: two flight and 50+ body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121204-13	Array 2 South	12/4/2012	CORA	11S	234245	3914577	Feather spot: two flight feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20121204-3	Array 2 South	12/4/2012	UNKN	11S	233883	3914885	Feather spot: two primary feathers with a few body feathers from unknown large bird.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130107-1	Array 8 Circuit 2	1/7/2013	HOLA	11S	233519	3912284	Feather spot: ten+ primary and 20+ body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130107-20	Array 8 Circuit 2	1/7/2013	MODO	11S	233740	3912137	Feather spot: Few tertiary and 20 body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130107-21	Array 8 Circuit 2	1/7/2013	MODO	11S	233986	3911832	Feather spot: three primary, two secondary, and one body feather.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.

Note:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN.

Incident ID	Site	Search Date	Species Code[1]	UTM Zone	Easting	Northing	Observation Details	Errata Notes
20130107-11	Array 8 Circuit 2	1/7/2013	MODO	11S	234117	3911957	Feather spot: 15+ body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-44	Array 4	1/9/2013	MODO	11S	235594	3912563	Feather spot: Six retrices and 20 contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-45	Array 4	1/9/2013	EUST	11S	235610	3912878	Feather spot: ten primary, nine secondary, two tertials, and ten contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-6	Array 4	1/9/2013	MODO	11S	235905	3912709	Feather spot: seven secondary and 40+ contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-7	Array 4	1/9/2013	MODO	11S	235609	3912839	Feather spot: eight retrices and ten+ contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-31	Array 4	1/9/2013	MODO	11S	235608	3912813	Feather spot: seven primary, ten secondary, and 50+ contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-32	Array 4	1/9/2013	MODO	11S	235568	3912818	Feather spot: four tail, two secondary, and seven contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-26	Array 4	1/9/2013	MODO	11S	235603	3913901	Feather spot: seven retrices and 20+ contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-41	Array 4	1/9/2013	MODO	11S	235601	3913521	Feather spot: two retrices and 25+ contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-8	Array 5	1/9/2013	MODO	11S	236647	3915788	Feather spot: four retrices and five contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-27	Array 5	1/9/2013	MODO	11S	236668	3913775	Feather spot: five retrices, one secondary, three wing coverts, and two primary feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130109-46	Array 5	1/9/2013	MODO	11S	236702	3913640	Feather spot: four retrices two secondary and 20+ contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.

Note:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN.

Incident ID	Site	Search Date	Species Code[1]	UTM Zone	Easting	Northing	Observation Details	Errata Notes
20130114-1	Array 8 Circuit 2	1/14/2013	MODO	11S	233450	3912428	Feather spot: four wing coverts, 50 contour, and three primary feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130116-11	Array 4	1/16/2013	MODO	11S	235677	3912709	Feather spot: two retrices, two secondary, and 15 breast feathers.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130123-	Array 4	1/23/2013	MODO	11S	235639	3913403	Feather spot: four tail, four primary, two secondary, and 40 contour feathers.	Incidental fatality was not reported in 2012-2013 report. Include in the record.
20130123-46	Gen-tie Line	1/23/2013	LASP	11S	234390	3917813	Feather spot: two fresh primaries. Found in wetland area.	Species was incorrectly identified as LOSH, but was later correctly identified as a LASP. Revise species to lark sparrow in the record.
20130214-6	Array 1	2/14/2013	WEME	11S	234022	3915705	Feather spot: 20+ flight feathers and over 100 body feathers.	UTM coordinates were incorrect. Coordinates are correct herein.
20130220-46	34.5kV Line	2/20/2013	MODO	11S	234612	3913242	Feather spot: five+ tail and 30+ body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130508-36	34.5kV Line	5/8/2013	UNKN	11S	233833	3911676	Feather spot: approximately 15 body feathers and one flight feather from unknown small bird.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130508-82	Array 4	5/8/2013	HOFI	11S	235724	3913524	Feather spot: seven wing feathers still attached and one secondary feather.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130508-6	Gen-tie Line	5/8/2013	WAVI	11S	234450	3914310	Whole carcass: possible broken neck and possible power line collision.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130509-56	Array 1	5/9/2013	HOLA	11S	234156	3915632	Feather spot: mostly body feathers, some primary feathers.	Fatality was not reported in 2012-2013 annual report. Include in the record.

Note:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN.

Incident ID	Site	Search Date	Species Code[1]	UTM Zone	Easting	Northing	Observation Details	Errata Notes
20130514-56	Array 2 North	5/14/2013	UNKN	11S	234342	3915286	Feather spot: cranium/skull covered by feathers from unknown small bird.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130515-57	Gen-tie Line	5/15/2013	HOFI	11S	234582	3914702	Partial carcass: Top half of wing.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130515-58	Gen-tie Line	5/15/2013	YRWA	11S	234424	3917882	Feather spot: approximately 10 flight feathers and 30 body feathers.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130515-56	Gen-tie Line	5/15/2013	UNKN	11S	234707	3915476	Feather spot: body and primary feathers from unknown small bird.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130529-72	Gen-tie Line	5/29/2013	YEWA	11S	234265	3917142	Feather spot: approximately 100 body feathers and 15 flight feathers.	Species was incorrectly identified as YRWA, but was later correctly identified as YEWA. Revise species to YEWA in the record.
20130529-28	Gen-tie Line	5/29/2013	YRWA	11S	234296	3917715	Feather spot: 12 flight and 30 body feathers. Found directly under the powerline.	Species was identified as warbler sp., but later correctly identified as YRWA. Revise to YRWA in the record.
20130604-46	Array 2 South	6/4/2013	CORA	11S	234368	3914685	Feather spot: approximately 35 body feathers.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130613-41	Array 1	6/13/2013	EUST	11S	234294	3915204	Partial carcass: two primaries, clump of body feathers, and part of wing.	Fatality was not reported in 2012-2013 annual report. Include in the record.
20130619-41	34.5kV Line	6/19/2013	HOSP	11S	235931	3912655	Feather spot: five flight and 15 contour feathers found directly under the powerline.	UTM Coordinates incorrect in 2012-2013 annual report. Coordinates should be revised as 11S 235931 m E 3912655 m N in the record.
20130626-46	Conservation Lands	6/26/2013	BUOW	11S	234199	3912839	Feather spot: approximately 20 pin feathers.	Incidental fatality was not reported in 2012-2013 annual report. Include in the record.
20130708-21	Array 6	7/8/2013	HOFI	11S	237194	3913141	Feather spot: Single distinct clump of 15+ body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.

Note:

[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN.

Incident ID	Site	Search Date	Species Code[1]	UTM Zone	Easting	Northing	Observation Details	Errata Notes
20130708-22	Array 6	7/8/2013	CORA	11S	237101	3912945	Feather Spot, Skin: ten primary and secondary feathers, 20-30 single contour feathers, three+ clumps of body feathers, and some skin fragments.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130708-23	Array 6	7/8/2013	HOLA	11S	237752	3912687	Feather spot: 100+ body feathers, eight flight feathers (primaries and secondaries), one leg, half of beak with attached lore and malar feathers, bone and skin fragments including eye socket.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130708-71	Array 6	7/8/2013	LASP	11S	234028	3911758	Feather spot: 100+ body feathers and about 12 flight feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130708-26	Array 6	7/8/2013	ROPI	11S	237689	3912612	Feather spot: 30 contour feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130708-27	Array 6	7/8/2013	BRBL	11S	237691	3912611	Feather spot: 100+ body feathers and 20 flight feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.
20130709-61	Array 7	7/9/2013	HOLA	11S	237689	3912656	Feather spot: approximately three flight feathers, two tail feathers and 40 body feathers.	Clearance fatality was not reported in 2012-2013 annual report. Include in the record.

Note:
[1] Codes are designated by the American Ornithologists' Union Check-list of North American Birds, and are defined in Table 5. Codes for unknown species are not designated by the AOU. For purposes of this report, unknown large bird, small bird, raptor, or passerine are designated as UNKN.

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE
Migratory Bird Permit Office
2800 Cottage Way - Room W-2606 - Sacramento, CA 95825
Tel: 916-978-6183 Fax: 916-978-6183
Email: permitsR8MB@fws.gov

FEDERAL FISH AND WILDLIFE PERMIT

1. PERMITTEE

DESERT SUNLIGHT 250, LLC
700 UNIVERSE BLVD
JUNO BEACH, FL 33408
U.S.A.

2. AUTHORITY-STATUTES
16 USC 703-712

REGULATIONS
50 CFR Part 13
50 CFR 21.27

3. NUMBER
MB56901B-0

4. RENEWABLE
☒ YES
☐ NO

5. MAY COPY
☒ YES
☐ NO

6. EFFECTIVE
03/18/2015

7. EXPIRES
03/18/2018

8. NAME AND TITLE OF PRINCIPAL OFFICER *(If # 1 is a business)*
MANUEL A SANCHEZ
VP FOSSIL AND SOLAR OPERATIONS

9. TYPE OF PERMIT
MIGRATORY BIRD SPECIAL PURPOSE UTILITY PERMIT - SOLAR

10. LOCATION WHERE AUTHORIZED ACTIVITY MAY BE CONDUCTED

Records Location: 44810 Kaiser Road, Desert Center, CA 92239
Carcasses Collection Location: T4S,R15E, Sections 9, 10, 13, 14, 15, 22, 23, 24.
Carcasses Stored: In freezer on site at collection location.

11. CONDITIONS AND AUTHORIZATIONS:

A. GENERAL CONDITIONS SET OUT IN SUBPART D OF 50 CFR 13, AND SPECIFIC CONDITIONS CONTAINED IN FEDERAL REGULATIONS CITED IN BLOCK #2 ABOVE, ARE HEREBY MADE A PART OF THIS PERMIT. ALL ACTIVITIES AUTHORIZED HEREIN MUST BE CARRIED OUT IN ACCORD WITH AND FOR THE PURPOSES DESCRIBED IN THE APPLICATION SUBMITTED. CONTINUED VALIDITY, OR RENEWAL, OF THIS PERMIT IS SUBJECT TO COMPLETE AND TIMELY COMPLIANCE WITH ALL APPLICABLE CONDITIONS, INCLUDING THE FILING OF ALL REQUIRED INFORMATION AND REPORTS.

B. THE VALIDITY OF THIS PERMIT IS ALSO CONDITIONED UPON STRICT OBSERVANCE OF ALL APPLICABLE FOREIGN, STATE, LOCAL, TRIBAL, OR OTHER FEDERAL LAW.

C. VALID FOR USE BY PERMITTEE NAMED ABOVE.

This permit does not supersede any State Requirements. You are responsible for ensuring that you are in compliance with all State laws, including but not limited to California Fish and Game Code 3511 (fully protected species) 3503.5 and 3513. For additional information on State requirements please contact: California Department of Fish and Wildlife, Magdalena Rodriguez, 909-945-3294.

D. **Possession and transport.**

1) You and subpermittees are authorized to collect, transport and temporarily possess carcasses and partial remains of birds protected under the Migratory Bird Treaty Act, **except Bald Eagles and Golden Eagles (Eagles)** and species listed as **Threatened or Endangered** under the U.S Endangered Species Act (see 50 CFR § 17.11), found at the location/property specified in Block 10 for monitoring bird mortality associated with operation of the wind facility. To accurately determine species fatality rates, the monitoring study must include standardized carcass searches, searcher efficiency trials, and carcass removal by scavenger trials. For **Eagles and federally listed Threatened or Endangered Species** you must call a U.S. Fish and Wildlife Service (Service), Office of Law Enforcement (OLE) special agent for instructions and approval before collecting or moving the carcass or its parts. It may be necessary to preserve the carcass or its parts onsite until an agent or other Service or State representative arrives to collect it.

☒ ADDITIONAL CONDITIONS AND AUTHORIZATIONS ALSO APPLY

12. REPORTING REQUIREMENTS

ANNUAL REPORT DUE: 01/31
You must submit an annual report to your Regional Migratory Bird Permit Office each year, even if you had no activity. Form: www.fws.gov/forms/3-202-17.pdf.

ISSUED BY

TITLE
MIGRATORY BIRD PERMIT SPECIALIST

DATE
03/18/2015

Your OLE contact phone number is. **Your OLE point-of-contact is Special Agent (SA) Michael Clark, Michael_Clark@fws.gov, (702) 281-9071.**

2) Except for take caused by your infrastructure and operations, you may not collect or disturb and must immediately report to OLE any dead migratory birds that appear to have been poisoned, shot, or otherwise killed or injured as the result of potential criminal activity.

3) With prior approval from your Migratory Bird Permit Office, you are authorized to receive lawfully acquired carcasses and parts to use for standardized carcass searches, searcher efficiency trials, and carcass removal by scavenger trials from federally permitted rehabilitation centers or other lawful sources. You must maintain records of all acquisitions, including source (name of permittee and permit number), species, description (carcass or type of part), date of receipt, and final disposition.

E. **Data Collection.**

Mortality monitoring data should be compiled in the attached Excel spreadsheet and submitted to the Service on a monthly basis until directed differently by permit official. It includes but is not limited to the collection of the following information:

1) All relevant and applicable data associated with each carcass or part collection, or injured bird, should be recorded, including the information below. Required data are designated with an asterisk (*).

    a) discovery date*
    b) collection date*
    c) species*
    d) sex and age (juvenile/adult), if known
    e) condition of bird (alive or dead) *
    f) condition of carcass (entire, partial, scavenged)*
    g) description of carcass (e.g., intact, feather spot, headless, wing sheared, blood in mouth, entanglement)*
    h) interval since last search*
    i) observer*
    j) search method used, including opportunistic discovery of carcasses*
    k) weather conditions at likely time of death, if known*
    l) identifying information for the infrastructure element, e.g. solar panel, evaporation pond, fencing, building
    m) the GPS coordinates in decimal degrees for the location where carcass/part found*
    n) ground distance of carcass from pole, line, panel, or other structure (e.g pond or building)
    o) azimuth of carcass from solar panel or infrastructure (including GPS coordinates in decimal degrees), if known
    p) apparent cause of mortality/injury (collision, electrocution, drowned, other) *
    q) estimated date of mortality or estimate of time since death (e.g., <1 day, 1 day, 2-3 days)*
    r) habitat surrounding carcass (*e.g.*, desert, grassland, rural, urban, cropland, bare ground, tall grass)
    s) information on carcass or injured bird disposition*
    t) any special notes or additional information

2) All carcasses and partial remains collected should be digitally photographed, bagged, and labeled with the following information:

    1) date collected
    2) a unique specimen number
    3) the information listed in E(1)(l and m) above
    4) facility name

3) Migratory birds, **other than Eagles and federally listed Threatened or Endangered Species**, may be used for searcher efficiency trials and carcass removal trials AFTER a mortality report has been submitted to Regional Migratory Bird Permit Office per condition H(1)(e) documenting their death, all data collected in condition E(2), and the unique specimen number assigned to that carcass in condition E(3) above.

F. **Injured birds.** Injured migratory birds, including **eagles and federally listed threatened or endangered species,** must be transferred to a federally permitted migratory bird rehabilitator or a licensed veterinarian for care. Rehabilitation and/or veterinary costs are the utility's responsibility. See condition H for reporting instructions.

G. **Take and collection of live, non-injured migratory birds, eggs, or nests is not authorized by this permit.** In addition, this permit does not authorize the take, capture, harassment or disturbance of **eagles or federally listed endangered or threatened species** (see 50 CFR 17.11).

H. **Reporting.**

1) You must report bird injuries and deaths in accordance with the time frames specified below (a-c).

a. You must submit a written report of avian mortality and injury **monthly** to OLE, the Regional Migratory Bird Permit Office (RMBPO), the Ecological Service's Field Office (Field Office) and California Department of Fish and Wildlife (CDFW). Your report must include as much of the data listed in condition E above that is available for each incident. In addition, we request that you voluntarily report bat injury and mortality information.

- OLE RAC: Erin Dean, (erin_dean@fws.gov, phone: 310-328-1516)
- RMBPO: Heather Beeler (heather_beeler@fws.gov, phone: 916-414-6651)
- Field Office-Palm Springs: (jody_fraser@fws.gov , phone: 760-322-2070)
- CDFW: Email to CDFW at: (armand.gonzales@wildlife.ca.gov and magdalena.rodriguez@wildlife.ca.gov)

b. In addition to the monthly reports, you must report any **bald eagle or golden eagle or threatened or endangered species** found dead or injured to the OLE and each contact listed in H(1)(a) immediately if possible, but no later than **24 hours after discovery.** Your report must include as much of the information from condition E that is available for each incident. A written mortality or injury report specific to the eagle or listed species must be submitted to all contacts listed in condition H(1)(a), to include the data in condition E, no later than **one week (7 days)** from the date of discovery of the carcass.

A list of Threatened and Endangered species by State may be found in the Service's Threatened and Endangered Species System (TESS) database at: *<http://www.fws.gov/endangered>*.

c. In the event that you discover 6 or more migratory birds that have been injured or killed within a 24 hour period, you must report the event to RMBPO and the Field Office listed in condition H(1)(a) above immediately if possible, but no later than the **next business day**. This summary must list the number of events by species. Within 14 days of carcass/injury discovery, a written mortality or injury report specific to the incident must be submitted to your FWS contacts, and should include as much of the data in E above as possible. This reporting requirement is intended to inform the Service of events or other variables that may have contributed to the mortality event.

2) You must submit an **Annual Report** of dead and injured birds, **including Eagles and Threatened and Endangered Species**, discovered and/or collected to your Migratory Bird Permit Office by January 31 following each calendar year in which the permit is in effect. Your written annual report is due by 1/31/14. The report form 3-202-17 is available at *<http://www.fws.gov/forms/3-202-17.pdf>*. Please submit a Special Purpose Utility Excel Data in lieu of using form 3-202-17. All of the information requested on the 3-202-17 form, including the signed certification statement, must be included.

I. **Disposition of Carcasses and Parts.**

1) In accordance with Condition D (1) above, the Service OLE will advise you on disposition of **eagle and threatened or endangered species** specimens. The special agent will advise if they will recover an eagle carcass or if you need to ship the carcass to the Service. With prior written authorization from an OLE special agent, you may ship carcasses directly to the National Eagle Repository (NER) (contact the NER at 303-287-2110 for shipping instructions). The written authorization from the special agent must accompany the eagle if it is shipped to the NER. Disposition must be reported in your final to your migratory bird permit issuing office.

2) Migratory Bird carcasses and parts (**other than eagles and threatened and endangered species**) collected during the duration of this permit must be stored in a freezer at the facilities at the location specified in Block 10. After receiving written permission from OLE and notification to your RMBPO, carcasses may be:
   a) used for searcher efficiency and scavenger removal trials; carcasses used in trials must be reported to the Service as outlined in Condition E(4) and H(1)(d) above. Heavily damaged carcasses should be excluded for use in these trials.
   b) donated to a public scientific or educational institution or to an individual or entity authorized by federal permit to acquire and possess migratory bird specimens.

All dead specimens and parts (except eagles and threatened and endangered species) that you do not transfer to another authorized party must be disposed of as directed by OLE.

J. **Renewal**. In addition to an updated monitoring protocol, any request for renewal of this permit must include information on the fatality rates of affected species or fatality patterns, analysis of those rates/patterns, whether any adjustments or measures were taken to avoid or minimize mortalities, and if so, any preliminary results of those modifications.

K. **Subpermittees.** Any person who is employed by or under contract to the permittee for the activities specified in this permit, or is otherwise designated as a subpermittee in writing by the permittee may exercise the authority of this permit.

L. **Standard Conditions.** You and any subpermittees must comply with the attached **Standard Conditions for Migratory Bird Special Purpose Utility Salvage Permits. These standard conditions are a continuation of your permit conditions and must remain with your permit.**

This permit does not supersede any State Requirements. You are responsible for ensuring that you are in compliance with all State laws, including but not limited to California Fish and Game Code 3511 (fully protected species) 3503.5 and 3513. For additional information on State requirements please contact: California Department of Fish and Wildlife, Deborah Hawk, 760-872-1126.

This permit does not, nor shall it be construed to, authorize lethal take or injury of migratory birds or limit or preclude the U.S. Fish and Wildlife Service from exercising its authority under any law, statute, or regulation, or from taking enforcement action against any individual, company, or agency. This permit is not intended to relieve any individual, company, or agency of its obligations to comply with any applicable Federal, State, Tribal, or local law, statute, or regulation.

This permit may be amended at any time in response to changes in national guidance or take reported.

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE
Migratory Bird Permit Office
2800 Cottage Way - Room W-2606 - Sacramento, CA 95825
Tel: 916-978-6183 Fax: 916-978-6183
Email: permitsR8MB@fws.gov

FEDERAL FISH AND WILDLIFE PERMIT

1. PERMITTEE

DESERT SUNLIGHT 300, LLC
700 UNIVERSE BLVD
JUNO BEACH, FL 33408
U.S.A.

2. AUTHORITY-STATUTES
16 USC 703-712

REGULATIONS
50 CFR Part 13
50 CFR 21.27

3. NUMBER
MB56908B-0

4. RENEWABLE
☒ YES
☐ NO

5. MAY COPY
☒ YES
☐ NO

6. EFFECTIVE
03/18/2015

7. EXPIRES
03/18/2018

8. NAME AND TITLE OF PRINCIPAL OFFICER *(If #1 is a business)*
MANUEL A SANCHEZ
VP FOSSIL AND SOLAR OPERATIONS

9. TYPE OF PERMIT
MIGRATORY BIRD SPECIAL PURPOSE UTILITY PERMIT - SOLAR

10. LOCATION WHERE AUTHORIZED ACTIVITY MAY BE CONDUCTED

Records Location: 44810 Kaiser Road, Desert Center, CA 92239
Carcasses Collection Location: T4S,R15E, Sections 9, 10, 13, 14, 15, 22, 23, 24.
Carcasses Stored: In freezer on site at collection location.

11. CONDITIONS AND AUTHORIZATIONS:

A. GENERAL CONDITIONS SET OUT IN SUBPART D OF 50 CFR 13, AND SPECIFIC CONDITIONS CONTAINED IN FEDERAL REGULATIONS CITED IN BLOCK #2 ABOVE, ARE HEREBY MADE A PART OF THIS PERMIT. ALL ACTIVITIES AUTHORIZED HEREIN MUST BE CARRIED OUT IN ACCORD WITH AND FOR THE PURPOSES DESCRIBED IN THE APPLICATION SUBMITTED. CONTINUED VALIDITY, OR RENEWAL, OF THIS PERMIT IS SUBJECT TO COMPLETE AND TIMELY COMPLIANCE WITH ALL APPLICABLE CONDITIONS, INCLUDING THE FILING OF ALL REQUIRED INFORMATION AND REPORTS.

B. THE VALIDITY OF THIS PERMIT IS ALSO CONDITIONED UPON STRICT OBSERVANCE OF ALL APPLICABLE FOREIGN, STATE, LOCAL, TRIBAL, OR OTHER FEDERAL LAW.

C. VALID FOR USE BY PERMITTEE NAMED ABOVE.

This permit does not supersede any State Requirements. You are responsible for ensuring that you are in compliance with all State laws, including but not limited to California Fish and Game Code 3511 (fully protected species) 3503.5 and 3513. For additional information on State requirements please contact: California Department of Fish and Wildlife, Magdalena Rodriguez, 909-945-3294.

D. **Possession and transport.**

1) You and subpermittees are authorized to collect, transport and temporarily possess carcasses and partial remains of birds protected under the Migratory Bird Treaty Act, **except Bald Eagles and Golden Eagles (Eagles)** and species listed as **Threatened or Endangered** under the U.S Endangered Species Act (see 50 CFR § 17.11), found at the location/property specified in Block 10 for monitoring bird mortality associated with operation of the wind facility. To accurately determine species fatality rates, the monitoring study must include standardized carcass searches, searcher efficiency trials, and carcass removal by scavenger trials. For **Eagles and federally listed Threatened or Endangered Species** you must call a U.S. Fish and Wildlife Service (Service), Office of Law Enforcement (OLE) special agent for instructions and approval before collecting or moving the carcass or its parts. It may be necessary to preserve the carcass or its parts onsite until an agent or other Service or State representative arrives to collect it.

☒ ADDITIONAL CONDITIONS AND AUTHORIZATIONS ALSO APPLY

12. REPORTING REQUIREMENTS

ANNUAL REPORT DUE: 01/31
You must submit an annual report to your Regional Migratory Bird Permit Office each year, even if you had no activity. Form: www.fws.gov/forms/3-202-17.pdf.

ISSUED BY	TITLE	DATE
	MIGRATORY BIRD PERMIT SPECIALIST	03/18/2015

Your OLE contact phone number is. **Your OLE point-of-contact is Special Agent (SA) Michael Clark, Michael_Clark@fws.gov, (702) 281-9071.**

2) Except for take caused by your infrastructure and operations, you may not collect or disturb and must immediately report to OLE any dead migratory birds that appear to have been poisoned, shot, or otherwise killed or injured as the result of potential criminal activity.

3) With prior approval from your Migratory Bird Permit Office, you are authorized to receive lawfully acquired carcasses and parts to use for standardized carcass searches, searcher efficiency trials, and carcass removal by scavenger trials from federally permitted rehabilitation centers or other lawful sources. You must maintain records of all acquisitions, including source (name of permittee and permit number), species, description (carcass or type of part), date of receipt, and final disposition.

E. **Data Collection.**

Mortality monitoring data should be compiled in the attached Excel spreadsheet and submitted to the Service on a monthly basis until directed differently by permit official. It includes but is not limited to the collection of the following information:

1) All relevant and applicable data associated with each carcass or part collection, or injured bird, should be recorded, including the information below. Required data are designated with an asterisk (*).

   a) discovery date*
   b) collection date*
   c) species*
   d) sex and age (juvenile/adult), if known
   e) condition of bird (alive or dead) *
   f) condition of carcass (entire, partial, scavenged)*
   g) description of carcass (e.g., intact, feather spot, headless, wing sheared, blood in mouth, entanglement)*
   h) interval since last search*
   i) observer*
   j) search method used, including opportunistic discovery of carcasses*
   k) weather conditions at likely time of death, if known*
   l) identifying information for the infrastructure element, e.g. solar panel, evaporation pond, fencing, building
   m) the GPS coordinates in decimal degrees for the location where carcass/part found*
   n) ground distance of carcass from pole, line, panel, or other structure (e.g pond or building)
   o) azimuth of carcass from solar panel or infrastructure (including GPS coordinates in decimal degrees), if known
   p) apparent cause of mortality/injury (collision, electrocution, drowned, other) *
   q) estimated date of mortality or estimate of time since death (e.g., <1 day, 1 day, 2-3 days)*
   r) habitat surrounding carcass (*e.g.*, desert, grassland, rural, urban, cropland, bare ground, tall grass)
   s) information on carcass or injured bird disposition*
   t) any special notes or additional information

2) All carcasses and partial remains collected should be digitally photographed, bagged, and labeled with the following information:
   1) date collected
   2) a unique specimen number
   3) the information listed in E(1)(l and m) above
   4) facility name

3) Migratory birds, **other than Eagles and federally listed Threatened or Endangered Species**, may be used for searcher efficiency trials and carcass removal trials AFTER a mortality report has been submitted to Regional Migratory Bird Permit Office per condition H(1)(e) documenting their death, all data collected in condition E(2), and the unique specimen number assigned to that carcass in condition E(3) above.

F. **Injured birds.** Injured migratory birds, including **eagles and federally listed threatened or endangered species,** must be transferred to a federally permitted migratory bird rehabilitator or a licensed veterinarian for care. Rehabilitation and/or veterinary costs are the utility's responsibility. See condition H for reporting instructions.

G. **Take and collection of live, non-injured migratory birds, eggs, or nests is not authorized by this permit.** In addition, this permit does not authorize the take, capture, harassment or disturbance of **eagles or federally listed endangered or threatened species** (see 50 CFR 17.11).

H. **Reporting.**

1) You must report bird injuries and deaths in accordance with the time frames specified below (a-c).

a. You must submit a written report of avian mortality and injury **monthly** to OLE, the Regional Migratory Bird Permit Office (RMBPO), the Ecological Service's Field Office (Field Office) and California Department of Fish and Wildlife (CDFW). Your report must include as much of the data listed in condition E above that is available for each incident. In addition, we request that you voluntarily report bat injury and mortality information.

- OLE RAC: Erin Dean, (erin_dean@fws.gov, phone: 310-328-1516)
- RMBPO: Heather Beeler (heather_beeler@fws.gov, phone: 916-414-6651)
- Field Office-Palm Springs: (jody_fraser@fws.gov , phone: 760-322-2070)
- CDFW: Email to CDFW at: (armand.gonzales@wildlife.ca.gov and magdalena.rodriguez@wildlife.ca.gov)

b. In addition to the monthly reports, you must report any **bald eagle or golden eagle or threatened or endangered species** found dead or injured to the OLE and each contact listed in H(1)(a) immediately if possible, but no later than **24 hours after discovery.** Your report must include as much of the information from condition E that is available for each incident. A written mortality or injury report specific to the eagle or listed species must be submitted to all contacts listed in condition H(1)(a), to include the data in condition E, no later than **one week (7 days)** from the date of discovery of the carcass.

A list of Threatened and Endangered species by State may be found in the Service's Threatened and Endangered Species System (TESS) database at: <*http://www.fws.gov/endangered*>.

c. In the event that you discover 6 or more migratory birds that have been injured or killed within a 24 hour period, you must report the event to RMBPO and the Field Office listed in condition H(1)(a) above immediately if possible, but no later than the **next business day**. This summary must list the number of events by species. Within 14 days of carcass/injury discovery, a written mortality or injury report specific to the incident must be submitted to your FWS contacts, and should include as much of the data in E above as possible. This reporting requirement is intended to inform the Service of events or other variables that may have contributed to the mortality event.

2) You must submit an **Annual Report** of dead and injured birds, **including Eagles and Threatened and Endangered Species**, discovered and/or collected to your Migratory Bird Permit Office by January 31 following each calendar year in which the permit is in effect. Your written annual report is due by 1/31/14. The report form 3-202-17 is available at <*http://www.fws.gov/forms/3-202-17.pdf*>. Please submit a Special Purpose Utility Excel Data in lieu of using form 3-202-17. All of the information requested on the 3-202-17 form, including the signed certification statement, must be included.

I. **Disposition of Carcasses and Parts.**

1) In accordance with Condition D (1) above, the Service OLE will advise you on disposition of **eagle and threatened or endangered species** specimens. The special agent will advise if they will recover an eagle carcass or if you need to ship the carcass to the Service. With prior written authorization from an OLE special agent, you may ship carcasses directly to the National Eagle Repository (NER) (contact the NER at 303-287-2110 for shipping instructions). The written authorization from the special agent must accompany the eagle if it is shipped to the NER. Disposition must be reported in your final to your migratory bird permit issuing office.

2) Migratory Bird carcasses and parts (**other than eagles and threatened and endangered species**) collected during the duration of this permit must be stored in a freezer at the facilities at the location specified in Block 10. After receiving written permission from OLE and notification to your RMBPO, carcasses may be:
   a) used for searcher efficiency and scavenger removal trials; carcasses used in trials must be reported to the Service as outlined in Condition E(4) and H(1)(d) above. Heavily damaged carcasses should be excluded for use in these trials.
   b) donated to a public scientific or educational institution or to an individual or entity authorized by federal permit to acquire and possess migratory bird specimens.

All dead specimens and parts (except eagles and threatened and endangered species) that you do not transfer to another authorized party must be disposed of as directed by OLE.

J. **Renewal**. In addition to an updated monitoring protocol, any request for renewal of this permit must include information on the fatality rates of affected species or fatality patterns, analysis of those rates/patterns, whether any adjustments or measures were taken to avoid or minimize mortalities, and if so, any preliminary results of those modifications.

K. **Subpermittees.** Any person who is employed by or under contract to the permittee for the activities specified in this permit, or is otherwise designated as a subpermittee in writing by the permittee may exercise the authority of this permit.

L. **Standard Conditions.** You and any subpermittees must comply with the attached **Standard Conditions for Migratory Bird Special Purpose Utility Salvage Permits. These standard conditions are a continuation of your permit conditions and must remain with your permit.**

This permit does not supersede any State Requirements. You are responsible for ensuring that you are in compliance with all State laws, including but not limited to California Fish and Game Code 3511 (fully protected species) 3503.5 and 3513. For additional information on State requirements please contact: California Department of Fish and Wildlife, Deborah Hawk, 760-872-1126.

This permit does not, nor shall it be construed to, authorize lethal take or injury of migratory birds or limit or preclude the U.S. Fish and Wildlife Service from exercising its authority under any law, statute, or regulation, or from taking enforcement action against any individual, company, or agency. This permit is not intended to relieve any individual, company, or agency of its obligations to comply with any applicable Federal, State, Tribal, or local law, statute, or regulation.

This permit may be amended at any time in response to changes in national guidance or take reported.

Attachment A. Standard Conditions

Migratory Bird Special Purpose

Utility Salvage Permits
50 CFR 21.27

All of the provisions and conditions of the governing regulations at 50 CFR part 13 and 50 CFR 21.27 are conditions of your permit. Failure to comply with the conditions of your permit could be cause for suspension of the permit. The standard conditions below are a continuation of your permit conditions and must remain with your permit. If you have any questions regarding these conditions, refer to the regulations or, if necessary, contact your migratory bird permit issuing office. For copies of the regulations and forms, or to obtain contact information for your issuing office, visit: http://www.fws.gov/migratorybirds/mbpermits.html.

1. **Personal use.** This permit does not authorize personal use of any migratory birds, parts, nests or eggs salvaged, transported, or temporarily possessed under the authority of this permit.

2. **Banded Birds** (carcasses collected and injured birds) must be reported to the U.S. Geological Survey Bird Banding Laboratory at 1-800-327-2263 or *http://www.reportband.gov*. Information provided must include, as accurately as possible, species of bird, band number, date recovered, recovery location, and name and contact information of the person who recovered the carcass or bird.

3. **Subpermittees.** A subpermittee is an individual to whom you have provided written authorization to conduct some or all of the permitted activities in your absence. Subpermittees must be at least 18 years of age. As the permittee, you are legally responsible for ensuring that anyone conducting activities under your permit is adequately trained and adheres to the terms of your permit. You are responsible for maintaining current records of who you have designated as a subpermittee, including copies of designation letters you have provided.

4. **Carrying your permit.** You and any subpermittees must carry a legible copy of this permit and display it upon request of any duly authorized federal, state or tribal officer whenever exercising its authority. Subpermittees must also carry your written subpermittee designation letter.

5. **Records.** You must maintain complete and accurate records of the activities conducted and the data collected under this permit. You must keep all required records and collected wildlife parts relating to permitted activities at the location you identified in writing to the migratory bird permit issuing office. (50 CFR 13.46 and 21.27)

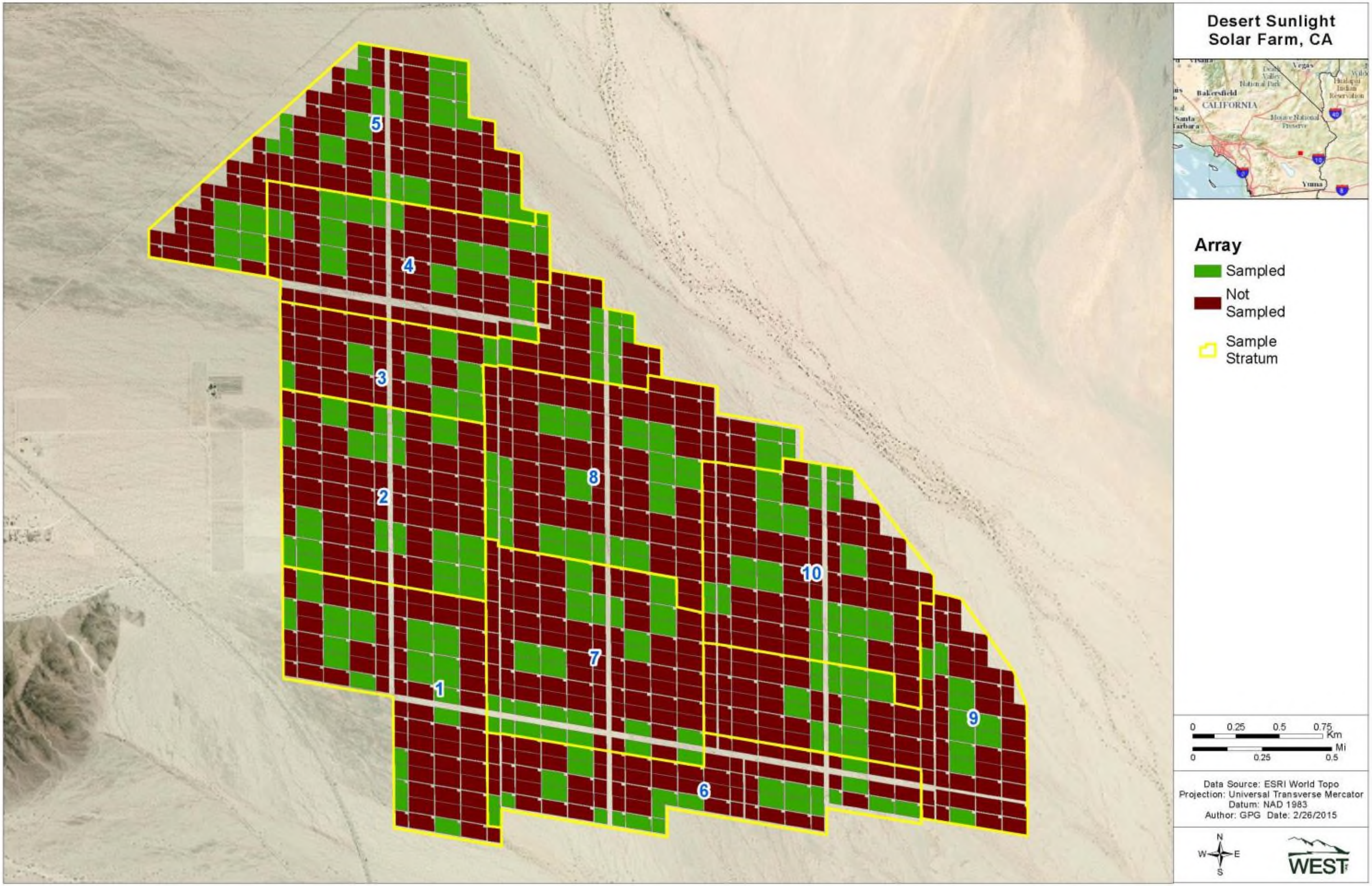
6. **Site inspections.** Acceptance of this permit authorizes the Director's agent to enter the utility property at any reasonable hour as necessary to inspect the wildlife, records, facilities, property, and associated infrastructure for wildlife impacted by the utility, and for compliance with the terms of this permit and governing regulations. (50 CFR 13.47)

7. **Applicable laws.** You may not conduct the activities authorized by this permit if doing so would violate the laws of the applicable State, county, municipal or tribal government or any other applicable law.

8. **Other permissions.** This permit does not authorize salvage of specimens on Federal, State, tribal, or other public or private property without additional prior written permits or permission from the agency/landowner/custodian.

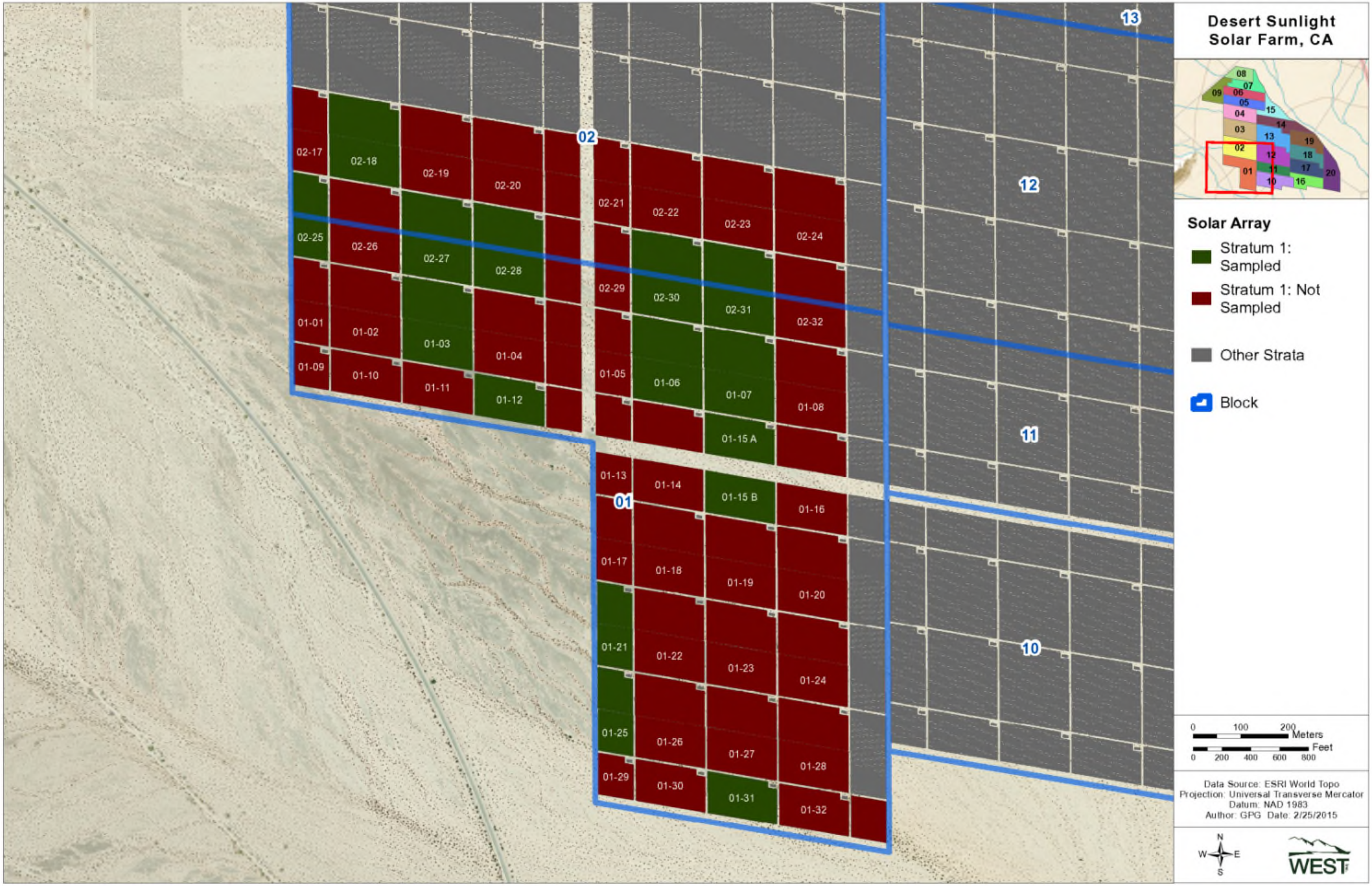
Desert Sunlight
Bird and Bat Conservation Strategy
Implementation
Business Confidential
February 26 2015

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

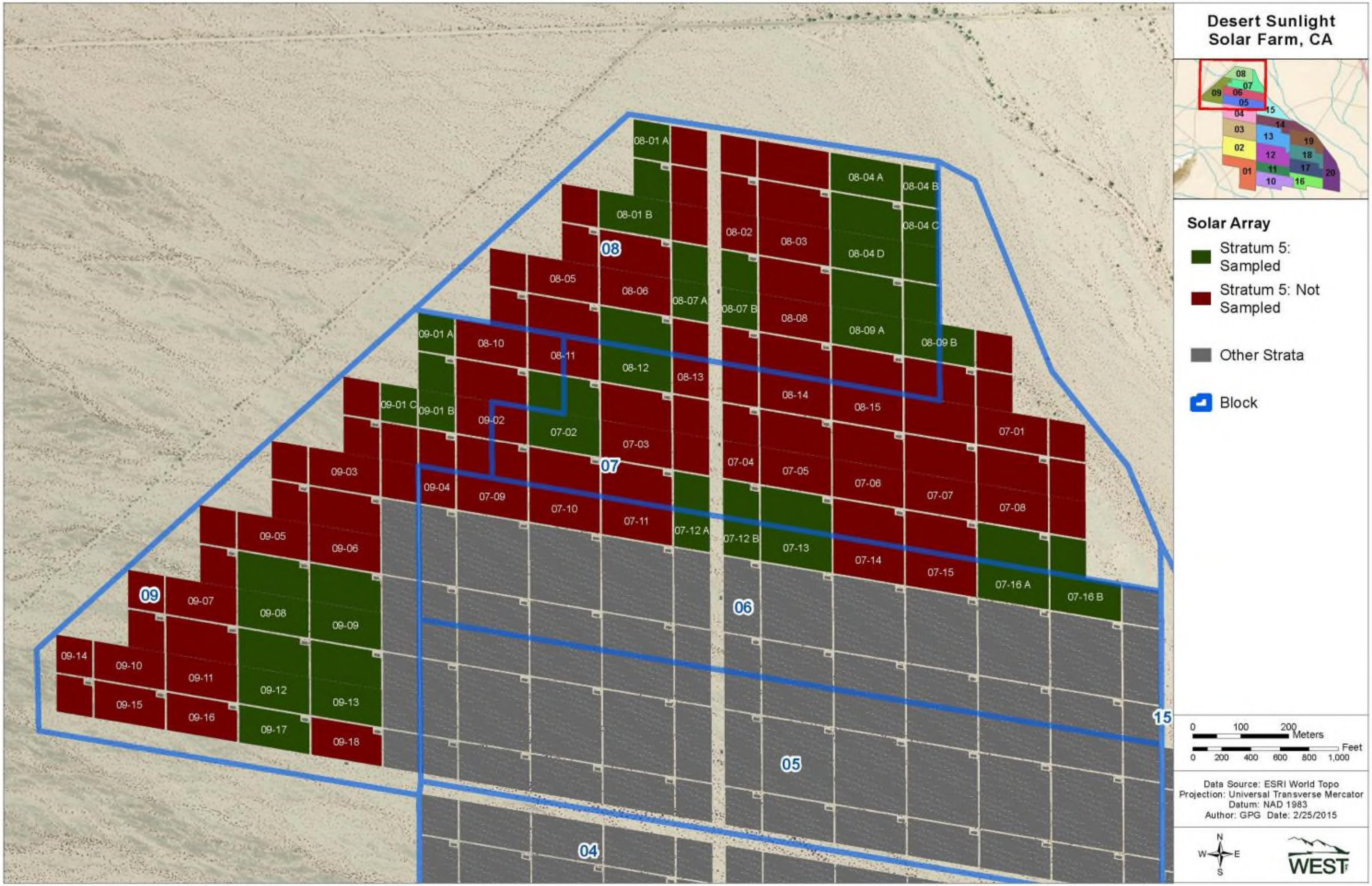


Data Source: ESRI World Topo
Projection: Universal Transverse Mercator
Datum: NAD 1983
Author: GPG Date: 2/26/2015

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

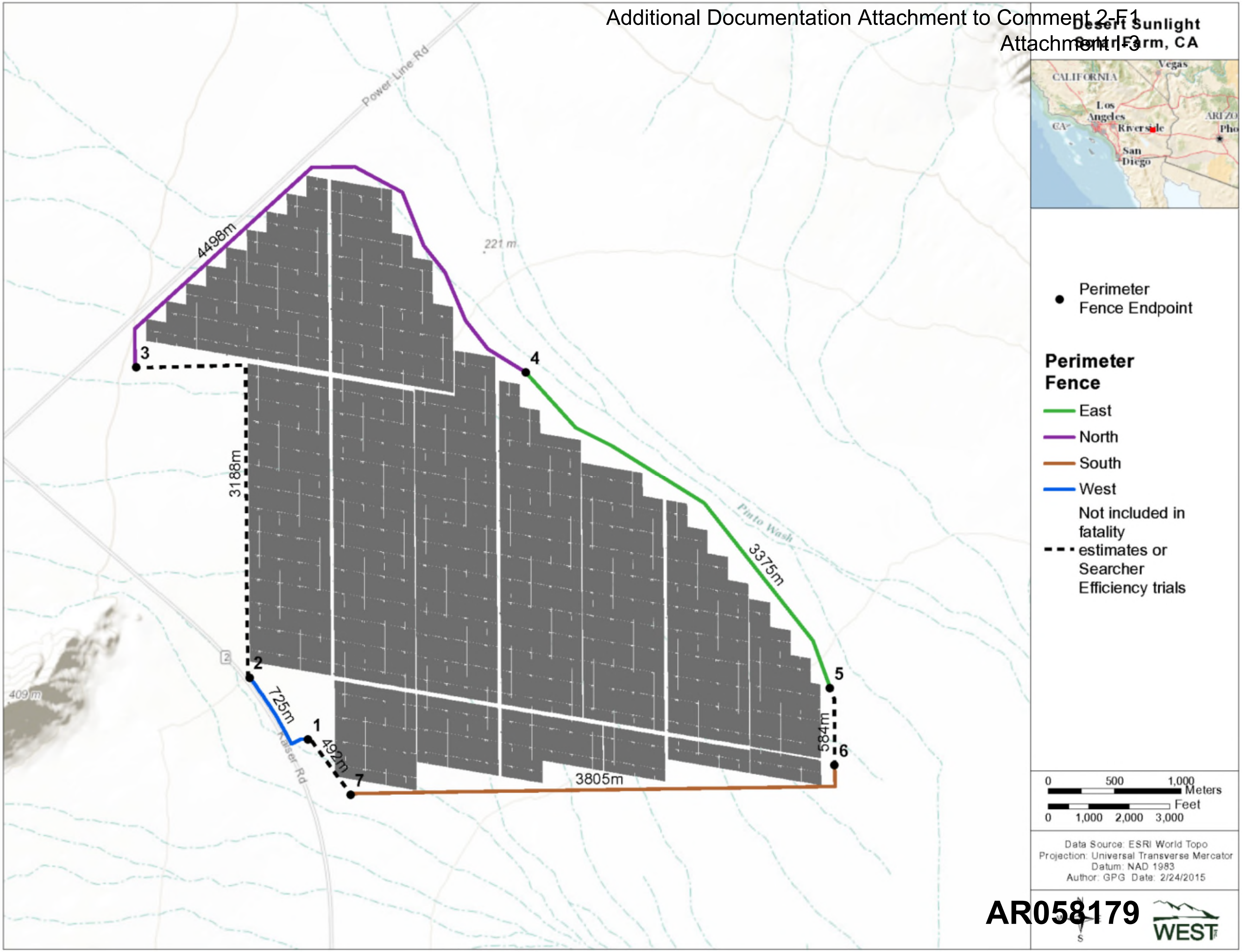


Data Source: ESRI World Topo
Projection: Universal Transverse Mercator
Datum: NAD 1983
Author: GPG Date: 2/25/2015



Data Source: ESRI World Topo
Projection: Universal Transverse Mercator
Datum: NAD 1983
Author: GPG Date: 2/25/2015

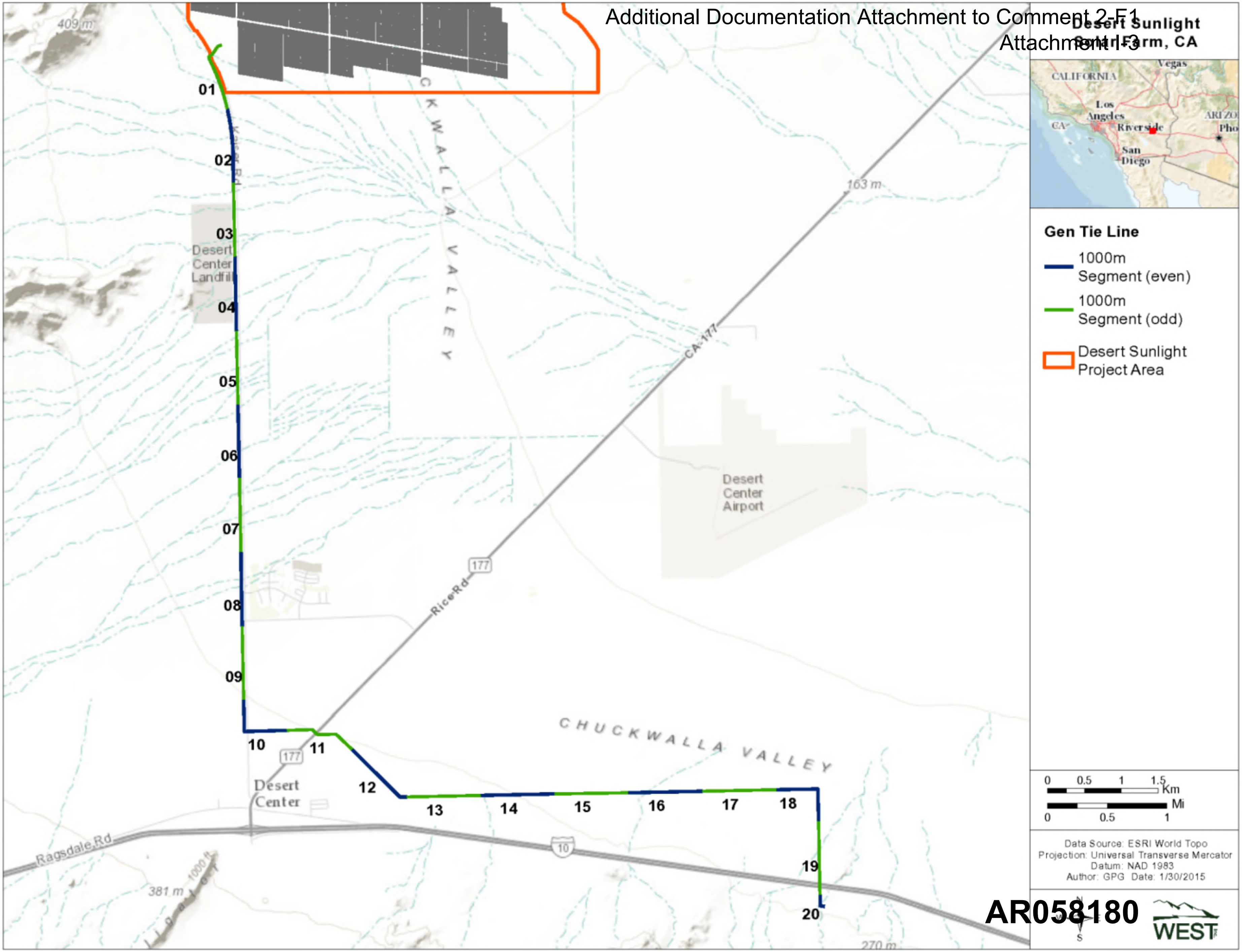
Additional Documentation Attachment to Comment 2-F1
Attachment I-3



Data Source: ESRI World Topo
Projection: Universal Transverse Mercator
Datum: NAD 1983
Author: GPG Date: 2/24/2015

Additional Documentation Attachment to Comment 2-F1

Attachment I-3



Monitoring Schedule – Carcass Searches

- Carcass searches
  - Clearance survey (3 – 10 Feb)
  - Winter search (23 Feb to present)
  - Spring – 7 day interval
    - Begin 9 Mar, and continue weekly through May 31st
  - Summer: 21 day interval: June, July, August
  - Fall: Sept 1 – Oct 31
  - Winter: 21 day interval Nov. 1 – Feb 28th

Clearance Survey Results

- One feather spot
  - Common raven
  - Solar field
    - 17-05

Monitoring Schedule -SEEF

- Winter
  - Initial trial this week
  - Small – house sparrows
  - medium – rock pigeons and coturnix quail
  - large – hen pheasants and mallards
- Spring - 3 trials with ~1/3 total sample size for each
  - March
  - April
  - May

Monitoring Schedule – Carcass Persistence Trials

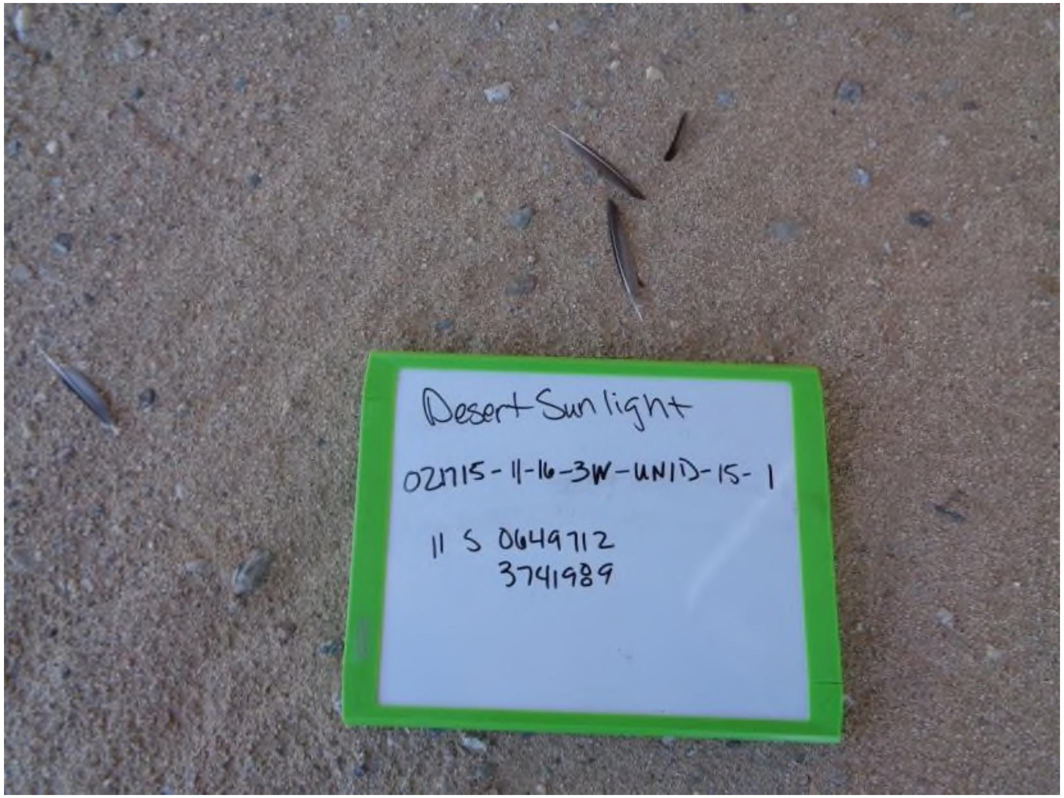
- 1 set of trials along gen-tie
- 1 set of trials within solar field/fence
- Began 17 Feb
- 8 carcasses with cameras (6 solar field/2 fence)
- 22 carcasses without cameras (15 gen-tie, 6 solar field/1 fence)
- N = 30 (1/2 trial)
- Same species as SEEF trials


2/21/2015 7:01 AM
Cuddeback Digital


KLM85 -12151-1
Cuddeback Digital
2/20/2015 1:02 AM

Incidentals

- One feather spot
  - Unknown species
  - Solar field
    - 11-16



Post-Construction Monitoring at the Genesis Solar Energy Project Riverside County, California

2015 Spring Report

Prepared for:

Genesis Solar LLC

700 Universe Blvd.,

Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.

415 West 17th Street, Suite 2000

Cheyenne, Wyoming

June 30, 2015

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from March 05 to May 31, 2015 (the spring season) at Genesis Solar Energy Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the first seasonal report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS.

Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 30% sample of solar troughs of both Project units, 2) at each evaporation pond, 3) along the perimeter of each power block and beneath each air condensed cooling (ACC) unit, 4) along inner and outer portions of the "fenceline", resulting in 100% of the length of the perimeter fence surveyed, and 5) along 25% of the total length of generation-tie (gen-tie) and distribution lines from the southernmost Project fence to Wiley's Well reststop, which co-occur with the Project access road. Searches were conducted within the spring season at intervals of approximately seven days.

All bird and bat fatalities and injuries that were discovered by observers, referred to as "detections" in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, 53 avian detections (including 2 stranded birds) were made, while there were no detections of bats.

According to specifications of the BBCS, avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were input into a fatality estimator model (Huso 2010) to provide a preliminary estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias. The estimate is considered preliminary because the annual report may pool information from bias trials and other data across seasons which could affect seasonal estimates.

Carcass persistence was influenced by carcass size. Small carcasses (0-100 g) had a 42.4% chance of persisting through the 7-day search interval, medium carcasses (101 – 999 g) had a 72.4% chance, and large carcasses (1000+ g) had an 84.5% chance. Mean removal time for small, medium, and large carcasses was 2.0, 7.3 and 14.6 days, respectively. In the solar field searcher efficiency was 92.3% over all carcass size classes. Along the gen-tie and distribution lines, searcher efficiency was influenced by carcass size: 42.9% for small birds, 100% for medium birds, and 100% for large birds.

Using the Huso (2010) fatality estimator model, during the spring period 2015, there were an estimated total 234 fatalities (90% confidence interval [CI]: 124 - 430) at the Project. Of these, 55 fatalities (23.4%) were estimated for the SCAs, 44 fatalities (18.6%) were estimated for the fence, 9 fatalities (4.0%) were estimated for evaporation ponds, 5 fatalities (2.2%) were estimated for power blocks, and 121 fatalities (51.8%; 90% CI: 32 - 307) were estimated for the gen-tie and distribution lines and project road. An estimated 113 (90% CI: 60 – 188) fatalities (0.065/acre, 0.434/nameplate MW) occurred for all components associated with both solar units (SCAs, power block, evaporation ponds, and along the perimeter fence, combined).

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Tracey Johnson	Research Biologist
Paul Rabie	Statistician
Andrea Polachek	Technical Editor
Tracey Johnson	Field Supervisor
Pamela Bullard	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2015. Post-construction monitoring at the Genesis Solar Energy Project, Riverside County, California. 2015 Spring Report. 26 pp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Project Background

The Genesis Solar Energy Project (referred to in this report as "Project") consists of two solar power electrical generating facilities (Units 1 and 2) with a combined net capacity of 250 megawatts. The Project facility consists collectively of two power blocks, power generating equipment (solar collector assemblies [SCAs] of mirrored parabolic troughs [solar troughs or troughs]), support facilities, and evaporation ponds. Linear facilities include a transmission line, distribution line, natural gas pipeline, and a main access road that are mostly co-located for approximately 10.5 km (6.5 miles). The Project comprises approximately 1,800 acres (728 hectares [ha]). The solar field and associated structures comprise 1,727 acres (699 ha) and linear facilities comprise 93 acres (38 ha). The Project is located on land managed by the Bureau of Land Management (BLM) 25 miles (40 kilometers [km]) west of Blythe, in Riverside County, California (Figure 1).

Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (2015; “BBCS”) was prepared by the Project proponent in collaboration with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), California Energy Commission (CEC), and Bureau of Land Management (BLM) to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency acceptance of the BBCS occurred in March 2015.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Genesis Solar in collaboration with the USFWS, CDFW, CEC, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with SCAs, overhead lines including the generation (gen-tie) line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near SCAs on the edge of the solar field versus the interior area of the solar field).
3. Provide information that will assist the CEC and BLM, in consultation with the USFWS and the CDFW, in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the CEC and BLM, in consultation with the USFWS and CDFW, may make comparisons with other solar sites.

Purpose of This Report

This report represents the first seasonal report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS and as required by CEC Condition of Certification BIO-16. This report covers the 2015 spring season, which includes the period from March 01 to May 31, 2015. As stated in the approved BBCS, this seasonal report includes the observed fatality rates broken out by likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and suspected causes of death. Species composition of carcasses and the results of the bias trials are also reported. This report presents information related to the spatial distribution of carcasses, but no formal statistical analysis will be conducted until the end of the monitoring year, given the limited data presently available.

[redacted]

Figure 1. Genesis Solar Energy Project vicinity map, Riverside County, California.

METHODS

The BBCS describes the methods by which monitoring and certain analyses, including compilation of the overall fatality estimate, will occur. Below is an abridged description (see BBCS for detailed methods).

Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. This section also describes the methods for conducting carcass removal and searcher efficiency trials; how data were reported and analyzed; and the methods for producing fatality estimates for the Project.

Areas Surveyed

Standardized carcass searches were conducted at a sample of the solar collector assemblies in each unit; the perimeter of each power block (including the area below each air condensed cooling [ACC] unit; Figures 2 and 3); the "fenceline" defined as the perimeter fences for each unit (100% of the total length of fence; Figures 2 and 3); and the gen-tie and distribution lines (25% of the total length of each line from the Project fence to Wiley's Well rest stop; Figure 4). Table 1 provides the total area of each component as well as the percent of each component that was searched.

To ensure a balanced distribution of plots in solar collector assemblies, each unit was divided into blocks, and each block was sampled using a systematic sample of 30% of pairs of rows with a random starting point. This sampling design ensures that survey plots were not spatially clumped.

Search Frequency and Timing

The spring survey season includes the period from March 01 through May 31, 2015. Standardized searches occurred at 7-day intervals beginning March 05, 2015. All project components included in standardized searches were surveyed 13 times.

The average spring search interval was 6.8 days (median 7 days) for all Project components included in standardized carcass searches. Slight variation in search interval was anticipated due to weather and logistical delays.

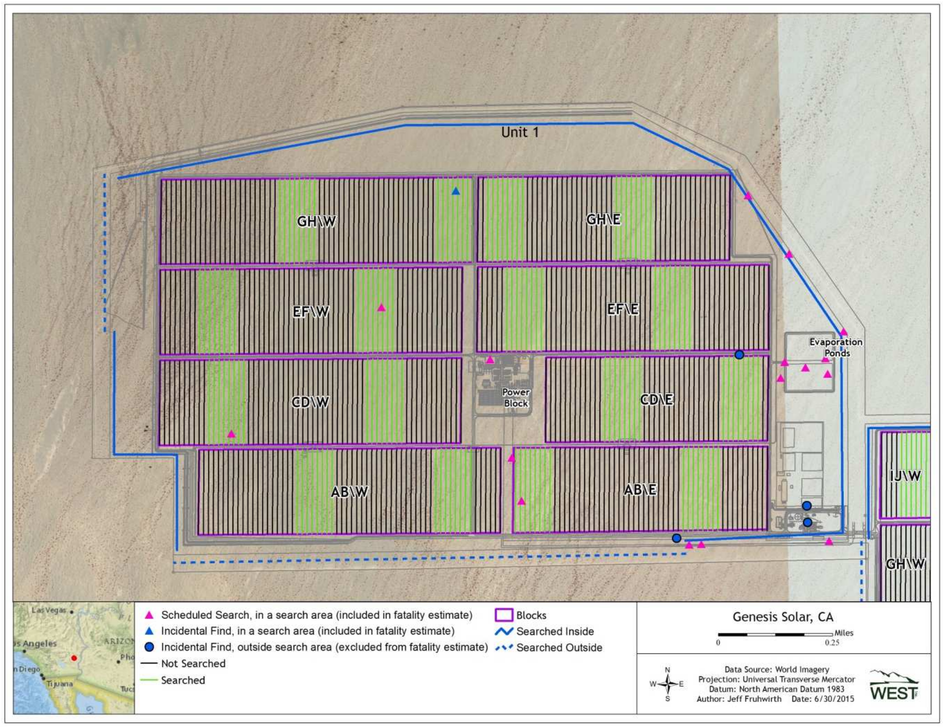


Figure 2. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at Unit 1 of the Genesis Solar Energy Project spring 2015.

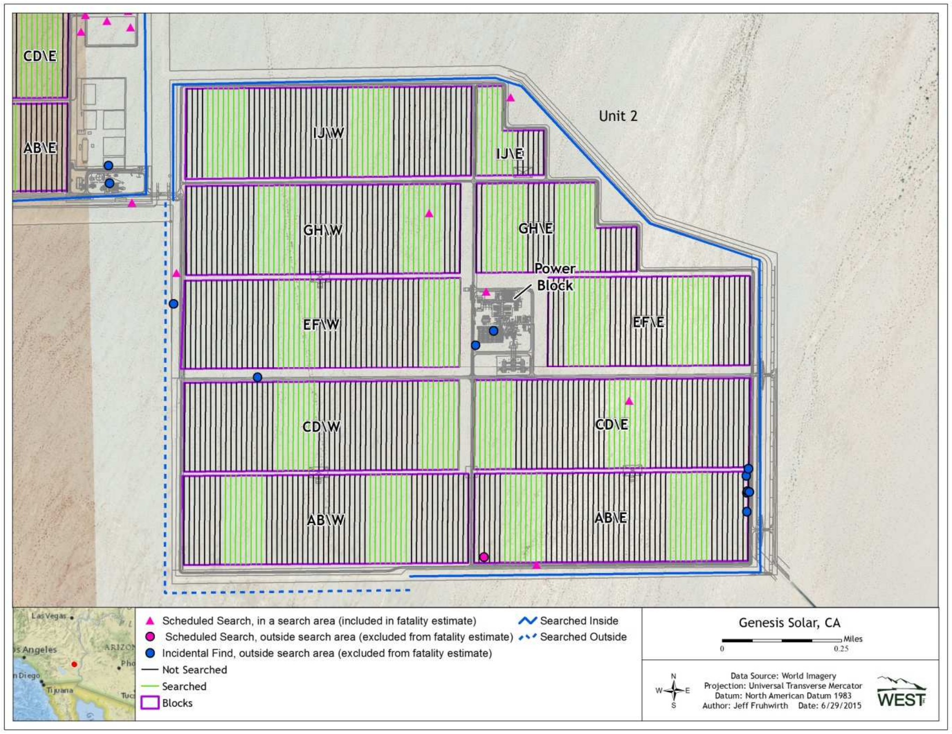


Figure 3. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at Unit 2 of the Genesis Solar Energy Project during spring 2015.

Table 1. Areas included in standardized carcass searches at the Genesis Solar Energy Project during spring 2015.

Project Component	**Total Size**	**Units**	**Percent of Component Searched**
SCAs	920	rows of solar troughs	30.4
Unit 1	460	rows of solar troughs	27.8
Unit 2	460	rows of solar troughs	33.0
ACC units	0.9	hectares	100
Power block (perimeter)	0.8	kilometers	100
Evaporation ponds	3.1	hectares	100
Distribution line	8.4	kilometers	25.0
Generation Tie line	8.4	kilometers	25.0
Fence	14.5	kilometers	100

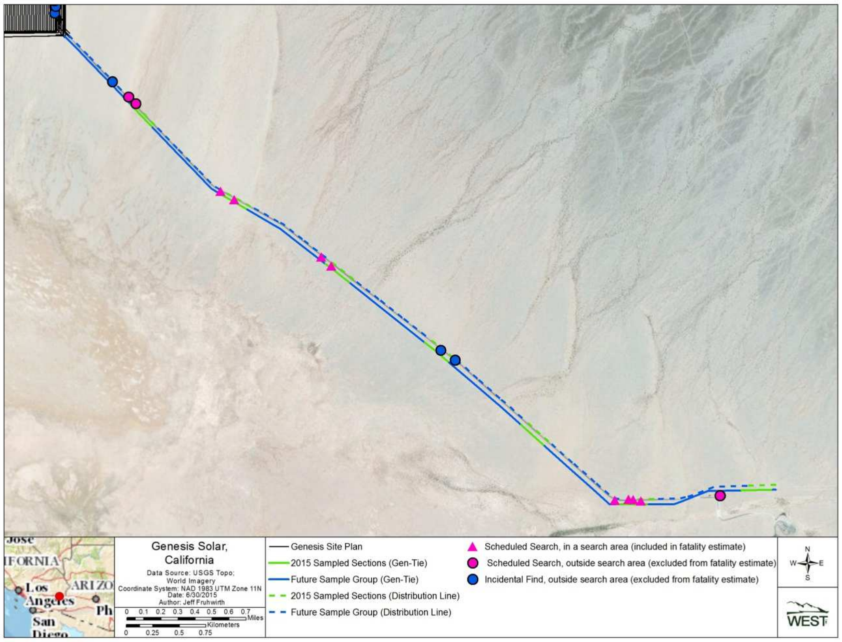


Figure 4. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance activities) along the distribution and generation tie lines and Project access road at the Genesis Solar Energy Project during spring 2015. Detailed maps of detections along both lines and the road are presented in Appendix C.

Search Methods

Standardized carcass searches were performed by CEC and BLM-approved biologists, in accordance with methods outlined in the BBCS.

Within the solar collector assemblies, 280 solar troughs (30.4% of the total number of troughs) were surveyed by vehicle. Biologists slowly drove (≤5 mph) parallel to troughs and centered between rows, searching ahead and to the driver's side of the vehicle for bird and bat carcasses. Biologists scanned out to a perpendicular distance of approximately 30 m, or the ground area encompassing two rows of solar troughs.

At each power block, biologists slowly walked around the entire perimeter looking for dead and injured birds and bats, and used binoculars to scan interior portions of the powerblock. Beneath ACC units, biologists walked four evenly-spaced transects through the gravel. The search area for the power block is defined as the 0.8 km of perimeter of each power block, and the area of the interior power block that was available for visual inspection from the periphery.

At each evaporation pond, biologists walked the entire perimeter looking for dead and injured birds and bats on the ground, in the netting, and in the pond below the netting. Binoculars or a spotting scope were used to scan across the top of the netting and the surface of each pond.

The entire length of fenceline (approximately 12 miles) was searched by vehicle. Biologists searched an approximately 1.5 to 2.5 miles (2.4 km) along drivable sections of the outside of the fence, and the remaining 9.5 to 10.5 miles (16.9 km) were surveyed from the inside of the fence (Figures 2 and 3). Travel speed was below five mph while searching.

The gen-tie and distribution lines were surveyed using a 15-m wide strip transect (i.e., 7.5 m of ground on either side of the overhead line). A 25% sample of both lines from the Project fence to the Project outer gate located near the Wiley's Well Road rest stop were searched for carcasses. Biologists slowly walked every fourth 300-ft segment of each line, scanning for dead or injured birds or bats within 7.5 m (24.6 ft) of the transect line. Given the location of the lines relative to the road, detections found in the strip transects below overhead lines could be caused by collision with an overhead line, vehicles along the road, or some combination of both.

Once a detection was made, suspected cause of death was assigned based on available evidence and proximity of a detection to Project infrastructure. Detections that had evidence of scavenging were assigned as “unknown” because it can’t be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However,~~m~~ it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed.

Carcass Persistence Trials

Carcass persistence trials were conducted throughout the spring period. Carcasses from three size classes (small [0-100 g], medium [101-999], and large [1000+ g]) were used for trials. The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), and the large size class comprised hen mallard (*Anas platyrhynchos*) and hen ring-necked pheasant (*Phasianus colchicus*).

Carcass Persistence Data Collection

To quantify carcass persistence rates, 15 small, 10 medium, and five large carcasses were randomly placed and monitored within the SCAs (including the fence line), and the same number of each size class were placed along the gen-tie and distribution lines, for a total of 60 carcass persistence trials at Genesis during the spring 2015 season. Fifteen carcasses within the Project fence (within SCAs and along the fence and perimeter of power blocks) and four carcasses along the gen-tie and distribution lines were monitored using motion-triggered digital trail cameras, while the remaining carcasses were visited on foot, for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality. Fewer carcasses along the gen-tie and distribution lines were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as “feeding stations”, trail cameras were installed five days before specimens were placed, and fake cameras without bias trial carcasses were also placed (eight within the Project fence, and four along the gen-tie and distribution lines). Periodic ground-based checking of carcasses with trail cameras also occured to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera’s field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire Project, not just in areas subject to standard searches, and trials were initiated in small numbers on four different dates throughout the spring season.

Estimating Carcass Persistence Times

Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g. days a carcass is present before being removed) may not be known exactly, but is known to be within a finite range. For example, suppose a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass was available to be found for between 7 and 10 days. This carcass would be considered “interval censored”. Similarly, if a carcass lasts the entire 30-day trial period, that carcass is “right censored”— it is known that the carcass lasted at least 30 days, but it may have persisted longer.

There were four distributions implemented in survival models used to estimate the probability a carcass is unscavenged and available to be found at the end of the search interval (*r)*: exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike’s Information Criterion adjusted for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model to observed carcass persistence data.

Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the spring period. Carcasses from three size classes (small, medium, and large) were used for trials. The small size class comprised house sparrows and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons, and the large size class comprised hen mallards and hen ring-necked pheasants.

Searcher Efficiency Data Collection

A total of 60 searcher efficiency trials (15 small birds, 10 medium birds, and five large birds within SCAs, power blocks, and along the perimeter fence, and the same number of each size class along the gen-tie and distribution lines) were placed at the Project during the 2015 spring season. Locations for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches. Trials were placed in various vegetation heights and in areas that had different soil and vegetation colors and values to represent the range of conditions under which searches occur. They were placed in all areas where standardized searches occur except the evaporation ponds.

Estimating Searcher Efficiency

There were not sufficient data for the spring season to assess whether searcher efficiency differed by Project component (e.g., SCAs/fence/power block [SCAs] versus gen-tie/distribution line [overhead lines]), so searcher efficiency was assumed to differ between the two areas and was estimated separately for SCAs and overhead lines. The nearly complete lack of vegetation cover in the SCAs suggests that searcher efficiency may be higher in the SCAs than along the gen-tie and distribution lines where vegetation cover is greater. If this hypothesis is true, accounting for this difference in searcher efficiency across Project components will be important for producing accurate fatality estimates at the end of the monitoring year.

To evaluate hypotheses regarding differences in carcass detectability among carcass size and visibility classes, logistic regression models were fit to searcher efficiency data and AICc was used to compare models. Models including effects of carcass size (3 classes) and visibility index (2 classes) were compared to each other and the null model. The two visibility classes present at the Project site are: easy (defined as ≥ 90% bare ground [BG]; vegetation <6" tall) and moderate (defined as 26-89% BG; vegetation <6" tall). However, within the SCAs the moderate visibility class has a very limited spatial extent due to management aimed at minimizing vegetation cover and thus, was represented by only two trial carcasses during the reporting period. Rather than eliminating the two carcasses in the moderate class from the analysis of searcher efficiency, we assumed there were no differences in searcher efficiency between the two visibility classes in the SCAs this spring, and the set of candidate models for searcher efficiency (within the SCAs only) did not include tests of the hypothesis that searcher efficiency varied between visibility classes. Future analyses of searcher efficiency trials in the SCAs may include tests of the effect of visibility class, once sample size has sufficiently increased.

Comentado [FWS1]: What sample size is adequate for an estimate? This should be calculated seasonally, not in the aggregate.

Once the best model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, *p,* was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from the spring 2015 season.

Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots are also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie and distribution lines versus cleared areas beneath SCAs). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where *F* is the total number of fatalities, *C* is the number fatalities detected and included in fatality estimation*, r* is the probability a carcass is unscavenged and available to be found at the end of the search interval, and *p* is the probability of detecting a carcass (Huso 2010).

All fatality estimates were calculated using the Huso estimator, as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates were used. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by WEST avian biologists and operational personnel and were considered “incidental” detections. When found by operational personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the SPUT Avian Injury and Mortality Report Forms March – May 2015. All detections made in search areas were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

MONITORING RESULTS

Summary of Avian Detections

During spring 2015, a total of 53 avian detections (including stranded birds and incidentals) of 23 identified species were recorded (Table 2). The most numerous detection of an identified species was Wilson's warbler (*Cardellina pusilla*), but with only three detections. Most detections (n = 22, or 41.5% of total detections) occurred beneath overhead lines (Figures 2, 3, and 4; Tables 2, 3, and 4), but those detections along the gen-tie and distribution lines are co-located with the road. Thirty-five (66.0%) detections were made during standardized carcass searches and 18 (34.0%) were documented as incidentals.

Table 2. Number of individual bird detections, by species, during spring 2015 at the Genesis Solar Energy Project, Riverside County, California.

Common Name	Scientific Name	Migration Behavior*	Guild	Count	Project Component
American kestrel	*Falco sparverius*	resident	falcons	1	Powerblock
barn owl	*Tyto alba*	unresolved	owls	1	Fence
Brewer's blackbird	*Euphagus cyanocephalus*	diurnal	blackbirds/ orioles	1	Overhead lines/Road
Brewer's sparrow	*Spizella breweri*	nocturnal	grassland/ sparrows	2	Overhead lines SCA
bufflehead	*Bucephala albeola*	nocturnal	waterbirds/ waterfowl	1	Storage units
common loon	*Gavia immer*	diurnal	waterbirds/ waterfowl	2	SCA
Eurasian collared-dove	*Streptopelia decaocto*	resident	doves/pigeons	1	Powerblock
European starling	*Sturnus vulgaris*	variable	blackbirds/ orioles	1	Powerblock

Table 2. Number of individual bird detections, by species, during spring 2015 at the Genesis Solar Energy Project, Riverside County, California.

Common Name	**Scientific Name**	**Migration Behavior***	**Guild**	**Count**	**Project Component**
great-tailed grackle	*Quiscalus mexicanus*	resident	blackbirds/ orioles	1	Water Treatment Plant
killdeer	*Charadrius vociferus*	variable	shorebirds	1	Evaporation pond
lazuli bunting	*Passerina amoena*	nocturnal	tanagers	2	Overhead lines
lesser goldfinch	*Spinus psaltria*	resident	finches/ crossbills	1	Evaporation pond
mallard	*Anas platyrhynchos*	variable	waterbirds/ waterfowl	1	Fence
mourning dove	*Zenaida macroura*	variable	doves/pigeons	2	Overhead lines
Nashville warbler	*Oreothlypis ruficapilla*	nocturnal	warblers	2	Overhead lines
orange-crowned warbler	*Oreothlypis celata*	nocturnal	warblers	1	Overhead lines

Table 2. Number of individual bird detections, by species, during spring 2015 at the Genesis Solar Energy Project, Riverside County, California.

Common Name	Scientific Name	Migration Behavior*	Guild	Count	Project Component
prairie falcon	*Falco mexicanus*	resident	falcons	1	Overhead lines/Road
Savannah sparrow	*Passerculus sandwichensis*	nocturnal	grassland/ sparrows	1	SCA
Townsend's warbler	*Setophaga townsendi*	unresolved	warblers	2	Overhead lines SCA
unidentified bird (medium)	–	unknown	unidentified birds	1	Evaporation pond
unidentified bird (small)	–	unknown	unidentified birds	1	SCA
unidentified bird (unknown size)	–	unknown	unidentified birds	13	Fence (7) Overhead lines (3) Evaporation pond (1) Powerblock (1) SCA (1)

Table 2. Number of individual bird detections, by species, during spring 2015 at the Genesis Solar Energy Project, Riverside County, California.

Common Name	Scientific Name	Migration Behavior*	Guild	Count	Project Component
unidentified merganser	*Mergus spp.*	unknown	waterbirds/ waterfowl	1	Evaporation pond
unidentified passerine	–	unknown	passerines	1	Overhead lines
unidentified sandpiper	–	unknown	shorebirds	1	Evaporation pond
unidentified sparrow	–	unknown	grassland/ sparrows	1	Overhead lines
unidentified warbler	–	unknown	warblers	1	Overhead lines/Road
western tanager	*Piranga ludoviciana*	nocturnal	tanagers	2	Overhead lines
western wood-pewee	*Contopus sordidulus*	nocturnal	flycatchers	1	SCA
Wilson's warbler	*Cardellina pusilla*	nocturnal	warblers	3	Overhead lines
yellow warbler	*Setophaga petechia*	nocturnal	warblers	2	Fence

Table 2. Number of individual bird detections, by species, during spring 2015 at the Genesis Solar Energy Project, Riverside County, California.

Common Name	Scientific Name	Migration Behavior*	Guild	Count	Project Component
Total				**53**	

* See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in Birds of North America (BNA) Online (http://bna.birds.cornell.edu/bna/); where information on migration behavior was lacking in BNA accounts, Newton (2008) or Murray (2004) were used.

Temporal Patterns of Avian Detections

The number of detections recorded daily during spring 2015 ranged from zero to seven (Figure 5). The period from March 22 to May 17 was characterized by peaks in detections with a high on April 24. This event was reported to agencies per Special Purpose Utilities Permit Condition H(c). There was less variation in the number of detections per day after April 24. The number of detections per day represents those discovered during standardized carcass searches and incidentally.

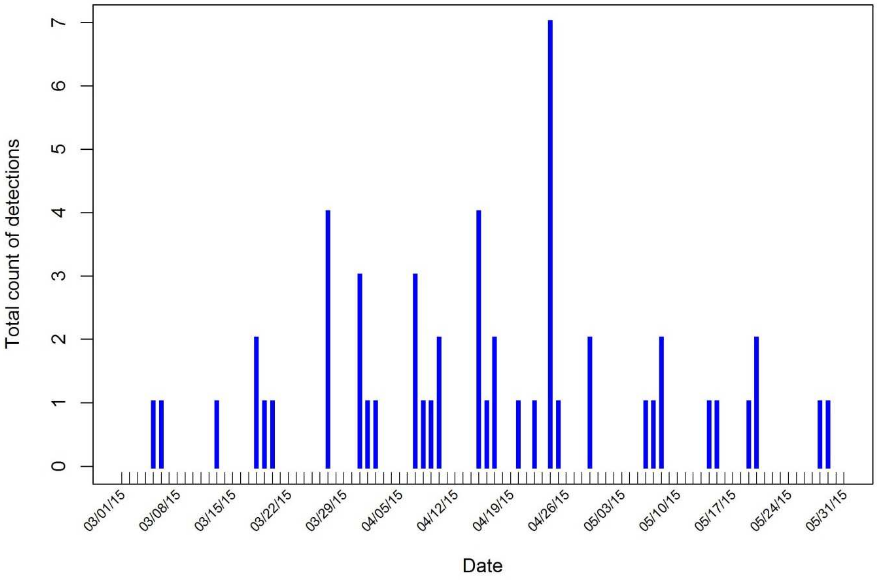


Figure 5. Total number of detections by date during spring 2015 at the Genesis Solar Energy Project, Riverside County, California.

Spatial Distribution of Avian Detections

Detections by Project Component

During spring 2015, detections were documented from the SCAs, power block or ACC unit within the power block, evaporation ponds, perimeter fence, gen-tie and distribution lines, road, water treatment plant, and storage units (Tables 2, 3, and 4). Of the 39 detections within the solar units 22 (56.4%) were detected in Unit 1, and 17 (43.6%) in Unit 2.

Table 3. Total avian detections by Project component and detection category during spring 2015 at the Genesis Solar Energy Project, Riverside County, California.

Project Component	Carcass search	Incidental	Percent of Total
Fence	10	1	20.8
Overhead lines/road	11	11	41.5
Pond	6	0	11.3
Powerblock	2	2	7.5
SCA	6	2	15.1
Storage Units	0	1	1.9
Water Treatment Plant	0	1	1.9
Percent of Total	66.0	34.0	100.0

Table 4. Total avian detections (including incidentals) by Project component and suspected cause of death during spring 2015 at the Genesis Solar Energy Project, Riverside County, California.

	Suspected Cause of Death*					
Project Component	**Collision**	**Drowned**	**Entangled**	**Predation**	**Unknown**	**Percent of Total**
Fence	2	0	0	0	9	20.8
Other	0	0	0	0	2	3.8
Overhead lines/road	14	0	0	1	7	41.5
Pond	2	0	2	0	2	11.3
Powerblock	2	2	0	0	0	7.5
SCA	2	0	0	0	6	15.1
Percent of Total	41.5	3.8	3.8	1.9	49.1	100.0

* Suspected cause of death was assigned based on available evidence and proximity of detection to Project infrastructure. Detections that had evidence of scavenging were assigned as “unknown” because it can’t be

determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainy associated with cause of death assignments because no events were directly observed.

Comentado [FWS2]: This blanket categorization is problematic. Other visual evidence may allow determination of a suspected cause of death despite evidence of scavenging (i.e., smudge on mirror). The presence of some scavenging should lead to an automatic categorization. Small levels of scavenging can be easily distinguished as not the cause of death (i.e., arthropod scavenging and minimal raven scavenging). Also, other indicators of the cause of mortality should also be considered (dust smudges, species identification, etc). This should not be a blanket categorization.

Feather Spot Detections

Seventeen (32.1%) of the 53 detections consisted only of feather spots. Along the fence, nine detections (81.8%) were feather spots. Six detections (27.3%) along gen-tie and distribution lines and road were feather spots. One detection (16.7%) at the evaporation ponds and one detaction (12.5%) at the SCAs were feather spots. None of the detections at power blocks were feather spots.

Detections of Stranded Birds

Comentado [FWS3]: Who detected the stranded birds?

Two birds were detected during the reporting period that were alive and uninjured but unable to take flight. A common loon was discovered on March 31 beneath the SCAs on the east side of Unit 1 near the evaporation ponds. A second common loon was detected on April 20 beneath the SCAs on the west side of Unit 1, north of the power block. Both of these birds were examined for injuries and when none were observed, were successfully released at Lake Tamarisk. Both individuals are included in this report (including the fatality analysis) as detections, resulting in a conservative estimate of fatalities.

Comentado [FWS4]: This is a good practice, since survival from the stranding is not guaranteed, even when the birds are released successfully.

Summary of Bat Detections

No bats were detected during the spring 2015 season.

Carcass Persistence Trials

Based on carcass persistence data from the spring 2015 season, 64 survival models were compared for relative quality using the corrected AICc score, as suggested in Huso (2010). The AICc score provides a relative measure of model fit and parsimony among a selection of candidate models. Carcass size is a potentially important variable, as larger carcasses tend to persist longer and may be more likely to leave feather spots which persist for long durations, whereas smaller carcasses may be more likely to be completely removed.

The model with lowest AICc is typically chosen as the "best" model relative to other models tested; however, any model within two AICc points of the best model is considered competitive with the best model (Burnham and Anderson 2004). The top six models had ΔAICc values <2. Ultimately, the loglogistic model that included an effect of carcass size was chosen as the most parsimonious of the top models. The chosen model predicted that 42.4% of small carcasses, 72.4% of medium carcasses, and 84.5% of large carcasses persisted for a standard 7-day search interval. Mean removal time for small carcasses was 2.0 days, for medium carcasses was 7.3 days, and for large carcasses was 14.6 days.

Searcher Efficiency Trials

During the 2015 spring season, a total of 60 searcher efficiency trials (30 small, 20 medium, and 10 large birds) were placed at the Project. Overall, 19 trials were placed in the SCAs, eight trials were placed along perimeter fences (inner and outer perimeters), and three trials were placed at power blocks (along perimeter and beneath ACC units). Thirteen trials were placed along the gen-tie and 17 were placed along the distribution lines. Fifty-five trials were available to be found, and five trials disappeared before the searcher efficiency trial began (two in the SCAs, two along the fence, and one along the gen-tie line).

In the SCAs, the null model was chosen as the best model to estimate searcher efficiency. Searcher efficiency rate in the SCAs was 92.3% (24 found of 26 available to be found) and was similar across carcass size classes. Along overhead lines searcher effiency was 42.9% for small birds, 100% for medium birds, and 100% for large birds (21 found of 29 available to be found).

Fatality Estimates

Fatality estimates were calculated separately for each component (SCAs, power blocks, fence, evaporation ponds, and overhead lines/road). Ultimately, one detection was excluded from the analysis because it was estimated to be older than the 7-day search interval (Huso 2010), and five detections were excluded because they were found outside standardized search areas. Only one of the 18

Comentado [FWS5]: Are these included in carcass summary? Excluded birds should still be included in the report. Also, age of a carcass can be quite subjective, so if there is any doubt or the age is uncertain, the carcass should be included in the analysis. This is particularly true when the search interval is longer and the weather conditions are hot and dry.

detections that were found incidentally was in a standardized search area, so 17 incidental detections were excluded from the fatality analysis.

During spring 2015, there were an estimated total 234 fatalities (90% confidence interval [CI]: 124 – 430) at the Project. Of these, 55 fatalities (23.4%) were estimated for the SCAs, 44 fatalities (18.6%) were estimated for the fence, 9 fatalities (4.0%) were estimated for evaporation ponds, 5 fatalities (2.2%) were estimated for power blocks, and 121 fatalities (51.8%; 90% CI: 32 - 307) were estimated for the gen-tie and distribution lines and project road. An estimated 113 (90% CI: 60 – 188) fatalities (0.065/acre, 0.434/MW) occurred for all components associated with each solar unit (SCAs, power block, evaporation ponds, and along the perimeter fence, combined). A complete list of estimates for each Project component and carcass size class with confidence intervals is presented in Appendix B.

DISCUSSION

The 2015 spring season represented the first season of standardized monitoring at Genesis per the BBCS. Searcher efficiency trials and carcass removal trials were conducted concurrently at the SCAs, power blocks, fencelines, and along the gen-tie and distribution lines. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. Although these estimates were produced from a statistically robust sample, only limited inference may be drawn from a single season of data. These results should be considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. As more data are collected throughout the monitoring year (and additional quality assurance/quality control measures occur, for example characterizing feather spots to species or size class), data from all seasons may be pooled. At that time, data will be tested for seasonal differences retrospectively, but because seasonal estimates will be produced from the much larger annual data set, they may differ from what is reported here because they are based on a larger, more informative sample.

Comentado [FWS6]: This is counter-intuitive. If there are inadequate samples to give a seasonal estimate for searcher efficiency, how will this be possible from the complete annual dataset. The number of carcasses should probably be increased based on a power analysis, so that seasonal estimates can be completed.

Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Thus, rates of carcass persistence reported here should be interpreted cautiously as they may change over the coming months.

Searcher efficiency was influenced by carcass size, but it is not yet clear if there may be an effect of habitat visibility class due to limited sample sizes. In the SCAs, searcher efficiency was high regardless of carcass size and this is likely influenced by the limited vegetation cover beneath solar troughs. Beneath overhead lines outside the Project fence vegetation cover is higher, but our analysis did not support the hypothesis that visibility class is a factor in searcher efficiency along the lines. Carcass size influenced searcher efficiency, but was relatively high over all carcass size classes (72.4%).

Searcher efficiency trials for this Project will be repeated seasonally. The desert landscape in which this Project is located generally changes little with the seasons, save for brief periods following winter and spring rains when floods may occur and blooming plants may flourish. A recent meta-analysis involving data from more than 70 wind-energy projects suggested that including habitat visibility class as a predictive variable generally eliminated any otherwise apparent seasonal effects on searcher efficiency (Smallwood 2013). Further, the possibility exists that searcher efficiency varies seasonally in some cover types but not others. Data from searcher efficiency trials conducted over the coming seasons will therefore continue to be tested for effects of habitat visibility class rather than effects of season.

Distribution of Fatalities and Fatality Estimates

The number of detections was highest during the middle of the spring monitoring period, and decreased at the end of May. The peak in number of detections on April 24 may have been influenced by weather conditions the preceding night. Winds were recorded from the southwest ranging from 20-30 mph from approximately 2000 hrs on April 23 to 1600 hrs on April 24, and were associated with changing cloud cover (Weather Underground, Blythe, CA).

Detections attributed to an unknown cause accounted for approximately 50% of all detections during the 2015 spring season, and the distribution of the unknown cause detections varied by project component with 81.8% occurring in association with the perimeter fence. Of the 11 detections made along the fence, 81.8% were feather spots. Determining a cause of mortality from a feather spot is challenging because there is rarely visible evidence available on which to determine a cause of death. Thus, feather spots with an unknown cause of mortality could be encountered anywhere birds occur, and an unknown cause of a sizeable proportion of the carcasses is not unique to the Project. Further, the large proportion of feather spots (32%) among the detections for the Project as a whole may inflate the fatality estimate when unknown cause detections are included based on the potential for multiple feather spots resulting from one fatality, feather spots resulting from predation not associated with the facility, or other causes.

Comentado [FWS7]: I don't agree with this statement. This is unknown. Feather spots may be more mobile, but as far as I know there have been no studies on whether they "multiply" and cause bias. If there has, please provide a reference. It is possible that feather spots could accumulate along fences, but in general, they are just as likely to migrate into a survey area as they are to leave. If this is a significant problem, then I recommend shorter search intervals and more complete coverage of the project site.

LITERATURE CITED

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in 2nd International Symposium on Information Theory (B. N. Petran and F. Csaki, Eds.). Akademiai Kiado, Budapest, Hungary.

Ammon, Elisabeth M. and William M. Gilbert. 1999. Wilson's Warbler (*Cardellina pusilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/478

Burnham, K.P., and D.R. Anderson. 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociological Methods & Research 33: 261-304.

Cabe, Paul R. 1993. European Starling (*Sturnus vulgaris*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/048 doi:10.2173/bna.48

Evers, David C., James D. Paruk, Judith W. Mcintyre and Jack F. Barr. 2010. Common Loon (*Gavia immer*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/313 doi:10.2173/bna.313

Gauthier, Gilles. 2014. Bufflehead (*Bucephala albeola*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/067 doi:10.2173/bna.67

Gilbert, W. M., M. K. Sogge and C. Van Riper III. 2010. Orange-crowned Warbler (*Oreothlypis celata*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/101 doi:10.2173/bna.101

Greene, Erick, Vincent R. Muehter and William Davison. 2014. Lazuli Bunting (*Passerina amoena*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/232 doi:10.2173/bna.232

Jackson, Bette J. and Jerome A. Jackson. 2000. Killdeer (*Charadrius vociferus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/517 doi:10.2173/bna.517

Johnson, Kristine and Brian D. Peer. 2001. Great-tailed Grackle (*Quiscalus mexicanus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/576 doi:10.2173/bna.576

Hudon, Jocelyn. 1999. Western Tanager (*Piranga ludoviciana*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/432 doi:10.2173/bna.432

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. doi: 10.1002/env.1052

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A New Method to Determine Bird and Bat Fatality at Wind Energy Turbines from Carcass Searches. Wildlife Biology 17: 350-363.

Lowther, P. E., C. Celada, N. K. Klein, C. C. Rimmer and D. A. Spector. 1999. Yellow Warbler (*Setophaga petechia*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/454 doi:10.2173/bna.454

Lowther, Peter E. and Janet McI. Williams. 2011. Nashville Warbler (*Oreothlypis ruficapilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/205 doi:10.2173/bna.205

Manly, B.F.J.1997. Randomization, Bootstrap and Monte Carlo Methods in Biology. Second Edition. CRC Press, LLC, Boca Raton, FL., 455 pp.

Marti, Carl D., Alan F. Poole and L. R. Bevier. 2005. Barn Owl (*Tyto alba*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/001 doi:10.2173/bna.1

Martin, Stephen G. 2002. Brewer's Blackbird (*Euphagus cyanocephalus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/616 doi:10.2173/bna.616

Murray, J. 2004. Nocturnal flight call analysis as a method for monitoring density and species composition of migratory songbirds (Order Passeriformes) across southern Vancouver Island, British Columbia in 2004. Rocky Point Bird Observatory, 16 pp.

Newton, I. 2008. The Migration Ecology of Birds. Academic Press, London.

Otis, David L., John H. Schulz, David Miller, R. E. Mirarchi and T. S. Baskett. 2008. Mourning Dove (*Zenaida macroura*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/117 doi:10.2173/bna.117

Romagosa, Christina Margarita. 2012. Eurasian Collared-Dove (*Streptopelia decaocto*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/630 doi:10.2173/bna.630

Rotenberry, J. T., M. A. Patten and K. L. Preston. 1999. Brewer's Sparrow (*Spizella breweri*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/390 doi:10.2173/bna.390

Smallwood, John A. and David M. Bird. 2002. American Kestrel (*Falco sparverius*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/602 doi:10.2173/bna.602

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine-cause avian fatality estimates. Journal of Wildlife Management 74(5): 1089-1096.

Smallwood, K. S. 2013. Comparing bird and bat ratality-rate Estimates among North American wind-energy projects. Wildlife Society Bulletin 37(1): 19-33.

Steenhof, Karen. 2013. Prairie Falcon (*Falco mexicanus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/346 doi:10.2173/bna.346

Watt, Doris J. and Ernest J. Willoughby. 2014. Lesser Goldfinch (*Spinus psaltria*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/392 doi:10.2173/bna.392

Wheelwright, N. T. and J. D. Rising. 2008. Savannah Sparrow (*Passerculus sandwichensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/045 doi:10.2173/bna.45

Appendix A. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during spring 2015

Table A-1. Weather conditions and body weights associated with avian detections estimated to be less than 24 hours old during spring 2015 at Genesis Solar Energy Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hrs)	Species	Weight (g)	Weather Summary for Preceding 24 hrs
041515-NAWA-GENTIE-12-4	4/15/2015	8-24	Nashville warbler	-	VERY WINDY YESTERDAY EVENING AND THIS MORNING
041515-UNBI-GENTIE-24-1	4/15/2015	0-8	mourning dove	-	NA
040815-NAWA-GENTIE-12-1	4/8/2015	8-24	Nashville warbler	-	WINDY OVERNIGHT-THIS MORNING, CLEAR SKIES
042415-WETA-GENTIE-20-1	4/24/2015	8-24	western tanager	-	WINDY OVERNIGHT (TOO FRESH TO BE RELATED TO THE TORNADOS)
042415-LAZB-GENTIE-20-2	4/24/2015	8-24	lazuli bunting	8	WINDY OVERNIGHT (TOO FRESH TO BE TORNADO RELATED)
042415-TOWA-GENTIE-21-3	4/24/2015	8-24	Townsend's warbler	-	WINDY OVERNIGHT (TOO FRESH TO BE RELATED TO THE TORNADO)
042415-UNWA-GENTIE-20-4	4/24/2015	8-24	unidentified passerine	-	WINDY OVERNIGHT (SEEMS TO FRESH TO BE A RESULT OF THE TORNADO)
042415-WIWA-GENTIE-20-5	4/24/2015	8-24	Wilson's warbler	-	WINDY OVERNIGHT (TOO FRESH TO BE TORNADO RELATED)
042415-WIWA-GENTIE-20-6	4/24/2015	8-24	Wilson's warbler	-	WINDY OVERNIGHT (TOO FRESH TO BE TORNADO RELATED)
042415-LAZB-GENTIE-5-8	4/25/2015	8-24	lazuli bunting	-	WINDY OVERNIGHT (TOO FRESH TO BE TORNADO RELATED)

042915-BRBL-GENTIELINES-1	4/29/2015	8-24	Brewer's blackbird	65	NA
060315-MODO-GENTIE24-1	3/6/2015	0-8	mourning dove	-	HIGH- 75F; LOW-48F; WIND 16MPH; NO RAIN
031915-PRFA-GENTIE23-1	3/19/2015	8-24	prairie falcon	-	SPRINKLES. OVERCAST OVERNIGHT THRU 0900
050615-WETA-GENTIETOWER-38-1	5/6/2015	0-8	western tanager	20	RELATIVELY CALM WINDS, COOLER TEMPS FROM PRECEEDING WEEK
050815-YEWA-1-FENCE-E-INSIDE-1	5/8/2015	8-24	yellow warbler	9	WEATHER FRONT MOVED THROUGH, VERY WINDY, GUSTS UP TO 30MPH, FROM YESTERDAY AFTERNOON THROUGH LATE EVENING. COOLER TEMPS LAST SEVERAL DAYS
050815-YEWA-2-FENCE-W-OUTSIDE-2	5/8/2015	8-24	yellow warbler	9	WEATHER FRONT PASSING THROUGH, VERTY WINDY YESTERDAY AFTERNOON THROUGH THE LATE EVENING-GUSTS OF 30MPH
051515-UNWA-GENTIE-01	5/15/2015	0-8	unidentified warbler	11	WINDS GREATER THEN 30MPH PREVIOUS AFTERNOON/EVENING. A FRONT IS MOVING THROUGH THE AREA
052015-WIWA-GENTIE-08-1	5/20/2015	0-8	Wilson's warbler	6	CLEAR OVERNIGHT, CLOUDS MOVING IN THIS MORNING

Appendix B. Correction Factors and Bird Fatality Rates at the Genesis Solar Energy Project during spring of 2015.

Table B-1. Correction factors and estimated numbers of carcasses at the Genesis Solar Energy Generation Facility during spring of 2015. *Counts of fatalities on the power block and ponds have no variance because all components at the facility were searched. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Search Area Adjustment								
Overhead lines	0.25	-	0.25	-	0.25	-	0.25	-
Fence	0.5	-	0.5	-	0.5	-	0.5	-
SCAs	0.30	-	0.30	-	0.30	-	0.30	-
Powerblock	1.00	-	1.00	-	1.00	-	1.00	-
Ponds	1.00	-	1.00	-	1.00	-	1.00	-
Observer Detection Rate								
Overhead lines	0.43	0.21 - 0.64	1.00	-	1.00	-	0.43	0.21 - 0.64
Fence	0.92	0.85 - 1	0.92	0.85 - 1	0.92	0.85 - 1	0.92	0.85 - 1
SCAs	0.92	0.85 - 1	0.92	0.85 - 1	0.92	0.85 - 1	0.92	0.85 - 1
Powerblock	0.92	0.85 - 1	0.92	0.85 - 1	0.92	0.85 - 1	0.92	0.85 - 1
Ponds	0.92	0.85 - 1	0.92	0.85 - 1	0.92	0.85 - 1	0.92	0.85 - 1
Average probability of carcass persistence to the next search								
All Areas	0.42	0.33 - 0.51	0.72	0.57 - 0.87	0.84	0.65 - 0.95	0.42	0.33 - 0.51
Observed Fatality Rates (Fatalities /Season)								
Overhead lines	4	1 - 7	2	0 - 6	0	-	1	0 - 3
Fence	1	0 - 3	0	-	1	0 - 3	7	2 - 13
SCAs	5	2 - 9	0	-	1	0 - 3	1	0 - 3

Table B-1. Correction factors and estimated numbers of carcasses at the Genesis Solar Energy Generation Facility during spring of 2015. *Counts of fatalities on the power block and ponds have no variance because all components at the facility were searched. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Powerblock*	1	-	0	-	0	-	1	-
Ponds*	0	-	2	-	1	-	2	-
Average Probability of Carcass Availability and Detected								
Overhead lines	0.18	0.09 - 0.29	0.72	0.57 - 0.87	0.84	0.65 - 0.95	0.18	0.09 - 0.29
Fence	0.39	0.3 - 0.48	0.67	0.51 - 0.81	0.78	0.6 - 0.9	0.39	0.3 - 0.48
SCAs	0.39	0.3 - 0.48	0.67	0.51 - 0.81	0.78	0.6 - 0.9	0.39	0.3 - 0.48
Powerblock	0.39	0.3 - 0.48	0.67	0.51 - 0.81	0.78	0.6 - 0.9	0.39	0.3 - 0.48
Ponds	0.39	0.3 - 0.48	0.67	0.51 - 0.81	0.78	0.6 - 0.9	0.39	0.3 - 0.48
Adjusted Fatality Estimates (Fatalities /Season)**								
Overhead lines	88.1	22.5 - 223.1	11.0	(2) - 31.14	0.0	-	22.0	(1) - 80.59
Fence	5.1	(1) - 14.06	0.0	-	2.6	(1) - 7.28	35.8	10.23 - 72.04
SCAs	42.0	15.65 – 77.98	0.0	-	4.2	(1) – 13.21	8.4	(1) - 24.01
Powerblock	2.6	2.07 - 3.34	0.0	-	0.0	-	2.6	2.07 - 3.34
Ponds	0.0	-	3.0	2.47 - 3.93	1.3	1.11 - 1.67	5.1	4.13 - 6.68

Appendix C. Detailed Areas of Standardized Searches and Carcass Locations along the Distribution and Generation Tie Lines of the Genesis Solar Energy Project during spring 2015.

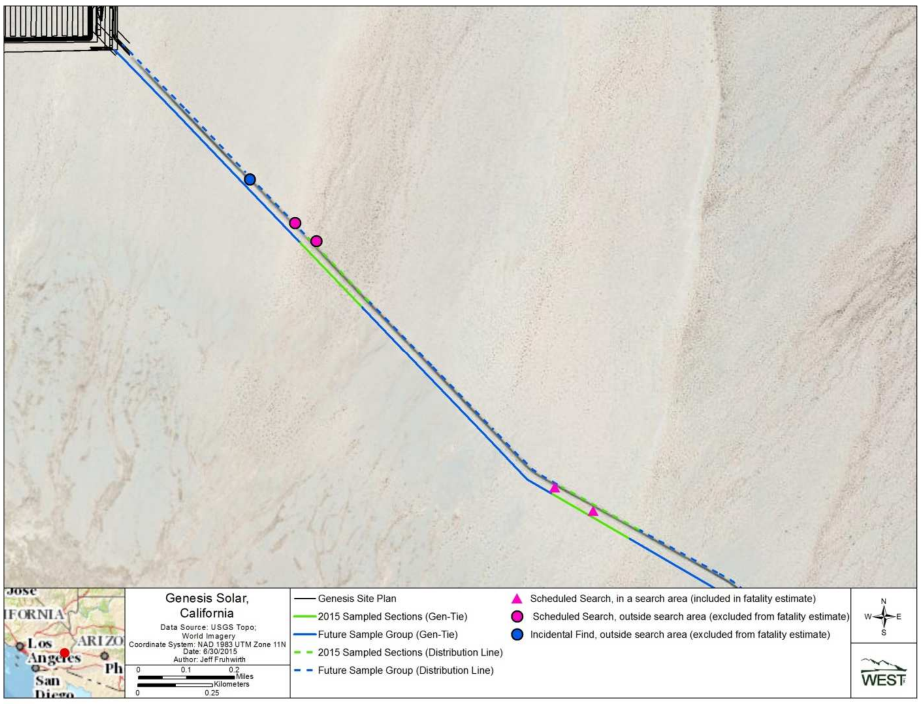


Figure C-1. Areas of standardized searches and carcass locations along two searched sections of the distribution and generation tie lines of the Genesis Solar Energy Project during spring 2015.

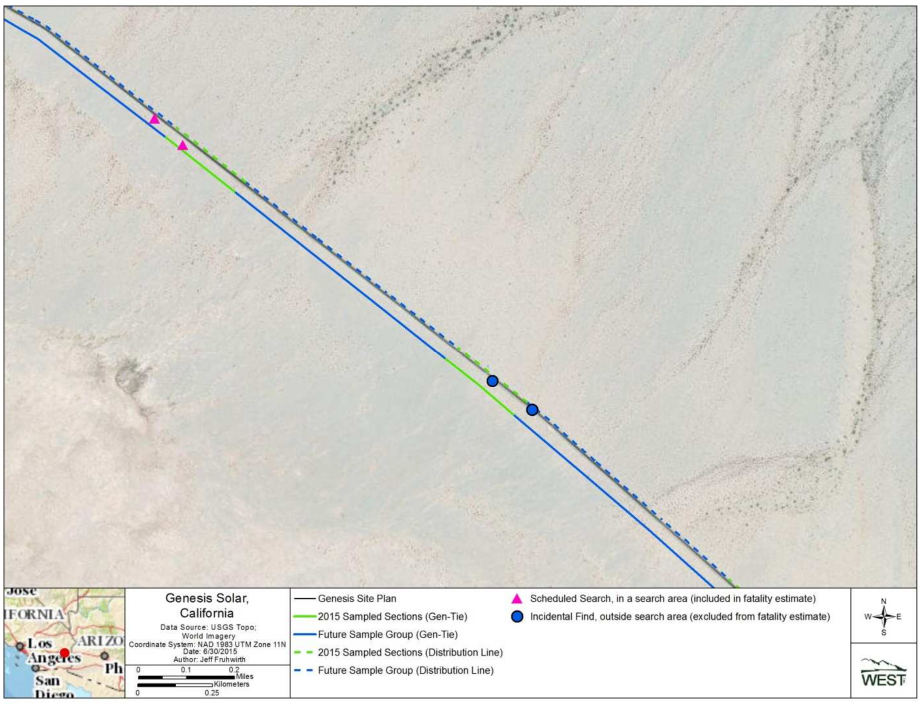


Figure C-2. Areas of standardized searches and carcass locations along two searched sections of the distribution and generation tie lines of the Genesis Solar Energy Project during spring 2015.

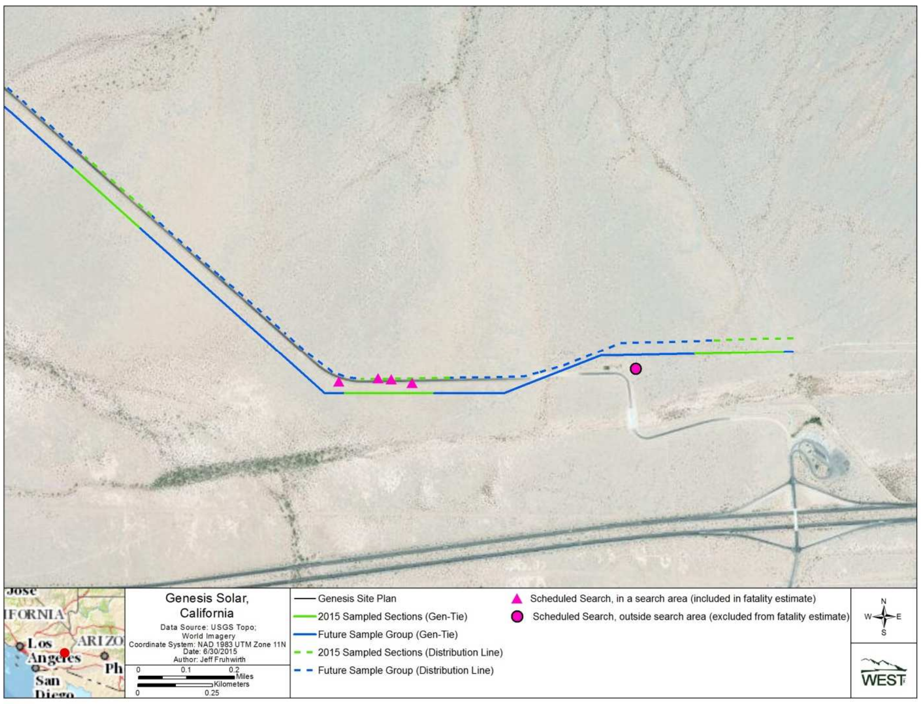


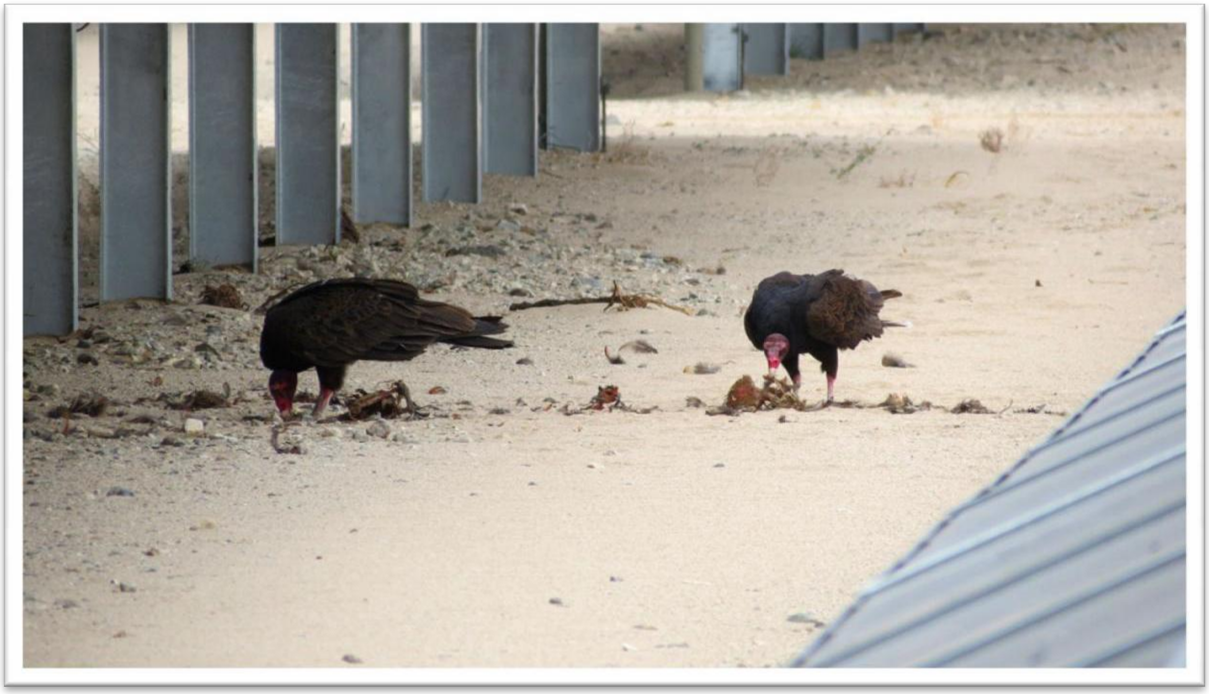
Figure C-3. Areas of standardized searches and carcass locations along three searched sections of the distribution and generation tie lines of the Genesis Solar Energy Project during spring 2015.

Desert Sunlight Carcass Persistence Trials

Round 1 through 4 Methodology and Results:

May 7th 2014 – May 18th 2015

FINAL REPORT



PREPARED FOR:

Desert Sunlight Holdings, LLC

111 Broadway Street, 4th Floor
Oakland, California 94607

PREPARED BY:

Corvus Ecological Consulting, LLC

7810 N. Highway 89
Suite 270
Flagstaff AZ 86004

CORVUS
ECOLOGICAL CONSULTING

Contents

List of Figures

List of Tables

Study Participants

Name	Affiliation	Position
Brooks Hart	Corvus Ecological Consulting	Project Manager & PI
Marguerite Hendrie	Corvus Ecological Consulting	Statistician/ GIS Specialist/ Data Management
Erin Lockward	Corvus Ecological Consulting	Field Technician
Brian Sandstrom	Ironwood Consulting	Field Technician
Kelsi Black	Ironwood Consulting	Field Technician
Lehong Chow	Ironwood Consulting	Field Technician
Paul Flores	Ironwood Consulting	Field Technician

CORVUS
ECOLOGICAL CONSULTING

Overview and Background

A Bird Fatality Monitoring Plan (Plan) is being implemented for the Desert Sunlight Solar Farm, located in Riverside County, California. Specific objectives of the Plan include (A. Birckey, pers. comm.. 5/23/2014):

1. Estimate the overall annual avian mortality rate associated with the facility. This estimate should include mortality associated with all the features of the project that are likely to result in injury and mortality (e.g., fences, ponds, solar panels, elevated solar flux).

2. Determine which species are impacted at the facility during daylight hours and which species are being impacted after nightfall.

3. Determine whether there is spatial differentiation within the solar field in the rates of mortality between species of birds (i.e, panels on the edge of the field vs. interior of the field).

In order to meet these objectives information is needed regarding seasonal differences in mortality rates as well as taxonomic-specific risk factors and rates. In addition, mortality estimates need to be adjusted to address carcass persistence as well as searcher efficiency and the associated temporal fluctuation in these factors.

This document describes the methodology and results related to a full year of Carcass Persistence Trials. Trial dates were as follows: Round 1 -- 7 May 2014 through 22 June 2014, Round 2 – 14 August 2014 through 9 December 2014, Round 3 – 16 December 2014 through 21 January 2015, Round 4 – 27 March 2015 through 18 May 2015. This methodology incorporates agency comments and feedback received from draft copies of the Project's Plan.

Methods

For each Round, thirty non-native bird species of three different size classes (ten of each) were randomly distributed within the Sample Area. A remote trail camera accompanied each placement and was used, in conjunction with ground-based monitoring, to determine: cause of removal (scavenger species or abiotic factor), date of removal and time of removal. Cautionary measures (described below) were implemented to minimize scavenger bias and avoid scavenger swamping. Rounds 1, 3, and 4 trial monitoring consisted of a 30-day period for each carcass placement. During the assessment period each trial specimen was classified into one of the following categories based its physical persistence and detectability:

Intact: Whole and un-scavenged other than by insects

Evidence of Scavenging: Carcass present but some feathers or flesh removed

Disarticulated: Carcass present, but separated into pieces. Flesh or bones still remain.

Feather Spot: Carcass scavenged and removed, but ten or more feathers remain to qualify as a detectable fatality

Removed: Not enough remains to be considered a detectable fatality

After reviewing the results of Round 1, we decided to employ a slightly different approach with our Round 2 carcasses. As will be discussed in the results section (below), 30 days post-placement during Round 1, there were still carcasses present and wholly intact. To explore just how long a carcass may persistence in this environment, Round 2 was conducted in exactly the same manner as Round 1, but instead of collecting carcasses at the conclusion of a 30-day period, we left them in place and monitored them on a less frequent schedule than during the first 30 days of the Round.

Randomization of Carcass Locations

At the time that these trials were initiated, the Plan proposed a distance-sampling strategy that is based on the assumption that avian fatalities are random within the Sample Area. The placement of trial specimens for Carcass Persistence Trials was based on this same assumption and a spatially-balanced routine was used to randomize the trial specimens within the 2,097 acre Sample Area. This routine was performed in a GIS and created a random sample which created an inclusion probability for each project component of interest including: solar modules and perimeter fence. This inclusion probability was created based on the relative area of each component within the Sample Area. In the case of the linear perimeter fence, an interior buffer distance of 35 meters was applied. Using this approach, thirty carcasses -- ten of each size class -- were randomly placed within the Sample Area (Figure 2) for each trial.

Figure 1. A medium-sized trial specimen is randomly placed between solar modules within a solar array.

Carcass Placements

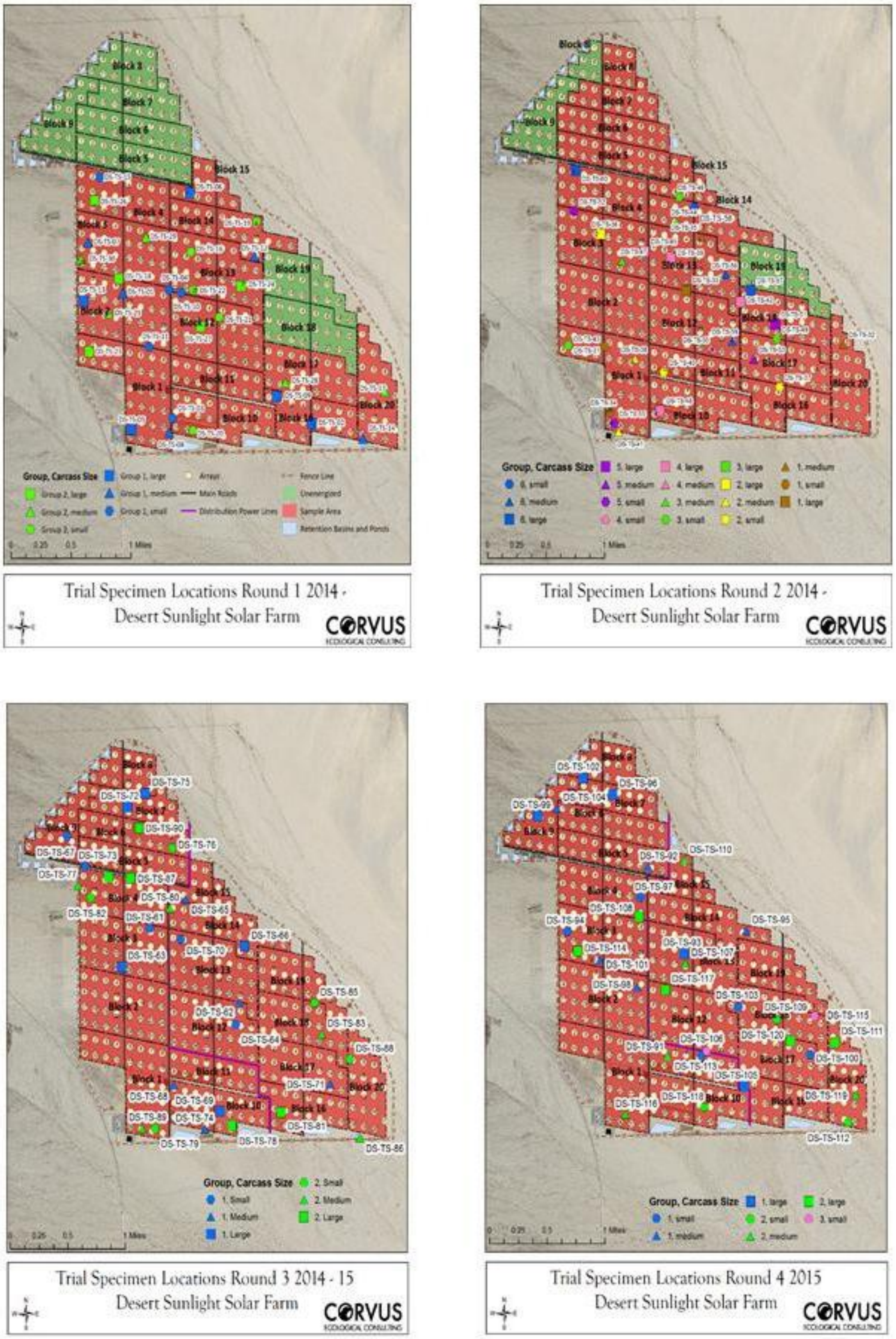
The Sample Area consisted of primary project components that will be the focus of fatality surveys including: energized solar arrays, perimeter fence and overhead power lines. Other project areas, such as retention basins, onsite sub-station and temporary water storage ponds, were not included as part of the Sample Area since focused fatality surveys will not take place within these project features. Areas of active construction, including main access roads, were excluded from the Sample Area due to the presence of uncontrollable variables that will not exist once the project enters into a fully-operational phase. It is important to note that additional panels were energized between consecutive rounds of trials so the size of the Sample Area was not consistent between all rounds. By Round 3, all panels were in place and energized, so the sample area remained consistent between the third and fourth rounds (Figure 2).

Timing of Carcass Placements

To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010) placement of trial specimens took place over a number of days. For Round 1, fifteen carcasses were placed followed by a fifteen-day period then another fifteen carcasses were placed. For Round 2, five carcasses were placed each day for 3 days followed by an eight-day gap and then another five carcasses each day for 3 days. We soon realized that given the size of the study area, 30 carcasses were not likely to have a great impact on predators. For Round 3, we placed fifteen carcasses followed by a two day gap, and then the remaining fifteen. For Round 4, we had some difficulty obtaining small trial specimen, so we placed 15 carcasses followed by a 4-day gap, and then another 13 carcasses. This final effort was shared by another contractor, West Inc., who provided data on two additional small trial specimens that were placed on 27 April 2015. Because of the asynchronous placement and the fact that we wanted each carcass to have at least 30 days of exposure, some of the carcasses were actually out for more than 30 days. For Rounds 1, 3, and 4, trial specimens were collected (if applicable) thirty to thirty-six days after their placement. As was stated above, Round 2 carcasses remained in the Study Area until they were completely removed or the next trial was set to begin.

For each round, a game camera was setup within 40-feet of each trial specimen. Game cameras were in place prior to the placement of carcasses and the initial placement of trial specimens marked the beginning of the trial period. All cameras remained in place and fully operational throughout the trial period except in a few cases where they were located along heavily traveled roads. In those cases, to protect the equipment, cameras were removed as soon as the carcass was determined to be completely removed.

Figure 2. Randomized and spatially-balanced trial specimen locations within the Sample Area Rounds 1 -4.



Game Cameras

Thirty game cameras were placed at randomized carcass locations within the Sample Area, at least five- days in advance of the trial period, in an effort to reduce the possibility that potential scavengers would form an association between cameras and a food subsidy. Cameras remained in place and operational until the end of the trial period, even after trial specimens had been removed. *Wildgame Innovations LO8* (eight megapixel) cameras were powered by external battery packs to help ensure trouble-free operation through the duration of the period.

Figure 3. Installation of a game camera within a solar array.

Trial Specimens

Trial specimens consisted of the following size classes/ species:

- Small/ House Sparrow (*Passer domesticus*)
- Medium/ Eurasian Collared-Dove (*Streptopelia decaocto*)
- Large/ Ring-necked Pheasant (*Phasianus colchicus*)

Trial specimens included only intact, fresh (i.e., estimated to be no more than 1–2 days old and not noticeably desiccated) bird carcasses that were frozen immediately following death.

All carcasses were handled with latex gloves and handling time was minimized. All trial specimens were inconspicuously marked by clipping a toe to distinguish them from unmarked fatalities and other trial specimens.

CORVUS
ECOLOGICAL CONSULTING

Table 1. Trial specimen locations -- detailed information.

Round	Group	Carcass ID	Date Placed	Zone	Easting	Northing	Block	Array	Row	Size Class
1	1	DS-TS-01	5/7/2014	11 S	648029	3743109			9999	M
		DS-TS-02	5/7/2014	11 S	650572	3741654	16.00	12.00	20	L
		DS-TS-03	5/7/2014	11 S	648699	3741715	10.00	19.00	1	S
		DS-TS-04	5/7/2014	11 S	648653	3743146	3.00	8.00	30	S
		DS-TS-05	5/7/2014	11 S	648152	3741583	1.00	29.00	29	L
		DS-TS-06	5/7/2014	11 S	648933	3744228	15.00	7.00	58	L
		DS-TS-07	5/7/2014	11 S	647564	3743677	3.00	18.00	4	M
		DS-TS-08	5/7/2014	11 S	648656	3741552	1.00	28.00	37	M
		DS-TS-09	5/7/2014	11 S	650094	3741955	16.00	2.00	18	L
		DS-TS-10	5/7/2014	11 S	648815	3743116	13.00	23.00	75	S
		DS-TS-11	5/7/2014	11 S	648385	3742514	2.00	31.00	20	S
		DS-TS-12	5/7/2014	11 S	649802	3743520	14.00	21.00	26	M
		DS-TS-13	5/7/2014	11 S	647508	3743024	2.00	9.00	40	L
		DS-TS-14	5/7/2014	11 S	651255	3741482	20.00	18.00	38	M
		DS-TS-15	5/7/2014	11 S	647725	3744402	4.00	3.00	21	S
	2	DS-TS-16	5/21/2014	11 S	648948	3743571	13.00	8.00	47	S
		DS-TS-17	5/21/2014	11 S	651550	3742012	20.00	9.00	35	M
		DS-TS-18	5/21/2014	11 S	647980	3743272	2.00	4.00	27	L
		DS-TS-19	5/21/2014	11 S	649831	3743912	14.00	8.00	9999	S
		DS-TS-20	5/21/2014	11 S	648969	3741575	10.00	20.00	61	S
		DS-TS-21	5/21/2014	11 S	649329	3742840	12.00	12.00	3	S
		DS-TS-22	5/21/2014	11 S	648978	3743145	13.00	25.00	25	S
		DS-TS-23	5/21/2014	11 S	647583	3742455	1.00	10.00	3	L
		DS-TS-24	5/21/2014	11 S	649622	3743188	13.00	21.00	29	L
		DS-TS-25	5/21/2014	11 S	647847	3742882	2.00	19.00	40	M
		DS-TS-26	5/21/2014	11 S	647652	3744141	4.00	18.00	44	L
		DS-TS-27	5/21/2014	11 S	649074	3742737	12.00	10.00	71	L
		DS-TS-28	5/21/2014	11 S	650212	3742110	17.00	17.00	54	M
		DS-TS-29	5/21/2014	11 S	648344	3743732	3.00	7.00	36	M
		DS-TS-30	5/21/2014	11 S	647473	3743489	3.00	25.00	14	M
2	1	DS-TS-31	8/14/2014	11 S	648065	3742402	1.00	5.00	16	S
		DS-TS-32	8/14/2014	11 S	651348	3742426	20.00	3.00	32	M
		DS-TS-33	8/14/2014	11 S	649185	3743056	13.00	26.00	36	L
		DS-TS-34	8/14/2014	11 S	648137	3741638	1.00	25.00	16	S
		DS-TS-35	8/14/2014	11 S	649397	3743671	13.00	5.00	47	M
	2	DS-TS-36	8/15/2014	11 S	648007	3743700	3.00	12.00	57	L
		DS-TS-37	8/15/2014	11 S	650470	3741929	16.00	4.00	47	S
		DS-TS-38	8/15/2014	11 S	648481	3742253	1.00	15.00	35	M
		DS-TS-40	8/15/2014	11 S	648875	3742100	11.00	10.00	30	S
		DS-TS-41	8/15/2014	11 S	648252	3741413	1.00	30.00	21	M
	3	DS-TS-43	8/16/2014	11 S	647563	3742414	1.00	9.00	35	S
		DS-TS-44	8/16/2014	11 S	649052	3743845	14.00	11.00	59	M
		DS-TS-46	8/16/2014	11 S	649091	3744132	15.00	8.00	76	S
		DS-TS-47	8/16/2014	11 S	648299	3743388	3.00	30.00	43	M
		DS-TS-49	8/16/2014	11 S	650430	3742483	17.00	4.00	2	S

Round	Group	Carcass ID	Date Placed	Zone	Easting	Northing	Block	Array	Row	Size Class
	4	DS-TS-39	8/22/2014	11 S	648975	3743433	13.00	8.00	76	L
		DS-TS-42	8/22/2014	11 S	649932	3742919	18.00	7.00	2	L
		DS-TS-45	8/22/2014	11 S	648612	3743503	3.00	24.00	41	L
		DS-TS-48	8/22/2014	11 S	648824	3741658	10.00	19.00	48	L
		DS-TS-50	8/22/2014	11 S	649559	3742367	12.00	29.00	58	M
	5	DS-TS-51	8/23/2014	11 S	650410	3742657	18.00	18.00	4	L
		DS-TS-52	8/23/2014	11 S	647640	3743965	3.00	2.00	10	S
		DS-TS-53	8/23/2014	11 S	650111	3742253	17.00	9.00	26	M
		DS-TS-54	8/23/2014	11 S	649130	3743629	13.00	4.00	27	L
		DS-TS-55	8/23/2014	11 S	648191	3741510	1.00	30.00	1	S
	6	DS-TS-56	8/24/2014	11 S	649729	3743231	13.00	21.00	55	M
		DS-TS-57	8/24/2014	11 S	650072	3743057	18.00	2.00	6	L
		DS-TS-58	8/24/2014	11 S	649299	3744011	14.00	5.00	15	S
		DS-TS-59	8/24/2014	11 S	649817	3742461	12.00	23.00	28	M
		DS-TS-60	8/24/2014	11 S	647660	3744441	4.00	2.00	54	L
3	1	DS-TS-61	12/16/2014	11 S	648406	3743829	3.00	7.00	12	S
		DS-TS-62	12/16/2014	11 S	649657	3742957	12.00	7.00	3	M
		DS-TS-63	12/16/2014	11 S	648013	3743377	3.00	28.00	56	L
		DS-TS-64	12/16/2014	11 S	649607	3742700	12.00	13.00	60	S
		DS-TS-65	12/16/2014	11 S	648906	3744170	15.00	7.00	73	M
		DS-TS-66	12/16/2014	11 S	649732	3743617	14.00	20.00	46	L
		DS-TS-67	12/16/2014	11 S	647246	3744902	9.00	12.00	45	S
		DS-TS-68	12/16/2014	11 S	648736	3741992	10.00	1.00	15	M
		DS-TS-69	12/16/2014	11 S	649388	3741688	10.00	14.00	19	L
		DS-TS-70	12/16/2014	11 S	648841	3743698	13.00	2.00	23	S
		DS-TS-71	12/16/2014	11 S	650934	3742008	17.00	22.00	12	M
		DS-TS-72	12/16/2014	11 S	648093	3745245	7.00	12.00	8	L
		DS-TS-73	12/16/2014	11 S	647500	3744551	5.00	11.00		S
		DS-TS-74	12/16/2014	11 S	649174	3741484	10.00	22.00	37	M
		DS-TS-75	12/16/2014	11 S	648344	3745410	8.00	15.00	33	L
	2	DS-TS-76	12/18/2014	11 S	648719	3744764	6.00	19.00	55	S
		DS-TS-77	12/18/2014	11 S	647402	3744331	4.00	9.00	13	M
		DS-TS-78	12/18/2014	11 S	649558	3741521	10.00	24.00	52	L
		DS-TS-79	12/18/2014	11 S	648479	3741487	1.00	31.00	39	S
		DS-TS-80	12/18/2014	11 S	648687	3744062	14.00	1.00	26	M
		DS-TS-81	12/18/2014	11 S	650243	3741675	16.00	10.00	29	L
		DS-TS-82	12/18/2014	11 S	647578	647578	4.00	10.00	38	S
		DS-TS-83	12/18/2014	11 S	650813	3742591	18.00	20.00	41	M
		DS-TS-84	12/18/2014	11 S	647825	3744428	4.00	3.00	50	L
		DS-TS-85	12/18/2014	11 S	650712	3742955	18.00	5.00	41	S
		DS-TS-86	12/18/2014	11 S	651348	3741377	20.00	19.00		M
		DS-TS-87	12/18/2014	11 S	648136	3744415	4.00	5.00	41	L
		DS-TS-88	12/18/2014	11 S	651208	3742299	20.00	4.00	24	S
		DS-TS-89	12/18/2014	11 S	648297	3741488	1.00	30.00	22	M
		DS-TS-90	12/18/2014	11 S	648250	3744997	6.00	6.00	22	L
4	1	DS-TS-91	3/23/2015	11 S	649410	3742254	11.00	5.00	52	S
		DS-TS-92	3/23/2015	11 S	648669	3744457	5.00	19.00	18	M

Round	Group	Carcass ID	Date Placed	Zone	Easting	Northing	Block	Array	Row	Size Class
		DS-TS-93	3/23/2015	11 S	649168	3743442	13.00	10.00	29	L
		DS-TS-94	3/23/2015	11 S	647544	3743705	3.00	9.00	74	S
		DS-TS-95	3/23/2015	11 S	650035	3743711	14.00	17.00	55	M
		DS-TS-96	3/23/2015	11 S	648177	3745300	7.00	4.00	64	L
		DS-TS-97	3/23/2015	11 S	648554	3744099	4.00	16.00	20	S
		DS-TS-98	3/23/2015	11 S	648515	3743046	2.00	8.00	16	M
		DS-TS-99	3/23/2015	11 S	647134	3745050	9.00	8.00	15	L
		DS-TS-100	3/23/2015	11 S	650925	3742262	2.00	7.00	33	S
		DS-TS-101	3/23/2015	11 S	647995	3743372	3.00	28.00	58	M
		DS-TS-102	3/23/2015	11 S	647765	3745493	8.00	11.00	36	L
		DS-TS-103	3/23/2015	11 S	649929	3742821	18.00	7.00	24	S
		DS-TS-104	3/23/2015	11 S	647400	3745142	9.00	6.00	56	M
		DS-TS-105	3/24/2015	11 S	650009	3741891	16.00	1.00	73	L
	2	DS-TS-107	3/27/2015	11 S	649185	3743330	13.00	18.00	16	M
		DS-TS-108	3/27/2015	11 S	648545	3743875	4.00	24.00	33	L
		DS-TS-109	3/27/2015	11 S	650464	3742673	18.00	10.00	76	S
		DS-TS-110	3/27/2015	11 S	649167	3744531	15.00	2.00	20	M
		DS-TS-111	3/27/2015	11 S	651272	3742408	20.00	2.00	83	L
		DS-TS-112	3/27/2015	11 S	651454	3741473	20.00	19.00	76	S
		DS-TS-113	3/27/2015	11 S	648936	3742247	11.00	2.00	72	M
		DS-TS-114	3/27/2015	11 S	647684	3743471	3.00	26.00	46	L
		DS-TS-116	3/27/2015	11 S	648350	3741566	1.00	30.00	25	M
		DS-TS-117	3/27/2015	11 S	648906	3743023	12.00	2.00	55	L
		DS-TS-118	3/27/2015	11 S	649453	3741648	10.00	14.00	63	S
		DS-TS-119	3/27/2015	11 S	651560	3741792	20.00	16.00	1	M
		DS-TS-120	3/27/2015	11 S	650652	3742423	17.00	5.00	47	L
	3	DS-TS-106	4/27/2015	11 S	649487	3742301	12.00	29.00		S
		DS-TS-115	4/27/2015	11 S	650992	3742716	18.00	13.00		S

Periodic Ground-based Monitoring

Biologists periodically checked the placement of each trial specimen to guard against misleading indicators of carcass removal, such as wind blowing the trial specimen out of the camera's field-of-view. To minimize the potential for scavenger bias caused by the activity pattern of biologists, every camera was checked (not just those with trial specimens) following a standard schedule. Whenever possible, ground-based monitoring took place during times of the day when potential scavengers were the most inactive (i.e. middle of the day). Often times, the placement and persistence of trial specimens was checked from a distance, using spotting scopes or binoculars, to avoid close approach. At least once every week, cameras were checked for proper functioning at the same time that ground-based monitoring occurred.

The following table provides a schedule which outlines the periodic ground-based monitoring of trial specimens:

Table 2. Carcass Removal Assessment – specimen placement and ground-based monitoring schedule.

TRIAL PERIOD - DAYS	TRIAL SPECIMEN GROUP 1 DISPOSITION	TRIAL SPECIMEN GROUP 2 DISPOSITION	GROUND-BASED MONITORING	CAMERA DISPOSITION/ CHECK
-5	NONE	NONE	NONE	PLACEMENT
0	PLACEMENT	NONE	X	X
1	PRESENT	NONE	X	X
3	PRESENT	NONE	X	X
5	PRESENT	NONE	X	X
8	PRESENT	NONE	X	X
14	PRESENT	PLACEMENT	X	X
15	PRESENT	PRESENT	X	X
17	PRESENT	PRESENT	X	X
20	PRESENT	PRESENT	X	X
22	PRESENT	PRESENT	X	X
27	PRESENT	PRESENT	X	X
29	REMOVE	PRESENT	X	X
33	NONE	PRESENT	X	X
37	NONE	PRESENT	X	X
43	NONE	PRESENT	X	X
46	NONE	REMOVE	X	X

Results

Round 1

Of the 30 carcasses placed during Round 1, 8 medium, 3 large, and 6 small trial specimens (56%) were completely removed during the 30-day trial period. The average time (number of days) a carcass persisted before removal (out of a maximum of 30) was 24.6 for large carcasses, 10.9 for medium carcasses, and 15.7 for small carcasses for an overall average of 17.1. Six of the 13 remaining carcasses (4 small and 2 large) were present and wholly intact at the conclusion of the trial, two large carcasses were present but scavenged, 4 were disarticulated (3 large and 1 medium) and 1 medium carcass remained detectable as a feather spot. Full monitoring results are present in the attached Excel Spreadsheet.

It took 19 days before 50% of all trial specimens were removed (Figure 4). The percentage of trial specimens removed remained constant at 50% between 19 and 27 days. The data indicates a spike in removal rates between 4 and 6 days following the placement of trial specimens. The removal rates then remain relatively constant. For the 17 carcasses that were wholly removed, 9 were detected during ground-based monitoring as having been scavenged, but still detectable while the other 8 were present and wholly intact until they were removed completely in one incident.

Round 2

Of the 30 carcasses placed in Round 2, 5 medium, 4 large, and 10 small trial specimens (63%) were completely removed during the first 32 days (Figure 4). These data were used for the graph to compare similar time periods, but rather than collecting carcasses after 30 days, as we did in Round 1, the carcasses in Round 2 that had not been removed were left in place to determine how long they would actually persist in this environment. Due to the need to start a new round, all remaining carcasses were eventually removed on 9 December 2014, 107-117 days after placement. The average time a carcass persisted before removal (maximum of 117) was 68.3 days for large carcasses, 44.6 days for medium carcasses, and 12.6 days for small carcasses for an overall average of 40.7 days. At the conclusion of the trial, 5 carcass remains (4 large and 1 medium) were still detectable. Full monitoring results are present in the attached Excel Spreadsheet.

It took 23 days before 50% of all trial specimens were removed (Figure 4). Unlike Round 1, a sharp spike in carcass removals was not detected at any point during the trial. Instead, a steady removal rate was observed over time. For the 19 carcasses that were wholly removed, 7 were detected during ground-based monitoring as having been scavenged, but still detectable while the other 12 were present and wholly intact until they were removed completely in one incident.

Round 3

In Round 3, 80% of the carcasses (10 small, 7 medium, and 7 large) were completely removed during the first 30 days. All carcasses were collected on 21 January 2015 which was 34-36 days after placement. At that time, 4 specimens still persisted as detectable feather spots. The average number of days carcasses persisted before removal (out of a maximum of 36) was 18.9 for large carcasses, 12.1 for medium carcasses, and 3.7 for small carcasses for an overall average of 11.6 days.

Over 50% of the carcasses were removed within 6 days of placement. As in Round 1, a very sharp spike in removal was observed during the first few days of the trial, although the spike was much sharper in Round 3 than in Round 1.

Round 4

At the time Round 4 was conducted, Corvus experienced some difficulty obtaining small carcasses for the trial; as such, West, Inc. provided data for 2 small carcasses which were placed on 4/27/2015 following completion of the Corvus Round 4 trial. Only 43% of the carcasses were removed during the first 30 days of the Round 4 trial. The original 28 carcasses were collected on 27 April 2015 (31-35 days after placement). At that time, 8 large and 5 medium carcasses were still detectable. Average carcass removal times (out of a maximum of 35 days) were 6.6 days for small, 20.9 days for medium, and 30.5 days for large. The overall average was 19.3 days.

In Round 4 it took 31 days before 50% of the placed carcasses were removed. The most striking difference between the fast removal of small specimens and the very slow removal of the large specimen was observed in Round 4.

All Rounds Combined

If data from all Rounds is pooled and the maximum number of days until removal is reset to 30 for all Rounds, the overall averages are 23.8 days for large carcasses, 15.4 days for medium, and 9.7 days for small (Table 3; Figure 5). The combined average is 16.3 days. A one-way ANOVA was run for each trial looking at size class as the source of variation (Table 3). The data showed that size was a significant factor in removal times in all but Round 1 at α = 0.05. The results of Tukey-Kramer multiple comparisons are summarized in the table. The same size class in different rounds was also compared to look at seasonal differences. The medium and large size classes showed no significant differences at α = 0.05 between rounds. The small size class was significant at α = 0.05 as was the combined average of all size classes. The Tukey-Kramer multiple comparisons revealed that the only significant differences were between the small size class removal times between rounds 1 and 3. A Two Factor ANOVA was run to examine the pooled results and found significant differences among the size classes and among the rounds, but the interaction between the two factors was not significant (Table 4). It is important to note that these numbers were scaled down to a maximum of 30 days when, in reality, it is likely that the large carcasses would persist for a much longer time.

Scavengers

There were three main scavengers present during all three trials: Common Ravens (*Corvus corax*), kit foxes (*Vulpes macrotis*), and Turkey Vultures (*Cathartes aura*). Kit Foxes were the most prevalent scavengers caught by the cameras (Table 4). During Round 3, kit foxes scavenged at 100% of the carcasses placed. Wind was the main factor in removal of feather spots.

Figure 4. Percentage of each size class removed over time for Round 1 through 4.

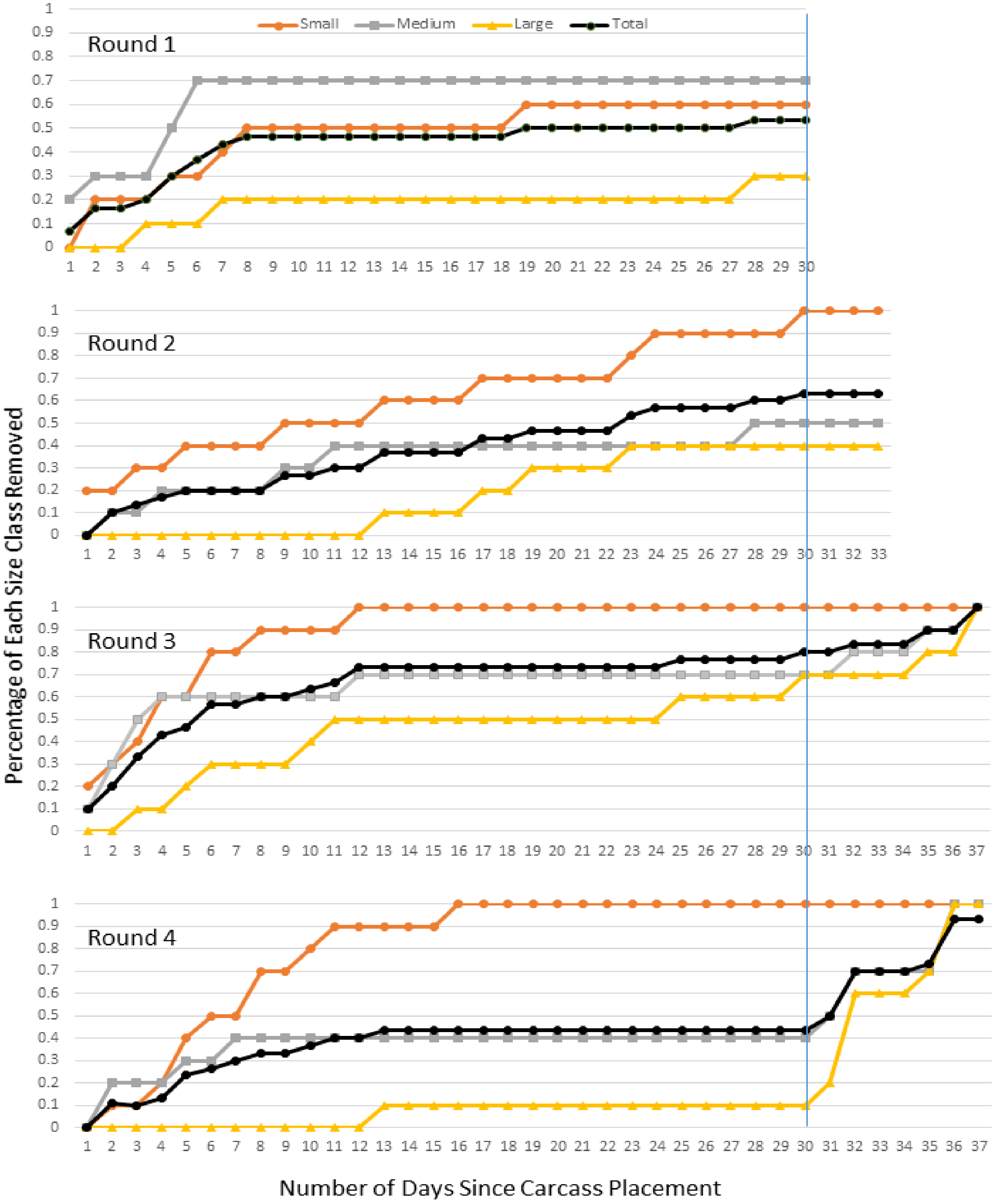


Table 3. Average # of days a carcass persisted in each trial (out of a maximum of 30) with the P-value associated with the ANOVA to test for significant differences between size classes.

Size	**Round 1**	**Round 2**	**Round 3**	**Round 4**	**Overall**	**P-value comparing rounds**
Small	15.7	12.6	3.7	6.6	9.7	0.02
Medium	10.9	20.4	11.0	19.2	15.4	0.23
Large	24.6	25.2	17.3	28.2	23.8	0.07
Combined	17.1	19.4	10.7	18.0	16.3	0.03
P-value comparing sizes	0.06	0.03	0.03	5.87E-05	5.48E-07	
Significant Differences	None at α = 0.05	Small different from large	Small different from large	Small different from medium & large	Large different from small & medium	
# Days Before 50% of carcasses removed	19	23	6	30	20	

Figure 5. Seasonal comparisons of differences in average removal times by size class.

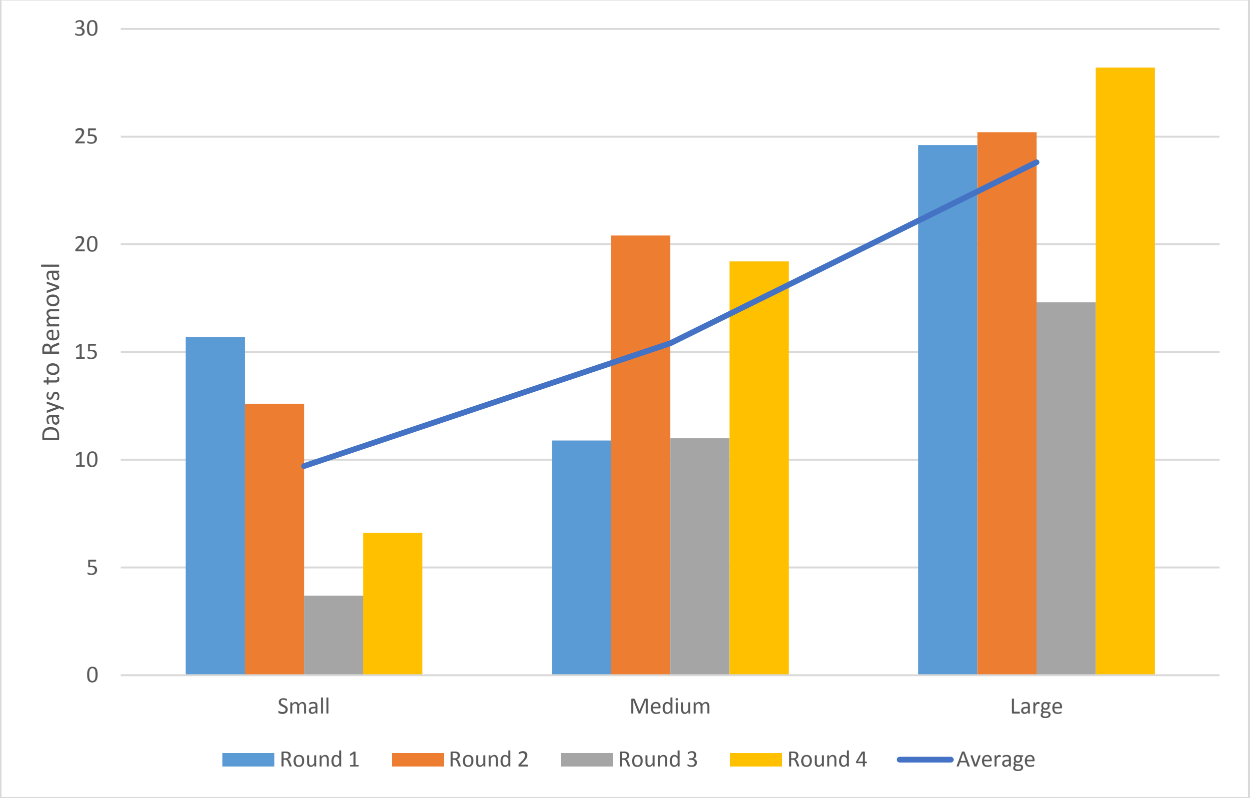


Table 4. Results of two-factor ANOVA to test for differences in removal times among size classes and seasons.

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Round	1343.331	3	447.777	3.956374	0.01015	2.688691
Size	4067.906	2	2033.953	17.97118	1.83E-07	3.080387
Interaction	988.3053	6	164.7176	1.455377	0.200465	2.183657
Within	12223.29	108	113.1786			
Total	18622.84	119				

Table 5. Scavengers detected by cameras during carcass removal trials.

Round	**Size Class**	**Kit fox**	**Common Raven**	**Turkey Vulture**	**Insects**	**Multiple Scavengers**
1	Small	4	2	0	0	0
	Medium	4	6	5	0	3
	Large	7	5	1	0	7
	Total	*15*	*13*	*6*	*0*	*10*
2	Small	8	2	0	1	1
	Medium	9	5	3	0	5
	Large	10	5	5	0	8
	Total	*27*	*12*	*8*	*1*	*14*
3	Small	10	2	0	0	2
	Medium	10	7	0	0	7
	Large	10	10	0	0	10
	Total	*30*	*19*	*0*	*0*	*19*
4	Small	6	5	0	0	1
	Medium	8	7	2	0	6
	Large	10	10	2	0	10
	Total	*24*	*20*	*4*	*0*	*17*

Spatial Analysis

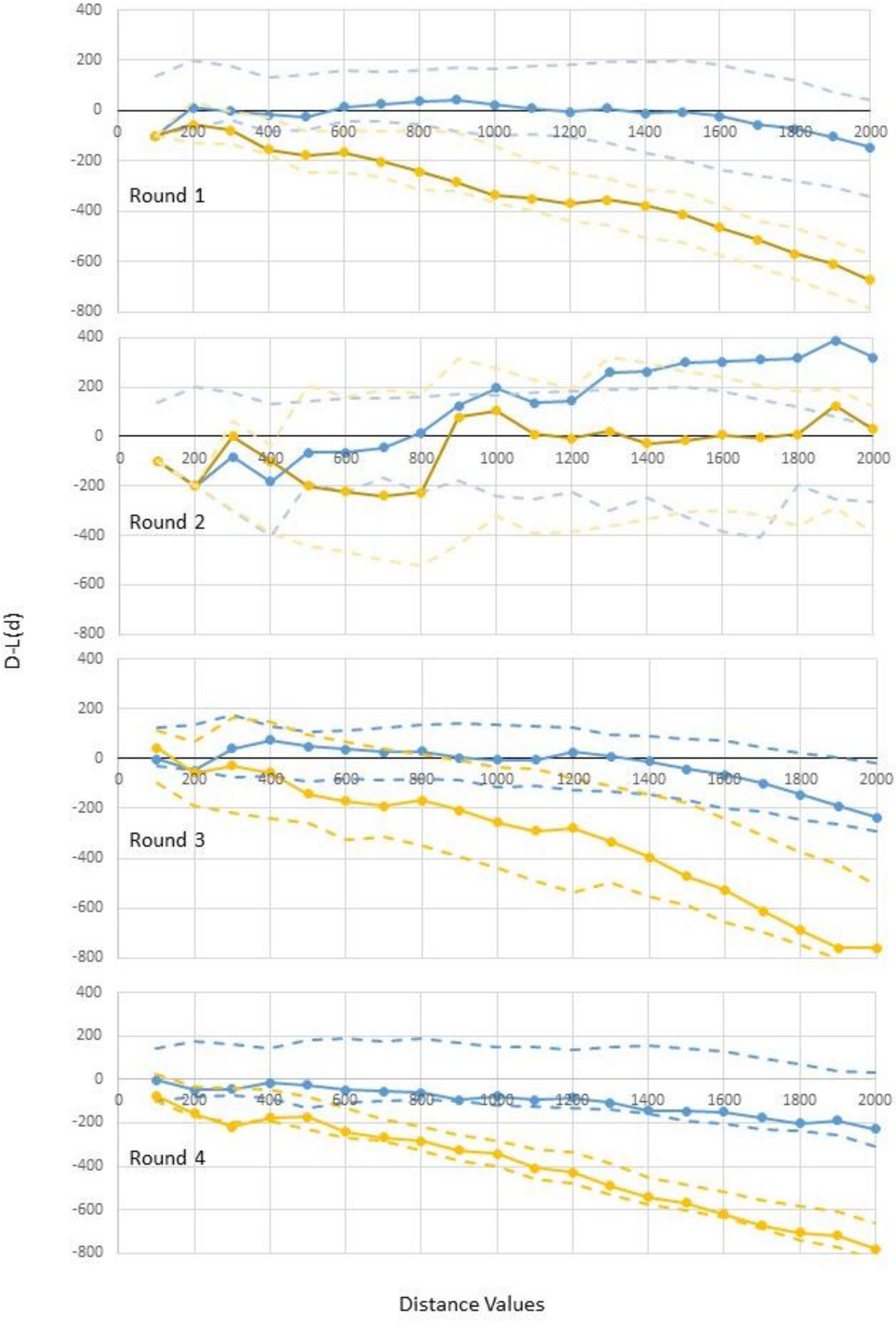
The carcasses were mapped with respect to removal time to assess whether or not the placement affected scavenging time. We then performed several spatial analyses to test whether the removals rates were spatially clustered. The first test was a Ripley's K-function analysis. We used the variance stabilized Ripley's K function represented by the following equation:

$$L(d) = \sqrt{\frac{A \ \sum_{i=1}^{n} \sum_{j=1, j \neq i}^{n} k(i,j)}{\pi n(n-1)}}$$

- Where d is the distance
- n is the number of features
- A is the total area of the features
- K_{ij} is a weight

This test measures deviations from spatial homogeneity. The carcass locations themselves were first analyzed, and then the analysis run using the time to carcass removal as the weight. The parameters used for the analysis were 20 distance bands ranging from 100 to 2000 meters using the sample area as the total area. A simulation of points (mirrors of points near the edges) outside the study area was performed to correct for edge effects and computed a confidence interval using 99 simulated samples. If the data are homogenous, the plot of d versus L(d) - d should follow the horizontal zero axis. A negative value of L(d) – d indicates spatial regularity (rather than randomness), while a positive value indicates clustering (Dixon 2002). We used the simulated confidence intervals to test for statistical significance. Because the sampling frame differed between Round 1 and 4 (more blocks were included in later rounds because construction had completed), analyze all rounds cannot be analyzed together. For Round 1, 3, and 4, analysis of the weighted data indicates more of a regular distribution of time to removal rather than clustering (Figure 6), but not statistically significant based on our constructed confidence intervals. In Round 2, the actual placement of carcasses showed statistically significant evidence of clustering at distances greater than 1200 meters (Figure 6). The weighted analysis did not indicate clustering using the Ripley's K function.

Figure 6. Results of Ripley's K Function analysis of spatial homogeneity for Round 1-4.



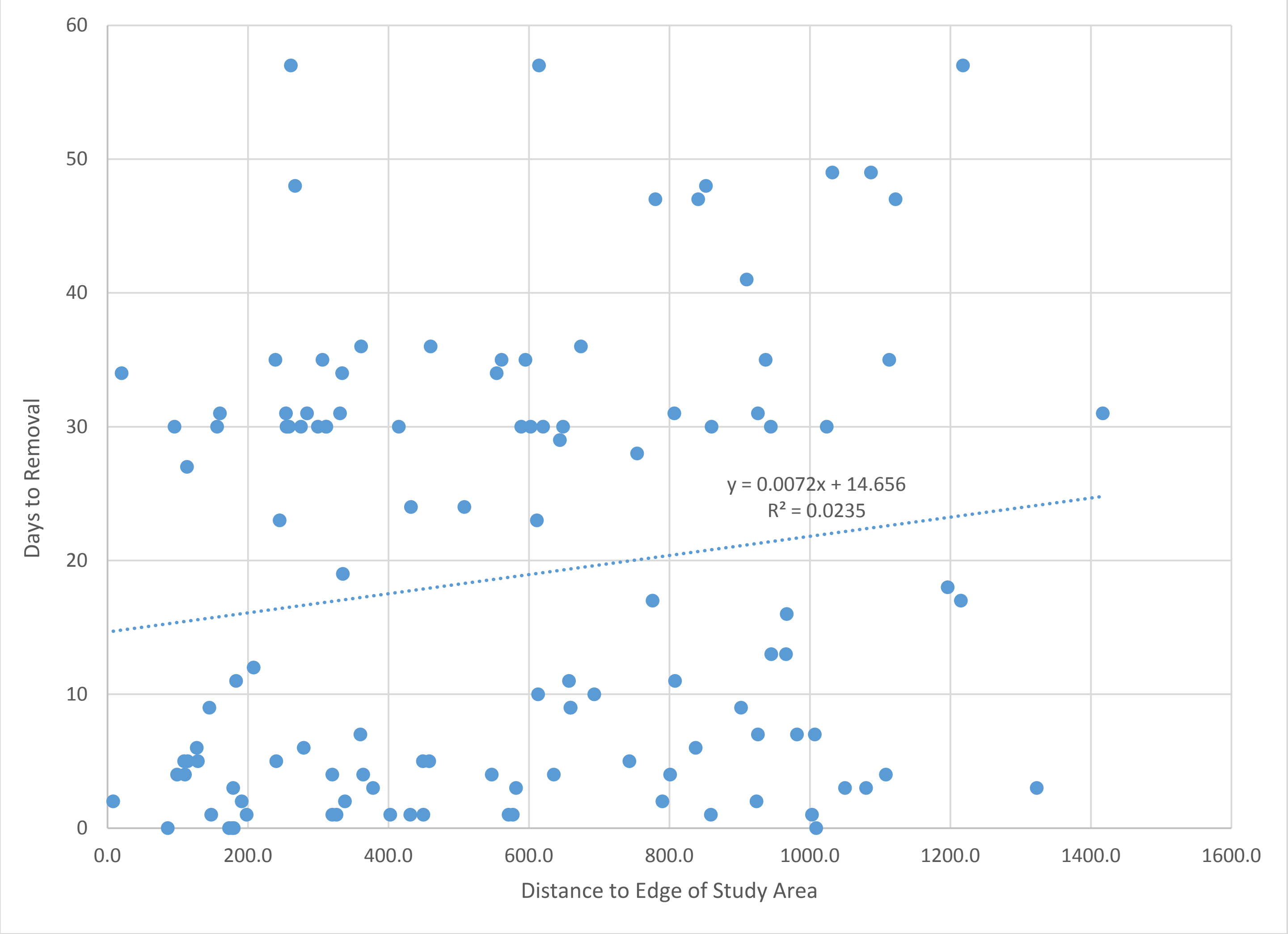
Spatial data was additionally analyzed with the Global Moran's I and the Getis-Ord General G statistic using ArcGIS 10.2 Software. Both are tests of spatial autocorrelation, while the General G will give an idea of clustering of either high or low values (ESRI 2012). In Rounds 1,3, and 4 there was no indication of clustering based on removal times. In Round 2, there was strong evidence of clustering using the Global Moran's test using both Inverse Distance Weighted and Zone of Indifference spatial relationships (Table 3). The Z scores of these tests during Round 2 are likely due more to the perception of clustering during placement rather than an effect of location on removal rates. In other words, it seems that the random placement of carcasses during Round 2 resulted in a clustering of carcasses spatially; however, there was not a clustering of removal times spatially.

Table 6. Results of tests of spatial autocorrelation.

Statistic		Global Moran's I		Getis-Ord General G
Spatial Relationship		Zone of Indifference	Inverse Distance Weighted	Inverse Distance Weighted
Round 1	Threshold Distance	1600	657	657
	Index Value	0.01726	0.062591	0.000265
	Z-score	1.220955	0.60901	-0.130234
	P-value	0.222103	0.542518	0.896381
Round 2	Threshold Distance	1600	1000	1000
	Index Value	0.76932	0.256895	0.000559
	Z-score	2.455789	2.809031	1.404347
	P-value	0.014058	0.004969	0.160215
Round 3	Threshold Distance	1600	755	755
	Index Value	-0.037919	0.124960	0.000244
	Z-score	-0.058703	1.094232	-0.200562
	P-value	0.953189	0.273853	0.841041
Round 4	Threshold Distance	1600	898	898
	Index Value	-0.101823	-0.049867	0.000223
	Z-score	-0.718858	-0.092056	-0.895708
	P-value	0.472228	0.926654	0.370409

Finally, the distance to the edge of the study area were compared to the removal times to see if carcasses near the edge were removed at a different rate from those toward the center (Figure 8). There was not a significant linear relationship between distance to the edge and days to removal (R2 = 0.02).

Figure 7. Comparison of distance to edge of study area and days to carcass removal.



Discussion

Effectiveness of Game Cameras

Game cameras were used to document scavengers and determine removal times due to scavenging events. While game cameras were successfully used for their intended purpose, there are some factors and limitations to consider when using them for Carcass Persistence Trials. Carcasses often become dismembered during scavenging events and remaining body parts evidence a fatality event although the majority of the carcass may have been removed. The photo sequence below (Figure 9 and Figure 10) captures a Common Raven removing a small-sized trial specimen but does not capture the fact that a wing was left behind, persisting as a detectable fatality for two additional days, until a wind event on 5/11/2014 removed it from the Sample Area.

Figure 8. First of two photos documenting the removal of a small-sized trial specimen by a Common Raven. Game cameras did not capture the fact that wing feathers persisted as a feather spot (detectable fatality) until a wind event two days later.

Figure 9. Second of two photos documenting the removal of a small-sized trial specimen by a Common Raven. Game cameras did not capture the fact that wing feathers persisted as a feather spot (detectable fatality) until a wind event two days later.

The persistence of dismembered body parts are not readily captured by game cameras and ground-based monitoring must be implemented in conjunction with game cameras to ensure that removal rates (carcass no longer detectable) are accurately determined. Additionally, game cameras require routine checks to ensure proper functioning and to assess whether or not trial specimens remain within the field-of-view after a scavenging or wind event.

Game cameras remained operational, even when trial specimens were not present, in an effort to determine whether or not Common Ravens formed an association between cameras and a food subsidy. A photo review of cameras with and without carcasses present determined that Common Ravens did not associate cameras with a food subsidy as this species was never documented at a camera location without a carcass present. Kit fox, however, were incidentally detected at camera locations especially after a carcass had been removed. This was most noticeable during Round 3 during which kit fox scavenging rates were at their highest. Kit fox were rarely detected at cameras prior to placement of carcasses. Incidental photo capture was also high for other non-carnivorous mammals such as black-tailed jackrabbit (*Lepus californicus*). It is likely that the smell of the old carcass, rather than the presence of a camera resulted in return visits by kit foxes.

Return visits by scavengers (kit foxes) coupled with the inability of the camera to adequately capture feather spots and severely disarticulated carcasses would also present a challenge when determining actual removal times in the absence of ground-based monitoring. If monitoring were performed solely by cameras, researchers may mistakenly assume that carcasses are still detectable after they have been fully removed due to visits to the area by kit foxes.

Scavenger Effects on Carcass Detectability

The scavenging of trial specimens was a main factor influencing removal rates and carcass detectability. In some instances, scavenging events temporally increased the detectability of a trial specimen by spreading the remains over a larger area (Figure 10).

Dismemberment was more common in larger specimens that are not easily carried away by the scavengers present within the Study Area. Trial specimens within the small size class were often removed, without a trace, in a single scavenging event.

The activities of one scavenger did not deter others. Many of the large and medium carcasses were scavenged by multiple species over the course of the trial period. Even attempts to relocate carcasses were ineffective at detouring the competition (Figure 11).

During carcass searches, field surveyors should be careful to associate dismembered remains to a particular carcass in an effort to avoid double-counting fatality events.

Figure 10. A medium-sized trial specimen is picked apart by a scavenger, increasing the detectability of this carcass by spreading it across a larger area.

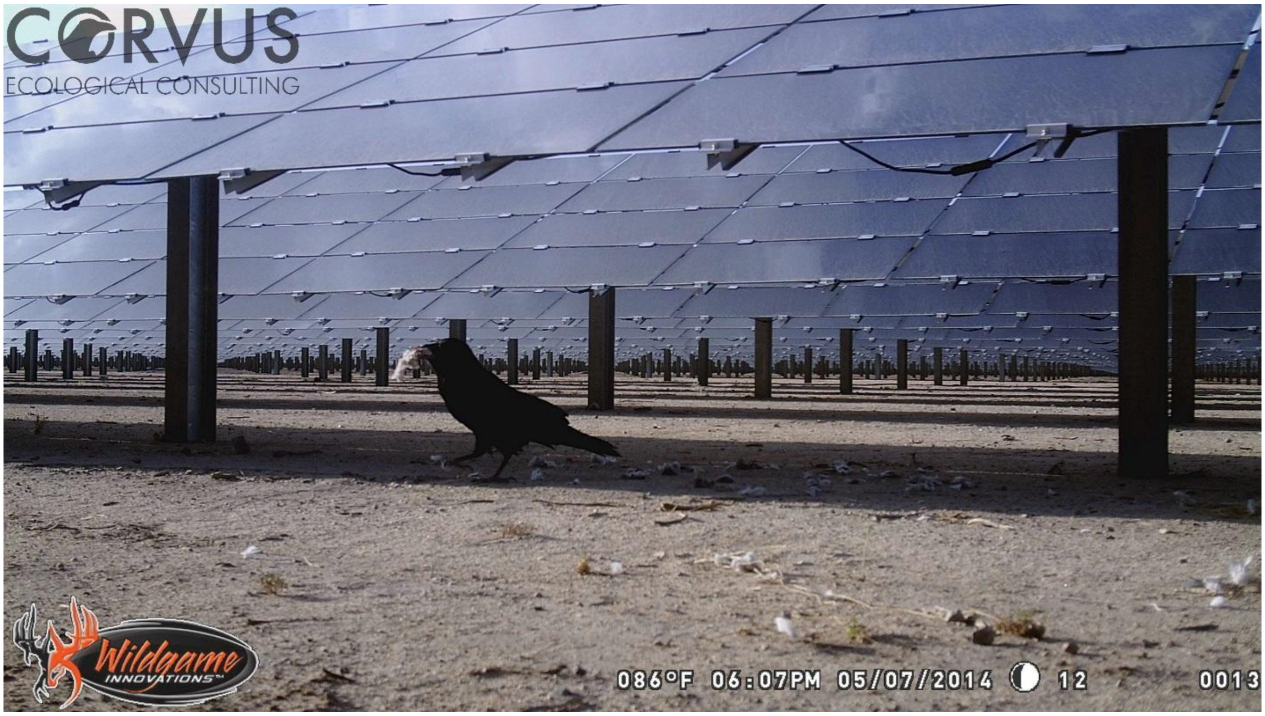


Figure 11. A kit fox is captured by game cameras on top of a solar panel where ravens had dropped a trial specimen.

Size Class Assessment

Data from the three rounds indicates that variation in removal rates among different size classes of carcasses can be expected. During most trials, the small carcasses were removed at a much faster rate than either medium or large. Small carcasses were generally removed completely in one event while the medium and large carcasses were often dismembered or plucked in place. As was stated earlier, these actions generally made a carcass temporally more detectable as it was scattered over a large area. Over time, however, wind events carry the feathers and wings and could complicate accounting of naturally occurring carcasses. It is also important to note again that for the purposes of analysis, we concluded our trials at 30 days. In reality, some of our large carcasses were clearly detectable upwards of 100 days post placement.

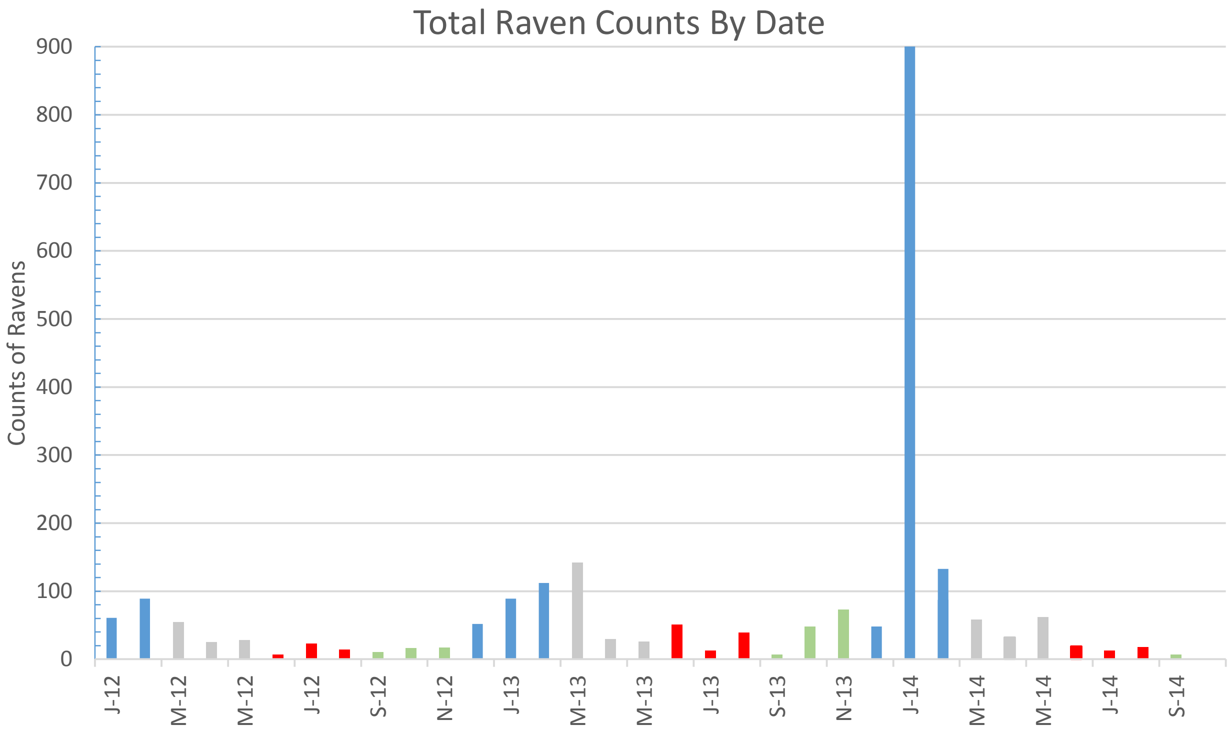
Species composition from incidental fatality data collected at the Desert Sunlight Solar Farm was assessed in an effort to categorize these data into corresponding size classes. Assessed incidental data included 133 instances resulting in fatality over the course of thirty-three months (between September 2011 and June 2014). Of the 133 carcasses documented, 26% would be classified as large (larger than an American Crow, *Corvus brachyrhynchos*), 33% would be classified as medium (approximately American Kestrel, *Falco sparverius*, to American Crow size), and 41% would be classified as small. The most frequently encountered carcass species was the Western Grebe (*Aechmophorus occidentalis*), accounting for 15 total fatalities. Western Grebes would be classified as a large carcass under the above classification scenario.

Seasonal Differences in Removal Times

Carcasses were placed during 4 distinct rounds in order to capture seasonal differences in scavenging and removal rates. With our relatively small sample sizes, we were unable to detect significant differences in removal rates except when comparing the small carcass size class between rounds 1 and 3. Round 3 took place during the winter months and kit foxes were the dominant scavengers captured by our game cameras. Another distinction of the trial in Round 3 is that it took place immediately upon the conclusion of the construction phase at the facility. It is possible that the kit fox population had previously been subsidized by human activities associated with the construction phase (trash etc.) and were motivated to patrol the facility for resources once those subsidies were removed. We did not see the same quick removal times in Round 4, so it is unlikely that prior to Round 3, human presence on the facility deterred their behavior. Further trials are needed in order to determine if it is a natural biological cycle that caused this increase in scavenging times.

Raven-specific surveys are conducted monthly to support requirements of the Project's Raven Management Plan. The data collected through these efforts shows a trend related to temporal fluctuations in the abundance of Common Ravens within the Chuckwalla Valley (Figure 9). Common Ravens were responsible for scavenging trial specimens and carcass persistence rates are likely to fluctuate with changes to the presence of Common Ravens. These data indicate that raven presence could also have been a factor in the quick removal times during Round 3.

Figure 12. Survey data shows a trend related to temporal fluctuations in the abundance of Common Ravens within the Chuckwalla Valley.



Wind Events

Inedible body parts such as: wings, body feathers, feet and legs would often remain detectable, post scavenging, until a wind event occurred. Wind events were most often responsible for removing evidence of fatalities including dismembered body parts and feather spots. There were some instances were wind was responsible for relocating trial specimens within the Sample Area. Wind was responsible for relocating two small-sized trial specimens, one was moved 17 meters (DS-TS-04) and the other was moved 10 meters (DS-TS-11). Major wind events, such as one which occurred on 5/11/2014 were responsible for the removal of dismembered parts and feather spots. Figures 10 and 11 below show a wind event captured by a game camera on 5/11/2014, when onsite weather stations recorded wind gusts as high as 50 miles-per-hour. The facility also experienced a tornado on 21 April 2015 which damaged several solar panels. While none of the trial specimen were affected by this event, repeat occurrences of wind events of this magnitude will likely have an effect on carcass detectability.

Figure 13. Photo 1 of 2 documenting a wind event on 5/11/2014 that spanned approximately 3.5 hours and removed three of the fifteen group 1 trial specimens from the Sample Area.

Figure 14. Photo 2 of 2 documenting a wind event on 5/11/2014 that spanned approximately 3.5 hours and removed three of the fifteen group 1 trial specimens from the Sample Area.

Search Effort and Carcass Persistence During Ground-based Monitoring

Ground-based monitoring efforts, in conjunction with remote game cameras, were used to assess and successfully determine carcass removal rates within the Sample Area. The level of effort undertaken by field workers was a factor in determining removal rates. Wind events and scavengers were the two primary factors influencing the detectability of trial specimens and it was not uncommon for trial specimens to be moved -- but not removed – within the Sample Area. Search efforts implemented during ground-based monitoring sometimes resulted in the detection of trial specimens at locations other than the point of their original placement; and these carcasses remained detectable when they might have been recorded as “removed” without an additional search effort.

Given the size of the Sample Area (2,097 acres), a comprehensive survey was not possible during scheduled ground- based monitoring efforts. A trial specimen was recorded as, “removed” once it was no longer detectable at the point of original placement or within 25 meters of the original placement. Consequently, the determination of removal rates resulting from this effort should be considered conservative since it is possible that displaced trial specimens remain detectable somewhere within the Sample Area.

Eight days following the conclusion of trial period 1, a trial specimen was incidentally encountered in a storage area where it persisted as a feather spot, detectable under a stack of pallets. This finding was not included in these results but provides support that these removal times are conservative.

Literature Cited

Dixon, P.M. 2002. "Ripley's K Function" in Encyclopedia of Environmetrics Vol 3. Edited by A. H. El-Shaarawi and W. W. Piegorsch, John Wiley & Sons, pp 1796-1803.

ESRI. 2012. ArcGIS Resource Center: Analyzing Patterns toolset. http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/An_overview_of_the_Analyzing_Patterns_tools et. Last Accessed 16 July 2014.

Smallwood, K. S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71:2781–2791.

Smallwood, K. S., D. A. Bell, S. A. Snyder, and J. E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine– caused avian fatality estimates. Journal of Wildlife Management 74:1089–1097.

Desert Sunlight Solar Farm Spring 2015 Monitoring Report Comment Response Document

Business confidential

December 9, 2015

The following is a list of comments made on the Desert Sunlight Spring 2015 Post-Construction Monitoring Report dated July 17, 2015 as well as responses to those comments. We have also addressed comments made during the July 21, 2015 TAG meeting.

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
FWS1	Pre-spring survey data are not meaningful and should probably be excluded. Please describe how these data were or were not incorporated into estimates.	Pre-spring carcass search data have been removed from the report and the FWS request to remove data memorialized in section 1.3.
FWS2	Please record and report the time of the surveys. This will help determine if the surveys can be used to predict nocturnal vs. diurnal mig behavior.	We have added the following text to section 2.1.2: All searches take place during daylight hours from 06:30 to 17:00.
FWS3	Please include median times and/or a curve showing # remaining over time.	We have included a new figure (Figure 7) reporting proportion of trial carcasses remaining as a function of days since placement.
FWS4	Please describe how detectability is being handled for the 25% being surveyed from a distance.	We added the following text to the footnote in Table 1: Fatality rates estimated for sections of the fence that are sampled were extrapolated to sections of the fence where the standard monitoring protocol cannot be used, as described in section 4.2.6 of the approved Desert Sunlight BBCS.
FWS5	Based on persistence trials? I suggest putting the carcass and searcher efficiency trials first since they dictate the timing of the standardized carcass searches.	We inserted the following text in section 2.1.1: As specified in the approved Desert Sunlight BBCS, the average search interval…
FWS6	This is not clear. Please clarify how sampling was affected by the damage from the tornado.	We revised text in section 2.1.1 to read: Six arrays were visited seven times from the beginning of the spring season until the tornado occurred on April 21, 2015; 3

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
	Further, articulate what was done to replace the arrays that were damaged in the sampling scheme.	weeks elapsed before the six damaged arrays were replaced with arrays in the solar field that were not affected by the tornado. During this 3-week period, Desert Sunlight LLC remained in contact with the BLM as details on access limitation developed. Once it was determined that access to damaged arrays would be limited for a longer time period, six replacement arrays were identified; five were visited twice and one was visited once. Replacement arrays were identified by choosing a random sample of non-damaged arrays within the same block that contained the original arrays that were damaged by the tornado.
FWS7	Was the carcass then processed and removed? Please clarify the carcass processing procedure.	We inserted text in section 2.1.2 to clarify: Once a carcass was detected, it was then photographed, and data were recorded according to specifications outlined in section 7.2.5 of the approved Desert Sunlight BBCS. Carcasses detected before amendment of the WEST California Scientific Collecting Permit (Permit # 3790) were covered and secured in place until permission was granted from California Department of Fish and Wildlife to handle carcasses on April 21, 2015. Since that date, all carcasses have been retrieved from their location on the ground, labeled, and placed in a freezer on site.
2.1.2 L13-14	Text inserted:"…with observers looking toward the center of the array."	Revision accepted
FWS8	Please describe how this is this accounted for in the overall estimates.	We inserted text in section 2.1.2 to clarify: As specified in section 4.2.6 in the approved Desert Sunlight BBCS, we assume that fatality rates are similar between the portion

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		of fence that was searched and the portion that was not.
FWS9	Again, please describe how this was accounted for in the estimates.	We inserted text to section 2.1.2 to clarify: As specified in section 4.2.6 in the approved Desert Sunlight BBCS, we assume that fatality rates are similar between the portion of fence that was searched and the portion that was not.
FWS10	This doesn't seem valid, given the site differences in these segments of the fences.	We revised text in section 2.1.2 to address: Fatality rates estimated for sections of the fence that were sampled were adjusted to account for the proportion of fence not sampled with the standard monitoring protocol, as specified in section 4.2.6 of the approved Desert Sunlight BBCS.
FWS11	The Service disagrees with this assumption. If it's under the line, the better assumption is that it was caused by the line and a scavenger subsequently discovered the carcass.	By assigning a suspected cause of death as unknown, collision with project infrastructure is not being discounted as a potential cause – it only means there is insufficient evidence to assign a specific cause. Detections made beneath the line could also potentially be a result of predation by raptors perched on the line. We revised text in section 2.1.2 to clarify: For each detection, a suspected cause of death or injury was assigned based on evidence available from the detection, evidence available on Project infrastructure, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as "unknown" because it cannot be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed. Detections assigned to the “unknown” category were included in fatality estimates if they were located within standardized carcass search areas.
2.2 L1	Text inserted:”…for the truncated winter season and…”	Revision not accepted due to exclusion of winter survey data.
FWS12	This number of carcasses is extremely low. Did you do a power analysis?	The sample size used for spring carcass persistence trials was compliant with the sample size specified in the Desert Sunlight BBCS approved December 2014. The number of carcasses placed for carcass trials is a balance between having a reasonable sample to estimate carcass removal rates, and subsidizing scavengers and potentially creating artificial scavenger dynamics at the Project. The sample size used was decided upon after extensive conversations with Amy Fesnock at BLM. Future seasonal reports and the annual report will pool information on carcass persistence and retrospectively test for seasonal effects using an information-theoretic modeling approach.
FWS13	With such a low number of carcasses this is unlikely to be a problem.	It is unclear what revisions are being requested, if any. Total sample size of carcasses placed at the Project (for all bias trials) is n = 210 per season (carcass persistence trials: 30 along gen-tie and 30

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		within the Project fence; searcher efficiency trials: 60 along gen-tie [30 in each visibility strata], 60 within the arrays [30 in each visibility strata], and 30 along the fence). We believe this is a large enough number, especially relative to the number of non-trial detections being made at the Project, that carcasses should be placed only a few at a time throughout the season.
FWS14	Does this mean n=15 was put out twice for the Feb trials? Please clarify. Also, are the gen-tie carcasses outside the project fence? If so, there seem to be two difference scavenger communities being tested.	We revised text in section 2.2.1 to clarify: Carcass persistence trials within the solar arrays and fence were initiated two days earlier in February than trials along the gen-tie line.
FWS15	Please describe the interval that carcasses were checked. Is there a reason that they are not checked daily, particularly during the first week?	Please refer to section 2.2.1, where the frequency of carcass checks is described: Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period; Periodic ground-based checking of carcasses with trail cameras also occurred to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera's field of view. This schedule has proven reliable in allowing persistence distributions to be estimated.
FWS16	This does not seem true. If the carcass is not there on day 10, they it has been removed before that and would not be available during some portion of the interval. Please clarify how this uncertainty affects the analysis. There should probably be a convention for determining the removal data	We have inserted additional text in section 2.2.2 to address data censoring: Because carcass persistence data were censored, persistence was analyzed using methods that can accommodate censored data and still produce unbiased estimates of the probability of persistence (Therneau 2015,

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
	(i.e., the mid-point). In general, the interval should be kept as short as possible.	Therneau and Grambsch 2000). USGS-developed fatality estimator software (Huso et al 2012) was used to fit survival models to the censored carcass persistence data.
FWS17	How does "censored" status affect the analysis?	We have inserted additional text in section 2.2.2 to address data censoring: Because carcass persistence data were censored, persistence was analyzed using methods that can accommodate censored data and still produce unbiased estimates of the probability of persistence (Therneau 2015, Therneau and Grambsch 2000).
FWS18	Has this been evaluated as adequate to determine searcher efficiency for a single strata? Please provide justification for small sample size.	We revised text in section 2.3.1 to clarify how sample sizes were determined: In the solar arrays, one set of searcher efficiency trials (n = 15 small birds, 10 medium birds, and 5 large birds as agreed upon in section 7.4 of the approved Desert Sunlight BBCS) was conducted in each strata. It is also standard practice to pool data across seasons or other initial strata if differences are not detected. For example, pooling searcher efficiency data across seasons is likely and reasonable given the small changes anticipated in ground cover among seasons.
FWS19	Is searcher efficiency tested for each observer? Please provide these results along with an indication of variation in searcher efficiency across observers.	As agreed upon in the approved Desert Sunlight BBCS, "Searcher efficiency will be summarized for each individual searcher but to avoid needlessly inflating the variance of the estimate, individual searcher effects will not be included in the fatality

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		estimation model." Section 7.4, p.29 (DSL BBCS). Estimates of individual searcher efficiency will be summarized for the annual report, but are beyond the scope and schedule of the seasonal report. We have added a list of observers and the number of searcher efficiency trials available for each observer to find during the spring season in section 3.7.
FWS20	Is sample size adequate to detect a difference between visibility categories?	Evaluation of differences in searcher efficiency between visibility categories will be made with additional data available in the annual report. This level of analysis is beyond the scope and schedule of the seasonal report.
FWS21	Shouldn't the curves then be for 35m and 70m?	We have revised the title for Figure 5 for clarity: Estimated detection probabilities for bird carcasses by size class during spring 2015 (including February) at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented. Further, we have added sample sizes for 70-m and 140-m arrays in Table 2.
FWS22	How does this relate to the curves above? Detectability for small birds drops off before 70 m and presumably is near zero for greater than 70 m.	We have revised section 2.3.2 to clarify how average searcher efficiency was estimated: The mean value of the detection curve is the integral of the detection function calculated between 0-m and the maximum survey distance (w; half the width of the solar array row), divided by the maximum

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		survey distance: $p = \frac{\int_0^w f(x)dx}{w}$ where f(x) is the detection function evaluated at distance, x. And, The weighted average searcher efficiency is calculated based on the number of panel rows of each length in the survey sample: $p_{weighted\ average} = \frac{n_{70}}{n} \times \int_0^{35} f(x)dx + \frac{n_{140}}{n} \times \int_0^{70} f(x)dx,$ where n_{70} is the number of 70-m rows in the sample, $n_{140}$is the number of 140-m rows in the sample, and *n* is the total number of rows in the sample.
FWS23	Was proximity to project features evaluated? Please describe how this information was utilized. Proximity distances may provide insights into which features may pose the greatest risks.	These data are reported in the monthly Avian Injury & Mortality Report. These data will be reported in the annual report but are beyond the scope and schedule of seasonal reports.
FWS24	Since scavenger rates are so high, this definition too easily categorizes carcasses as unknown. Low levels of scavenging should not exclude birds from a more thoughtful evaluation of the cause of the mortality. Other criteria should be considered, including patterns of disturbed dust on solar panels, proximity to a feature with collision risk. Such a blanket categorization, probably masks useful information.	Other criteria are considered. We revised text in section 2.1.2 and the footnote of Table 4 to clarify: Suspected cause of death or injury was assigned based on evidence available from the detection, evidence available on Project infrastructure, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it cannot be determined

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		whether the event was caused by predation or interaction with project infrastructure. Assignments to "suspected cause of death" categories reported in the DSL spring 2015 post-construction monitoring report is consistent with what has been reported in previously-submitted monthly SPUT reports. Per recent discussions, we are looking for additional guidance provided with the SPUT report on making determinations of suspected cause of death.
Table 4 footnote	Text revised: "…in the absence of a completed necropsy,	Revision not accepted. Definitive cause of death is not determined for 100% of necropsies. WEST biologists look for evidence of collision on Project infrastructure, but there is very little information available in terms of evidence suggesting cause of death for the vast majority of detections, and this the case for most all bird fatality studies at renewable energy sites.
FWS25	Spatial distribution of different taxonomic groups should be discussed, particularly as more data come in.	Spatial distribution of carcasses is reported in Table 2. To include discussion of this topic at present would not be meaningful, and it will be addressed in the annual report.
FWS26	This is a good (and more conservative) practice, even if the dove were successfully released, because the viability of the released bird is unknown.	No revisions made.
FWS27	This looks like there may be an effect on persistence time from being outside the fence. This may be due to differences in the scavenger community. Was this tested?	We did not test the scavenger community, but we did test the hypothesis that carcass persistence time inside the fence was different than persistence time outside the fence by comparing models of carcass

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		persistence with and without a covariate for project component using an information-theoretic framework. The best model supported the hypothesis that persistence times were specific to project component, hence we reported two different estimates of persistence. We have revised text in section 3.6 to clarify: The model with lowest AICc score is typically chosen as the “best” model relative to other models tested; however, any model within two AICc points of the best model is considered competitive with the best model (Burnham and Anderson 2004). The best model had a ∆AICc value of 0.77 and included effects of carcass size (small, medium or large), and location (solar arrays/fence or generation-tie line) with a Weibull-distributed removal time, but no effect of season. Estimates of carcass removal time and persistence probabilities are reported from the best model in Table 5.
FWS28	How was this broken down by visibility categories and size classes? See Appendix C?	A breakdown of sample sizes for searcher efficiency trials is found in section 2.3.1. WEST will report more detailed results regarding how many were available to be found by category in the annual report. This level of detail is beyond the scope and schedule of the seasonal reports.
FWS29	Shouldn’t both season and habitat visibility class be evaluated?	That will be tested in future seasonal reports. Removed paragraph as it is unnecessary for the report.
FWS30	Again, a more thoughtful evaluation of cause of mortality should be done to reduce the number of unknowns. In particular, mortalities associated with project features	Please see revised text in section 2.1.2 regarding assignment of suspected cause of death.

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
	that may present a collision risk are probably better categorized as collisions (i.e., solar panels and overhead electrical lines).	
FWS31	This is the same as for Genesis.	This number has been revised as a result of dropping carcass search data from February.
FWS32	This table/appendix requires more explanation.	We have revised the table title and added footnotes for clarification.
TAG Meeting Topics		
	Definition of overhead lines	We revised text throughout the report to clarify; generation tie line and medium voltage overhead lines (associated with the solar field) are now reported separately.
	Sample units associated with overhead collector lines vs. sample units not associated with lines	We revised Figure 2 to include information about sample units that are and are not associated with overhead lines. We included a new table (Table 3) that presents information on the extent of line-associated and non-line-associated arrays in the solar field, representation in the sample, and number of detections associated with each type of array.

Desert Sunlight Solar Farm Summer 2015 Monitoring Report Comment Response Document (draft)

Business Confidential

February 2, 2016

The following is a listing of comments made on the Desert Sunlight Summer 2015 Post-Construction Monitoring Report dated October 15, 2015 as well as responses to those comments.

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
FWS1	Please explain why carcass persistence is influenced by project component.	"During the reporting period, carcass persistence was influenced by carcass size and Project component" is a standard way of reporting model results where AIC supported a best model that included main effects of carcass size and Project component. We have added text in the executive summary and Section 3.6 about why this pattern was observed: The difference in carcass removal times between Project components is because scavengers likely occur in higher densities outside the perimeter fence.
FWS2	Please report median removal times and a figure showing the curve of # remaining over time.	We have included median removal times in the Executive Summary and Table 6. See Figure 7 for the curve of proportion of trial carcasses remaining as a function of days since placement.
FWS3	Is this the searcher efficiency averaged for all observers? What is n?	All searcher efficiency rates are averaged over searchers, as stated in Section 7.4 of the approved Desert Sunlight BBCS. For searcher efficiency rates at the arrays in summer we pooled all available searcher efficiency trial data over all seasons because we found no effect of season on searcher efficiency rates supported by our AIC modeling approach. However at the fence and gen-tie, there were significant seasonal differences so searcher efficiency

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		trial data from the summer only was used at these components. See section 3.7 for text revised for clarity. We have also provided information on the sample sizes per individual
FWS4	IMPORTANT: WEST has said that it modified the Huso estimator, and despite several requests, those modifications have not been shared with the agencies. Until we understand what changes to the code were made, we are reserving judgment on these results.	Revision to the Huso estimator is strictly to the searcher efficiency component of the model. Huso (2010) uses a binomial model to estimate searcher efficiency; the current analysis calculates searcher efficiency via a distance-sampling model, which is detailed in this report (the formula provided for p in Section 2.3.2). Otherwise the model is not modified. We have revised the Executive Summary to include an explanation of the modification, as follows: Using the Huso (2010) fatality estimator model, modified to accommodate a distance-sampling approach to the estimation of searcher efficiency, Text has also been added to Section 2.4 to clarify how the modified estimation of searcher efficiency was used to estimate fatalities.
FWS5	This supports increased frequency for this component.	Any changes to the monitoring plan will be discussed with the TAG.
FWS6	Is this relevant? Please delete. All projects are reporting all mortalities via SPUT reporting regardless of how many.	Revision accepted.
FWS7	Please describe how detectability is being handled for the 25% being surveyed from a distance.	We added the following text to the footnote in Table 1: Fatality rates estimated for sections of the fence that are sampled were extrapolated to sections of the fence where the standard monitoring protocol cannot be used, as described in section 4.2.6 of the

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		approved Desert Sunlight BBCS.
FWS8	Please record and report data on the time of the surveys. This will help determine if the surveys can be used to predict nocturnal vs. diurnal mig behavior. Raw data sheets and GIS files should be submitted with each report.	We have added the following text to section 2.1.2: All searches take place during daylight hours from approximately 530 am to 5 pm. In the summer searches took place from 5:40 am to 2:08 pm Transfer of data files will be discussed by the TAG.
FWS9	Please discuss the effect of the long search interval in relation to the carcass persistence trial data.	We added the following text to Section 4.1: Fatality estimates are influenced by the relationship between carcass removal dynamics and search intervals. In practical terms, longer search intervals reduce average probability that a carcass persists until the next search. In terms of the analysis, this can manifest as a lower probability of persistence through the effective search interval, or an effective search interval that is shorter than the nominal search interval. In either case, the adjustment to carcass counts due to carcass removal dynamics is calculated as (length of effective search interval)/(length of nominal search interval*average probability of persistence through the effective search interval) The adjustment to estimated fatality for carcass removal increases with longer search intervals, and the variance in the estimate may increase, also.
FWS10	Please explain details about how/when the processing occurred in relation to when carcasses were detected.	We revised text in Section 2.1.2 to clarify: As soon as a carcass was detected, it was photographed, and data were recorded according to specifications outlined in

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		section 7.2.5 of the approved Desert Sunlight BBCS. Carcasses were then immediately retrieved from their location on the ground, labeled, and placed in a freezer on site.
FWS11	The Service is still concerned that this section of the fence is not being adequately sampled. Mortality rates may be different along this section of the fence.	The current monitoring method and analysis treats this section of the fence as described in the approved Desert Sunlight BBCS. Furthermore, the very low number of detections that have occurred along the fence (n = 5 since monitoring began in Feb. 2015) suggests the fence has not been a significant source of mortality thus far. This approach has been used at wind energy facilities. In addition, a very high proportion of the fence is sampled.
FWS12	The Service disagrees with this assumption. If it's under the line, the better assumption is that it was caused by the line and a scavenger subsequently discovered the carcass.	By assigning a suspected cause of death as unknown, collision with project infrastructure is not being discounted as a potential cause – it only means there is insufficient evidence to assign a specific cause. Detections made beneath the line could also potentially be a result of predation by raptors perched on the line. We revised text in section 2.1.2 to clarify: For each detection, a suspected cause of death or injury was assigned based on evidence available from the detection, *evidence available on Project infrastructure*, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as "unknown" because it cannot be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed. Detections assigned to the "unknown" category were included in fatality estimates if they were located within standardized carcass search areas. This is consistent with approaches used in wind energy studies.
FWS13	This number of carcasses is extremely low. The Service recommends increasing the number of trial carcasses to help reduce the confidence intervals on estimates.	The number of carcasses used for trials is the number outlined in the approved Desert Sunlight BBCS. The annual report will include a sample of 240 carcass persistence trials (4 seasons) plus an additional 30 from Feb. 2015, and this pooled sample will result in increased power to detect differences.
FWS14	With such a low number of carcasses this is unlikely to be a problem.	It is unclear what revisions are being requested, if any. Total sample size of carcasses placed at the Project (for all bias trials) is n = 210 per season (carcass persistence trials: 30 along gen-tie and 30 within the Project fence; searcher efficiency trials: 60 along gen-tie [30 in each visibility strata], 60 within the arrays [30 in each visibility strata], and 30 along the fence). We believe this is a large enough number, especially relative to the number of non-trial detections being made at the Project, that carcasses should be placed only a few at a

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		time throughout the season. There needs to be a balance between large sample sizes for estimating fatality parameters and too large of sample sizes to a point of increasing scavengers and bringing in more ravens.
FWS15	Please describe the interval that carcasses were checked. Is there a reason that they are not checked daily, particularly during the first week?	Please refer to section 2.2.1, where the frequency of carcass checks is described: Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period; Periodic ground-based checking of carcasses with trail cameras also occurred to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera's field of view. We also added the same language to section 2.2.2 for ease of reference. This schedule has proven reliable in allowing persistence distributions to be estimated.
FWS16	Please clarify how censored data were analyzed and how the analytical methods affected the results. The referenced book is not available to the reader; please provide citation to the agencies. How does the method affect the effective search interval?	WEST has included a copy of the requested citation along with this response matrix. We have revised text in Section 2.2.2 to clarify: It is beyond the scope of this document to provide statistical foundations of censored-data survival models but functions identical to those provided with the USGS-developed fatality estimator software (Huso et al 2012)

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		were used to fit survival models to the censored carcass persistence data, and some background is available in the documentation provided with that software. Some additional detail will be provided in the annual report.
FWS17	The Service proposed larger sample sizes for carcass persistence and searcher efficiency trials. Hence, has this been evaluated as adequate to determine searcher efficiency for a single strata? Please provide justification for small sample size.	We revised text in section 2.3.1 to clarify how sample sizes were determined: In the solar arrays, one set of searcher efficiency trials (n = 15 small birds, 10 medium birds, and 5 large birds as agreed upon in section 7.4 of the approved Desert Sunlight BBCS) was conducted in each strata. It is also standard practice to pool data across seasons or other initial strata if differences are not detected. For example, pooling searcher efficiency data across seasons is likely and reasonable given the small changes anticipated in ground cover among seasons. In addition, fewer samples for the large carcasses is justified, given the lower removal rates and the higher detection for that class. See also the response to FWS14.
FWS18	The terminology here is inconsistent with above. Each carcass counts as a trial or a trial consist of n carcasses?	We revised text in Section 2.3.1 to clarify: Thirty searcher efficiency trial carcasses (n = 15 small birds, 10 medium birds, and 5 large birds) were placed along the fence in the only visibility class present on the fence (easy visibility).
FWS19	Is searcher efficiency tested for each observer? Please provide these results along with an indication of variation in searcher efficiency across observers.	As agreed upon in the approved Desert Sunlight BBCS, “Searcher efficiency will be summarized for each individual searcher but to avoid needlessly inflating the variance of the estimate, individual searcher

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		effects will not be included in the fatality estimation model." Section 7.4, p.29 (DSL BBCS). Estimates of individual searcher efficiency will be summarized for the annual report, but are beyond the scope and schedule of the seasonal report. We have added a list of observers and the number of searcher efficiency trials available for each observer to find during the spring season in section 3.7. This approach is consistent with other fatality monitoring programs for solar and wind.
FWS20	Please provide an analysis that the sample size is adequate to detect a difference between visibility categories. This result seems to be an artifact of the low sample size.	The power of a particular sample size to detect a difference between visibility categories depends on the magnitude of the difference that exists. We have stratified by visibility category, resulting in a 100% increase in the sample size at the solar arrays and along the gen-tie line. Given the fact that we have been able to detect differences among components at Genesis with the same sample sizes (e.g., a 10% difference in searcher efficiency for medium birds between components), we believe we have the power to detect reasonable differences between visibility categories should they exist. In addition, while stratification of visibility is a reasonable design parameter, the general high detection rates observed in the solar arrays and relatively small differences in detection greatly limit the potential influence this decision has on fatality estimates.
FWS21	Please explain the dots in the figure. The number of dots is greater than the number of trial carcasses.	The dots represent trial carcasses used for the estimation of searcher efficiency in the solar arrays, which includes trial carcasses

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		from multiple seasons (supported by AIC modeling – see section 2.3.2). We revised the title for Table 5 to clarify: Estimated detection probabilities for bird carcasses by size class across all available seasons used for during summer (June 01 – August 30) 2015 fatality estimates at the Desert Sunlight Solar Farm Project, Riverside County, California.
FWS22	The denominator (w) from the equation for p (from page 12 equation) is missing from this equation. Is this a typo or was the equation modified for a reason? If so, please explain.	We have revised the typo in the equation.
FWS23	Please provide the values for n_{70} and n_{140}.	We have revised the text to include the values: where $n_{70} = 2580$ is the number of 70-m rows in the sample, $n_{140} = 4020$ is the number of 140-m rows in the sample, and *n* is the total number of rows in the sample.
FWS24	Is this the weighted average probability from above?	Yes. We inserted text to clarify: where *F* is the total number of fatalities, *C* is the number fatalities detected and included in fatality estimation, *r* is the probability a carcass is not scavenged and available to be found at the end of the search interval, and *p* is the probability of detecting a carcass (Huso 2010). Huso (2010) describes the use of a binomial model to estimate the probability of carcass detection; in the present study, the binomial carcass detection model was used to calculate fatalities at project linear features (fence, overhead lines), and the weighted average probability of detection based on distance sampling (described above) was used to estimate probability of detection within the solar arrays.

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
FWS25	Please describe what was bootstrapped and how. The table in the appendix is difficult to understand without a better understanding of the bootstrapping methods.	We revised the text in Section 2.4 to clarify: A total of 1,000 bootstrap replicates was used for each variable including searcher efficiency (*p*), probability of a carcass persisting to the next search ($\hat{r}$), adjusted search interval and observed fatalities. From these bootstrap samples, the probability of available and detected was calculated and applied to the bootstrapped observed fatalities.
FWS26	Aechmophorus species or a different genus?	Yes, *Aechmophorus* sp. Revised.
FWS27	Was proximity to project features evaluated? Please describe how this information was utilized. Proximity distances may provide insights into which features may pose the greatest risks.	These data are reported in the monthly Avian Injury & Mortality Report. These data will be reported in the annual report but are beyond the scope and schedule of seasonal reports. We have included maps of the fatality locations to help understand any large scale patterns and we will be presenting additional maps by guild in the annual report. During the January TAG meeting, we presented such maps.
FWS28	Since scavenger rates are so high, this definition too easily categorizes carcasses as unknown. Low levels of scavenging should not exclude birds from a more thoughtful evaluation of the cause of the mortality. Other criteria should be considered, including patterns of disturbed dust on solar panels, proximity to a feature with collision risk. Such a blanket categorization, probably masks useful information.	Other criteria are considered. We revised text in section 2.1.2 and the footnote of Table 5 to clarify: Suspected cause of death or injury was assigned based on evidence available from the detection, evidence available on Project infrastructure, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it cannot be determined whether the event was caused by predation or interaction with project infrastructure.

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		Assignments to “suspected cause of death” categories reported in the DSL spring 2015 post-construction monitoring report is consistent with what has been reported in previously-submitted monthly SPUT reports. Per recent discussions, we are looking for additional guidance provided with the SPUT report on making determinations of suspected cause of death. In addition, we will be presenting statistics in the final report such as the percent of fresh carcasses that showed collision evidence (e.g. broken neck, beak damage). We also are interested in understanding what the USFWS plans for the carcasses in the freezers, and whether they plan to necropsy those birds.
FWS29	Spatial distribution of different taxonomic groups should be discussed, particularly as more data come in.	Spatial distribution of carcasses is reported in Table 2. To include discussion of this topic at present would not be meaningful, and it will be addressed in the annual report. We presented maps of spatial distribution for waterfowl/waterbirds during the January TAG meeting.
FWS30	This is not clear. Are you suggesting that feather spots from large carcasses last longer than feather spots from small carcasses? Or are you suggesting that large carcasses are more likely to produce feather spots than small carcasses and feather spots in general (large or small) persist for long durations? Please clarify and provide a rationale for the assertion and describe how it might affect the analysis.	We have removed reference to feather spots and revised the text in Section 3.6 to clarify: Carcass size was tested as a potentially important variable, as larger carcasses tend to persist longer than smaller carcasses.
FWS31	Is there enough data to do a good analysis?	The approved Desert Sunlight BBCS states that the goal is to gain a general

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		understanding of the magnitude of the impacts of the solar facility, not necessarily a highly precise estimate of fatalities. The study has been designed to meet that objective. Additional analyses will be conducted for the annual report, after a year of data is available as well as on-going through the 2nd year of monitoring. These additional data will result in increased power to detect patterns, and likely increased precision of point estimates.
FWS32	Please include the timeframe for the persistence trials for ease of reference (30 days?).	The persistence probabilities presented in Table 6 represent the probability of a carcass persisting through the effective search interval. Thus, the 30-day timeframe for the trial is irrelevant to the results presented in the table. We added the effective search interval to the table title for ease of reference.
FWS33	This looks like there may be an effect on persistence time from being outside the fence. This may be due to differences in the scavenger community. Was this tested?	We did not test the scavenger community, but we did test the hypothesis that carcass persistence time inside the fence was different than persistence time outside the fence by comparing models of carcass persistence with and without a covariate for project component using an information-theoretic framework. The best model supported the hypothesis that persistence times were specific to project component, hence we reported two different estimates of persistence. We have revised text in section 3.6 to clarify: The model with lowest AICc score is typically chosen as the “best” model relative to other models tested; however, any model within two AICc points of the best model is

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		considered competitive with the best model (Burnham and Anderson 2004). The best model had a ∆AICc value of 0.77 and included effects of carcass size (small, medium or large), and location (solar arrays/fence or generation-tie line) with a Weibull-distributed removal time, but no effect of season. Estimates of carcass removal time and persistence probabilities are reported from the best model in Table 6.
FWS34	This is the Gen-Tie, right? Better to refer to this as the Gen-Tie to distinguish it from the internal overhead lines above the panels.	Revision accepted.
FWS35	The y-axis is cut off at 0.5. This obscures data for small and med bird size categories. Please provide the Figure with a y-axis range from 0.0-1.0.	We have revised Figure 7 to correct the Y-axis.
FWS36	How was this broken down by visibility categories and size classes? See Appendix C?	A breakdown of sample sizes for searcher efficiency trials is found in section 2.3.1. WEST will report more detailed results regarding how many were available to be found by category in the annual report. This level of detail is beyond the scope and schedule of the seasonal reports.
FWS37	Please provide an additional summary table with the following information for each component and for the entire facility: carcasses detected, estimated fatalities; 90% CI. An additional table with the same information for each size category is also requested.	All of the requested information is presented in Appendix C. We revised the text to direct readers to Appendix C.: Detections used in the analysis, bias corrections, summer fatality estimates, and 90% confidence intervals for summer fatality estimates are detailed in Appendix C.
FWS38	The Service continues to recommend 95% CI, but even at 90% the CI is still too wide to be useful.	90% confidence intervals are the standard in renewable energy and many field studies (Arnett 2005; TRC Environmental Corporation 2008; Johnson et al. 2009). There are other intervals used as well, often

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
		wider than 90%, including the USFWS use of 80% credible intervals for the Eagle Risk Model and 50% credible interval is being considered in some regional Habitat Conservation Plans. Study examples of the use of 90% confidence intervals include the USFWS Western-wide eagle surveys (Nielson et al 2014) as well as the WAFWA prairie chicken surveys (McDonald et al. 2015)
FWS39	Given the size of utility scale projects "per 1000 acres" seems more appropriate.	Revision accepted but we believe a per acre basis is also relevant because other studies that may serve as comparisons are reported on a per acre basis. We reported it both ways.
FWS40	Given the low number of trial carcasses, you can detect a difference between visibility classes [sic].	We have revised the text in Section 4.1 to clarify: Placement of trial carcasses in both difficult and easy visibility classes ensures that the adjustment due to searcher efficiency accounts for both visibility classes, even if there is a real difference in searcher efficiency that cannot be detected with the trial data.
FWS41	What fraction of these unknown detections are feather spots?	We revised text in Section 4.2 to include the percentage of feather spots that made up "unknown cause" detections.
FWS42	We don't agree with this statement. This is unknown. Feather spots may be more mobile, but as far as I know there have been no studies on whether they "multiply" and cause bias. If there has, please provide a reference. It is possible that feather spots could accumulate along fences, but in general, they are just as likely to migrate into a survey area as they are to leave. If	We inserted text to clarify: Further, game cameras trained on carcasses for carcass persistence trials at the Project have documented multiple feather spots originating from a single trial carcass. Ravens and turkey vultures, and possibly roadrunners, dislodge feathers from their attachment to the skin of carcasses during the scavenging process. There are a very

Agency Comment Number or Section-Line number reference	Agency Comment	Response from Desert Sunlight – reference new section
	this is a significant problem, then I recommend shorter search intervals and more complete coverage of the project site.	large number of potential feather spots present on a single bird carcass (because a feather spot is defined as at least two or more primary flight feathers, at least five or more tail feathers, or two primaries within five m (16.4 ft) or less of each other, or a total of 10 or more feathers of any type concentrated together in an area of three square m).
FWS43	This table/appendix requires more explanation.	We have revised the table title and added more descriptive section titles for clarification.
Additional revisions		
NA		We added two tables to the report (Table 7 in Section 3.8 and Table C-2 in Appendix C) to clarify which carcasses were excluded from the fatality analysis. We also revised the maps to reflect carcass status in the fatality analysis.

<u>Literature cited</u>

Arnett, E. B., technical editor. 2005. Relationships between bats and wind turbines in Pennsylvania and West Virginia: an assessment of bat fatality search protocols, patterns of fatality, and behavioral interactions with wind turbines. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Johnson, G.D., M. Ritzert, S. Nomani, and K. Bay. 2009. Final report: bird and bat fatality studies, Fowler Ridge I wind-energy facility, Benton County, Indiana. Western Ecosystems Technology, Inc. Cheyenne, Wyoming.

Nielson, R. M., L. McManus, T. Rintz, L. L. McDonald, R. K. Murphy, W. H. Howe, and R. E. Good. 2014. Monitoring Abundance of Golden Eagles in the Western United States. Journal of Wildlife Management 78(4): 721-730. doi:10.1002/jwm.704.

McDonald, L., K. Adachi, T. Rintz, and G. Gardner. 2015. Range-Wide Population Size of the Lesser Prairie-Chicken: 2012, 2013, 2014, and 2015. Prepared for Western Association of Fish and Wildlife Agencies (WAFWA), c/o Bill Van Pelt, WAFWA Grassland Coordinator, Arizona Game and Fish Department, Phoenix, Arizona. Prepared by Western EcoSystems Technology, Inc. (WEST), Laramie, Wyoming. July 9, 2015.

TRC Environmental Corporation. 2008. Post-construction avian and bat fatality monitoring and grassland bird displacement surveys at the Judith Gap Wind Energy Project, Wheatland County, Montana. TRC Environmental Corporation, Laramie, Wyoming.

Post-Construction Monitoring at the Desert Sunlight Solar Project Riverside County, California

2015 - 2016 Annual Report

Prepared for:

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC

700 Universe Blvd.,
Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.

415 W. 17th St.
Cheyenne, Wyoming 82001

May 31, 2016

WEST Inc.

Draft Pre-Decisional Document – Privileged and Confidential – Not For Distribution

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from March 1, 2015 to February 28, 2016 (the 2015 – 2016 monitoring year) at Desert Sunlight Solar Farm Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the comprehensive annual report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS.

Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 29.5% sample of solar photovoltaic (PV) panels, 2) along inner portions of the fenceline, resulting in 74.4% of the length of the perimeter fence, and 3) along 47.9% of the total length of generation-tie (gen-tie) line from the Project fence to the Red Bluff Substation located south of Interstate 10 (I-10). Searches were conducted at intervals of approximately seven days during spring and fall and 21 days during summer and winter.

All bird and bat fatalities and injuries that were discovered by observers, referred to as "detections" in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, 149 avian detections (including all stranded and injured birds and incidental detections), of 19 guilds and including 53 identified species, were made. The most numerous detection of an identified species was of American coot (*Fulica americana*) with 12 detections, followed by mourning dove (*Zenaida macroura*; n = 6). The most numerous detection in the solar arrays was American coot (n = 9), followed by western grebe (*Aechmophorus occidentalis*; n = 5) with no other species with more than four detections. The only species observed along the fence were American coot (n = 1), common raven (*Corvus corax*; n = 1), common loon (*Gavia immer*; n = 1), white-winged dove (*Zenaida asiatica*; n = 1), and mallard (*Anas platyrhynchos*; n = 1). Eurasian collared-dove (*Streptopelia decaocto*; n = 4) and orange-crowned warbler (*Oreothlypis celata*; n = 3) were the species with the most detections along the gen-tie/road. No bats were detected during the 2015 – 2016 monitoring year.

Avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were applied to a fatality estimator model (Huso 2010) to provide an estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias.

Mean (median) removal time within the solar field was 4.9 (6.0) days during spring, 12.7 (12.6) during summer, 2.5 (1.5) during fall, and 6.5 (6.0) during winter for small carcasses; 36.0 (27.8) days during spring, 36.0 (24.3) during summer, 12.2 (18.0) during fall, and 12.2 (6.8) during winter for medium carcasses; and 58.3 (31.0) days during spring, 13.7 (30.0) during summer,

58.3 (30.0) during fall, and 13.7 (5.1) during winter. At the overhead lines, removal time was 0.8 (0.5), 0.8 (0.5), 0.4 (0.5), and 2.3 (2.5) during spring, summer, fall, and winter respectively. For medium birds, mean (median) removal time at the overhead lines was 14.4 (2.0), 14.4 (15.8), 4.9 (1.5), and 4.9 (2.5) days during spring, summer, fall, and winter respectively. Mean (median) removal time for large birds was 5.8 (19.0), 1.4 (0.5), 5.8 (3.5), and 1.4 (3.5) days during spring, summer, fall, and winter respectively.

Within the solar arrays, searcher efficiency for small birds was influenced by cobble cover and season: small birds in high cobble cover in the fall had a searcher efficiency of 33.2% (CI: 13.3 – 63.9%; n = 15) and small birds in low cobble cover in the fall had a searcher efficiency of 57.8% (CI: 39.0 – 77.7%; n = 27). Searcher efficiency for small birds in high cobble cover during winter, spring and summer was 36.0% (CI: 21.1 – 45.4%; n = 50), and small birds in low cobble cover during winter, spring and summer had a searcher efficiency of 64.5% (CI: 44.5 – 63.4%; n = 70). For medium birds, searcher efficiency within the solar arrays was similar across cobble cover classes but differed by season: in winter, medium bird searcher efficiency was 93.5% (CI: 87.5 – 98.5%; n = 45), and in spring, summer and fall medium bird searcher efficiency was 83.2% (CI: 76.5 – 89.8%; n = 63). For large birds, searcher efficiency among the solar arrays differed between migration seasons (spring and fall) and non-migration seasons (summer and winter). Searcher efficiency during spring and fall for large birds was 83.9% (CI: 72.0 – 94.3%; n = 31). Searcher efficiency for large birds during summer and winter was 100% with no variance (n = 35). Sample sizes refer to numbers of trial carcasses that were available to be found, not numbers of trial carcasses that were placed.

For the fence, the model that included an effect of carcass size, and season (with spring and winter data lumped and summer and fall data lumped) was chosen as the most supported model to estimate searcher efficiency. Along the fence, searcher efficiency was 65% (CI: 52 – 77%), 94% (CI: 88 - 100%), and 100% (CI: 100 - 100%), for small, medium, and large carcasses, respectively during spring and winter and 87% (CI: 77 – 97%), 98% (CI: 96 – 100%), and 100% (CI: 100 – 100%) for small, medium, and large carcasses respectively during summer and fall.

For the gen-tie line, the chosen model included main effects of size, season (with spring and summer data lumped and fall and winter data lumped), and visibility class, with an interaction between visibility class and season. It ranked second by AICc, but was only 0.59 AICc points from the top model. It was chosen because it has similar predictive performance as the top model, but with fewer parameters to estimate. For the easy visibility class, searcher efficiency was 67% (CI: 53 – 81%), 89% (CI: 80 – 95%), and 89% (CI: 80 – 96%) for small, medium, and large carcasses, respectively during spring and summer and 57% (CI:46 – 68%), 84% (CI: 75 – 91%), and 85% (CI: 73 – 93%) for small, medium, and large birds respectively during fall and winter (Table 12). For the difficult visibility class, searcher efficiency was 75% (CI: 62 – 86%), 92% (CI: 86 – 97%), and 92% (CI: 84 – 97%) for small, medium, and large birds respectively during spring and summer and 33% (CI: 22 – 44%), 65% (CI: 53 – 77%), and 67% (CI: 51 – 82 %) for small, medium, and large birds respectively during fall and winter.

Using the Huso (2010) fatality estimator model, during the 2015 – 2016 monitoring year, there were an estimated 1,328 bird carcasses (CI: 1,007 – 2,303) at the Project (all components combined). There were an estimated 53 (CI: 28 – 85) large birds, 336 (CI: 246 – 449) medium birds, 881 (CI: 566 – 1,843) small birds, and 58 (CI: 22 – 143) birds of unknown size at the Project (all components combined).

There were an estimated 628 (CI: 496 – 951) bird carcasses (152/1000 acres, 1.16/nameplateMW) at the solar arrays, 11 (CI: 2 – 26) at the fence, and 688 (CI: 364 – 1,567) along the gen-tie line. Estimates of fatalities along the gen-tie are heavily influenced by the high rates of scavenging observed during the limited trials at the gen-tie (i.e., large correction factors) and are likely very unreliable.

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Michael Gerringer	Wildlife Biologist
Sarah Nichols	Research Biologist/Field Supervisor
Lacey Jeroue	Statistician
Paul Rabie	Statistician
Pam Bullard	Designated Biologist
Darin Blood	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2016. Avian and Bat Monitoring at the Desert Sunlight Solar Project Riverside County, California, 2015 -2016 Annual Report. Prepared for Desert Sunlight 250, LLC and Desert Sunlight 300, LLC, Juno Beach, Florida. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne Wyoming.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

1.1 Project Background

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC (collectively, Desert Sunlight) constructed and operates the Desert Sunlight Solar Farm Project (Project), which consists of two main components: 1) a 550-megawatt (MW) photovoltaic (PV) generating facility; and 2) a 220-kilovolt generation interconnection (gen-tie) line. The Project comprises approximately 1,700 hectares (ha; 4,200 acres) of land administered by the Bureau of Land Management (BLM) six miles north of Desert Center in Riverside County, California (Figure 1).

1.2 Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (BBCS; 2014) was prepared by the Project proponent in collaboration with the US Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and BLM to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency approval of the BBCS occurred in December 2014. Amendments to the sampling protocol along some portions of the Project fenceline were made by Desert Sunlight and approved by the BLM on February 11, 2015.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Desert Sunlight in collaboration with the USFWS, CDFW, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the gen-tie line, perimeter fence and other features of the Project that may result in injury and fatality.

2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with Project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
3. Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

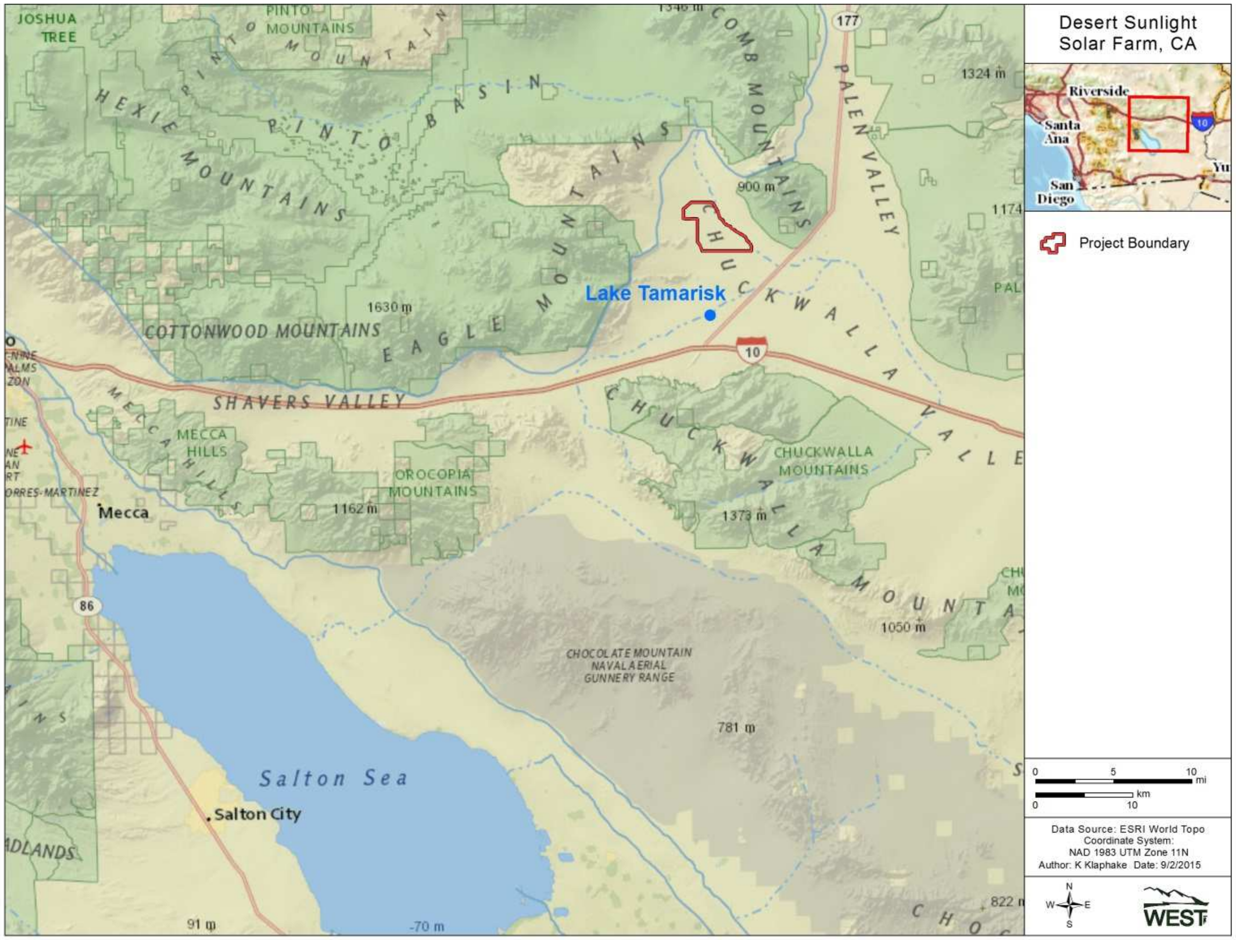


Figure 1. Desert Sunlight Solar Farm Project vicinity map, Riverside County, California.

1.3 Purpose of This Report

This report represents the comprehensive annual report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS. This report includes data and final information from all four quarterly monitoring periods.

This report covers the 2015 – 2016 monitoring year, which includes the period from March 1, 2015 to February 28, 2016. All carcasses and injuries that were discovered by observers are referred to as “detections” in this report. As stated in the approved BBCS, this report includes the observed detections for likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and for suspected causes of death. Species composition of detections and the results of the bias trials are also included in this report.

2 METHODS

The following section describes the field and statistical methods used during the monitoring period, including the analytical methods for estimating overall avian fatality rates.

2.1 Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. This section also describes the methods for conducting carcass removal and searcher efficiency trials; the methods for reporting and analyzing data, and the methods for producing fatality estimates for the Project.

2.1.1 Areas Surveyed

Standardized carcass searches were conducted at sampling units, which include the solar arrays (Table 1, 2; Figure 2); the “fenceline” defined as the perimeter fence for the Project (Table 1, Figure 2); and the gen-tie line (from the Project fence to the Red Bluff Substation on the south side of I-10; Table 1, Figure 3). Some overhead lines co-occur with solar arrays (medium voltage overhead (MVOH) lines). The MVOH lines were part of standardized carcass searches to the extent that they co-occurred with solar arrays included in the sample (Table 2; Figure 2).

Table 1. Areas included in standardized carcass searches at the Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

Project Component	Total Size	Units	% of Component Searched
Solar arrays	1045.9	Hectares	30.0[1]
Fence	16.7	Kilometers	99.0[2]
Gen-tie line	19.2	Kilometers	47.9[3]

[1] Percent area that was searched in spring (28.2) summer (29.5), fall (29.5), and winter (29.5), slightly less than 30% total because of unequally sized arrays.

[2] 74.4% of the fence is fully accessible and surveyed following the standard protocol, while approximately 25% of the fence is surveyed from a distance. Fatality rates estimated for sections of the fence that are sampled were extrapolated to sections of the fence where the standard monitoring protocol cannot be used, as described in Section 4.2.6 of the approved Desert Sunlight BBCS. A very short segment near the gate is not sampled due to restoration activities.

[3] 52.1% of the gen-tie will be sampled in 2016.

Comentado [A1]: Is this supposed to be 99.4 based on the footnote explanation?

Table 2. Area and proportion of solar arrays that are and are not associated with overhead lines at the Desert Sunlight Solar Farm Project, Riverside County, CA.

	Line-associated[1]	Not line-associated	Proportion line-associated
Entire facility	89.4 ha	956.5 ha	0.09
Standardized searches	32.2 ha	291.0 ha	0.10

[1] Line-associated area was estimated as the area of any array that fell within the 30-m strip transect below the MVOH line.

Note: Hectares (ha)

To ensure a balanced distribution of sample units in the solar field (defined as the collection of all PV solar panels), the entire field was divided into ten strata, and individual sampling units were randomly selected within each stratum to compose an approximately 30% sample. This sampling design ensures that units included in the sample were not spatially clumped within the solar field. The solar field consists of arrays of solar panels (referred to as a solar array) that are either 70 meters (m) or 140-m wide. The sample includes 133 of each type of array. There are 2,580 70-m rows, and 3,900 140-m rows in the sample.

On April 21, 2015, the Project was struck by a tornado. The tornado damaged some of the sampling units and resulted in limited access that ultimately lasted longer than initially expected. Thus, 142 sample units (128 arrays, fence, and gen-tie combined) were visited 12 times continuously and without interruption during the spring season. Six arrays were visited seven times from the beginning of the spring season until the tornado occurred on April 21, 2015; three weeks elapsed before the six damaged arrays were replaced with arrays in the solar field that were not affected by the tornado. During this three week period, Desert Sunlight LLC remained in contact with the BLM as details on access limitation developed. Once it was determined that access to damaged arrays would be limited for a longer time period, six replacement arrays were identified by choosing a random sample of non-damaged arrays within the same block that contained the original arrays that were damaged by the tornado.

2.1.2 Search Frequency and Timing

Standardized searches occurred during the 2015 – 2016 monitoring year, which includes the period from March 1, 2015 through February 28, 2016. All Project components included in standardized searches were surveyed 31 times during the 2015 – 2016 monitoring year (12 times during spring, four times during summer, nine times during fall, and six times during winter). All searches took place during daylight hours from 06:30 to 17:00.

The average search interval for all Project components included in standardized carcass searches was 7.0 (median 7.0) during spring, 22.8 days (median 21.0 days) during summer, 8.1 days (median 7.0 days) during fall, and 19.1 days (median 21.0 days) during winter. Slight variation in search interval was anticipated due to weather and logistical delays.

2.1.3 Search Methods

Standardized carcass searches were performed by BLM-approved biologists in accordance with methods outlined in the BBCS.

Within the solar field, arrays of solar panels were surveyed by observers traveling on foot. A distance sampling approach was used whereby biologists slowly walked a transect line along the ends of rows of solar panels in a direction perpendicular to the rows, searching ahead and to the side within the array for bird and bat detections. Biologists scanned out to a maximum perpendicular distance of approximately 70 m from the transect. Biologists carried binoculars to allow them to verify the presence of a detection as opposed to rocks or vegetation. Once a detection was confirmed, the distance of the detection to the transect line was estimated using laser range finders. Each array included in the sample was searched by observers walking two transects – one on the west side and one on the east side of the array with observers looking toward the center of the array.

Comentado [A2]: Does the observer stop and scan with binoculars at each row? Or do they just walk slowly look with the naked eye and then use binocs if they see something? They walk slowly use the naked eye and stop only if they see something.

Once a carcass was detected, it was photographed, and data were recorded according to specifications outlined in Section 7.2.5 of the approved Desert Sunlight BBCS. Carcasses were then retrieved from their location on the ground, labeled, and placed in a freezer on site.

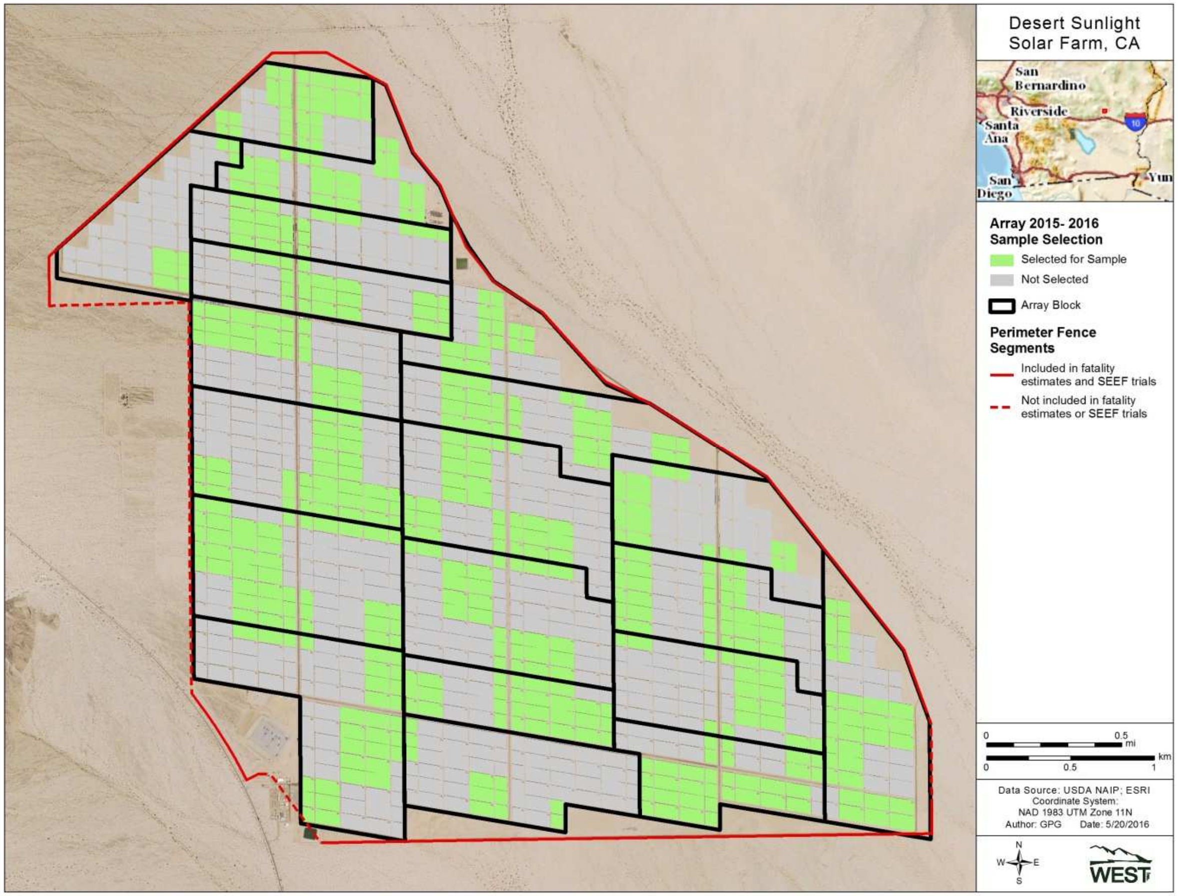


Figure 2. Areas of standardized searches at the solar field, visitor center, and overhead lines within the fence at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

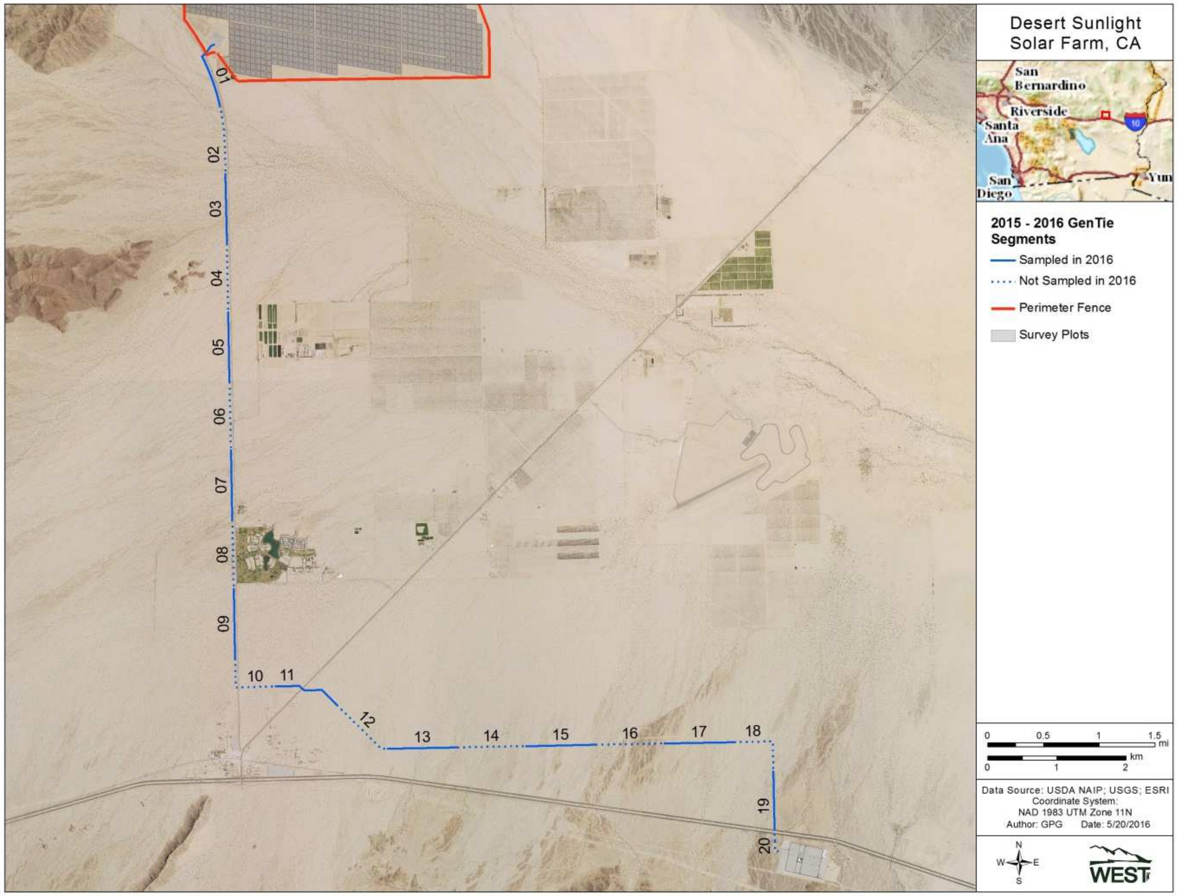


Figure 3. Areas of standardized searches along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

Most (74.4%) of the length of fenceline (approximately 10 miles; Figure 2) was searched from a vehicle using the standard protocol. Biologists searched a 6-m wide strip transect centered on the fence from the inner perimeter. Travel speed was below five miles per hour (mph) while searching. Some sections along the fence cannot be driven close to the fence line. The fence line along the western edge of the Project is drivable but the road is approximately 15 m away from the fence and the road and fence are separated by a drainage ditch. The fence along this section is covered with a tan tarp and trees and shrubs have been planted to reduce visibility of the Project from the west. Additions of vegetation and the tarp likely reduce potential for bird collision with the fence. This section of the fence was driven to document carcasses, but detections along this portion of the fence are not included in adjusted fatality estimates because detection rates are likely very low. As specified in Section 4.2.6 in the approved Desert Sunlight BBCS, we assume that fatality rates are similar between the portion of fence that was searched and the portion that was not. A separate section of the fence in the southeastern corner of the Project cannot be driven because the eastern edge of the berm that bounded construction ponds is too narrow for a vehicle. Along this portion of the fence, the observer stopped at both north and south ends of the berm and used binoculars to search for carcasses. Finally, the area along a portion of the southwest fence line near the entrance gate is approximately 30 to 50 m from the road and is separated from the fence by an area that has recently undergone vegetation restoration. This area was also eliminated from sampling. Fatality rates estimated for sections of the fence that were sampled were adjusted to account for the proportion of fence not sampled with the standard monitoring protocol, as specified in section 4.2.6 of the approved Desert Sunlight BBCS. In other words, the fatality rates (number of carcasses/m of fenceline sampled) was multiplied by the total fenceline in the facility to get the total fenceline carcass estimate for the facility.

The gen-tie line was searched using a 30-m wide strip transect (i.e., 15 m of ground on either side of the overhead line). Sample units along the gen-tie line were chosen by dividing the total length of line from the Project fence south to the Red Bluff Substation just south of I-10 into 1-kilometer (km) segments. Thus, a 47.9% sample of the total length of the line was searched (Figure 3). Biologists slowly walked every other 1-km segment of the line, meandering the width of the strip transect, scanning for dead or injured birds or bats within 15 m (49.2 feet [ft]) of the overhead line.

For each detection, a suspected cause of death or injury was assigned based on evidence available from the detection, evidence available on Project infrastructure, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned “unknown” cause of death because it cannot be determined whether the event was caused by predation or interaction with Project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed. Detections assigned to the “unknown” category were included in fatality estimates if they were located within standardized carcass search areas, and all detections made during the 2015 – 2016 monitoring year are reported here.

2.2 Carcass Persistence Trials

Carcass persistence trials were conducted in each of the four seasons during the 2015 – 2016 monitoring year. Carcasses from three size classes were used for trials (small: zero-100 grams [g], medium: 101-999 g, and large: 1000+ g). The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quails (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), chukar (*Alectoris chukar*) and adult coturnix quail, and the large size class comprised of hen mallards (*Anas platyrhynchos*) and hen ring-necked pheasants (*Phasianus colchicus*).

2.2.1 Carcass Persistence Data Collection

To quantify carcass persistence rates, 15 small, 10 medium, and 5 large carcasses were randomly placed and monitored along the gen-tie line during each seasonal monitoring period. Within the solar arrays the same numbers of each size category were placed at Desert Sunlight, as specified in the approved Desert Sunlight BBCS. During spring, an additional five large bird carcasses were placed within the solar arrays. During winter, an additional five large birds (two along the gen-tie and three within the solar arrays), 10 medium birds (five along the gen-tie and five within the solar arrays), and 15 small birds (eight along the gen-tie and seven within the solar arrays) were placed. Thus, 275 carcasses were placed during the 2015 – 2016 monitoring year. By placing carcasses inside (within arrays and along inner perimeter of the fence) and outside (along the gen-tie) the Project fence, the possibility of different carcass persistence rates inside and outside the Project fence is accounted for. During the 2015 – 2016 monitoring year, 70 carcasses (13 during spring, 15 during summer, 15 during fall, and 27 during winter) within the Project fence (within solar arrays and along the fence) were monitored using motion-triggered digital trail cameras as well as by visits on foot. The remaining carcasses were visited on foot for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality. No carcasses along the gen-tie line were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as "feeding stations," trail cameras were installed five days before specimens were placed. In addition, two fake cameras (four cameras used during spring) were placed within the Project fence in areas without bias trial carcasses and periodically moved to new locations within the fence. Periodic ground-based checking of carcasses with trail cameras also occurred to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera's field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire Project, not just in areas subject to standard searches, and trials were initiated in smaller numbers on two to three different dates throughout each of the four seasonal monitoring periods.

2.2.2 Estimating Carcass Persistence Times

Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g., days a carcass is present before being removed) may not be exactly known, but is known to be within a finite range. For example, suppose a carcass was checked on day seven and was present, and was checked again on day ten, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass became unavailable at some point between seven and ten days. This carcass would be considered “interval censored”. Similarly, if a carcass lasts the entire 30-day trial period, that carcass is “right censored”— it is known that the carcass lasted at least 30 days, but it may have persisted longer. Because carcass persistence data was censored, persistence was analyzed using methods that can accommodate censored data and still produce unbiased estimates of the probability of persistence (Therneau 2015, Therneau and Grambsch 2000). It is beyond the scope of this document to provide statistical foundations of censored-data survival models, but functions identical to those provided with the USGS-developed fatality estimator software (Huso et al 2012) were used to fit survival models to the censored carcass persistence data, and some background is available in the documentation provided with that software.

USGS-developed fatality estimator software (Huso et al 2012) was used to fit survival models to the censored carcass persistence data. The USGS software used to estimate carcass persistence calculates the period over which there is less than a 1% chance for a carcass to persist. The 'effective search interval' is defined as the shorter of a) the length of time beyond which there is less than a 1% probability that a carcass persists, and b) the actual search interval (Huso 2010). The probability of persistence is given for the effective search interval, and the probability that a carcass persists through the actual search interval is equal to *p* (persist through effective search interval) * effective search interval / actual search interval.

There were four distributions implemented in survival models used to estimate the probability a carcass is un-scavenged and available to be found at the end of the search interval (*r*): exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike’s Information Criterion corrected for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model with combinations of the covariates carcass size, Project component, season, and visibility, to observed carcass persistence data.

2.3 Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the 2015 – 2016 monitoring year. Carcasses from three size classes (small, medium, and large) were used for trials. The small size class comprised house sparrows and two- to three-week-old coturnix quails, the medium size class comprised rock pigeons, chukars, and older coturnix quails, and the large size class comprised hen mallards and hen ring-necked pheasants.

2.3.1 Searcher Efficiency Data Collection

Training of biologists on the Project-specific protocol and early assessments of habitat conditions within the solar arrays suggested that the amount of cobble present in the soil may be an important factor influencing searcher efficiency. To satisfy requirements regarding consideration of visibility class per the BBCS and address the influence of cobble cover on searcher efficiency, sample units in the solar arrays and along the gen-tie were stratified by cobble cover and assigned to one of two classes (<15% and >15% cobble cover). Classes were determined by making ocular estimates of cobble cover at each sample unit and then evaluating the frequency histogram of sample units across the range of estimated cobble cover (Figure 4). A natural break point was identified at 15% cobble cover, so the same value was chosen as the break point that defined the two cobble cover classes. The high cobble class made up only 13% of the sample units. Thus, in the solar arrays, two sets of searcher efficiency trials were conducted during the 2015 – 2016 monitoring year (one set in each cobble cover class; *n* in low cobble equals 110 small birds, 71 medium birds, and 41 large birds; *n* in high cobble equals 71 small birds, 42 medium birds and 25 large birds [see Table 3 for placement by size, visibility class, and Project component for each season]). Along the gen-tie, visibility was expected to be related to vegetation and rock cover. Thus, searcher efficiency trials along the gen-tie occurred in two visibility classes (easy: ≥90% bare ground, vegetation <6" tall; and more difficult: <90% bare ground, vegetation ≥6" tall). Sample sizes for the easy class and the more difficult class were 75 small birds, 50 medium birds, and 27 large birds and 76 small birds, 50 medium birds, and 27 large birds respectively. The entire fence line was considered an easy visibility class. One hundred fifty searcher efficiency trials occurred along the fence (n = 75 small birds, 50 medium birds, 25 large birds). During the 2015 – 2016 monitoring year, 810 searcher efficiency trials occurred at the Project. Locations for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches.

Table 3. Searcher Efficiency Placements by size, visibility class, and Project component for each of the four seasonal monitoring periods at the Desert Sunlight Solar Farm Project, Riverside County, California.

Project Component	Visibility Class	Size	Spring	Summer	Fall	Winter	Total
Solar Arrays	High	LB	4	0	6	15	25
Solar Arrays	High	MB	3	0	9	30	42
Solar Arrays	High	SB	11	0	15	45	71
Solar Arrays	Low	LB	12	10	9	10	41
Solar Arrays	Low	MB	10	20	21	20	71
Solar Arrays	Low	SB	20	30	30	30	110
Fence	Easy	LB	5	5	5	10	25
Fence	Easy	MB	10	10	10	20	50
Fence	Easy	SB	15	15	15	30	75
Gen-tie	Diff	LB	5	3	4	10	22
Gen-tie	Diff	MB	9	11	11	19	50
Gen-tie	Diff	SB	15	16	15	30	76
Gen-tie	Easy	LB	5	6	6	10	27
Gen-tie	Easy	MB	11	9	9	21	50
Gen-tie	Easy	SB	15	15	15	30	75
Season Totals			**150**	**150**	**180**	**330**	**810**

Large bird = (LB); Medium bird = (MB); Small bird = (SB). Low = low coble cover; High = high coble cover; Diff = difficult visibility class; Easy = easy visibility class.

Comentado [A3]: Why 0?

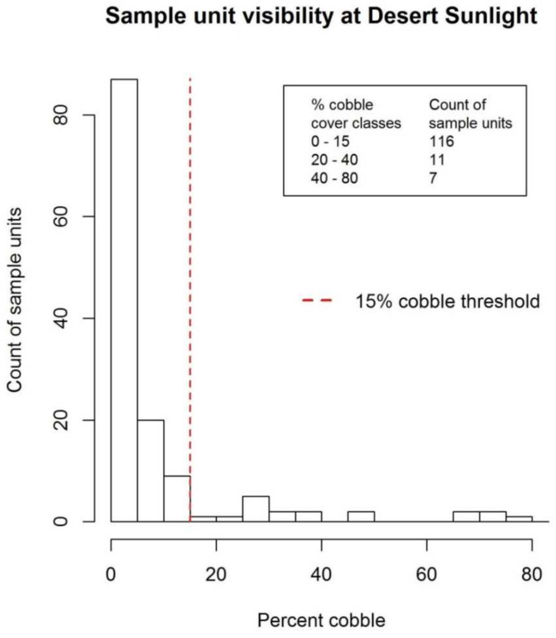


Figure 4. Frequency histogram of sample units (in the arrays only) at Desert Sunlight Solar Farm Project by estimates of cobble cover. Based on this distribution, each sample unit was assigned to one of two classes of cobble cover (<15%; >15%).

2.3.2 Estimating Searcher Efficiency

Searcher efficiency at Desert Sunlight was estimated separately for linear features (the Project fence and the gen-tie line), and the solar arrays, reflecting the different search methods used on arrays and linear features. For linear features, logistic regression models were fit to searcher efficiency data, and AICc was used to compare models. Models including effects of carcass size (three classes), visibility (two classes; gen-tie only), and season were compared to each other and the null (i.e., intercept only) model. Once the most supported model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, *p*, was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from the 2015 – 2016 monitoring year.

For the solar arrays, searcher efficiency was evaluated using a distance sampling approach (Buckland et al. 1993). Distance sampling assumes perfect detection on the transect line (at distance = 0), an assumption that is likely valid in the solar arrays given the relatively flat & vegetation-free nature of the soil surface. A curve is fitted to the observed carcass data that predicts probability of detection as a function of distance from the transect line. The mean value of this function over a specified distance, *w,* is equal to the average searcher efficiency for a transect of width *w*. The mean value of the detection curve is the integral of the detection function calculated between 0-m and the maximum survey distance (*w;* half the width of the solar array row), divided by the maximum survey distance:

$$p = \frac{\int_0^w f(x)dx}{w},$$

where f(x) is the detection function evaluated at distance, *x*.

One departure in the methods used here, relative to the methods presented in Buckland et al. (1993), was that for this study the detection function was estimated using trial carcasses, which meant that there were both presence (detected) and absence (not detected) data available to fit the detection function (Figure 5, 6, and 7). The availability of both presence and absence data means that the detection function can be estimated using only trial carcasses whose distribution is known. Therefore the detection function, the average searcher efficiency among the arrays, and the final fatality estimate within the arrays are all insensitive to the spatial distribution of carcasses within individual arrays, and the overall searcher efficiency estimate is valid even if the distribution of carcasses among the arrays is not uniform.

Distances of trial carcasses (trials both found and missed) from the transect line were used to fit half-normal, exponential, and hazard rate distribution detection functions for searches among the arrays, which are all commonly used functions for distance sampling surveys (Buckland et al. 1993). The fit of detection functions were compared using AICc and each model was fit with covariates season, carcass size, cobble cover class), and without. Model fits that indicated searcher efficiency increasing at greater distances (n = 54 of 312 candidate models) were excluded from consideration. Size classes were evaluated separately: small bird searcher efficiency was best described by a hazard rate detection function and a model that included cobble cover and split seasons into fall and spring/summer/winter (Figure 5). Medium bird searcher efficiency was best described using an exponential detection function and differed between winter and spring/summer/fall (Figure 6). Large bird searcher efficiency was best described using a uniform detection function and differed between spring/fall and summer/winter (Figure 7).

Comentado [A4]: What does this mean?

Because the solar arrays were surveyed by searchers who walked down both sides of the rows of panels, the width of the search transect was specified as half the width of the rows of panels. For larger birds, there is almost certainly a non-zero detection probability beyond this distance but the bias that occurs by ignoring this non-zero detection probability is conservative (i.e., the searcher efficiency is underestimated). Some solar arrays have row widths of 70 m (search transect width of 35 m) and some have row widths of 140 m (search transect width of 70 m). The weighted average searcher efficiency is calculated based on the number of panel rows of each length in the survey sample:

$$p_{weighted\ average} = \frac{n_{70}}{n} \times \frac{\int_0^{35} f(x)dx}{35} + \frac{n_{140}}{n} \times \frac{\int_0^{70} f(x)dx}{70},$$

where n_{70} is the number of 70-m rows in the sample, n_{140} is the number of 140-m rows in the sample, and *n* is the total number of rows in the sample. Searcher efficiency was higher for the arrays with a width of 70 m, and overall searcher efficiency was estimated as a weighted average based on the proportions of 70-m arrays and 140-m arrays in the sample units.

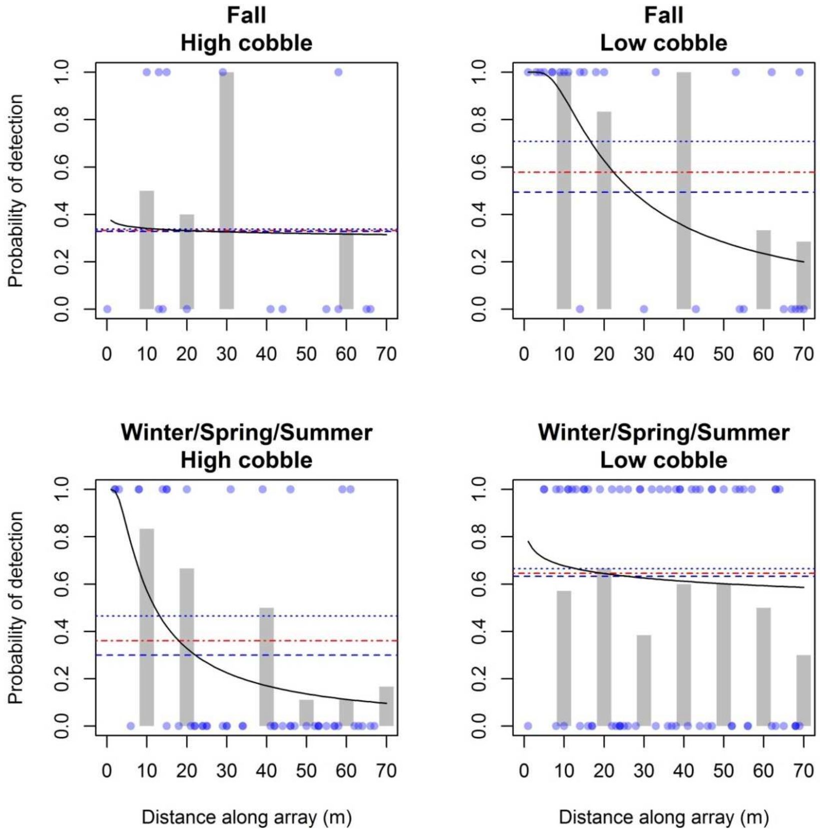


Figure 5. Estimated detection probabilities for small bird carcasses by cobble cover class and season during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented.

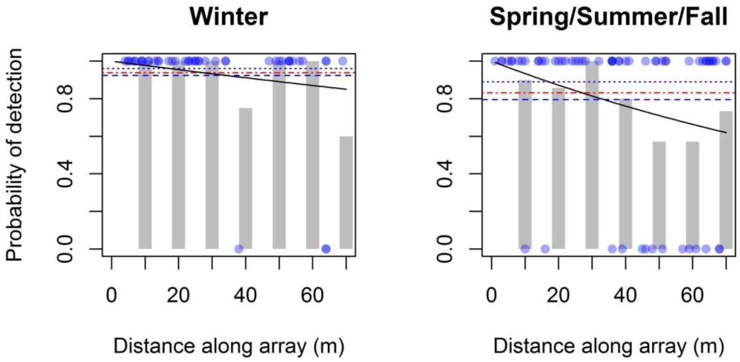


Figure 6. Estimated detection probabilities for medium bird carcasses by season during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented.

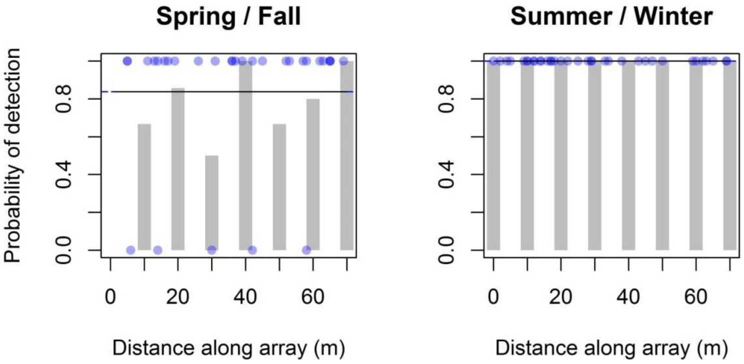


Figure 7. Estimated detection probabilities for large bird carcasses by season during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented.

2.4 Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots were also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie line versus cleared areas beneath solar panels). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where F is the total number of fatalities, C is the number fatalities detected and included in fatality estimation, r is the probability a carcass is un-scavenged and available to be found at the end of the search interval, and p is the probability of detecting a carcass (Huso 2010). Huso (2010) describes the use of a binomial model to estimate the probability of carcass detection in the present study. The binomial carcass detection model was used to calculate fatalities at Project linear features (fence, overhead lines) and the weighted average probability of detection based on distance sampling (described above) was used to estimate probability of detection within the solar arrays.

All fatality estimates were calculated using the Huso estimator (modified to accommodate the distance-sampling based estimate of searcher efficiency in the solar arrays), as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates was used for each variable including of searcher efficiency (p), probability of a carcass persisting to the next search ($\hat{r}$), adjusted search interval and observed fatalities. From these bootstrap samples, the probability of available and detected was calculated and applied to the bootstrapped observed fatalities. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

2.5 Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by either WEST avian biologists or operations personnel and were considered “incidental” detections. When found by operations personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the Desert Sunlight SPUT Avian Injury and Mortality Report Forms, March 2015 - February 2016. All detections made in search areas during the reporting period were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

3 MONITORING RESULTS

3.1 Summary of Avian Detections

Figures 6 – 9 show the location of detections found during the monitoring year. Detailed areas of carcass locations along the gen-tie line are provided in Appendix A. During the 2015 – 2016 monitoring year, a total of 149 avian detections (including all stranded and injured birds and incidental detections) of 19 guilds and including 53 identified species were recorded (Table 4; Figure 8, 9, 10, and 11). The most numerous detection of an identified species was of American coot (*Fulica americana*) with 12 detections, followed by mourning dove (*Zenaida macroura*; n = 6). The highest detection in the solar arrays were American coot (n = 9), followed by western grebe (*Aechmophorus occidentalis*; n = 5) with no other species with more than four detections. The only species observed along the fence were American coot (n = 1), common raven (*Corvus corax*; n = 1), common loon (*Gavia immer*; n = 1), white-winged dove (*Zenaida asiatica*; n = 1), and mallard (*Anas platyrhynchos*; n = 1). Eurasian collared-dove (*Streptopelia decaocto*; n = 4) and orange-crowned warbler (*Oreothlypis celata*; n = 3) were the species with the most detections along the gen-tie/road. No bats were detected during the 2015 – 2016 monitoring year. For fresh carcasses, body weights and weather conditions the preceding nights are described in Appendix B.

The majority of detections (n = 98, or 65.8% of total detections) occurred at the solar arrays (Tables 4, 5, and 6). Forty-one detections (27.5%) occurred along the gen-tie line, seven along the fence and three at buildings. There do not appear to be major concentration areas of detections within the solar arrays (Figures 6, 7). One hundred thirteen detections (75.8%) were made during standardized carcass searches and 36 (24.2%) were documented as incidentals.

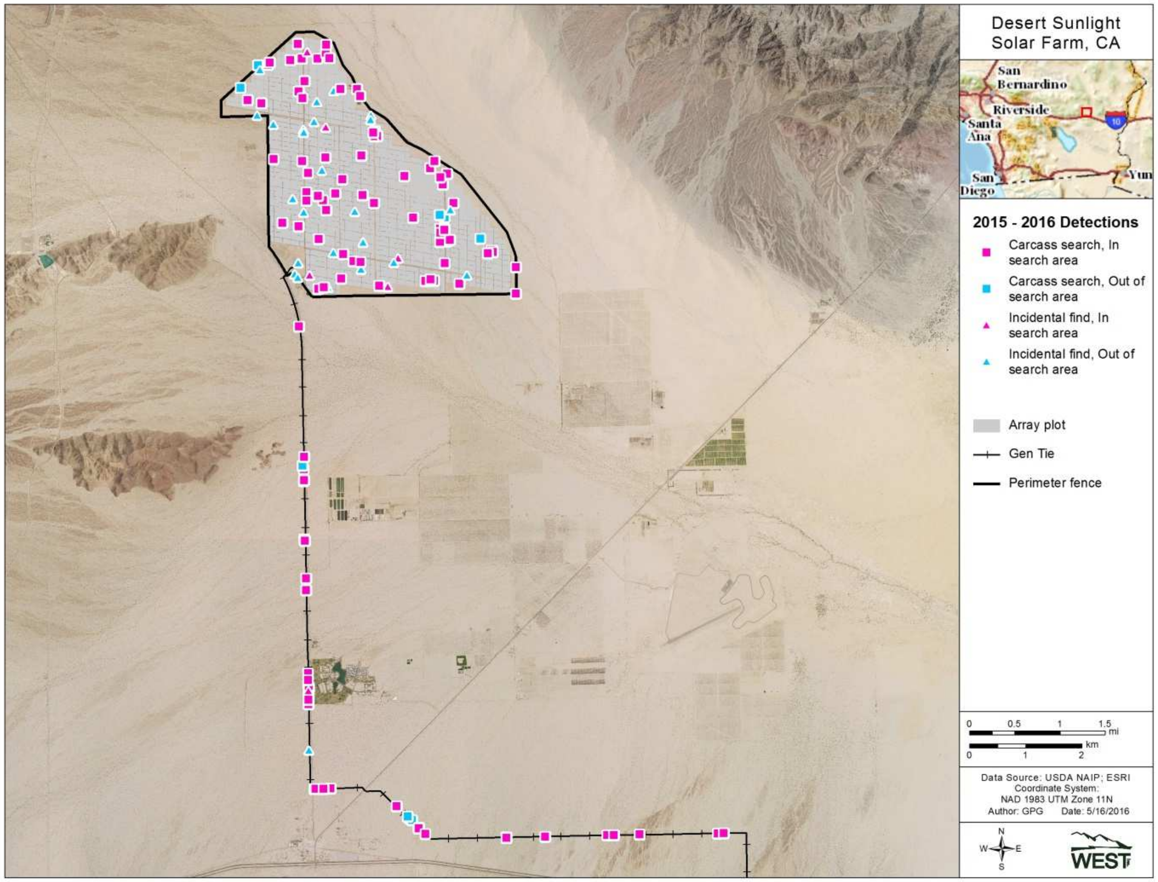


Figure 8. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at the solar field, visitor center, overhead lines within the fence, and the gen-tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

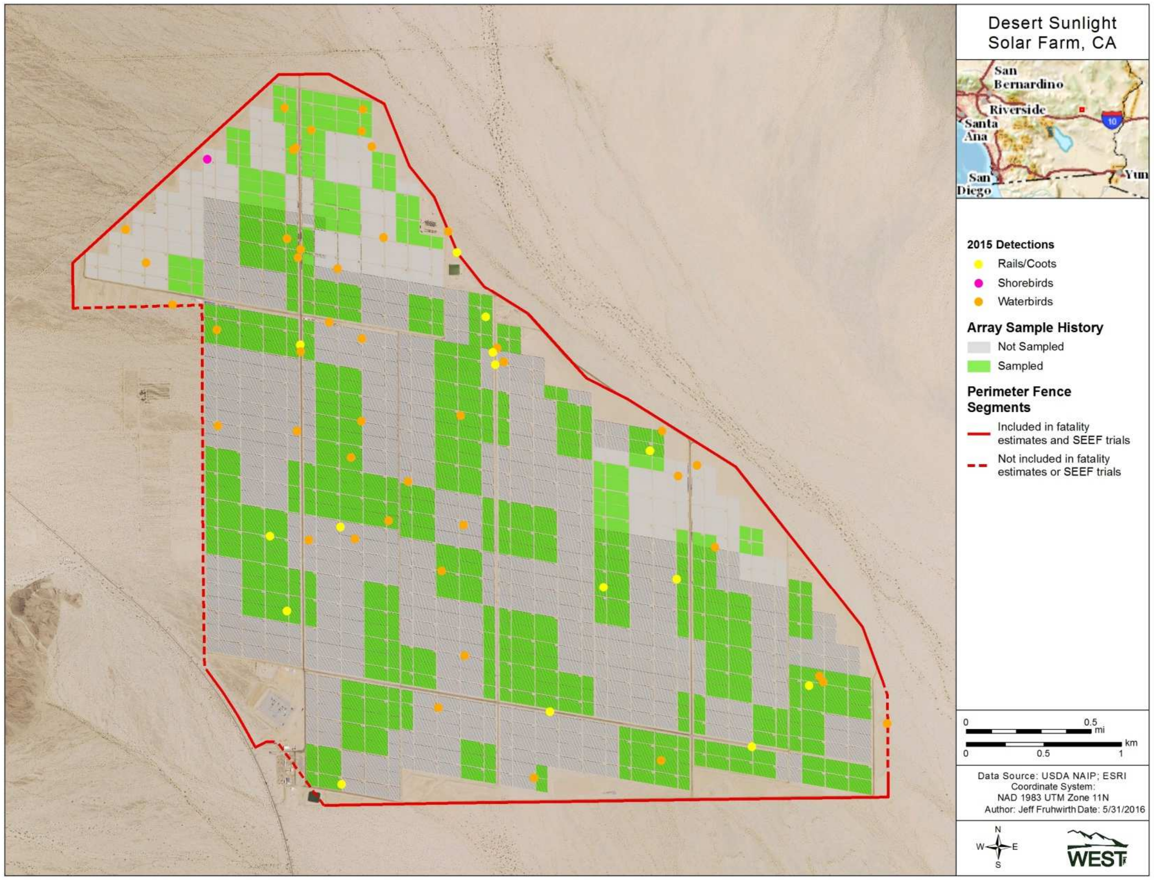


Figure 9. Location of water-associated bird carcass detections throughout the solar field, visitor center, and overhead lines within the fence at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

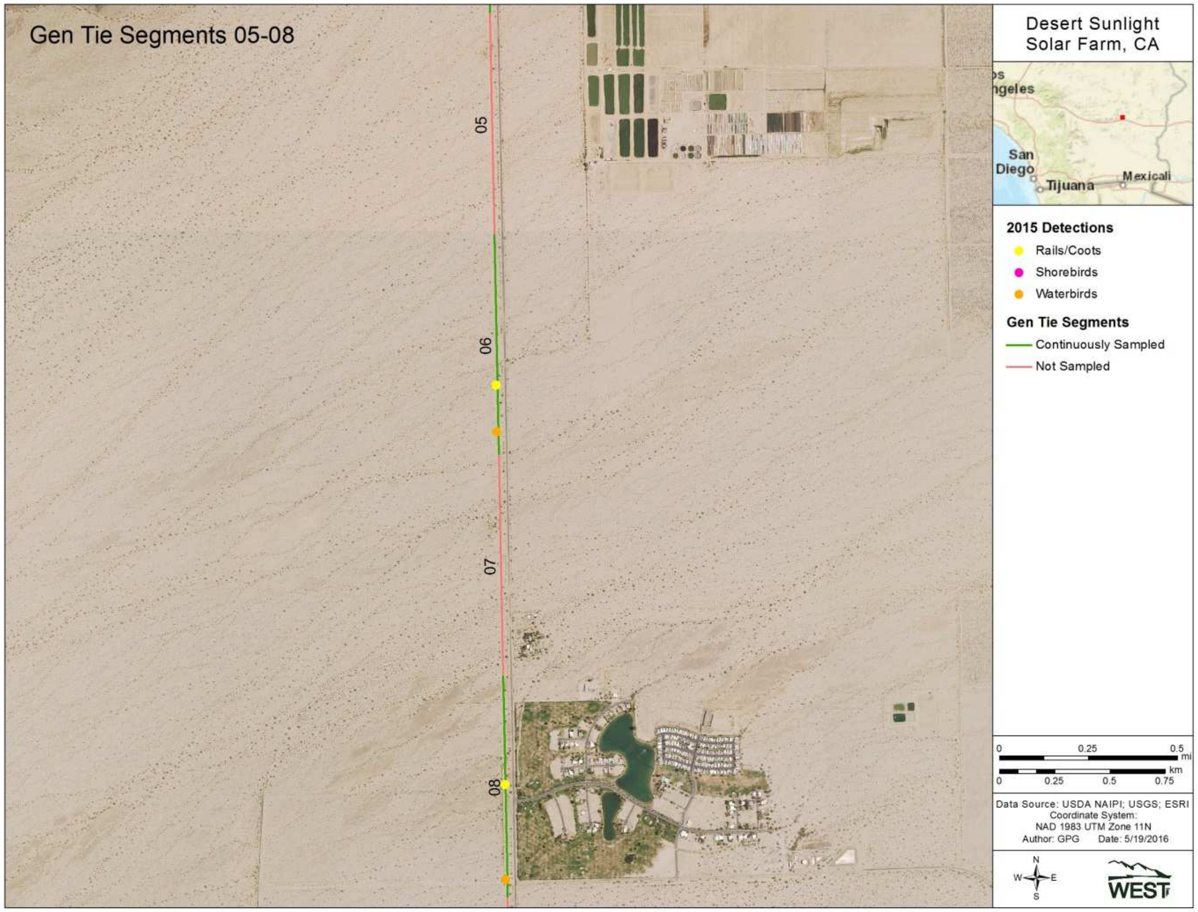


Figure 10. Location of water-associated bird carcass detections along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

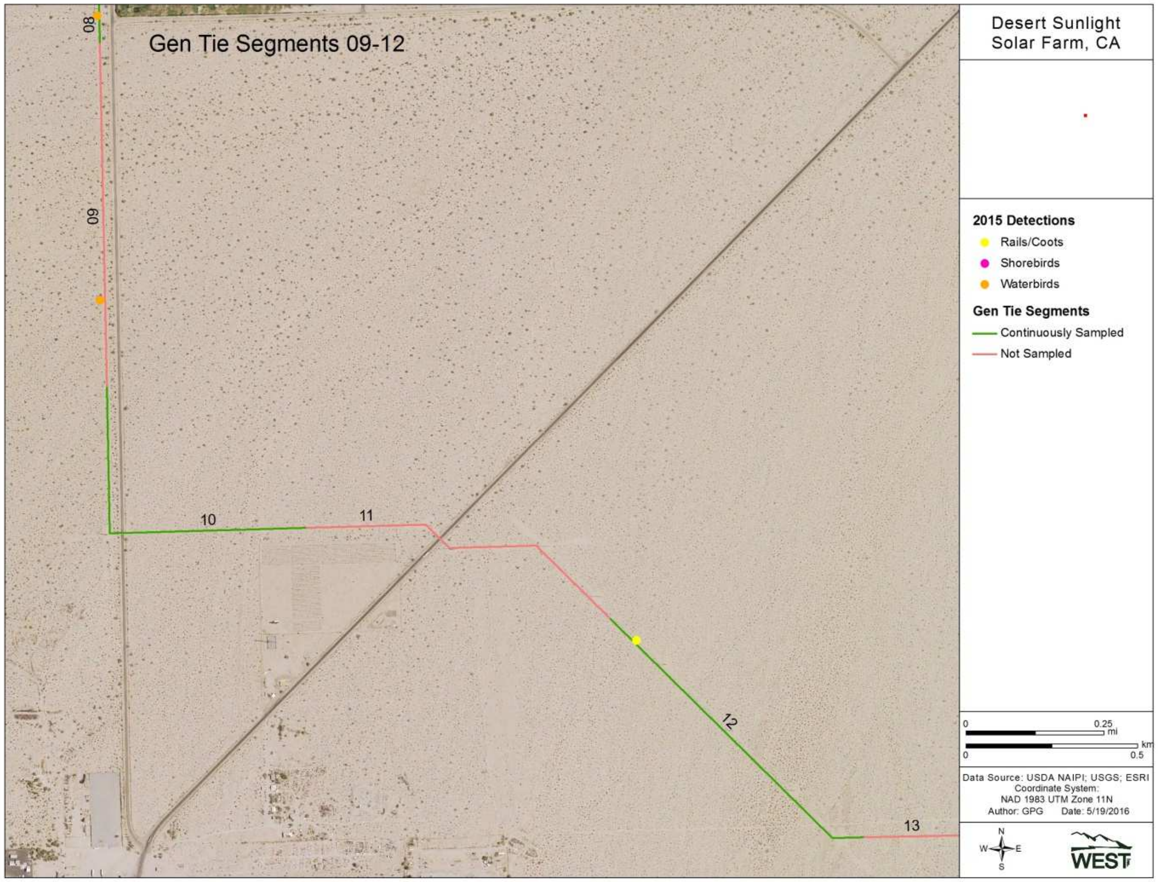


Figure 11. Location of water-associated bird carcass detections along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

Table 4. Number of individual bird detections, by species, found during scheduled searches and incidentally during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

Common Name	Scientific Name	Migration Behavior*	Guild	Solar Array	Fence	Gen-tie Line	Visitor Center	Total
			Water-associated birds					
unidentified grebe	na	na	Waterbirds/Waterfowl	11	1	1	0	13
American coot	*Fulica americana*	nocturnal	Rails/Coots	9	1	2	0	12
unidentified duck	na	na	Waterbirds/Waterfowl	5	1	0	0	6
common loon	*Gavia immer*	diurnal	Waterbirds/Waterfowl	4	1	0	0	5
Western grebe	*Aechmophorus occidentalis*	nocturnal	Waterbirds/Waterfowl	5	0	0	0	5
ruddy duck	*Oxyura jamaicensis*	nocturnal	Waterbirds/Waterfowl	3	0	1	0	4
sora	*Porzana carolina*	nocturnal	Rails/Coots	3	0	1	0	4
mallard	*Anas platyrhynchos*	variable	Waterbirds/Waterfowl	1	1	1	0	3
eared grebe	*Podiceps nigricollis*	nocturnal	Waterbirds/Waterfowl	3	0	0	0	3
unidentified teal	*Anas spp*	na	Waterbirds/Waterfowl	2	0	0	0	2
Virginia rail	*Rallus limicola*	nocturnal	Rails/Coots	2	0	0	0	2
northern shoveler	*Anas clypeata*	both	Waterbirds/Waterfowl	1	0	0	0	1
northern pintail	*Anas acuta*	nocturnal	Waterbirds/Waterfowl	1	0	0	0	1
cinnamon teal	*Anas cyanoptera*	nocturnal	Waterbirds/Waterfowl	1	0	0	0	1
blue-winged teal	*Anas discors*	nocturnal	Waterbirds/Waterfowl	1	0	0	0	1
pied-billed grebe	*Podilymbus podiceps*	nocturnal	Waterbirds/Waterfowl	1	0	0	0	1
least sandpiper	*Calidris minutilla*	both	Shorebirds	1	0	0	0	1
double-crested cormorant	*Phalacrocorax auritus*	diurnal	Waterbirds/Waterfowl	1	0	0	0	1
Subtotal (waterbirds)				**55**	**5**	**6**	**0**	**66**

Table 4. Number of individual bird detections, by species, found during scheduled searches and incidentally during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

Common Name	Scientific Name	Migration Behavior*	Guild	Solar Array	Fence	Gen-tie Line	Visitor Center	Total
			Non-water-associated birds					
mourning dove	*Zenaida macroura*	variable	Doves/Pigeons	4	0	1	1	6
common raven	*Corvus corax*	resident	Corvids	4	1	0	0	5
western meadowlark	*Sturnella neglecta*	diurnal	Blackbirds/Orioles	2	0	2	0	4
Eurasian collared-dove	*Streptopelia decaocto*	resident	Doves/Pigeons	0	0	4	0	4
white-winged dove	*Zenaida asiatica*	variable	Doves/Pigeons	1	1	2	0	4
Savannah sparrow	*Passerculus sandwichensis*	nocturnal	Grassland/Sparrows	2	0	2	0	4
unidentified bird (small)	na	na	Unidentified Birds	3	0	1	0	4
unidentified bird (unknown size)	na	na	Unidentified Birds	3	0	1	0	4
orange-crowned warbler	*Oreothlypis celata*	nocturnal	Warblers	0	0	3	0	3
lesser goldfinch	*Spinus psaltria*	resident	Finches/Crossbills	2	0	0	0	2
black-throated sparrow	*Amphispiza bilineata*	diurnal	Grassland/Sparrows	0	0	2	0	2
unidentified sparrow	na	na	Grassland/Sparrows	1	0	1	0	2
Lincoln's sparrow	*Melospiza lincolnii*	nocturnal	Grassland/Sparrows	0	0	2	0	2
white-crowned sparrow	*Zonotrichia leucophrys*	nocturnal	Grassland/Sparrows	0	0	2	0	2
loggerhead shrike	*Lanius ludovicianus*	diurnal	Shrikes	2	0	0	0	2
ring-necked pheasant	*Phasianus colchicus*	resident	Upland Game Birds	2	0	0	0	2

Table 4. Number of individual bird detections, by species, found during scheduled searches and incidentally during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

Common Name	Scientific Name	Migration Behavior*	Guild	Solar Array	Fence	Gen-tie Line	Visitor Center	Total
Wilson's warbler	*Cardellina pusilla*	nocturnal	Warblers	1	0	1	0	2
yellow-rumped warbler	*Setophaga coronata*	nocturnal	Warblers	2	0	0	0	2
black-throated gray warbler	*Setophaga nigrescens*	nocturnal	Warblers	1	0	1	0	2
house wren	*Troglodytes aedon*	nocturnal	Wrens	1	0	1	0	2
Cooper's hawk	*Accipiter cooperii*	diurnal	Accipiters	1	0	0	0	1
great-tailed grackle	*Quiscalus mexicanus*	resident	Blackbirds/Orioles	1	0	0	0	1
Brewer's blackbird	*Euphagus cyanocephalus*	diurnal	Blackbirds/Orioles	0	0	0	1	1
brown-headed cowbird	*Molothrus ater*	diurnal	Blackbirds/Orioles	0	0	1	0	1
greater roadrunner	*Geococcyx californianus*	resident	Cuckoos	0	0	1	0	1
unidentified dove	na	na	Doves/Pigeons	0	0	1	0	1
Say's phoebe	*Sayornis saya*	diurnal	Flycatchers	1	0	0	0	1
western wood-pewee	*Contopus sordidulus*	nocturnal	Flycatchers	0	0	0	1	1
American pipit	*Anthus rubescens*	diurnal	Grassland/Sparrows	1	0	0	0	1
Sagebrush sparrow	*Artemisiospiza nevadensis*	nocturnal	Grassland/Sparrows	0	0	1	0	1
vesper sparrow	*Pooecetes gramineus*	nocturnal	Grassland/Sparrows	0	0	1	0	1
Brewer's sparrow	*Spizella breweri*	nocturnal	Grassland/Sparrows	1	0	0	0	1
horned lark	*Eremophila alpestris*	resident	Grassland/Sparrows	1	0	0	0	1
northern mockingbird	*Mimus polyglottos*	resident	Mimids	1	0	0	0	1

Table 4. Number of individual bird detections, by species, found during scheduled searches and incidentally during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

Common Name	Scientific Name	Migration Behavior*	Guild	Solar Array	Fence	Gen-tie Line	Visitor Center	Total
northern rough-winged swallow	*Stelgidopteryx serripennis*	diurnal	Swallows	1	0	0	0	1
unidentified hummingbird	na	na	Swifts/Hummingbirds	1	0	0	0	1
western tanager	*Piranga ludoviciana*	nocturnal	Tanagers	0	0	1	0	1
Gambel's quail	*Callipepla gambelii*	resident	Upland Game Birds	0	0	1	0	1
common yellowthroat	*Geothlypis trichas*	nocturnal	Warblers	0	0	1	0	1
Nashville warbler	*Oreothlypis ruficapilla*	nocturnal	Warblers	0	0	1	0	1
yellow warbler	*Setophaga petechia*	nocturnal	Warblers	1	0	0	0	1
Townsend's warbler	*Setophaga townsendi*	unresolved	Warblers	1	0	0	0	1
northern flicker	*Colaptes auratus*	both	Woodpeckers	1	0	0	0	1
Subtotal non-waterbirds				35	2	35	3	83
Subtotal all birds				**78**	**7**	**41**	**3**	**149**

[1] Ring-necked pheasants are used for bias trials and the two detections were likely from trial carcasses; however, ring-necked pheasants have been reported in Riverside County, CA south of the Project area near the Salton Sea (eBird 2015). Thus, we cannot be certain that these detections were exclusively from trial carcasses.

[2] See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in The Birds of North America website (BNA 2016); where information on migration behavior was lacking in BNA accounts, Newton (2008) or Murray (2004) were used.

3.2 Suspected Cause of Avian Mortality

Most carcasses observed do not show clear signs of cause of death (Table 5 and 6). Evidence of collision as cause of death could include broken neck or beak, or bird imprint in the dust on a solar panel, but only a few carcass incidents had such evidence. There were 149 birds detected during the 2015 – 2016 monitoring year. Most of the detections were assigned an unknown cause of death; however 19.5% were suspected to be due to collision (with gen-tie, fence and solar arrays), 5.4% stranded, and 1.3% were due to predation (Table 5). There were 66 water-associated birds detected during the 2015 – 2016 monitoring year. Most were assigned unknown cause of death; however 10.6% were stranded, and 9.1% were likely collision-caused (Table 6).

Table 5. Total bird detections (including incidentals) by Project component and suspected cause of death during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

	Suspected Cause of Death*				
Project Component	**Collision**	**Predation**	**Stranded**	**Unknown**	**Percent of Total Avian Fatalities**
Fence	1	0	0	6	4.7
Building	0	0	0	3	2.0
Gen-tie line	15	2	0	24	27.5
Solar arrays	13	0	8	77	65.8
Percent of Total	**19.5**	**1.3**	**5.4**	**73.8**	**100.0**

* Suspected cause of death was assigned based on evidence available on the detection, evidence available on Project infrastructure, and proximity of detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as "unknown" because it cannot be determined whether the event was caused by predation or interaction with Project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, there is substantial uncertainty associated with cause of death assignments because no events were directly observed.

Table 6. Total waterbird detections (including incidentals) by Project component and suspected cause of death during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

	Suspected Cause of Death*				
Project Component	**Collision**	**Predation**	**Stranded**	**Unknown**	**Percent of Total Avian Fatalities**
Fence	0	0	0	5	9.4
Building	0	0	0	0	0
Gen-tie line	2	0	0	4	7.5
Solar arrays	4	0	7	44	83.0
Percent of Total	**9.1**	**0**	**10.6**	**80.3**	**100.0**

* Suspected cause of death was assigned based on evidence available on the detection, evidence available on Project infrastructure, and proximity of detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it cannot be determined whether the event was caused by predation or interaction with Project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, there is substantial uncertainty associated with cause of death assignments because no events were directly observed.

3.3 Temporal Patterns of Avian Detections

Both spring and fall migration seasons were seven-day searches, while summer and winter had a 21-day average search interval, so interpretations of temporal patterns should keep those differences in mind. The number of detections recorded per day represents those discovered during standardized carcass searches as well as those discovered incidentally. For each day in which there were six or more detections made, an Avian Injury & Mortality Report form (in accordance with Special Utilities Permit Condition H.1(c)) was submitted within 24 hours to the USFWS, BLM, and CDFW. The 2015 – 2016 monitoring year was characterized by a peak in avian detections during the fall season. The number of avian detections recorded daily during the 2015 – 2016 monitoring year ranged from zero to six (Figure 12). On September 22, 2015, six detections were reported. During all other survey days, five or fewer birds were detected.

The highest peaks in avian detections at the arrays and along the gen-tie occurred during the fall season, while there was no apparent pattern observed along the fence or at buildings as only a few were detected at these locations (Figure 13). The greatest number of avian detections occurred during the month of October (Figure 13; n = 44) followed by September (n = 38), with waterbird and waterfowl detections greatest during the same two months (Figure 13).

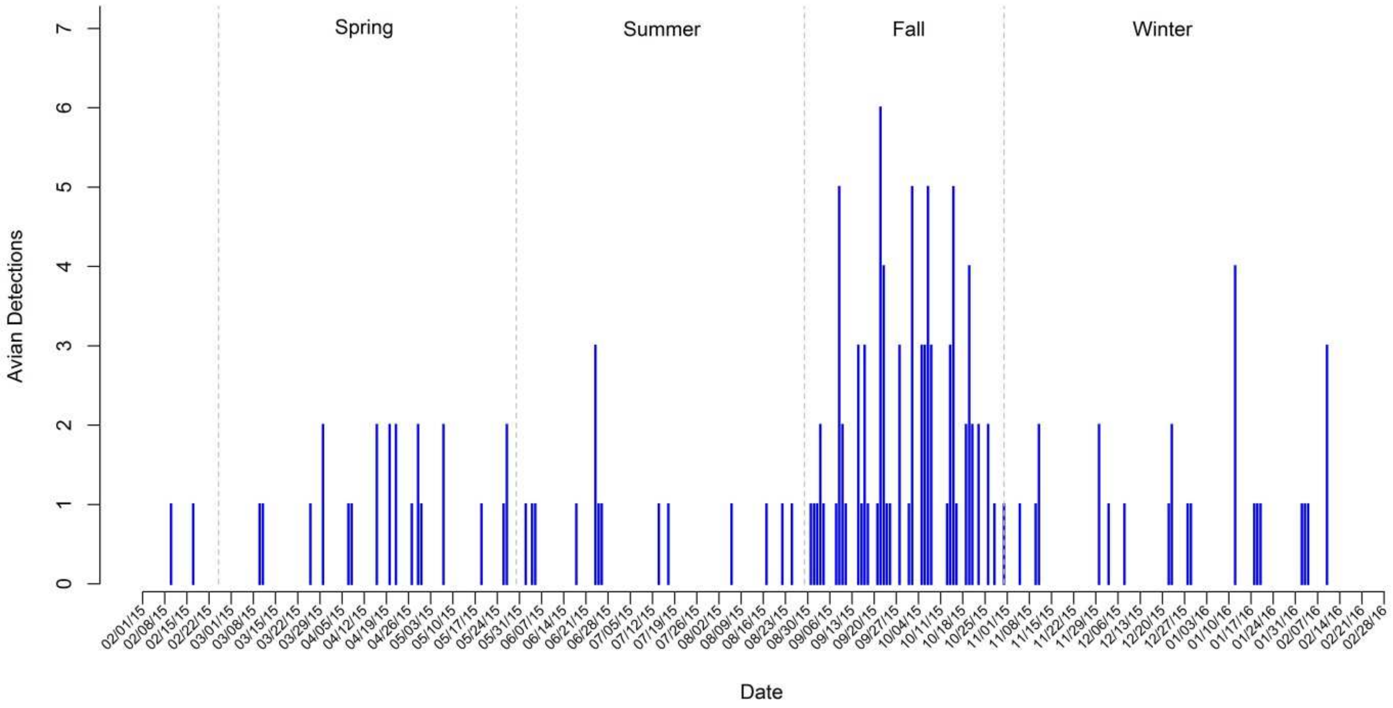


Figure 12. Total count of detections (including incidentals) by date during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

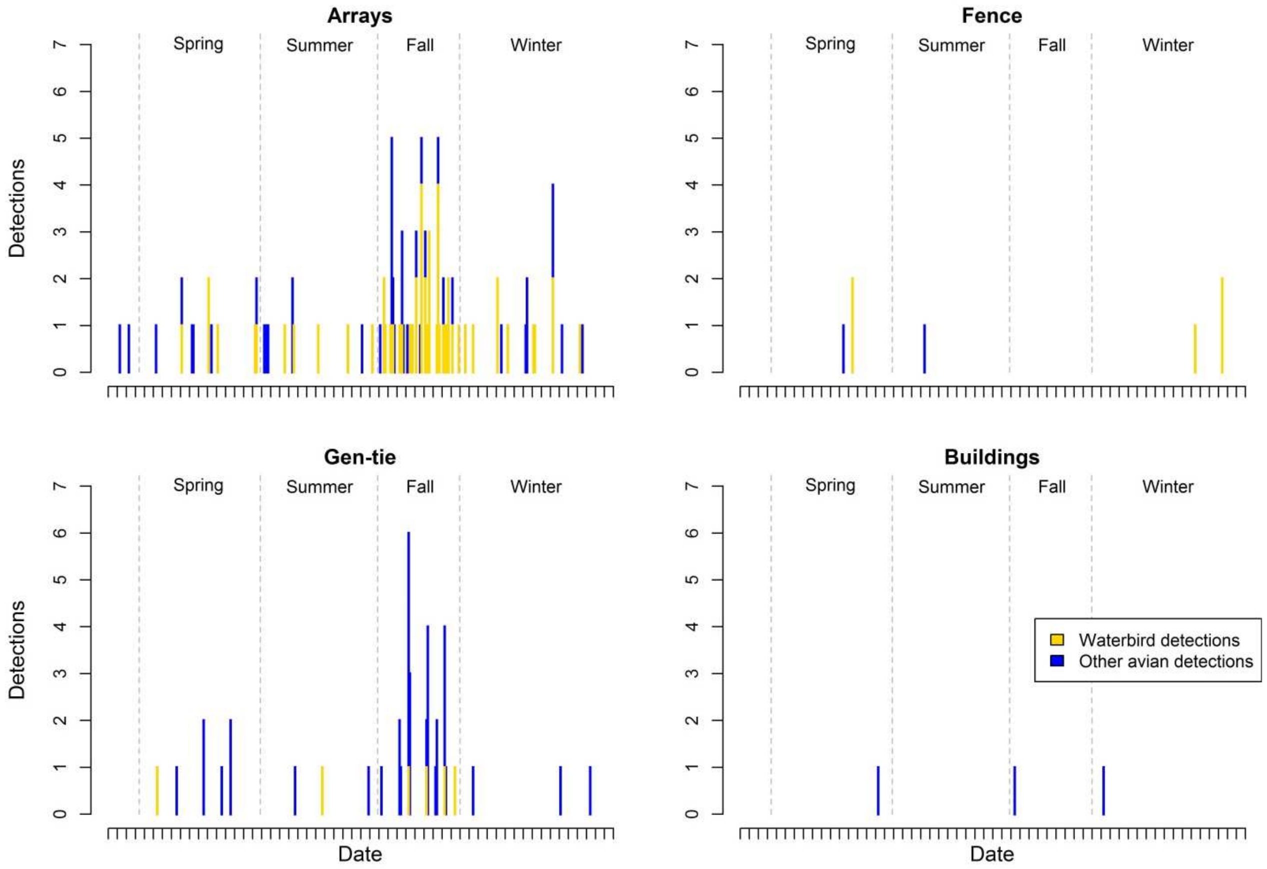


Figure 13. Total count of detections (including incidentals) by date for both waterbirds/waterfowl detections and all avian detections during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.4 Spatial Distribution of Avian Detections

3.4.1 Detections by Project Component

During the 2015 – 2016 monitoring year, detections were documented from the solar arrays, the Visitor Center, the fence, and the gen-tie line (Tables 4 and 5). There were 98 detections (65.8% of all detections) at the solar arrays. Forty-one detections (27.5% of annual total) were along the gen-tie line, seven were along the fence (4.7% of annual total) and three detections (2.0% of annual total) were at the Visitor Center. The majority of non-water-associated birds (n = 43; Table 7) and water associated birds (n = 55; Table 8) were detected at the solar arrays, and is not unexpected given the large spatial extent of the arrays (over 4000 acres).

Table 7. Total non-waterbird detections by Project component and detection category during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California. Only carcasses found within search areas were included in fatality estimates.

Project Component	Inside carcass search area		Outside carcass search area	
	Carcass search	Incidental	Carcass search	Incidental
Fence	1	0	1	0
Buildings	0	0	0	3
Gen-tie line	28	1	5	1
Solar arrays	31	2	2	8
Total	**60**	**3**	**8**	**12**

Table 8. Total waterbird detections by Project component and detection category during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California. Only carcasses found within search areas were included in fatality estimates.

Project Component	Inside carcass search area		Outside carcass search area	
	Carcass search	Incidental	Carcass search	Incidental
Fence	3	0	1	1
Buildings	0	0	0	0
Gen-tie line	5	0	0	1
Solar arrays	34	6	2	13
Total	**42**	**6**	**3**	**15**

3.4.2 Detections at solar collector assemblies

Upon ocular examination, fatalities among the solar arrays appear evenly dispersed throughout the Project site (Figure 14). The distance between the average location of the search areas and the average location of fatalities found inside search areas is 73 meters suggesting no obvious concentration of fatalities in a particular direction (e.g. more fatalities towards the west or towards the south side of the facility).

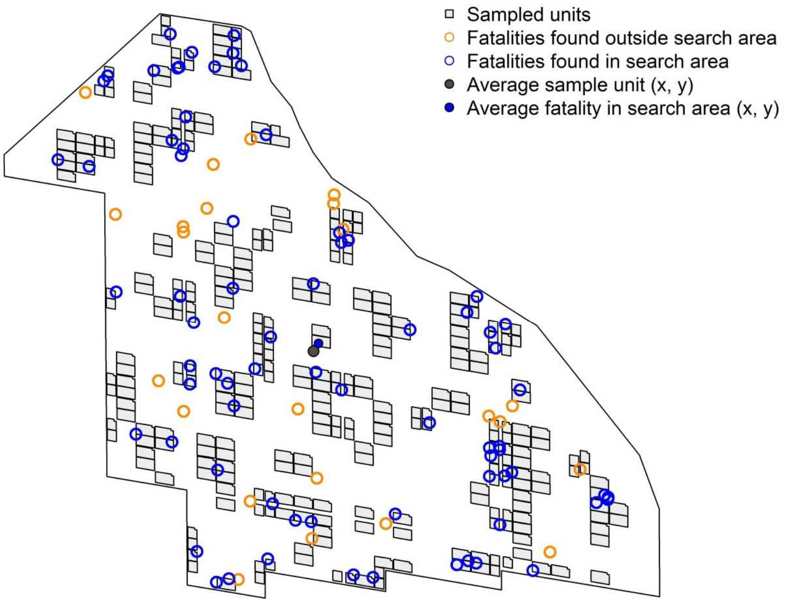


Figure 14. Spatial distribution of carcass search and incidental detections from SCAs during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.4.3 Feather Spot Detections

Thirty-eight (25.5%) of the 149 detections made during the 2015 – 2016 monitoring year consisted only of feather spots. Along the gen-tie, 14 of 41 detections (34.1%) were feather spots. Twenty-two of 98 detections (22.5%) in the solar arrays were feather spots. Along the fence, two of seven total detections (28.6%) were feather spots.

3.5 Detections of Injured or Stranded Birds

There were six detections of stranded or injured birds during the 2015 – 2016 monitoring year, each of which occurred during the fall monitoring period. Three injured birds were detected within the solar arrays (ruddy duck [*Oxyura jamaicensis*], western grebe [*Aechmophorus occidentalis*], and mourning dove [*Zenaida macroura*]). Three stranded but uninjured birds were detected in the arrays (common loon [*Gavia immer*]) and ruddy duck and eared grebe [*Podiceps nigricollis*]). The injured mourning dove and ruddy duck were transported to wildlife rehabilitation facilities; the ruddy duck was released by the rehabilitator on the same day. The injured western grebe died before it got to a rehabilitation facility. The stranded ruddy duck, eared grebe, and common loon were evaluated for a short period for injuries and general stress and when none were observed, released at Lake Tamarisk.

3.6 Summary of Bat Detections

No bats were detected during the 2015 – 2016 monitoring year.

3.7 Carcass Persistence Trials

Data from carcass persistence trials were available from all four seasonal monitoring periods within the solar arrays and along the gen-tie line. A total of 275 carcasses were available for fitting the model.

Using carcass persistence data from the 2015 – 2016 monitoring year, survival models were fitted separately for each size class for relative quality using the corrected AICc score, as suggested in Huso (2010). The model with the lowest AICc is typically chosen as the “best” model relative to other models tested; however, any model within two AICc points of the best model is considered competitive with the best model (Burnham and Anderson 2004).

Models were fit to each size class separately to allow for the selection of different model distributions and covariate combinations to achieve the best fit for each size class. Model comparisons using AICc suggested that season and Project component location (whether at the solar field or at the overhead lines) are important predictors of carcass persistence for small, medium and large birds.

Both Project component location and season were important in the large bird persistence model. For large birds, the AICc suggested that a seasonal covariate with two categories, spring and fall data pooled and winter and summer data pooled together was not the top rated model, but within two AICc points from the top model. This model was chosen because it has similar predictive ability as the top model but also has fewer parameters to estimate. For medium birds, the best predictive model included the main effects of Project component location and season. The AICc suggested that a seasonal covariate with two categories, spring and summer data pooled and fall and winter data pooled together was the best predictive model for medium birds. The best model for small birds included the main effects of Project component location, season (with no pooling), and an interaction between Project component location and season. The best models for small, medium, and large birds followed a lognormal, Weibull, and loglogistic distribution respectively (Table 9).

Table 9. Top five carcass persistence models for each size class from the AICc model selection process. (bold) indicates chosen model. Sp = spring, Su = summer, Fa = fall, Wi = winter, and Δ = change. The covariate 'season' has no seasonal grouping.

Size	Model Predictors	Distribution	AICc	ΔAICc
Small Birds	**Project (Proj.) Location + season + Proj. Location * season**	**Lognormal**	**596.66**	**0**
	Proj. Location + season + Proj. Location * season	Exponential	597.04	0.38
	Proj. Location + season + Proj. Location * season	Loglogistic	597.07	0.41
	Proj. Location + season + Proj. Location * season	Weibull	598.76	2.10
	Proj. Location + season	Lognormal	600.00	3.34
Medium Birds	**Proj. Location + Sp/Su & Fa/Wi**	**Weibull**	**466.35**	**0**
	Proj. Location + Sp/Su & Fa/Wi	Loglogistic	467.59	1.24
	Proj. Location + Sp/Su & Fa/Wi	Lognormal	467.74	1.39
	Proj. Location + Sp/Su & Fa/Wi + Proj. Location * Sp/Su & Fa/Wi	Weibull	468.54	2.19
	Proj. Location season + Proj. Location * season	Weibull	469.65	3.30
Large Birds	**Proj. Location + season + Proj. Location * season**	**Loglogistic**	**258.71**	**0**
	Proj. Location + season + Proj. Location * season	Lognormal	259.29	0.58
	Proj. Location + Sp/Fa & Su/Wi	Loglogistic	259.34	0.63
	Proj. Location + Sp/Fa & Su/Wi	Lognormal	260.40	1.69
	Proj. Location + Sp & Su/Fa/Wi	Loglogistic	260.91	2.20

The sample size for the intercept of each of the three models was 135, 90 and 50 for small, medium, and large trial carcasses respectively.

The average probability that a carcass at the solar field or a carcass along the gen-tie persists for an average search interval (approximately 7 days for spring and fall; 21 days for summer and winter), is provided for each season and size class in Table 10. Mean (median) removal time within the solar field was 4.9 (6.0) days during spring, 12.7 (12.6) during summer, 2.5 (1.5) during fall, and 6.5 (6.0) during winter for small carcasses; 36.0 (27.8) days during spring, 36.0 (24.3) during summer, 12.2 (18.0) during fall, and 12.2 (6.8) during winter for medium carcasses; and 58.3 (31.0) days during spring, 13.7 (30.0) during summer, 58.3 (30.0) during fall, and 13.7 (5.1) during winter (Table 11). At the overhead lines, removal time was 0.8 (0.5), 0.8 (0.5), 0.4 (0.5), and 2.3 (2.5) for small birds during spring, summer, fall, and winter respectively. For medium birds, mean (median) removal time at the overhead lines was 14.4 (2.0), 14.4 (15.8), 4.9 (1.5), and 4.9 (2.5) days during spring, summer, fall, and winter respectively. Mean (median) removal time for large birds was 5.8 (19.0), 1.4 (0.5), 5.8 (3.5), and 1.4 (3.5) days during spring, summer, fall, and winter respectively (Table 11). Figure 15 shows the proportion of trial carcasses remaining as a function of days since placement and carcass model covariate (component location and/or season).

Comentado [A5]: Less than the 7 day and significantly less than 21 day search interval.

Table 10. Average probability of carcass persistence to the next search (search interval approximately 7 days during spring and fall migration periods, and 21 days during summer and winter non-migration periods)

	Small Birds		Medium Birds		Large Birds	
	$\hat{r}$	CI	$\hat{r}$	CI	$\hat{r}$	CI
Solar Field						
Spring	0.64	0.52 - 0.74	0.80	0.72 - 0.88	0.95	0.90 - 0.98
Summer	0.62	0.47 - 0.76	0.66	0.56 - 0.78	0.62	0.43 - 0.76
Fall	0.44	0.25 - 0.66	0.65	0.56 - 0.73	0.95	0.90 - 0.98
Winter	0.43	0.35 - 0.51	0.46	0.37 - 0.55	0.62	0.43 - 0.76
Gen-tie						
Spring	0.19	0.09 - 0.30	0.68	0.56 - 0.78	0.65	0.47 - 0.81
Summer	0.07	0.04 - 0.10	0.49	0.36 - 0.62	0.18	0.09 - 0.29
Fall	0.09	0.04 - 0.15	0.48	0.36 - 0.59	0.65	0.47 - 0.81
Winter	0.19	0.14 - 0.25	0.27	0.17 - 0.36	0.18	0.09 - 0.29

Table 11. Mean and median carcass removal time and probability of a carcass persisting through the effective search interval during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

	Small Birds		Medium Birds		Large Birds	
	Mean	Median	Mean	Median	Mean	Median
Solar Field						
Spring	4.9	6.0	36.0	27.8	58.3	31.0
Summer	12.7	12.6	36.0	24.3	13.7	30.0
Fall	2.5	1.5	12.2	18.0	58.3	30.0
Winter	6.5	6.0	12.2	6.8	13.7	5.1
Overhead lines						
Spring	0.8	0.5	14.4	2.0	5.8	19.0
Summer	0.8	0.5	14.4	15.8	1.4	0.5
Fall	0.4	0.5	4.9	1.5	5.8	3.5
Winter	2.3	2.5	4.9	2.5	1.4	3.5

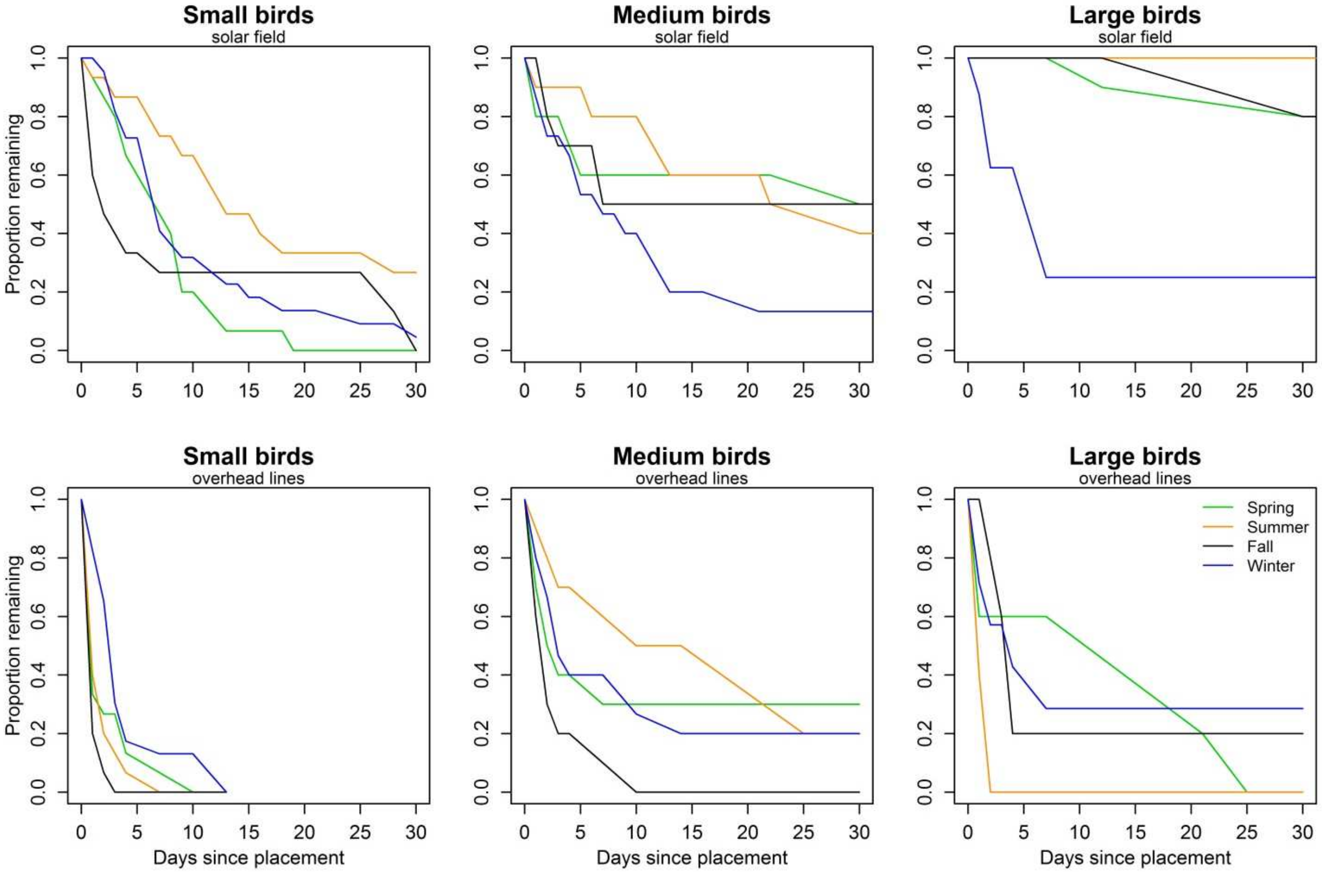


Figure 15. Proportion of trial carcasses remaining as a function of days since placement and carcass size class during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California. Sample size used to produce each panel of the above figure was n = 67, 45, and 28 for small, medium, and large birds at the solar field and 68, 45, and 22 small, medium, and large birds at the overhead lines.

3.8 Searcher Efficiency Trials

During the reporting period, a total of 810 searcher efficiency trials were placed at the Project. Most trials were available to be found, but some disappeared before or during the trial. Overall, 360 trials were placed in the solar arrays and 336 were available to be found; 150 trials were placed along the perimeter fence (inner perimeter only) and 148 were available to be found; and 300 trials were placed along the gen-tie line and 270 were available to be found. Three observers conducted searches at the Project during fall. Searcher efficiency trials were conducted on each observer in approximate proportion to the number of searches they conducted at the Project, as follows: Sarah N. (number of trials available to be found: 281), Jennifer J. (223), Wanda B. (77), Darin B. (71), David G. (58), Pamela B. (27), Anika M. (nine), and Frank M. (eight). All trials were included in estimation of searcher efficiency. These numbers were generally in proportion to the amount of searching conducted by these biologists.

For the solar arrays, searcher efficiency was modeled separately for small, medium, and large birds. The best model for each carcass size is presented in Table 12 below. Within the solar arrays, searcher efficiency for small birds was influenced by cobble cover and season: small birds in high cobble cover in the fall had a searcher efficiency of 33.2% (CI: 13.3 – 63.9%; n = 15) and small birds in low cobble cover in the fall had a searcher efficiency of 57.8% (CI: 39.0 – 77.7%; n = 27; Table 13). Searcher efficiency for small birds in high cobble cover during winter, spring and summer was 36.0% (CI: 21.1 – 45.4%; n = 50), and small birds in low cobble cover during winter, spring and summer had a searcher efficiency of 64.5% (CI: 44.5 – 63.4%; n = 70). For medium birds, searcher efficiency within the solar arrays was similar across cobble cover classes but differed by season: in winter, medium bird searcher efficiency was 94.0% (CI 87.5 – 98.5%; n = 45), and in spring, summer and fall, medium bird searcher efficiency was 83.2% (CI: 76.5 – 89.8%; n = 63). For large birds, searcher efficiency among the solar arrays differed between migration seasons (spring and fall) and non -migration seasons (summer and winter). Searcher efficiency during spring and fall for large birds was 83.9% (CI: 72.0 – 94.3%; n = 31). Searcher efficiency for large birds during summer and winter was 100% with no variance (n = 35). Sample sizes refer to numbers of trial carcasses that were available to be found, not numbers of trial carcasses that were placed (Figure 5 - 7).

For the fence, the model that included an effect of carcass size, and season (with data from spring and winter pooled and summer and fall pooled) was chosen as the most supported model to estimate searcher efficiency (Table 14). Along the fence, searcher efficiency was 65% (CI: 52 – 77%), 94% (CI: 88 - 100%), and 100%, for small, medium, and large carcasses, respectively during spring and winter and 87% (CI: 77 – 97%), 98% (CI: 96 – 100%), and 100% for small, medium, and large carcasses respectively during summer and fall (Table 13).

For the gen-tie line, the chosen model included main effects of size, season (with data from spring and summer data pooled and fall and winter pooled), and visibility class, with an interaction between visibility class and season (Table 14). It ranked second by AICc but was only 0.59 AICc points from the top model. It was chosen because it has similar predictive performance as the top model, but with fewer parameters to estimate. For the easy visibility class, searcher efficiency was 67% (CI: 53 – 81%), 89% (CI: 80 – 95%), and 89% (CI: 80 – 96%) for small, medium, and large carcasses, respectively during spring and summer and 57% (CI:46 – 68%), 84% (CI: 75 – 91%), and 85% (CI: 73 – 93%) for small, medium, and large birds respectively during fall and winter (Table 13). For the difficult visibility class, searcher efficiency was 75% (CI: 62 – 86%), 92% (CI: 86 – 97%), and 92% (CI: 84 – 97%) for small, medium, and large birds respectively during spring and summer and 33% (CI: 22 – 44%), 65% (CI: 53 – 77%), and 67% (CI: 51 – 82 %) for small, medium, and large birds respectively during fall and winter (Table 13). A summary of searcher efficiency estimates are reported in Appendix C.

Table 12. Top five searcher efficiency models from model selection for the solar arrays. (bold text) indicates chosen model form. Sp = spring, Su = summer, Fa = fall, Wi = winter and Δ = change.

Size	Model Predictors	Distribution	AICc	ΔAICc
Small Birds	**cobble + Fa & Sp/Su/Wi + cobble*Fa & Sp/Su/Wi**	**Hazard Rate**	**205.30**	**0.00**
	cobble + Sp & Su/Fa/Wi	Exponential	206.46	1.16
	cobble + Sp/Wi & Su/Fa	Hazard Rate	207.10	1.80
	Cobble	Exponential	207.58	2.28
	cobble + Sp/Su & Fa/Wi	Exponential	208.26	2.96
Medium Birds	**Wi & Sp/Su/Fa**	**Exponential**	**85.20**	**0.00**
	Sp/Fa & Su/Wi	Exponential	86.64	1.44
	Intercept Only	Exponential	86.70	1.50
	Found ~ cobble + Wi & Sp/Su/Fa	Exponential	86.78	1.58
	Sp/Wi & Su/Fa	Exponential	86.96	1.76
Large Birds	**Sp/Fa & Su/Wi**	**Uniform**	**31.58**	**0.00**
	cobble + Sp/Fa & Su/Wi + cobble*Sp/Fa & Su/Wi	Uniform	34.23	2.65
	cobble + Sp/Fa & Su/Wi	Uniform	34.55	2.97
	Wi & Sp/Su/Fa	Uniform	34.60	3.01
	cobble + Wi & Sp/Su/Fa + cobble*Wi & Sp/Su/Fa	Uniform	35.75	4.17

Table 13. Searcher efficiency estimates by Project component.

	Small Birds		Medium Birds		Large Birds	
	Seef	**90% CI**	**Seef**	**90% CI**	**Seef**	**90% CI**
Fence						
Spring & Winter	0.65	0.52 - 0.77	0.94	0.88 - 1.00	1.00	1.00 - 1.00
Summer & Fall	0.87	0.77 - 0.97	0.98	0.96 - 1.00	1.00	1.00 - 1.00
Gen-tie Line						
Easy Visibility						
Spring & Summer	0.67	0.53 - 0.81	0.89	0.80 - 0.95	0.89	0.80 - 0.96
Fall & Winter	0.57	0.46 - 0.68	0.84	0.75 - 0.91	0.85	0.73 - 0.93
Difficult Visibility						
Spring & Summer	0.75	0.62 - 0.86	0.92	0.86 - 0.97	0.92	0.84 - 0.97
Fall & Winter	0.33	0.22 - 0.44	0.65	0.53 - 0.77	0.67	0.51 - 0.82
Solar Arrays						
Low cobble						
Spring	0.65	0.45 - 0.63	0.83	0.77 - 0.90	0.84	0.72 - 0.94
Summer	0.65	0.45 - 0.63	0.83	0.77 - 0.90	1.00	1.00 - 1.00
Fall	0.58	0.39 - 0.78	0.83	0.77 - 0.90	0.84	0.72 - 0.94
Winter	0.65	0.45 - 0.63	0.94	0.87 - 0.99	1.00	1.00 - 1.00
High cobble						
Spring	0.36	0.21 - 0.45	0.83	0.77 - 0.90	0.84	0.72 - 0.94
Summer	0.36	0.21 - 0.45	0.83	0.77 - 0.90	1.00	1.00 - 1.00
Fall	0.33	0.13 - 0.64	0.83	0.77 - 0.90	0.84	0.72 - 0.94
Winter	0.36	0.21 - 0.45	0.94	0.87 - 0.99	1.00	1.00 - 1.00

Comentado [A6]: Low efficiency for small birds.

Table 14. Top five searcher efficiency models from model selection for the fence and gen-tie line. (bold text) indicates chosen model form. Sp = spring, Su = summer, Fa = fall, Wi = winter and Δ = change.

Model Form – Fence	**AICc**	**ΔAICc**
size + Sp/Wi & Su/Fa	**103.45**	**0.00**
size + Su & Sp/Fa/Wi	106.46	3.01
Size	106.67	3.22
size + Sp/Wi & Su/Fa + size * Sp/Wi & Su/Fa	107.03	3.57
season + size	107.75	4.29
Model Form - Gen-tie Line	**AICc**	**ΔAICc**
size + Sp/Su & Fa/Wi + visibility + size * Sp/Su & Fa/Wi + visibility * Sp/Su & Fa/Wi	301.53	0.00
size + Sp/Su & Fa/Wi + visibility + visibility * Sp/Su & Fa/Wi	302.13	0.59
size + Sp/Su & Fa/Wi + visibility + size * Sp/Su & Fa/Wi	304.29	2.76
size + Sp/Su & Fa/Wi + visibility	305.03	3.50
size + Sp/Su & Fa/Wi + size * Sp/Su & Fa/Wi	306.17	4.64

3.9 Fatality Estimates

Fatality estimates were calculated separately for each component (solar arrays, fence, and overhead lines). There were 149 detections during the 2015 – 2016 monitoring year. Fatalities found in the sample standardized search areas that were estimated not less than twice the length of the search interval were included. This conservative definition was used due to uncertainty in aging carcasses and should result in a positive (overestimate) bias. Detections used in the analysis, bias corrections, fatality estimates, and 90% confidence intervals are detailed in Appendix C.

Using the Huso (2010) fatality estimator, during the 2015 – 2016 monitoring year, there were an estimated total of 1,328 bird carcasses (CI: 1,007 – 2,303) at the Project (all components combined). There were an estimated 53 (CI: 28 – 85) large birds, 336 (CI: 246 – 449) medium birds, 881 (CI: 566 – 1,843) small birds, and 58 (CI: 22 – 143) birds of unknown size at the Project (all components combined; Table 15).

The model estimates 628 (CI: 496 – 951) bird carcasses (152/1000 acres, 1.16/nameplateMW) at the solar arrays, 688 (CI: 364 – 1,567) along the gen-tie line and 11 (CI: 2 – 26) at the fence. Estimates of fatalities along the gen-tie are heavily influenced by the high rates of scavenging observed during the limited trials at the gen-tie (i.e., large correction factors) and are likely very unreliable. Adjusted fatality estimates for each Project component are provided by guild in Table 16. A complete list of estimates by Project component and carcass size class with confidence intervals is presented in Appendix C.

Table 15. Adjusted fatality estimates by size and guild during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California

Size	Actual Fatalities	Total Adjusted Fatalities	90% CI
Large Birds	21	53	28 – 85
Medium Birds	68	336	246 – 449
Small Birds	56	881	566 – 1,843
Unknown size	4	58	22 - 143
Guild		**Total Adjusted Fatalities**	**90% CI**
Passerines	56	879	576 – 1,811
All water-associated birds	66	210	148 - 289
Doves/Pigeons	15	60	30 - 98
Diurnal Raptors	1	1	na

Table 16. Adjusted fatality estimates by guild and component during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

Guild	Solar array	90% CI	Fence	90% CI	Gen-tie	90% CI	Overall	90% CI
Passerines	310	206 - 580	-	-	571	267 - 1406	881	588 - 1804
All water-associated birds	272	191 - 391	9	3 - 24	67	9 - 185	348	242 - 529
Waterbirds/Waterfowl	194	129 – 273	6	3 - 16	10	4 - 25	210	148 - 289
Rails/Coots	56	24 - 100	3	3 - 10	57	5 - 175	116	42 - 243
Doves/Pigeons	21	5 – 40	2	2 - 6	37	14 - 71	60	30 - 99
Shorebirds	22	11 - 98	-	-	-	-	22	11 - 98
All Birds	**628**	496 – 952	11	3 – 26	688	364 – 1567	1328	1007 – 2303

Note: confidence interval (CI)

4 DISCUSSION

The 2015 – 2016 monitoring year represented the first full year of standardized monitoring at Desert Sunlight. Searcher efficiency and carcass persistence trials were conducted concurrently at the solar arrays, fence lines, and along the gen-tie line. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. The results provided in each seasonal report were considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. For this annual report, the analysis is comprehensive, with data from all four seasons included in the analysis.

4.1 Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, the frequency of flooding events, and other factors. Carcass persistence was low along the gen-tie line, while persistence rates were longer within the Project fence. Overall, carcass persistence rates were longer for medium and large birds compared to smaller birds but there was variation by season and Project component. The longer persistence rates for larger sized birds is a consistent result seen in many other studies (Smallwood et al. 2010, and Morrison 2002).

The experimental bias trials themselves may influence scavenging on site. The large number of carcasses used in trials may be attracting scavengers to the Project site and negatively influencing the bias adjustments for the fatality estimates. Scavengers may learn from visual and olfactory cues that carcasses are being placed for trials. Placing carcasses in the early morning, placing fake cameras at locations without carcasses, and varying the clothes of the biologists placing the carcasses are all methods that were used to try to reduce this bias.

Searcher efficiency was influenced by carcass size, season, and cobble cover within the solar arrays. Some of the relationships that were apparent were not always explainable and expected from a biological perspective (e.g. some of the seasonal effects), but were still included in the final models. Consideration for simplifying the models will be given for the 2nd year monitoring data analysis and reporting.

4.2 Fatalities Timing and Guild/Species Composition, and Other Fatality Characteristics

There were no large mortality events (e.g., >30 birds found on a day) during this 2015 – 2016 monitoring period. More detections occurred during the fall season, beginning in early September and continuing through late October. This peak in detections coincides with the fall bird migration period as well as the time when population sizes are typically highest during fledging in the summer. The increased detections in the fall were primarily due to detections of water-associated birds, especially during the month of October. The peak observed during the fall was apparent within both the solar arrays and along the gen-tie. At the solar arrays, the increase in the fall was mostly waterbird species, whereas the fall increase observed along the gen-tie was primarily non-water associated species.

During the 2015 – 2016 monitoring year, the 149 avian detections (including all stranded and injured birds and incidental detections) consisted of 19 guilds and included 53 identified species. The most numerous detection of an identified species was American coot with 12 detections, most of which were at the solar arrays. Mourning dove (n = 6) was the next most commonly detected species. The most numerous detection in the solar arrays was American coot (n = 9), followed by western grebe, with no other species with more than four detections. The only species observed along the fence were American coot (n = 1), common raven (n = 1), common loon (n = 1), white-winged dove (n = 1), and mallard (n = 1). Eurasian collared-dove (n = 4) and orange-crowned warbler (n = 3) were the species with the most detections along the gen-tie/road.

There were no strong spatial patterns observed within the solar arrays or along the fenceline. Along the gen-tie line, there were a few clusters of detections, the majority of which were small bird species.

4.3 Causation

Detections attributed to an unknown cause accounted for approximately 74% of all detections during the 2015 – 2016 monitoring year. Determining a cause of mortality from a feather spot or scavenged bird is challenging because there is rarely visible evidence available on which to determine a cause of death. Especially for passerine species found on the Project, an unknown but potentially measurable number of the carcasses might have been caused by factors other than collision with the Project facilities. Due to this uncertainty of causation, some studies have estimated background fatality estimates at reference or control areas. There have been two studies of background mortality at solar facilities: CVSR and Topaz had conducted background avian fatality monitoring in an effort to assess causation (H.T Harvey and Associates 2014; Althouse and Mead Inc. 2014). These studies were designed to try and quantify the potential degree to which fatalities were likely the result of interactions with facility infrastructure (PV panels, etc.) or whether some of the fatalities might be unrelated to the presence of the facility. Mortality at these two Project sites was not unlike the estimates of background mortality observed on nearby reference sites. Given the low density of carcasses found within the solar arrays (<0.2/acre/year), a large field effort would likely be required to characterize background mortality with reasonable levels of precision if background rates were similar to the rates in the arrays.

In addition to issues associated with background mortality, multiple feather spots found on site may be from the same detection. Game cameras trained on carcasses for carcass persistence trials at the Project have documented the potential for multiple feather spots originating from a single trial carcass. Ravens and turkey vultures, and possibly roadrunners, dislodge feathers from their attachment to the skin of the carcass during the scavenging process. There are a very large number of potential feather spots present from a single bird carcass. This large number occurs because a feather spot is defined as at least two or more primary flight feathers, at least five or more tail feathers, or two primaries within five m (16.4 ft) or less of each other, or a total of 10 or more feathers of any type concentrated together in an area of three square m. Thus, the presence of feather spots among the detections for the Project would inflate the fatality estimate based on the potential for multiple feather spots, resulting from one fatality being counted as separate detections if feathers are either blown around the site, scattered by predators (e.g., plucking by ravens), resulting from predation not associated with the facility, or resulting from other unrelated causes. Nonetheless, feather spots are included in the analysis here to provide a more conservative estimate of fatality. If feather spots were excluded from the analysis, the overall estimates would be reduced by approximately 25%.

4.4 Fatality Estimates

The estimated density of carcasses for the Project components within the fence (solar arrays and fence) is only 0.15 carcasses/acre/year. More carcasses were estimated for the gen-tie than the solar arrays; however, the estimates for the gen-tie are unreliable due to very high carcass removal rates along that Project component. Approximately 270 water-associated carcasses (or 0.06 per acre) were estimated for the solar arrays.

5 LITERATURE CITED

Akaike, H. 1973. Information Theory and an Extension of the Maximum Likelihood Principle. Presented at the Proceedings of the Second International Symposium on Information Theory. B. N. Petrov and F. Csaki, eds. Pp. 267-281. Akademiai Kiado. 1973.

Althouse and Meade, Inc. 2014. Topaz Solar Farms 2013 Fourth Quarter/Second Annual Report for Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. Prepared for Topaz Solar Farms LLC, Santa Margarita, California. Prepared by Althouse and Mead Inc., Paso Robles, California. March 2014.

Birds of North America (BNA). 2016. The Birds of North America Online. Cornell Lab of Ornithology and the American Ornithologists' Union. Accessed December 2012. BNA homepage at: http://bna.birds.cornell.edu/bnaBuckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. Distance Sampling: Estimating Abundance of Biological Populations. Chapman & Hall, London, United Kingdom.

Burnham, K. P. and D. R. Anderson. 2004. Multimodel Inference: Understanding Aic and Bic in Model Selection. Sociological Methods and Research 33(2): 261-304.

eBird. 2015. eBird: An Online Database of Bird Distribution and Abundance (Web Application). eBird, Cornell Lab of Ornithology, Ithaca, New York. Accessed March 25, 2015. Available online at: http://ebird.org/content/ebird/

H.T. Harvey and Associates. 2014. California Valley Solar Ranch Project Avian and Bat Protection Plan Annual Postconstruction Fatality Report: 16 August 2012 - 15 August 2013. Project # 3326-03. Prepared for HPR II, LLC, California Valley Solar Ranch, Santa Margarita, California. Prepared by H.T. Harvey and Associates, San Luis Obispo, California. March 28, 2014.

Huso, M. 2010. An Estimator of Wildlife Fatality from Observed Carcasses. Environmetrics 22(3): 318–329. doi: 10.1002/env.1052.

Huso, M., N. Som, and L. Ladd. 2012. Fatality Estimator User's Guide. US Geological Survey (USGS) Data Series 729. 22 pp. Available online at: http://pubs.usgs.gov/ds/729/pdf/ds729.pdf

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A New Method to Determine Bird and Bat Fatality at Wind Energy Turbines from Carcass Searches. Wildlife Biology 17: 350-363.

Manly, B. F. J. 1997. Randomization, Bootstrap, and Monte Carlo Methods in Biology. 2nd Edition. Chapman and Hall, London.

Morrison, M. 2002. Searcher Bias and Scavenging Rates in Bird/Wind Energy Studies. NREL/SR-500-30876. National Renewable Energy Laboratory. Golden, Colorado.

Murray, J. M. 2004. Nocturnal Flight Call Analysis as a Method for Monitoring Density and Species Composition of Migratory Songbirds (Order Passeriformes) across Southern Vancouver Island, British Columbia, 2004. Available online at: http://rpbo.org/acousticmonjjm.pdf

Newton, I. 2008. The Migration Ecology of Birds. Academic Press, London.

Smallwood, K. S. 2007. Estimating Wind Turbine-Caused Bird Mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K. S., D. A. Bell, S. A. Snyder, and J. E. DiDonato. 2010. Novel Scavenger Removal Trials Increase Wind Turbine-Caused Avian Fatality Estimates. Journal of Wildlife Management 74: 1089-1097. doi: 10.2193/2009-266.

Therneau, T. and T. Lumley. 2015. A Package for Survival Analysis in S. Version 2.38. Information available at: http://CRAN.R-project.org/package=survival

Therneau, T. M., and P. M. Grambsch. 2000. Modeling Survival Data: Extending the Cox Model. Springer-Verlag, New York.

Appendix A. Detailed Areas of Carcass Locations along the Generation Tie Line of the Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016

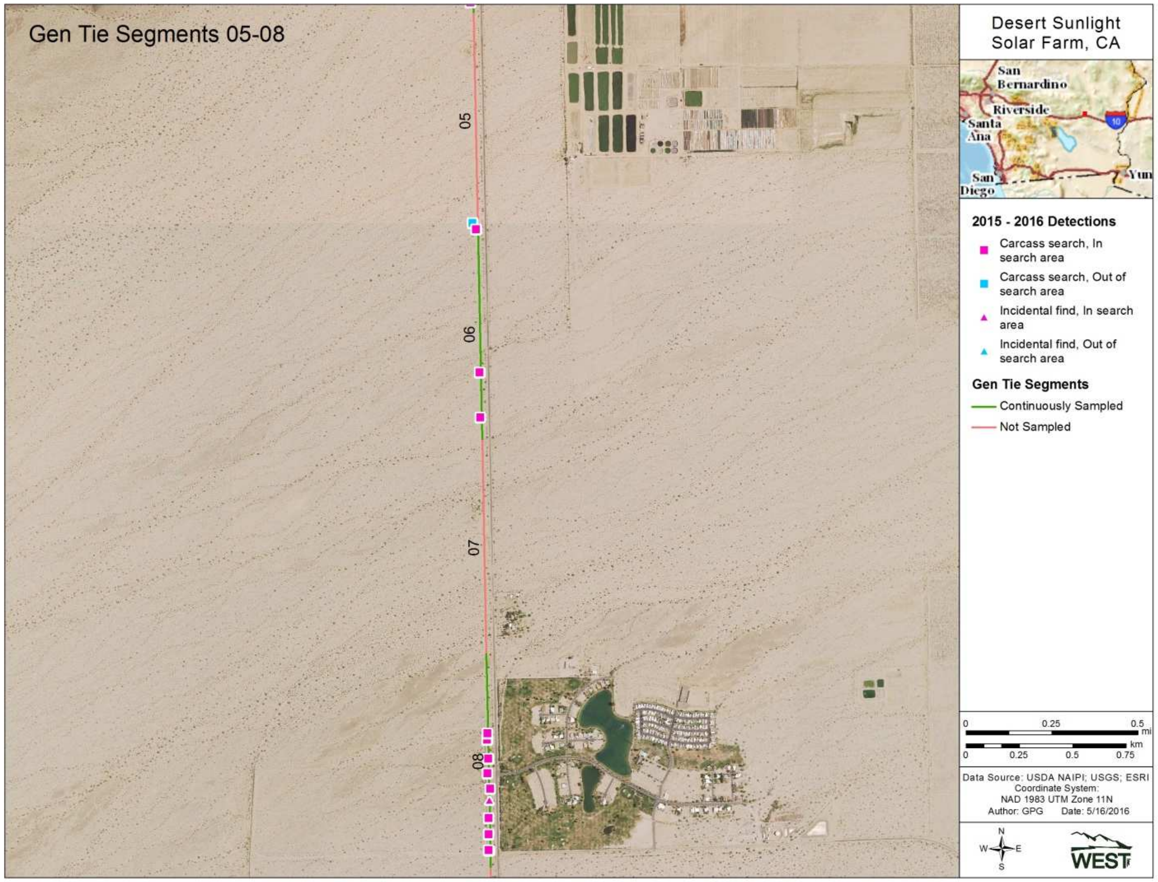


Figure A-1. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

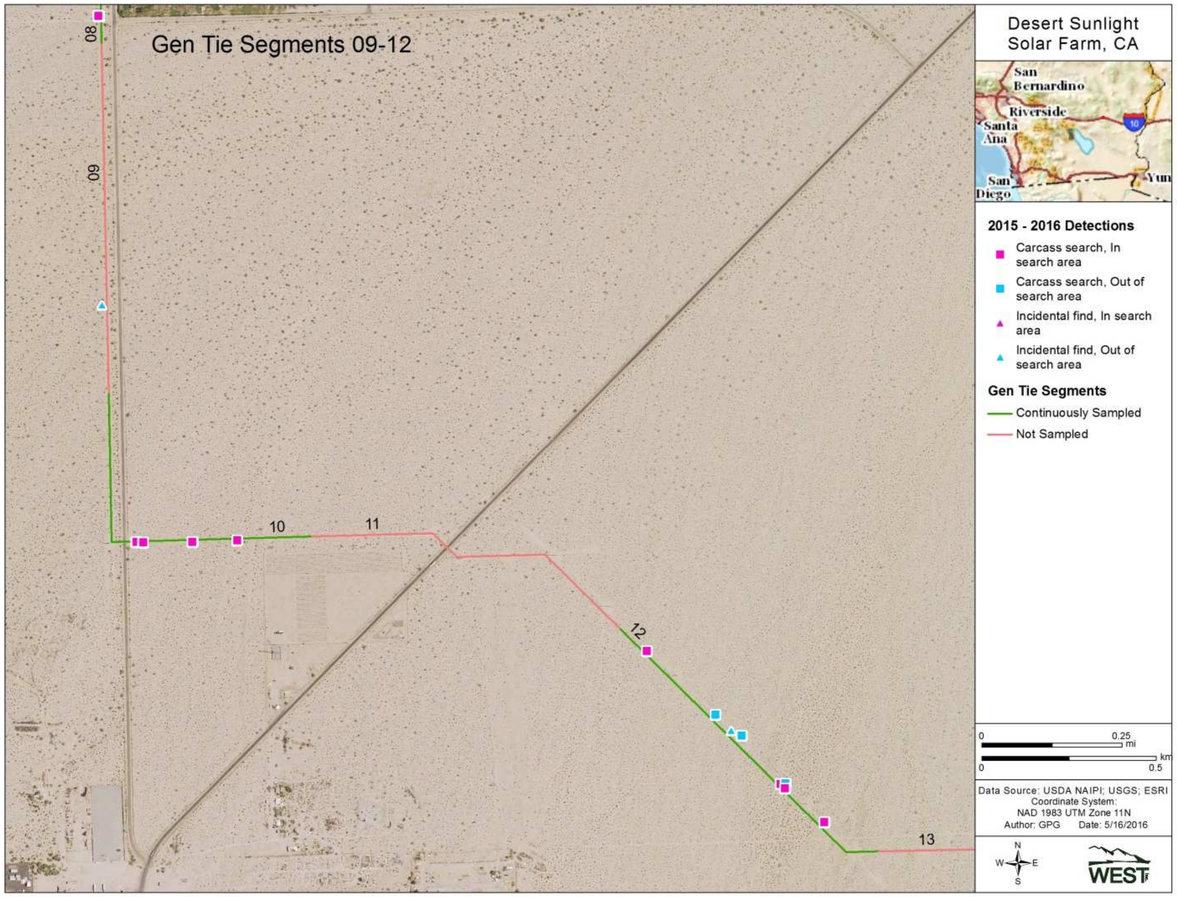


Figure A-2. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

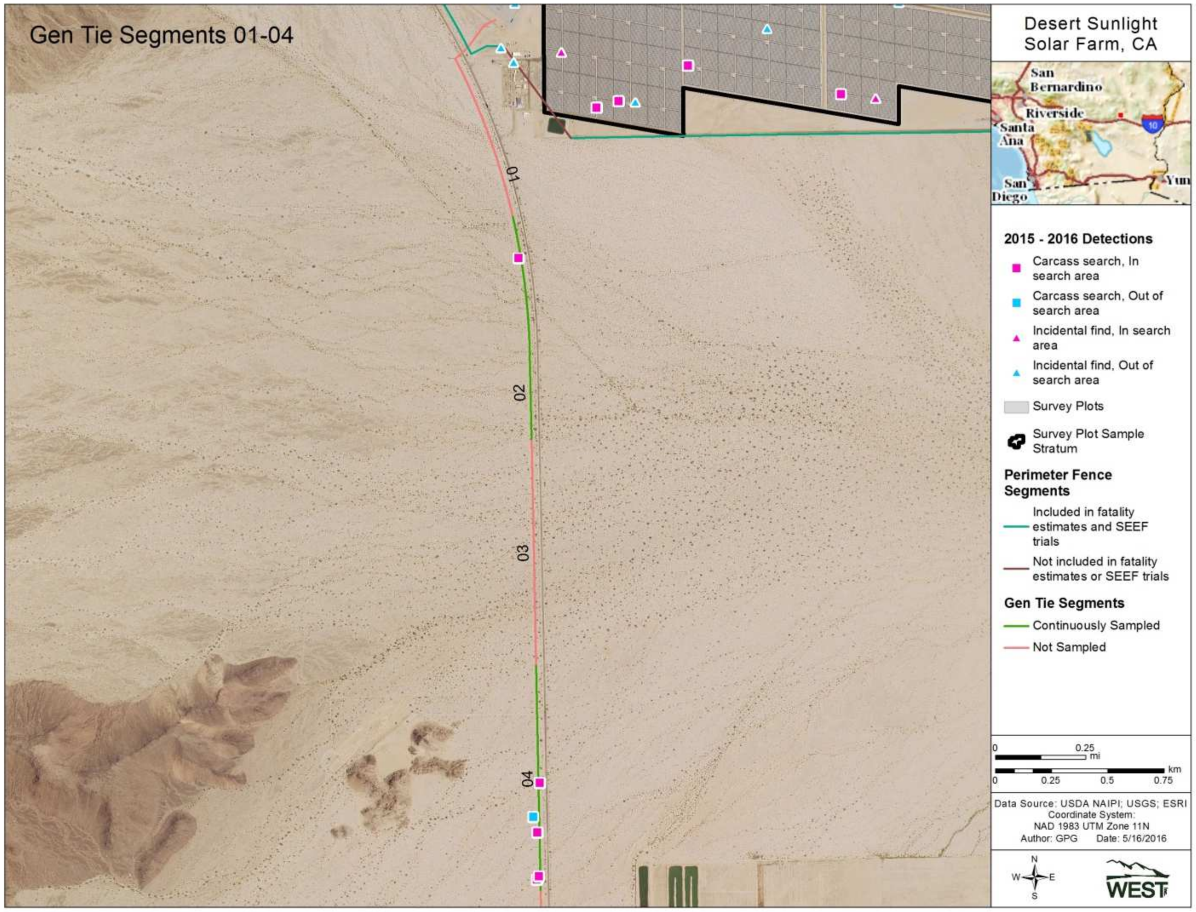
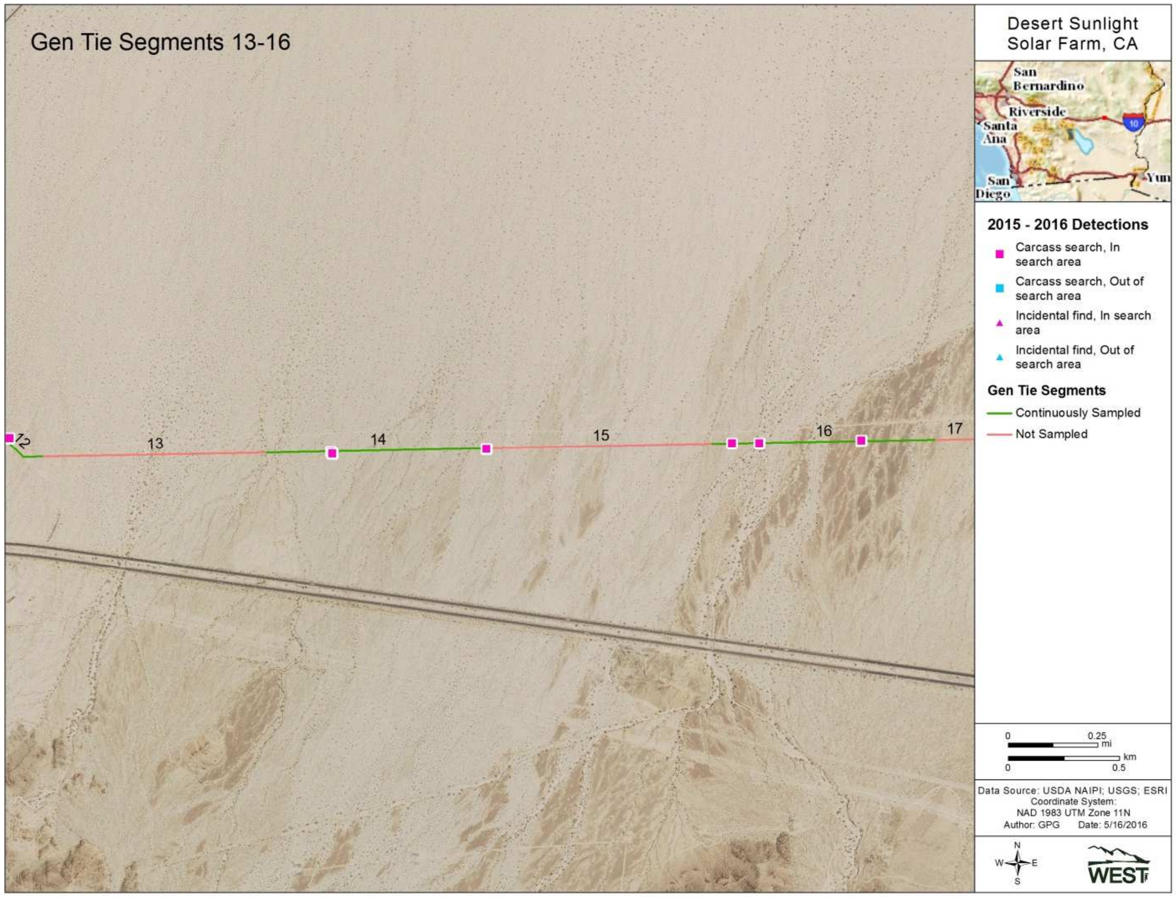


Figure A-3. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).



Data Source: USDA NAIPI; USGS; ESRI
Coordinate System:
NAD 1983 UTM Zone 11N
Author: GPG Date: 5/16/2016

Figure A-4. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

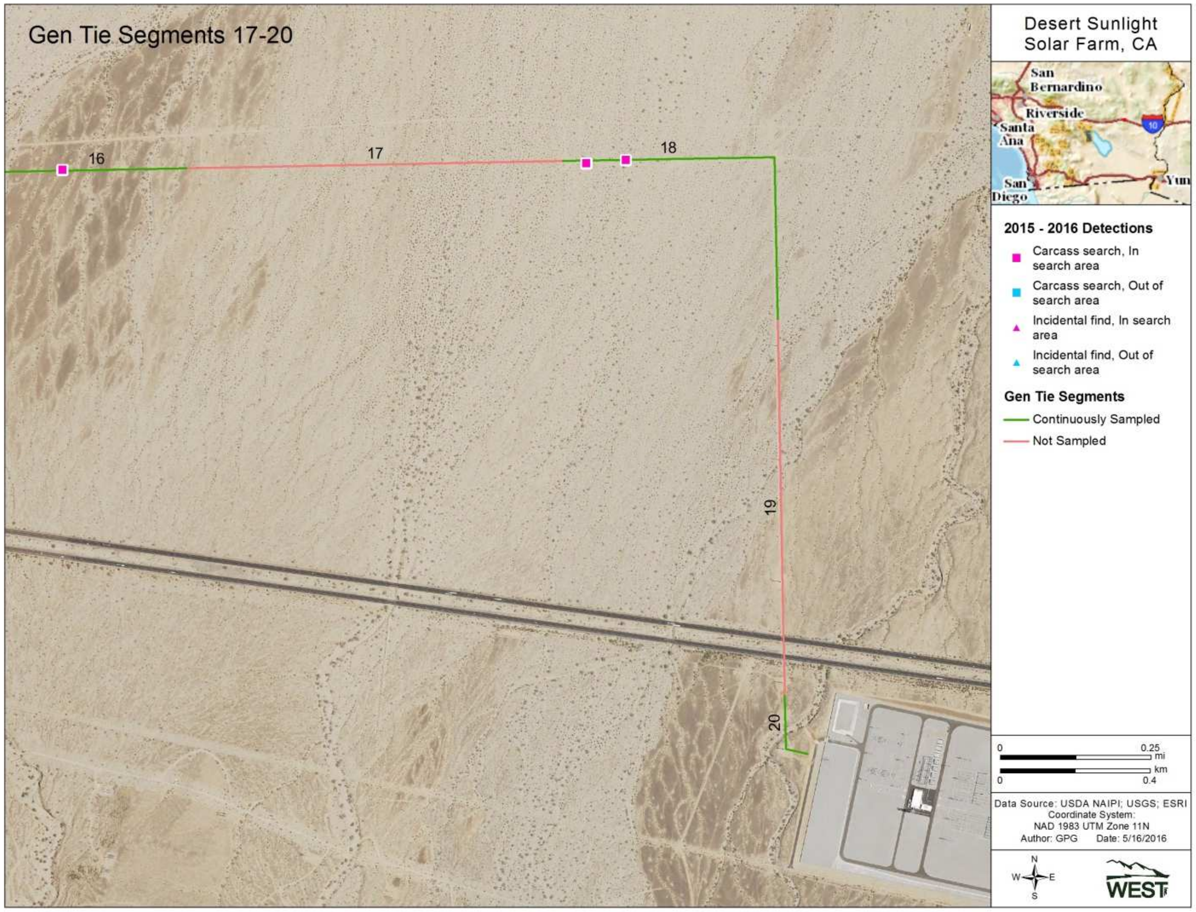


Figure A-5. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

Appendix B. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016)

Table B-1. Weather conditions and body weights associated with detections estimated to be less than 24 hours old during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hours)	Species	Weight (g)[1]	Weather Summary for Preceding 24 hours
040715-TOWA-13-27A-MVOH-01	4/7/2015	8-24hrs	Townsend's warbler	NA	na
042215-WWDO-FENCE-NORTH-15-01	4/22/2015	0-8hrs	white-winged dove	NA	tornado
042215-WWDO-18-19A-MVOH-1-01	4/22/2015	8-24hrs	white-winged dove	NA	na
043015-WIWA-GENTIE-08-01	4/30/2015	8-24hrs	Wilson's warbler	NA	temp high 97 degrees, 2-5 pm overnight low was 67 degrees, winds < 10 mph
050715-WETA-GENTIE-12-01	5/7/2015	8-24hrs	western tanager	NA	na
051915-WEWP-O&MBUILDING-01	5/19/2015	0-8hrs	western wood-pewee	7	clear overnight, relatively calm winds, max 8mph
062415-HOWR-01-16MVOH-02	6/24/2015	8-24hrs	house wren	7	jun 23, max temp 114, avg wind speed 10mph-ssw, max wind speed 16mph. max gust 21mph. vis 10 miles, clear until 3pm then partly cloudy until 7pm, then clear through noght. moon phase: waxing cresent. clear all day 6/24. temp 99 deg F when bird found
071715-SORA-GENTIE-06-01	7/17/2015	0-8hrs	sora	63	average wind speed of 9mph to the south, clear 10 mile visibility, max temperature is 107 degrees, minimum is 79 degrees, new moon 1% illuminated
091015-BTYW-02-21-A-MVOH-04	9/9/2015	8-24hrs	black-throated gray warbler	8	max wind speed- 34. avg wind speed-10. wind direction- sse. moon phase- waning crescent. max temp 108. clear until 2pm on 09/08
090915-YWAR-18-11-A-MVOH-03	9/9/2015	8-24hrs	yellow warbler	8	max wind speed- 34 mph. ang wind speed- 10. wind direction- sse. moon phase- waning crescent. max temp- 108. clear until 2pm on 9/08. haze/thunderstorm until 5pm, then clear.
091115-MODO-17-05-B-19W-01	9/11/2015	0-8hrs	mourning dove	NA	max wind speed-17. avg wind speed- 11. wind direction- SSW. moon phase- waning crescent. some rain
091615-UNSP-GENTIE12-01	9/16/2015	0-8hrs	black-throated sparrow	14	14 max wind. 8 average wind. sse wind direction. maxing crescent moon phase. no clouds. very sunny and a very nice breeze ~95 degrees F.
092215-LISP-GENTIE-10-01	9/22/2015	8-24hrs	Lincoln's sparrow	13	6-16mph SE wind, 9.21 max temp 91F, clear until 4pm, partly cloudy until 5pm, clear until 3am then clear/partly cloudy/overcast until bird found
092315-VIRA-11-15-MVOH-01	9/23/2015	0-8hrs	Virginia rail	60	14 max wind speed. 3 average wind speed. nne wind direction. waxing gibbous moon phase. max temp. 94. clear until bird found.
092315-SAVS-GENTIE-12-03	9/23/2015	8-24hrs	Savannah sparrow	18	3-14 mph NNE wind, waxing gibbous moon, max temp 94, clear
092515-RUDU-19-05-B-2W-01	9/25/2015	8-24hrs	ruddy duck	NA	4-14mph NE wind, waxing gibbous moon, clear until bird found
092815-WEGR-10-24-A-PCS-02	9/28/2015	8-24hrs	western grebe	630	12 max wind speed. gusts 16. 4 avg wind speed. ese wind direction. full moon phase. max temp 105 F. clear until bird found, according to weather underground. 40-55% clouds morning bird found as seen in field.

Table B-1. Weather conditions and body weights associated with detections estimated to be less than 24 hours old during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hours)	Species	Weight (g)[1]	Weather Summary for Preceding 24 hours
092815-YRWA-10-19-B-01W-03	9/28/2015	8-24hrs	yellow-rumped warbler	10	12 max wind speed. gusts 16. 4 avg wind speed. ese wind direction. full moon phase. max temp 105 F. according to weather underground clear until bird found. however 40-55% clouds in field on morning of 09/28 until bird found.
100615-AMCO-GENTIE-8-01	10/6/2015	0-8hrs	American coot	465	20 mph max wind speed. 9 mph avg wind speed. WSW wind direction. last quarter moon phase.
100615-LISP-GENTIE-06-01	10/6/2015	0-8hrs	Lincoln's sparrow	14	max wind speed: 20. ang wind speed: 9. wind direction: wsw. moon phase: last quarter. mostly cloudy
100715-SAVS-GENTIE-12-01	10/7/2015	8-24hrs	Savannah sparrow	16	max wind speed: 13. avg wind speed: 6. wind direction: NNW. gusts 17. moon phase: waning crescent. high temp 89 F. clear until 4 pm on 10/06, then overcast/ mostly cloudy. clear again from 7pm until bird found on 10/07.
100715-VESP-GENTIE-16-03	10/7/2015	8-24hrs	vesper sparrow	23	max wind speed: 13. avg wind speed: 6. wind direction: nnw. moon phase: waning crescent. high temp 89 deg F. clear until 4 pm on 0\10/06, then overcast/ mostly cloudy. clear again from 7 pm until bird found on 10/07.
100715-HOWR-GENTIE-18-04	10/7/2015	8-24hrs	house wren	9	max wind speed: 13. avg wind speed: 6. wind direction: NNW. gusts: 17. moon phase: waning crescent. high temp 89 def F. clear until 4pm on 10/06, the overcast/mostly cloudy. clear again from 7pm until bird found on 10/07.
100715-WCSP-GENTIE-14-02	10/7/2015	8-24hrs	white-crowned sparrow	24	max wind speed: 13. avg wind speed: 6. wind direction: NNW. moon phase: waning crescent. high temp 89 deg F. clear until 4 pm on 10/06, then overcast/ mostly cloudy. clear again from 7 pm until bird found on 10/07.
100815-EAGR-05-16-MAINROAD-02	10/8/2015	0-8hrs	eared grebe	NA	max wind speed: 10. avg wind speed: 4. wind direction: wsw. moon phase: waning crescent. clear.
101315-WEME-GENTIE-10-01	10/13/2015	8-24hrs	western meadowlark	72	max wind speed: 9. avg wind speed: 5. wind direction: SW. moon phase: waning crescent. clear.
101415-WEGR-07-15-A-34-01	10/14/2015	0-8hrs	western grebe	670	max wind speed: 13. avg wind speed: 5. wind direction: NE. moon phase: new moon. clear.
101515-RUDU-06-15-A-10E-02	10/15/2015	0-8hrs	ruddy duck	NA	max wind speed: 6 mph. avg wind speed: 3 mph. wind direction: ENE. moon phase: waxing crescent. 10 mile visibility
101515-RUDU-08-01-B-14-E-01	10/15/2015	0-8hrs	ruddy duck	NA	max wind speed: 13 mph. avg wind speed: 4 mph. wind direction: NW. moon phase: waxing crescent. mostly cloudy, light sprinkles, avg temo 90 deg F

Table B-1. Weather conditions and body weights associated with detections estimated to be less than 24 hours old during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hours)	Species	Weight (g)[1]	Weather Summary for Preceding 24 hours
101615-AMCO-20-08-A-7-E-01	10/16/2015	8-24hrs	American coot	NA	max wind speed: 21 mph. avg wind speed: 6 mph. wind direction: NNW. moon phase: waxing crescent. heavy cloud cover greater than 80%. t-storm previous night, on 101515 (with rain and lightening)
102015-BHCO-GENTIE-10-01	10/20/2015	0-8hrs	brown-headed cowbird	43	10-18 NNW wind, gusts to 25 mph, waxing crescent moon, max temp 85, clear until 6pm then partly cloudy/overcast until midnight then clear until bird found
102115-WCSP-GENTIE-14-01	10/21/2015	8-24hrs	white-crowned sparrow	27	8-33 mph NNW wind, waxing crescent moon, rain, thunderstorm
102315-COLO-04-05-A-02	10/23/2015	0-8hrs	common loon	NA	max wind speed: 7. avg wind speed: 3. wind direction: ene. moon phase: waxing gibbous. max temp on 10/22 84 deg F. clear, visibility 10 miles on 10/22 and 10/23

[1] Weight recorded only for intact carcasses with no evidence of scavenging.

Appendix C. Correction Factors and Bird Fatality Rates at the Desert Sunlight Solar Farm Project during the 2015 – 2016 Monitoring Period

(March 1, 2015 – February 28, 2016)

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during the 2015 – 2016 (February 2, 2015 – February 28, 2016) monitoring year. *Distribution of easy and difficult visibility on the gen-tie line was 50% and 50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

Parameter	Small birds		Medium birds		Large birds		Unknown size	
	Mean	90% CI	Mean	90% CI	Mean	90% CI	Mean	90% CI
Proportion of area searched by component								
Fence	0.74	-	0.74	-	0.74	-	0.74	-
Gen-tie line	0.48	-	0.48	-	0.48	-	0.48	-
Solar arrays	0.30	-	0.30	-	0.30	-	0.30	-
Searcher efficiency by component and visibility class								
Fence								
Spring & Winter	0.65	0.52 - 0.77	0.94	0.88 - 1.00	1.00	1.00 - 1.00	0.65	0.52 - 0.77
Summer & Fall	0.87	0.77 - 0.97	0.98	0.96 - 1.00	1.00	1.00 - 1.00	0.87	0.77 - 0.97
Gen-tie line								
Easy visibility								
Spring & Summer	0.67	0.53 - 0.82	0.89	0.80 - 0.95	0.89	0.80 - 0.96	0.67	0.53 - 0.81
Fall & Winter	0.57	0.46 - 0.68	0.84	0.75 - 0.91	0.85	0.73 - 0.93	0.57	0.46 - 0.681
Difficult visibility								
Spring & Summer	0.75	0.62 - 0.86	0.92	0.86 - 0.97	0.92	0.84 - 0.97	0.75	0.62 - 0.86
Fall & Winter	0.33	0.22 - 0.44	0.65	0.53 - 0.77	0.67	0.51 - 0.82	0.33	0.22 - 0.44
Solar arrays								
Low cobble								
Spring	0.65	0.45 - 0.63	0.83	0.77 - 0.90	0.84	0.72 - 0.94	0.65	0.45 - 0.63
Summer	0.65	0.45 - 0.63	0.83	0.77 - 0.90	1.00	1.00 - 1.00	0.65	0.45 - 0.63
Fall	0.58	0.39 - 0.78	0.83	0.77 - 0.90	0.84	0.72 - 0.94	0.58	0.39 - 0.78
Winter	0.65	0.45 - 0.63	0.94	0.87 - 0.99	1.00	1.00 - 1.00	0.65	0.45 - 0.63
High cobble								
Spring	0.36	0.21 - 0.45	0.83	0.77 - 0.90	0.84	0.72 - 0.94	0.36	0.21 - 0.45
Summer	0.36	0.21 - 0.45	0.83	0.77 - 0.90	1.00	1.00 - 1.00	0.36	0.21 - 0.45
Fall	0.33	0.13 - 0.64	0.83	0.77 - 0.90	0.84	0.72 - 0.94	0.33	0.13 - 0.64
Winter	0.36	0.21 - 0.45	0.94	0.87 - 0.99	1.00	1.00 - 1.00	0.36	0.21 - 0.45
Average probability of carcass persistence through the effective search interval								
Gen-tie lines								
Spring	0.19	0.09 - 0.30	0.68	0.56 - 0.78	0.65	0.47 - 0.81	0.19	0.09 - 0.30
Summer	0.07	0.03 - 0.10	0.49	0.36 - 0.62	0.18	0.09 - 0.29	0.07	0.03 - 0.10
Fall	0.09	0.04 - 0.15	0.48	0.36 - 0.59	0.65	0.47 - 0.81	0.09	0.04 - 0.15

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during the 2015 – 2016 (February 2, 2015 – February 28, 2016) monitoring year. *Distribution of easy and difficult visibility on the gen-tie line was 50% and 50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

Parameter	Small birds		Medium birds		Large birds		Unknown size	
	Mean	90% CI	Mean	90% CI	Mean	90% CI	Mean	90% CI
Winter	0.19	0.14 - 0.25	0.27	0.17 - 0.36	0.18	0.09 - 0.29	0.19	0.14 - 0.25
Solar arrays & fence								
Spring	0.64	0.52 - 0.74	0.80	0.72 - 0.88	0.95	0.90 - 0.98	0.64	0.52 - 0.74
Summer	0.62	0.47 - 0.76	0.66	0.56 - 0.78	0.62	0.43 - 0.76	0.62	0.47 - 0.76
Fall	0.44	0.25 - 0.66	0.65	0.56 - 0.73	0.95	0.90 - 0.98	0.44	0.25 - 0.66
Winter	0.43	0.35 - 0.51	0.46	0.37 - 0.55	0.62	0.43 - 0.76	0.43	0.35 - 0.51
Adjustment for effective search interval (proportion of nominal search interval; all others not listed are 1)								
Gen-tie line: Fall	0.66	0.29 - 1.00	1.00	-	1.00	-	1.00	-
Gen-tie line: Summer	0.49	0.23 - 0.74	1.00	-	1.00	-	1.00	-
Carcass counts by component								
Fence								
Spring	0	-	1	0 - 3	0	-	0	-
Summer	0	-	0	-	0	-	0	-
Fall	0	-	0	-	0	-	0	-
Winter	0	-	3	0 - 7	0	-	0	-
Gen-tie								
Spring	3	1 - 6	2	0 - 5	0	-	1	0 - 3
Summer	1	0 - 3	1	0 - 3	0	-	0	-
Fall	13	5 - 22	10	3 - 19	0	-	0	-
Winter	1	0 - 3	2	0 - 5	0	-	0	-
Solar arrays								
Spring	2	0 - 5	3	0 - 6	2	0 - 5	2	0 - 5
Summer	1	0 - 3	4	0 - 10	3	0 - 6	0	-
Fall	10	5 - 16	21	14 - 29	7	3 - 12	0	-
Winter	7	0 - 12	9	4 - 14	0	-	1	0 - 3
Average probability of carcass availability and detected (searcher efficiency * average probability of carcass persistence)								
Fence								
Spring	0.41	0.30 - 0.52	0.76	0.67 - 0.84	0.95	0.90 - 0.98	0.41	0.30 - 0.52
Summer	0.54	0.40 - 0.68	0.65	0.55 - 0.77	0.62	0.43 - 0.76	0.54	0.40 - 0.68
Fall	0.38	0.21 - 0.59	0.64	0.55 - 0.72	0.95	0.90 - 0.98	0.38	0.21 - 0.59
Winter	0.28	0.21 - 0.36	0.43	0.34 - 0.53	0.62	0.43 - 0.76	0.28	0.21 - 0.36
Gen-tie								
Easy visibility								
Spring	0.13	0.06 -	0.60	0.49 -	0.58	0.43 -	0.13	0.06 -

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during the 2015 – 2016 (February 2, 2015 – February 28, 2016) monitoring year. *Distribution of easy and difficult visibility on the gen-tie line was 50% and 50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

Parameter	Small birds		Medium birds		Large birds		Unknown size	
	Mean	90% CI	Mean	90% CI	Mean	90% CI	Mean	90% CI
		0.21		0.70		0.75		0.21
Summer	0.04	0.02 - 0.07	0.44	0.31 - 0.55	0.16	0.09 - 0.27	0.04	0.02 - 0.07
Fall	0.05	0.02 - 0.09	0.40	0.29 - 0.50	0.55	0.29 - 0.59	0.05	0.02 - 0.09
Winter	0.11	0.07 - 0.15	0.23	0.14 - 0.31	0.15	0.06 - 0.20	0.11	0.07 - 0.15
Difficult visibility								
Spring	0.14	0.07 - 0.22	0.62	0.51 - 0.72	0.60	0.41 - 0.73	0.14	0.07 - 0.22
Summer	0.05	0.03 - 0.08	0.45	0.33 - 0.57	0.16	0.08 - 0.25	0.05	0.03 - 0.08
Fall	0.03	0.01 - 0.05	0.31	0.22 - 0.40	0.43	0.38 - 0.70	0.03	0.01 - 0.05
Winter	0.06	0.04 - 0.09	0.18	0.11 - 0.25	0.12	0.08 - 0.24	0.06	0.04 - 0.09
Solar arrays								
Low cobble								
Spring	0.41	0.26 - 0.43	0.67	0.59 - 0.75	0.80	0.68 - 0.91	0.41	0.26 - 0.43
Summer	0.40	0.24 - 0.43	0.55	0.46 - 0.65	0.62	0.43 - 0.76	0.40	0.24 - 0.43
Fall	0.25	0.13 - 0.42	0.54	0.46 - 0.62	0.80	0.68 - 0.91	0.25	0.13 - 0.42
Winter	0.28	0.17 - 0.29	0.43	0.34 - 0.52	0.62	0.43 - 0.76	0.28	0.17 - 0.29
High cobble								
Spring	0.23	0.13 - 0.30	0.67	0.59 - 0.75	0.80	0.68 - 0.91	0.23	0.13 - 0.30
Summer	0.22	0.12 - 0.31	0.55	0.46 - 0.65	0.62	0.43 - 0.76	0.22	0.12 - 0.31
Fall	0.15	0.05 - 0.35	0.54	0.46 - 0.62	0.80	0.68 - 0.91	0.15	0.05 - 0.35
Winter	0.15	0.09 - 0.21	0.43	0.34 - 0.52	0.62	0.43 - 0.76	0.15	0.09 - 0.21
Adjusted fatality estimates (fatalities/season; values in italics are considered unreliable due to low counts of carcasses: carcass count / (proportion of area searched * average probability of carcass availability and detected)**								
Fence	-	-	**11.31**	2.58 - 26.09	**-**	-	-	**-**
Spring	-	-	1.76	1.62 - 5.87	-	-	-	-
Summer	-	-	-	-	-	-	-	-
Fall	-	-	-	-	-	-	-	-
Winter	-	-	9.55	2.93 - 24.45	-	-	-	-
Gen-tie	**590.82**	266.27 - 1426.64	**82.14**	35.91 - 149.79	-	-	**15.24**	9.88 - 63.10
Spring	45.72	13.14 -	6.60	3.04 -	-	-	15.24	9.88 -

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during the 2015 – 2016 (February 2, 2015 – February 28, 2016) monitoring year. *Distribution of easy and difficult visibility on the gen-tie line was 50% and 50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

Parameter	Small birds		Medium birds		Large birds		Unknown size	
	Mean	90% CI	Mean	90% CI	Mean	90% CI	Mean	90% CI
		125.68		15.84				63.10
Summer	47.21	30.32 - 192.93	4.68	3.87 - 15.85	-	-	-	-
Fall	479.02	171.10 - 1276.61	54.55	14.40 - 111.10	-	-	-	-
Winter	18.87	14.56 - 64.02	16.31	6.54 - 44.76	-	-	-	-
Solar arrays	**289.72**	181.58 - 574.38	**242.6**	166.44 - 333.35	**52.96**	28.00 - 84.82	**41.40**	12.39 – 115.44
Spring	16.05	8.41 - 46.45	15.21	4.83 - 31.21	8.50	3.90 - 20.70	20.54	10.60 - 62.73
Summer	8.59	8.37 - 36.13	23.60	5.86 - 61.89	13.47	4.13 - 28.17	-	-
Fall	148.51	61.70 - 352.34	132.69	84.10 - 187.84	31.00	11.92 - 54.96	-	-
Winter	116.57	51.30 - 260.42	71.10	34.10 - 120.04	-	-	22.35	17.45 – 88.83
Facility Total	**880.532**	566.33 - 1843.05	**336.05**	246.44 - 448.58	**52.96**	28.00 - 84.82	**58.13**	22.32 - 143.95

Table C-2. Carcasses excluded from the 2015 – 2016 monitoring year fatality analysis at the Desert Sunlight Solar Farm due to 1) having been detected outside of a regular search area or 2) having an estimated carcass age that is greater than the actual search interval and hence violating assumptions of the Huso estimator.

Parameter	Small birds	Medium birds	Large birds	Unknown size	Bats
Building	0	1	2	0	0
Fence	3	0	0	0	0
Gen-tie	1	0	6	0	0
Solar Array	5	11	10	0	0

Post-Construction Monitoring at the Desert Sunlight Solar Project Riverside County, California

2015 - 2016 Annual Report

Prepared for:

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC

700 Universe Blvd.,
Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.

415 W. 17th St.
Cheyenne, Wyoming 82001

May 31, 2016

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from March 1, 2015 to February 28, 2016 (the 2015 – 2016 monitoring year) at Desert Sunlight Solar Farm Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the comprehensive annual report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS.

Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 29.5% sample of solar photovoltaic (PV) panels, 2) along inner portions of the fenceline, resulting in 74.4% of the length of the perimeter fence, and 3) along 47.9% of the total length of generation-tie (gen-tie) line from the Project fence to the Red Bluff Substation located south of Interstate 10 (I-10). Searches were conducted at intervals of approximately seven days during spring and fall and 21 days during summer and winter.

All bird and bat fatalities and injuries that were discovered by observers, referred to as "detections" in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, 149 avian detections (including all stranded and injured birds and incidental detections), of 19 guilds and including 53 identified species, were made. The most numerous detection of an identified species was of American coot (*Fulica americana*) with 12 detections, followed by mourning dove (*Zenaida macroura*; n = 6). The most numerous detection in the solar arrays was American coot (n = 9), followed by western grebe (*Aechmophorus occidentalis*; n = 5) with no other species with more than four detections. The only species observed along the fence were American coot (n = 1), common raven (*Corvus corax*; n = 1), common loon (*Gavia immer*; n = 1), white-winged dove (*Zenaida asiatica*; n = 1), and mallard (*Anas platyrhynchos*; n = 1). Eurasian collared-dove (*Streptopelia decaocto*; n = 4) and orange-crowned warbler (*Oreothlypis celata*; n = 3) were the species with the most detections along the gen-tie/road. No bats were detected during the 2015 – 2016 monitoring year.

Avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were applied to a fatality estimator model (Huso 2010) to provide an estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias.

Mean (median) removal time within the solar field was 4.9 (6.0) days during spring, 12.7 (12.6) during summer, 2.5 (1.5) during fall, and 6.5 (6.0) during winter for small carcasses; 36.0 (27.8) days during spring, 36.0 (24.3) during summer, 12.2 (18.0) during fall, and 12.2 (6.8) during winter for medium carcasses; and 58.3 (31.0) days during spring, 13.7 (30.0) during summer,

58.3 (30.0) during fall, and 13.7 (5.1) during winter. At the overhead lines, removal time was 0.8 (0.5), 0.8 (0.5), 0.4 (0.5), and 2.3 (2.5) during spring, summer, fall, and winter respectively. For medium birds, mean (median) removal time at the overhead lines was 14.4 (2.0), 14.4 (15.8), 4.9 (1.5), and 4.9 (2.5) days during spring, summer, fall, and winter respectively. Mean (median) removal time for large birds was 5.8 (19.0), 1.4 (0.5), 5.8 (3.5), and 1.4 (3.5) days during spring, summer, fall, and winter respectively.

Within the solar arrays, searcher efficiency for small birds was influenced by cobble cover and season: small birds in high cobble cover in the fall had a searcher efficiency of 33.2% (CI: 13.3 – 63.9%; n = 15) and small birds in low cobble cover in the fall had a searcher efficiency of 57.8% (CI: 39.0 – 77.7%; n = 27). Searcher efficiency for small birds in high cobble cover during winter, spring and summer was 36.0% (CI: 21.1 – 45.4%; n = 50), and small birds in low cobble cover during winter, spring and summer had a searcher efficiency of 64.5% (CI: 44.5 – 63.4%; n = 70). For medium birds, searcher efficiency within the solar arrays was similar across cobble cover classes but differed by season: in winter, medium bird searcher efficiency was 93.5% (CI: 87.5 – 98.5%; n = 45), and in spring, summer and fall medium bird searcher efficiency was 83.2% (CI: 76.5 – 89.8%; n = 63). For large birds, searcher efficiency among the solar arrays differed between migration seasons (spring and fall) and non-migration seasons (summer and winter). Searcher efficiency during spring and fall for large birds was 83.9% (CI: 72.0 – 94.3%; n = 31). Searcher efficiency for large birds during summer and winter was 100% with no variance (n = 35). Sample sizes refer to numbers of trial carcasses that were available to be found, not numbers of trial carcasses that were placed.

For the fence, the model that included an effect of carcass size, and season (with spring and winter data lumped and summer and fall data lumped) was chosen as the most supported model to estimate searcher efficiency. Along the fence, searcher efficiency was 65% (CI: 52 – 77%), 94% (CI: 88 - 100%), and 100% (CI: 100 - 100%), for small, medium, and large carcasses, respectively during spring and winter and 87% (CI: 77 – 97%), 98% (CI: 96 – 100%), and 100% (CI: 100 – 100%) for small, medium, and large carcasses respectively during summer and fall.

For the gen-tie line, the chosen model included main effects of size, season (with spring and summer data lumped and fall and winter data lumped), and visibility class, with an interaction between visibility class and season. It ranked second by AICc, but was only 0.59 AICc points from the top model. It was chosen because it has similar predictive performance as the top model, but with fewer parameters to estimate. For the easy visibility class, searcher efficiency was 67% (CI: 53 – 81%), 89% (CI: 80 – 95%), and 89% (CI: 80 – 96%) for small, medium, and large carcasses, respectively during spring and summer and 57% (CI:46 – 68%), 84% (CI: 75 – 91%), and 85% (CI: 73 – 93%) for small, medium, and large birds respectively during fall and winter (Table 12). For the difficult visibility class, searcher efficiency was 75% (CI: 62 – 86%), 92% (CI: 86 – 97%), and 92% (CI: 84 – 97%) for small, medium, and large birds respectively during spring and summer and 33% (CI: 22 – 44%), 65% (CI: 53 – 77%), and 67% (CI: 51 – 82 %) for small, medium, and large birds respectively during fall and winter.

Using the Huso (2010) fatality estimator model, during the 2015 – 2016 monitoring year, there were an estimated 1,328 bird carcasses (CI: 1,007 – 2,303) at the Project (all components combined). There were an estimated 53 (CI: 28 – 85) large birds, 336 (CI: 246 – 449) medium birds, 881 (CI: 566 – 1,843) small birds, and 58 (CI: 22 – 143) birds of unknown size at the Project (all components combined).

There were an estimated 628 (CI: 496 – 951) bird carcasses (152/1000 acres, 1.16/nameplateMW) at the solar arrays, 11 (CI: 2 – 26) at the fence, and 688 (CI: 364 – 1,567) along the gen-tie line. Estimates of fatalities along the gen-tie are heavily influenced by the high rates of scavenging observed during the limited trials at the gen-tie (i.e., large correction factors) and are likely very unreliable.

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Michael Gerringer	Wildlife Biologist
Sarah Nichols	Research Biologist/Field Supervisor
Lacey Jeroue	Statistician
Paul Rabie	Statistician
Pam Bullard	Designated Biologist
Darin Blood	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2016. Avian and Bat Monitoring at the Desert Sunlight Solar Project Riverside County, California, 2015 -2016 Annual Report. Prepared for Desert Sunlight 250, LLC and Desert Sunlight 300, LLC, Juno Beach, Florida. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne Wyoming.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

1.1 Project Background

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC (collectively, Desert Sunlight) constructed and operates the Desert Sunlight Solar Farm Project (Project), which consists of two main components: 1) a 550-megawatt (MW) photovoltaic (PV) generating facility; and 2) a 220-kilovolt generation interconnection (gen-tie) line. The Project comprises approximately 1,700 hectares (ha; 4,200 acres) of land administered by the Bureau of Land Management (BLM) six miles north of Desert Center in Riverside County, California (Figure 1).

1.2 Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (BBCS; 2014) was prepared by the Project proponent in collaboration with the US Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and BLM to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency approval of the BBCS occurred in December 2014. Amendments to the sampling protocol along some portions of the Project fenceline were made by Desert Sunlight and approved by the BLM on February 11, 2015.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Desert Sunlight in collaboration with the USFWS, CDFW, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the gen-tie line, perimeter fence and other features of the Project that may result in injury and fatality.

2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with Project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
3. Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

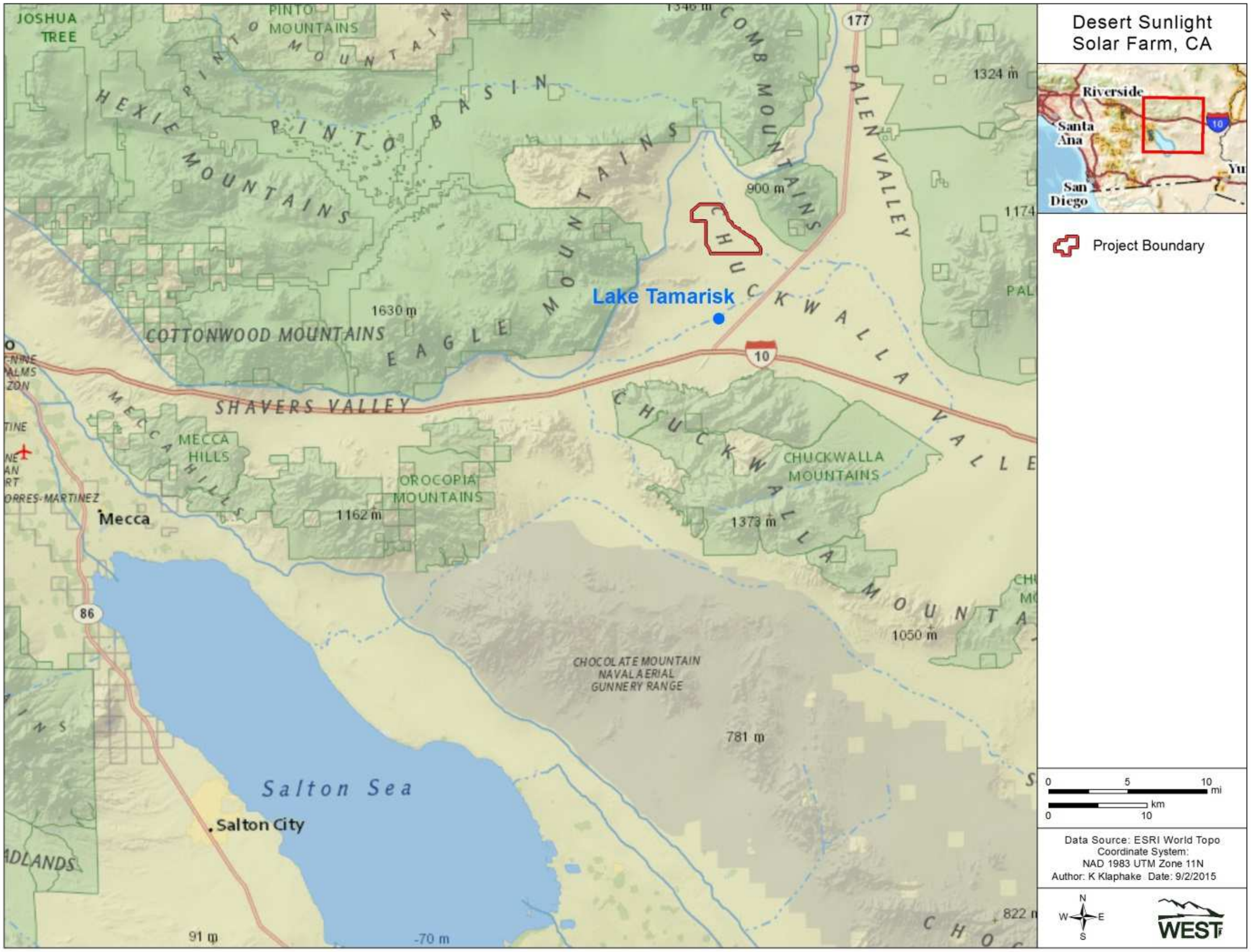


Figure 1. Desert Sunlight Solar Farm Project vicinity map, Riverside County, California.

1.3 Purpose of This Report

This report represents the comprehensive annual report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS. This report includes data and final information from all four quarterly monitoring periods.

This report covers the 2015 – 2016 monitoring year, which includes the period from March 1, 2015 to February 28, 2016. All carcasses and injuries that were discovered by observers are referred to as "detections" in this report. As stated in the approved BBCS, this report includes the observed detections for likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and for suspected causes of death. Species composition of detections and the results of the bias trials are also included in this report.

2 METHODS

The following section describes the field and statistical methods used during the monitoring period, including the analytical methods for estimating overall avian fatality rates.

2.1 Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. This section also describes the methods for conducting carcass removal and searcher efficiency trials; the methods for reporting and analyzing data, and the methods for producing fatality estimates for the Project.

2.1.1 Areas Surveyed

Standardized carcass searches were conducted at sampling units, which include the solar arrays (Table 1, 2; Figure 2); the "fenceline" defined as the perimeter fence for the Project (Table 1, Figure 2); and the gen-tie line (from the Project fence to the Red Bluff Substation on the south side of I-10; Table 1, Figure 3). Some overhead lines co-occur with solar arrays (medium voltage overhead (MVOH) lines). The MVOH lines were part of standardized carcass searches to the extent that they co-occurred with solar arrays included in the sample (Table 2; Figure 2).

Table 1. Areas included in standardized carcass searches at the Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

Project Component	Total Size	Units	% of Component Searched
Solar arrays	1045.9	Hectares	30.0[1]
Fence	16.7	Kilometers	99.0[2]
Gen-tie line	19.2	Kilometers	47.9[3]

[1] Percent area that was searched in spring (28.2) summer (29.5), fall (29.5), and winter (29.5), slightly less than 30% total because of unequally sized arrays.

[2] 74.4% of the fence is fully accessible and surveyed following the standard protocol, while approximately 25% of the fence is surveyed from a distance. Fatality rates estimated for sections of the fence that are sampled were extrapolated to sections of the fence where the standard monitoring protocol cannot be used, as described in Section 4.2.6 of the approved Desert Sunlight BBCS. A very short segment near the gate is not sampled due to restoration activities.

[3] 52.1% of the gen-tie will be sampled in 2016.

Table 2. Area and proportion of solar arrays that are and are not associated with overhead lines at the Desert Sunlight Solar Farm Project, Riverside County, CA.

	Line-associated[1]	Not line-associated	Proportion line-associated
Entire facility	89.4 ha	956.5 ha	0.09
Standardized searches	32.2 ha	291.0 ha	0.10

[1] Line-associated area was estimated as the area of any array that fell within the 30-m strip transect below the MVOH line.

Note: Hectares (ha)

To ensure a balanced distribution of sample units in the solar field (defined as the collection of all PV solar panels), the entire field was divided into ten strata, and individual sampling units were randomly selected within each stratum to compose an approximately 30% sample. This sampling design ensures that units included in the sample were not spatially clumped within the solar field. The solar field consists of arrays of solar panels (referred to as a solar array) that are either 70 meters (m) or 140-m wide. The sample includes 133 of each type of array. There are 2,580 70-m rows, and 3,900 140-m rows in the sample.

On April 21, 2015, the Project was struck by a tornado. The tornado damaged some of the sampling units and resulted in limited access that ultimately lasted longer than initially expected. Thus, 142 sample units (128 arrays, fence, and gen-tie combined) were visited 12 times continuously and without interruption during the spring season. Six arrays were visited seven times from the beginning of the spring season until the tornado occurred on April 21, 2015; three weeks elapsed before the six damaged arrays were replaced with arrays in the solar field that were not affected by the tornado. During this three week period, Desert Sunlight LLC remained in contact with the BLM as details on access limitation developed. Once it was determined that access to damaged arrays would be limited for a longer time period, six replacement arrays were identified by choosing a random sample of non-damaged arrays within the same block that contained the original arrays that were damaged by the tornado.

2.1.2 Search Frequency and Timing

Standardized searches occurred during the 2015 – 2016 monitoring year, which includes the period from March 1, 2015 through February 28, 2016. All Project components included in standardized searches were surveyed 31 times during the 2015 – 2016 monitoring year (12 times during spring, four times during summer, nine times during fall, and six times during winter). All searches took place during daylight hours from 06:30 to 17:00.

The average search interval for all Project components included in standardized carcass searches was 7.0 (median 7.0) during spring, 22.8 days (median 21.0 days) during summer, 8.1 days (median 7.0 days) during fall, and 19.1 days (median 21.0 days) during winter. Slight variation in search interval was anticipated due to weather and logistical delays.

2.1.3 Search Methods

Standardized carcass searches were performed by BLM-approved biologists in accordance with methods outlined in the BBCS.

Within the solar field, arrays of solar panels were surveyed by observers traveling on foot. A distance sampling approach was used whereby biologists slowly walked a transect line along the ends of rows of solar panels in a direction perpendicular to the rows, searching ahead and to the side within the array for bird and bat detections. Biologists scanned out to a maximum perpendicular distance of approximately 70 m from the transect. Biologists carried binoculars to allow them to verify the presence of a detection as opposed to rocks or vegetation. Once a detection was confirmed, the distance of the detection to the transect line was estimated using laser range finders. Each array included in the sample was searched by observers walking two transects – one on the west side and one on the east side of the array with observers looking toward the center of the array.

Once a carcass was detected, it was photographed, and data were recorded according to specifications outlined in Section 7.2.5 of the approved Desert Sunlight BBCS. Carcasses were then retrieved from their location on the ground, labeled, and placed in a freezer on site.

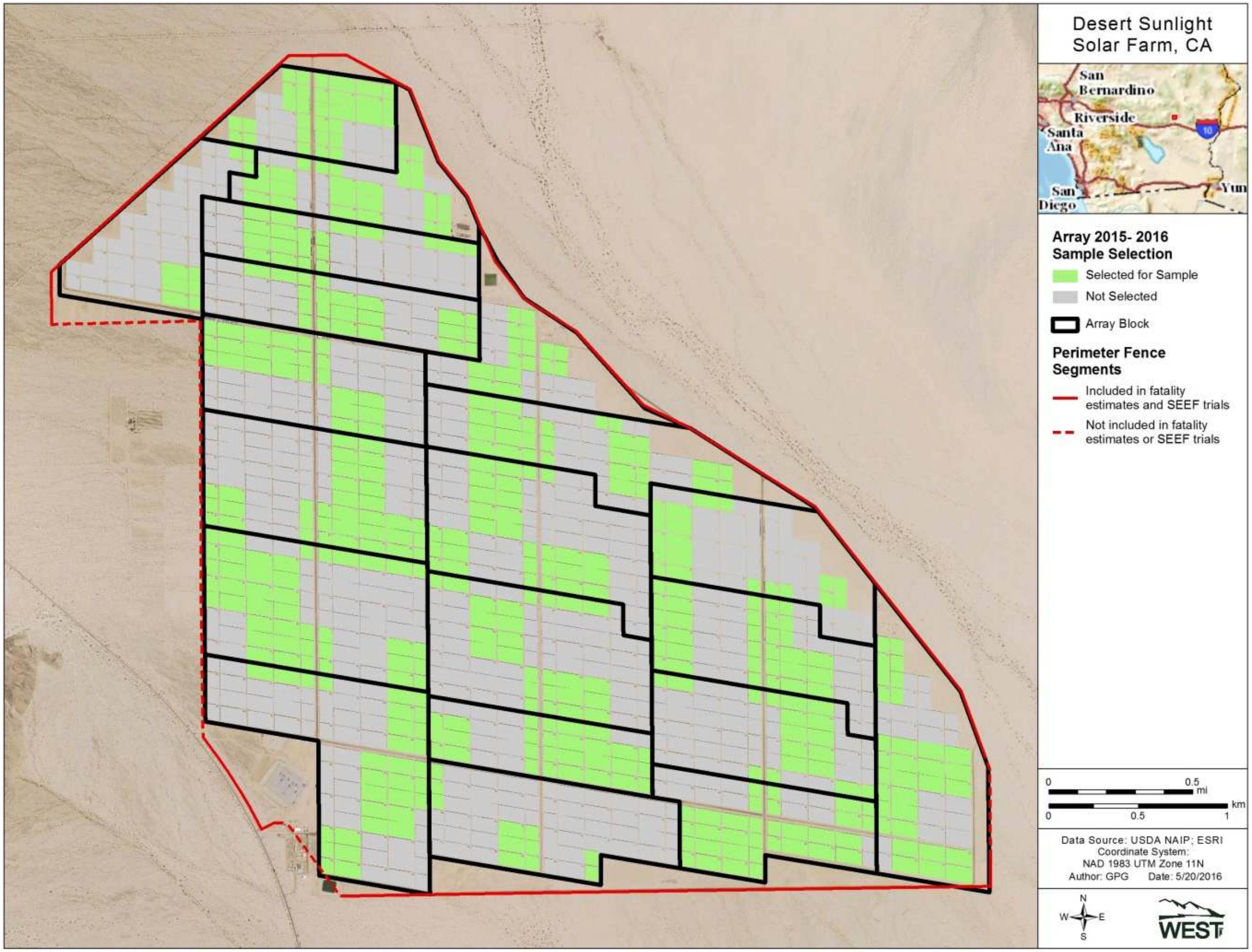


Figure 2. Areas of standardized searches at the solar field, visitor center, and overhead lines within the fence at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

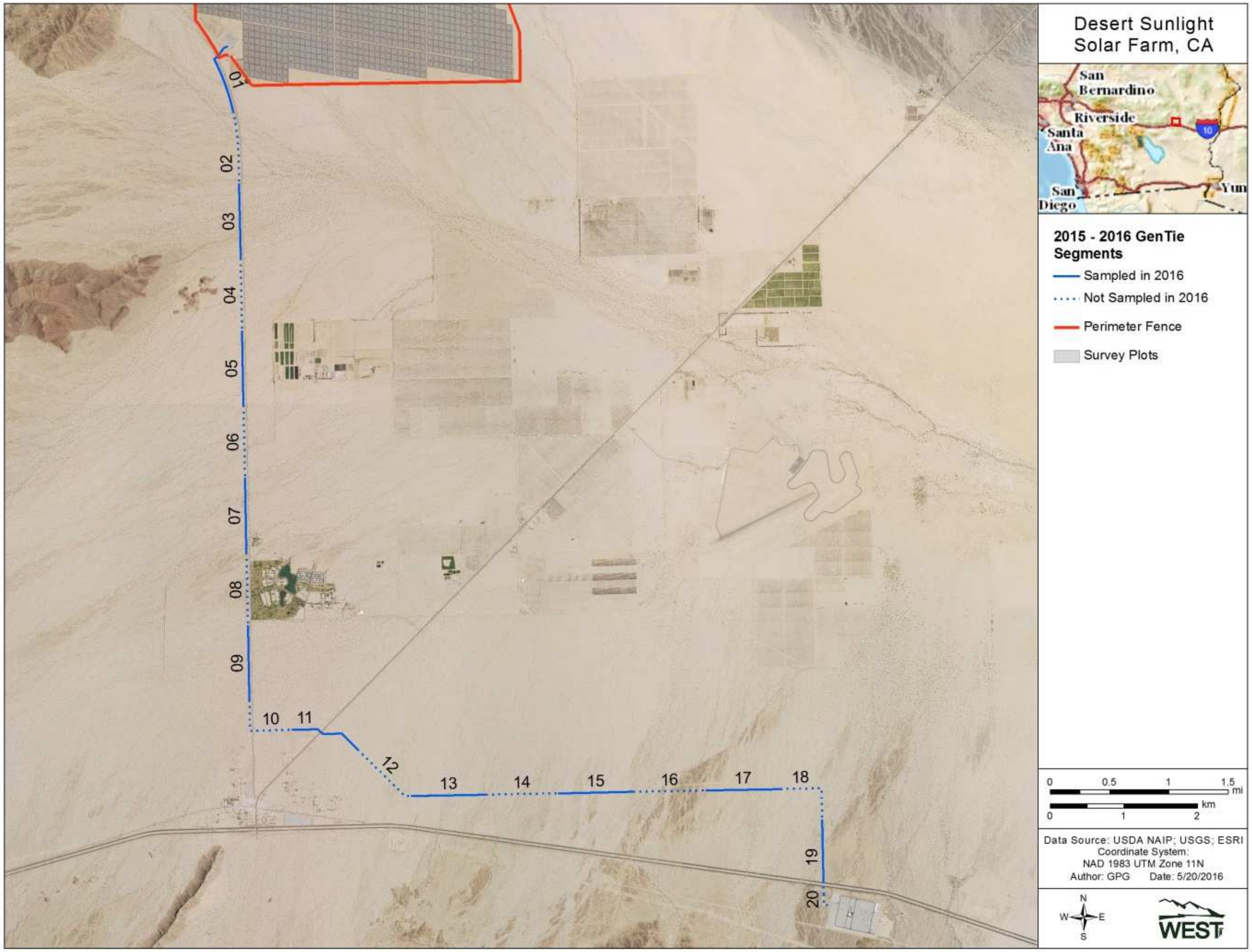


Figure 3. Areas of standardized searches along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

Most (74.4%) of the length of fenceline (approximately 10 miles; Figure 2) was searched from a vehicle using the standard protocol. Biologists searched a 6-m wide strip transect centered on the fence from the inner perimeter. Travel speed was below five miles per hour (mph) while searching. Some sections along the fence cannot be driven close to the fence line. The fence line along the western edge of the Project is drivable but the road is approximately 15 m away from the fence and the road and fence are separated by a drainage ditch. The fence along this section is covered with a tan tarp and trees and shrubs have been planted to reduce visibility of the Project from the west. Additions of vegetation and the tarp likely reduce potential for bird collision with the fence. This section of the fence was driven to document carcasses, but detections along this portion of the fence are not included in adjusted fatality estimates because detection rates are likely very low. As specified in Section 4.2.6 in the approved Desert Sunlight BBCS, we assume that fatality rates are similar between the portion of fence that was searched and the portion that was not. A separate section of the fence in the southeastern corner of the Project cannot be driven because the eastern edge of the berm that bounded construction ponds is too narrow for a vehicle. Along this portion of the fence, the observer stopped at both north and south ends of the berm and used binoculars to search for carcasses. Finally, the area along a portion of the southwest fence line near the entrance gate is approximately 30 to 50 m from the road and is separated from the fence by an area that has recently undergone vegetation restoration. This area was also eliminated from sampling. Fatality rates estimated for sections of the fence that were sampled were adjusted to account for the proportion of fence not sampled with the standard monitoring protocol, as specified in section 4.2.6 of the approved Desert Sunlight BBCS. In other words, the fatality rates (number of carcasses/m of fenceline sampled) was multiplied by the total fenceline in the facility to get the total fenceline carcass estimate for the facility.

The gen-tie line was searched using a 30-m wide strip transect (i.e., 15 m of ground on either side of the overhead line). Sample units along the gen-tie line were chosen by dividing the total length of line from the Project fence south to the Red Bluff Substation just south of I-10 into 1-kilometer (km) segments. Thus, a 47.9% sample of the total length of the line was searched (Figure 3). Biologists slowly walked every other 1-km segment of the line, meandering the width of the strip transect, scanning for dead or injured birds or bats within 15 m (49.2 feet [ft]) of the overhead line.

For each detection, a suspected cause of death or injury was assigned based on evidence available from the detection, evidence available on Project infrastructure, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned “unknown” cause of death because it cannot be determined whether the event was caused by predation or interaction with Project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed. Detections assigned to the “unknown” category were included in fatality estimates if they were located within standardized carcass search areas, and all detections made during the 2015 – 2016 monitoring year are reported here.

2.2 Carcass Persistence Trials

Carcass persistence trials were conducted in each of the four seasons during the 2015 – 2016 monitoring year. Carcasses from three size classes were used for trials (small: zero-100 grams [g], medium: 101-999 g, and large: 1000+ g). The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quails (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), chukar (*Alectoris chukar*) and adult coturnix quail, and the large size class comprised of hen mallards (*Anas platyrhynchos*) and hen ring-necked pheasants (*Phasianus colchicus*).

2.2.1 Carcass Persistence Data Collection

To quantify carcass persistence rates, 15 small, 10 medium, and 5 large carcasses were randomly placed and monitored along the gen-tie line during each seasonal monitoring period. Within the solar arrays the same numbers of each size category were placed at Desert Sunlight, as specified in the approved Desert Sunlight BBCS. During spring, an additional five large bird carcasses were placed within the solar arrays. During winter, an additional five large birds (two along the gen-tie and three within the solar arrays), 10 medium birds (five along the gen-tie and five within the solar arrays), and 15 small birds (eight along the gen-tie and seven within the solar arrays) were placed. Thus, 275 carcasses were placed during the 2015 – 2016 monitoring year. By placing carcasses inside (within arrays and along inner perimeter of the fence) and outside (along the gen-tie) the Project fence, the possibility of different carcass persistence rates inside and outside the Project fence is accounted for. During the 2015 – 2016 monitoring year, 70 carcasses (13 during spring, 15 during summer, 15 during fall, and 27 during winter) within the Project fence (within solar arrays and along the fence) were monitored using motion-triggered digital trail cameras as well as by visits on foot. The remaining carcasses were visited on foot for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality. No carcasses along the gen-tie line were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as "feeding stations," trail cameras were installed five days before specimens were placed. In addition, two fake cameras (four cameras used during spring) were placed within the Project fence in areas without bias trial carcasses and periodically moved to new locations within the fence. Periodic ground-based checking of carcasses with trail cameras also occurred to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera's field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire Project, not just in areas subject to standard searches, and trials were initiated in smaller numbers on two to three different dates throughout each of the four seasonal monitoring periods.

2.2.2 Estimating Carcass Persistence Times

Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g., days a carcass is present before being removed) may not be exactly known, but is known to be within a finite range. For example, suppose a carcass was checked on day seven and was present, and was checked again on day ten, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass became unavailable at some point between seven and ten days. This carcass would be considered “interval censored”. Similarly, if a carcass lasts the entire 30-day trial period, that carcass is “right censored”— it is known that the carcass lasted at least 30 days, but it may have persisted longer. Because carcass persistence data was censored, persistence was analyzed using methods that can accommodate censored data and still produce unbiased estimates of the probability of persistence (Therneau 2015, Therneau and Grambsch 2000). It is beyond the scope of this document to provide statistical foundations of censored-data survival models, but functions identical to those provided with the USGS-developed fatality estimator software (Huso et al 2012) were used to fit survival models to the censored carcass persistence data, and some background is available in the documentation provided with that software.

USGS-developed fatality estimator software (Huso et al 2012) was used to fit survival models to the censored carcass persistence data. The USGS software used to estimate carcass persistence calculates the period over which there is less than a 1% chance for a carcass to persist. The 'effective search interval' is defined as the shorter of a) the length of time beyond which there is less than a 1% probability that a carcass persists, and b) the actual search interval (Huso 2010). The probability of persistence is given for the effective search interval, and the probability that a carcass persists through the actual search interval is equal to *p* (persist through effective search interval) * effective search interval / actual search interval.

There were four distributions implemented in survival models used to estimate the probability a carcass is un-scavenged and available to be found at the end of the search interval (*r)*: exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike’s Information Criterion corrected for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model with combinations of the covariates carcass size, Project component, season, and visibility, to observed carcass persistence data.

2.3 Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the 2015 – 2016 monitoring year. Carcasses from three size classes (small, medium, and large) were used for trials. The small size class comprised house sparrows and two- to three-week-old coturnix quails, the medium size class comprised rock pigeons, chukars, and older coturnix quails, and the large size class comprised hen mallards and hen ring-necked pheasants.

2.3.1 Searcher Efficiency Data Collection

Training of biologists on the Project-specific protocol and early assessments of habitat conditions within the solar arrays suggested that the amount of cobble present in the soil may be an important factor influencing searcher efficiency. To satisfy requirements regarding consideration of visibility class per the BBCS and address the influence of cobble cover on searcher efficiency, sample units in the solar arrays and along the gen-tie were stratified by cobble cover and assigned to one of two classes (<15% and >15% cobble cover). Classes were determined by making ocular estimates of cobble cover at each sample unit and then evaluating the frequency histogram of sample units across the range of estimated cobble cover (Figure 4). A natural break point was identified at 15% cobble cover, so the same value was chosen as the break point that defined the two cobble cover classes. The high cobble class made up only 13% of the sample units. Thus, in the solar arrays, two sets of searcher efficiency trials were conducted during the 2015 – 2016 monitoring year (one set in each cobble cover class; *n* in low cobble equals 110 small birds, 71 medium birds, and 41 large birds; *n* in high cobble equals 71 small birds, 42 medium birds and 25 large birds [see Table 3 for placement by size, visibility class, and Project component for each season]). Along the gen-tie, visibility was expected to be related to vegetation and rock cover. Thus, searcher efficiency trials along the gen-tie occurred in two visibility classes (easy: ≥90% bare ground, vegetation <6" tall; and more difficult: <90% bare ground, vegetation ≥6" tall). Sample sizes for the easy class and the more difficult class were 75 small birds, 50 medium birds, and 27 large birds and 76 small birds, 50 medium birds, and 27 large birds respectively. The entire fence line was considered an easy visibility class. One hundred fifty searcher efficiency trials occurred along the fence (n = 75 small birds, 50 medium birds, 25 large birds). During the 2015 – 2016 monitoring year, 810 searcher efficiency trials occurred at the Project. Locations for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches.

Table 3. Searcher Efficiency Placements by size, visibility class, and Project component for each of the four seasonal monitoring periods at the Desert Sunlight Solar Farm Project, Riverside County, California.

Project Component	Visibility Class	Size	Spring	Summer	Fall	Winter	Total
Solar Arrays	High	LB	4	0	6	15	25
Solar Arrays	High	MB	3	0	9	30	42
Solar Arrays	High	SB	11	0	15	45	71
Solar Arrays	Low	LB	12	10	9	10	41
Solar Arrays	Low	MB	10	20	21	20	71
Solar Arrays	Low	SB	20	30	30	30	110
Fence	Easy	LB	5	5	5	10	25
Fence	Easy	MB	10	10	10	20	50
Fence	Easy	SB	15	15	15	30	75
Gen-tie	Diff	LB	5	3	4	10	22
Gen-tie	Diff	MB	9	11	11	19	50
Gen-tie	Diff	SB	15	16	15	30	76
Gen-tie	Easy	LB	5	6	6	10	27
Gen-tie	Easy	MB	11	9	9	21	50
Gen-tie	Easy	SB	15	15	15	30	75
Season Totals			**150**	**150**	**180**	**330**	**810**

Large bird = (LB); Medium bird = (MB); Small bird = (SB). Low = low coble cover; High = high coble cover; Diff = difficult visibility class; Easy = easy visibility class.

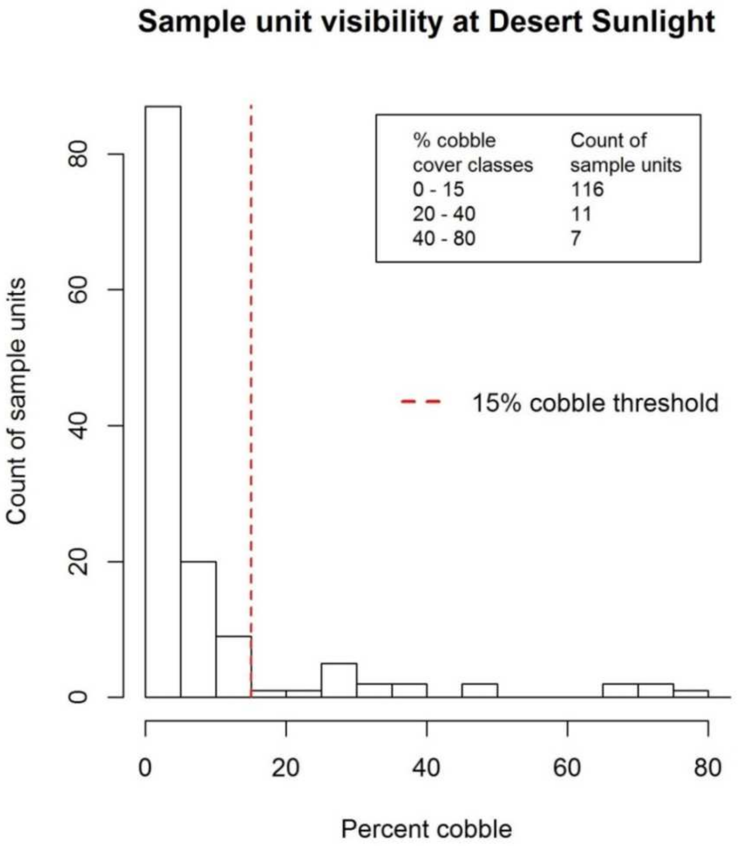


Figure 4. Frequency histogram of sample units (in the arrays only) at Desert Sunlight Solar Farm Project by estimates of cobble cover. Based on this distribution, each sample unit was assigned to one of two classes of cobble cover (<15%; >15%).

2.3.2 Estimating Searcher Efficiency

Searcher efficiency at Desert Sunlight was estimated separately for linear features (the Project fence and the gen-tie line), and the solar arrays, reflecting the different search methods used on arrays and linear features. For linear features, logistic regression models were fit to searcher efficiency data, and AICc was used to compare models. Models including effects of carcass size (three classes), visibility (two classes; gen-tie only), and season were compared to each other and the null (i.e., intercept only) model. Once the most supported model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, *p*, was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from the 2015 – 2016 monitoring year.

For the solar arrays, searcher efficiency was evaluated using a distance sampling approach (Buckland et al. 1993). Distance sampling assumes perfect detection on the transect line (at distance = 0), an assumption that is likely valid in the solar arrays given the relatively flat & vegetation-free nature of the soil surface. A curve is fitted to the observed carcass data that predicts probability of detection as a function of distance from the transect line. The mean value of this function over a specified distance, *w,* is equal to the average searcher efficiency for a transect of width *w*. The mean value of the detection curve is the integral of the detection function calculated between 0-m and the maximum survey distance (*w;* half the width of the solar array row), divided by the maximum survey distance:

$$p = \frac{\int_0^w f(x)dx}{w},$$

where f(x) is the detection function evaluated at distance, *x*.

One departure in the methods used here, relative to the methods presented in Buckland et al. (1993), was that for this study the detection function was estimated using trial carcasses, which meant that there were both presence (detected) and absence (not detected) data available to fit the detection function (Figure 5, 6, and 7). The availability of both presence and absence data means that the detection function can be estimated using only trial carcasses whose distribution is known. Therefore the detection function, the average searcher efficiency among the arrays, and the final fatality estimate within the arrays are all insensitive to the spatial distribution of carcasses within individual arrays, and the overall searcher efficiency estimate is valid even if the distribution of carcasses among the arrays is not uniform.

Distances of trial carcasses (trials both found and missed) from the transect line were used to fit half-normal, exponential, and hazard rate distribution detection functions for searches among the arrays, which are all commonly used functions for distance sampling surveys (Buckland et al. 1993). The fit of detection functions were compared using AICc and each model was fit with covariates season, carcass size, cobble cover class), and without. Model fits that indicated searcher efficiency increasing at greater distances (n = 54 of 312 candidate models) were excluded from consideration. Size classes were evaluated separately: small bird searcher efficiency was best described by a hazard rate detection function and a model that included cobble cover and split seasons into fall and spring/summer/winter (Figure 5). Medium bird searcher efficiency was best described using an exponential detection function and differed between winter and spring/summer/fall (Figure 6). Large bird searcher efficiency was best described using a uniform detection function and differed between spring/fall and summer/winter (Figure 7).

Because the solar arrays were surveyed by searchers who walked down both sides of the rows of panels, the width of the search transect was specified as half the width of the rows of panels. For larger birds, there is almost certainly a non-zero detection probability beyond this distance but the bias that occurs by ignoring this non-zero detection probability is conservative (i.e., the searcher efficiency is underestimated). Some solar arrays have row widths of 70 m (search transect width of 35 m) and some have row widths of 140 m (search transect width of 70 m). The weighted average searcher efficiency is calculated based on the number of panel rows of each length in the survey sample:

$$p_{weighted\ average} = \frac{n_{70}}{n} \times \frac{\int_0^{35} f(x)dx}{35} + \frac{n_{140}}{n} \times \frac{\int_0^{70} f(x)dx}{70},$$

where n_{70} is the number of 70-m rows in the sample, n_{140} is the number of 140-m rows in the sample, and *n* is the total number of rows in the sample. Searcher efficiency was higher for the arrays with a width of 70 m, and overall searcher efficiency was estimated as a weighted average based on the proportions of 70-m arrays and 140-m arrays in the sample units.

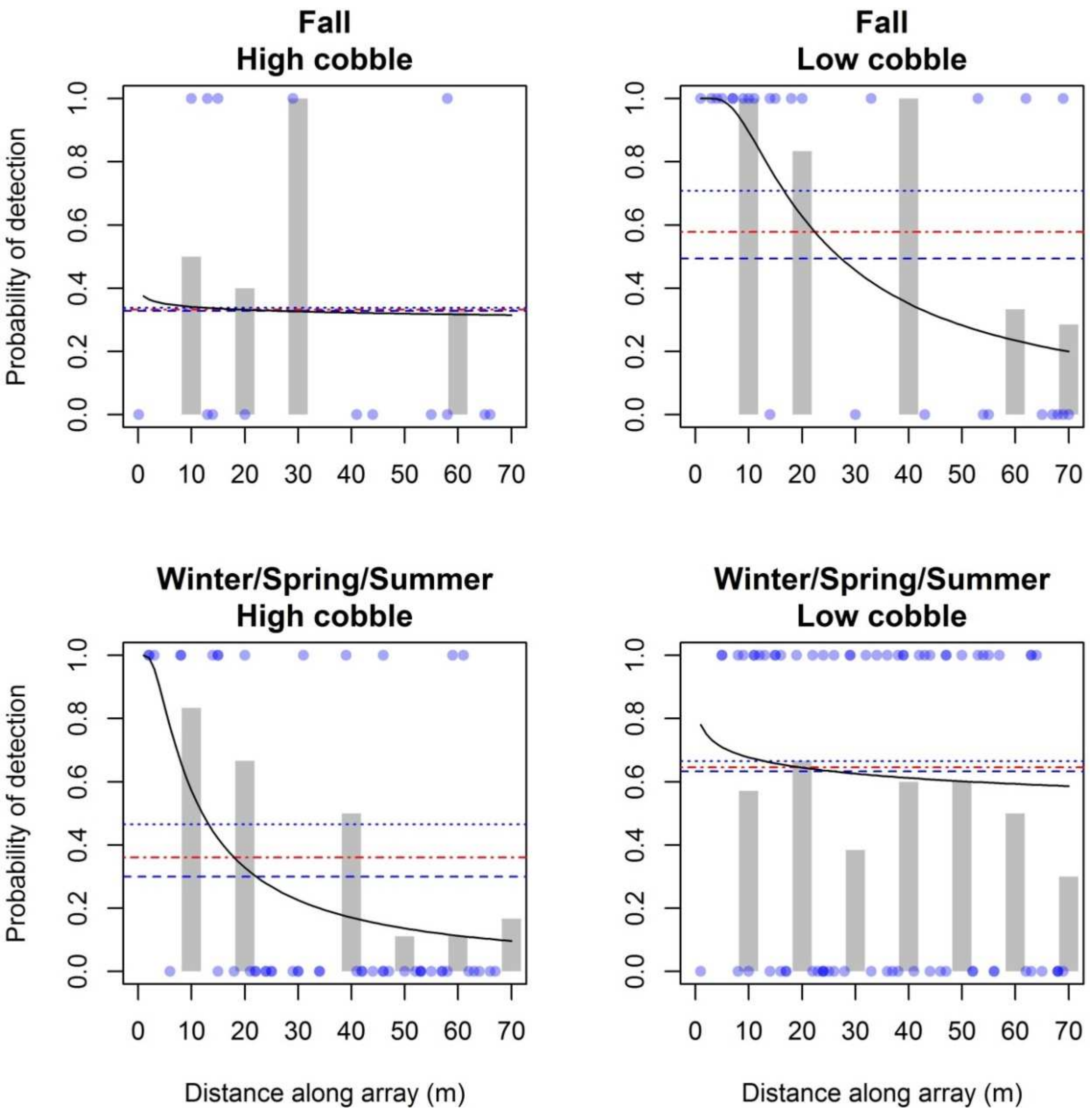


Figure 5. Estimated detection probabilities for small bird carcasses by cobble cover class and season during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented.

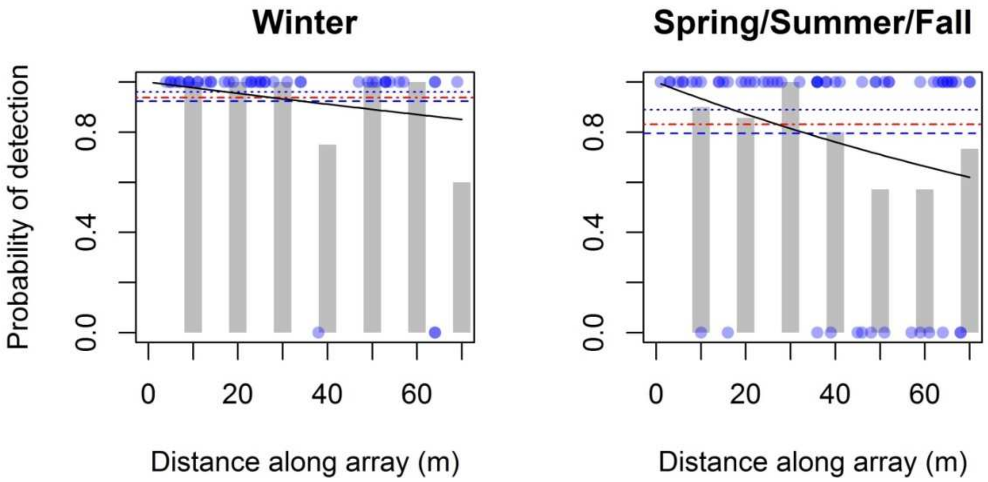


Figure 6. Estimated detection probabilities for medium bird carcasses by season during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented.

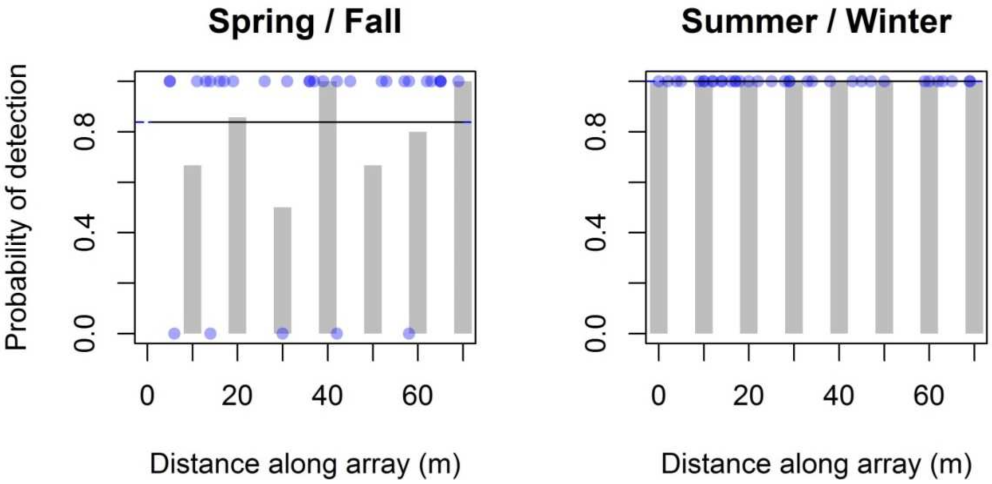


Figure 7. Estimated detection probabilities for large bird carcasses by season during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented.

2.4 Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots were also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie line versus cleared areas beneath solar panels). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where F is the total number of fatalities, C is the number fatalities detected and included in fatality estimation, r is the probability a carcass is un-scavenged and available to be found at the end of the search interval, and p is the probability of detecting a carcass (Huso 2010). Huso (2010) describes the use of a binomial model to estimate the probability of carcass detection in the present study. The binomial carcass detection model was used to calculate fatalities at Project linear features (fence, overhead lines) and the weighted average probability of detection based on distance sampling (described above) was used to estimate probability of detection within the solar arrays.

All fatality estimates were calculated using the Huso estimator (modified to accommodate the distance-sampling based estimate of searcher efficiency in the solar arrays), as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates was used for each variable including of searcher efficiency (p), probability of a carcass persisting to the next search ($\hat{r}$), adjusted search interval and observed fatalities. From these bootstrap samples, the probability of available and detected was calculated and applied to the bootstrapped observed fatalities. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

2.5 Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by either WEST avian biologists or operations personnel and were considered “incidental” detections. When found by operations personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the Desert Sunlight SPUT Avian Injury and Mortality Report Forms, March 2015 - February 2016. All detections made in search areas during the reporting period were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

3 MONITORING RESULTS

3.1 Summary of Avian Detections

Figures 6 – 9 show the location of detections found during the monitoring year. Detailed areas of carcass locations along the gen-tie line are provided in Appendix A. During the 2015 – 2016 monitoring year, a total of 149 avian detections (including all stranded and injured birds and incidental detections) of 19 guilds and including 53 identified species were recorded (Table 4; Figure 8, 9, 10, and 11). The most numerous detection of an identified species was of American coot (*Fulica americana*) with 12 detections, followed by mourning dove (*Zenaida macroura*; n = 6). The highest detection in the solar arrays were American coot (n = 9), followed by western grebe (*Aechmophorus occidentalis*; n = 5) with no other species with more than four detections. The only species observed along the fence were American coot (n = 1), common raven (*Corvus corax*; n = 1), common loon (*Gavia immer*; n = 1), white-winged dove (*Zenaida asiatica*; n = 1), and mallard (*Anas platyrhynchos*; n = 1). Eurasian collared-dove (*Streptopelia decaocto*; n = 4) and orange-crowned warbler (*Oreothlypis celata*; n = 3) were the species with the most detections along the gen-tie/road. No bats were detected during the 2015 – 2016 monitoring year. For fresh carcasses, body weights and weather conditions the preceding nights are described in Appendix B.

The majority of detections (n = 98, or 65.8% of total detections) occurred at the solar arrays (Tables 4, 5, and 6). Forty-one detections (27.5%) occurred along the gen-tie line, seven along the fence and three at buildings. There do not appear to be major concentration areas of detections within the solar arrays (Figures 6, 7). One hundred thirteen detections (75.8%) were made during standardized carcass searches and 36 (24.2%) were documented as incidentals.

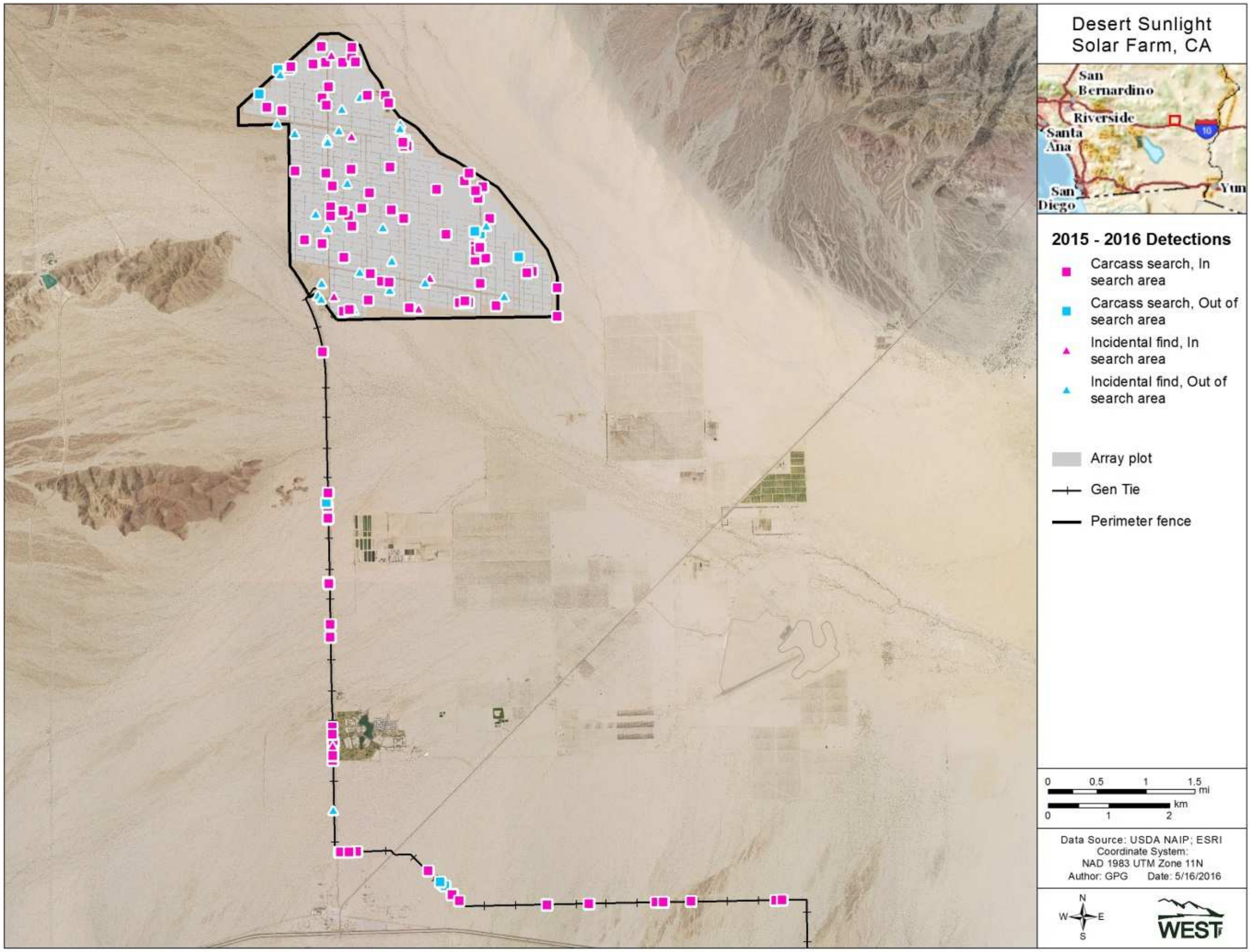


Figure 8. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at the solar field, visitor center, overhead lines within the fence, and the gen-tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

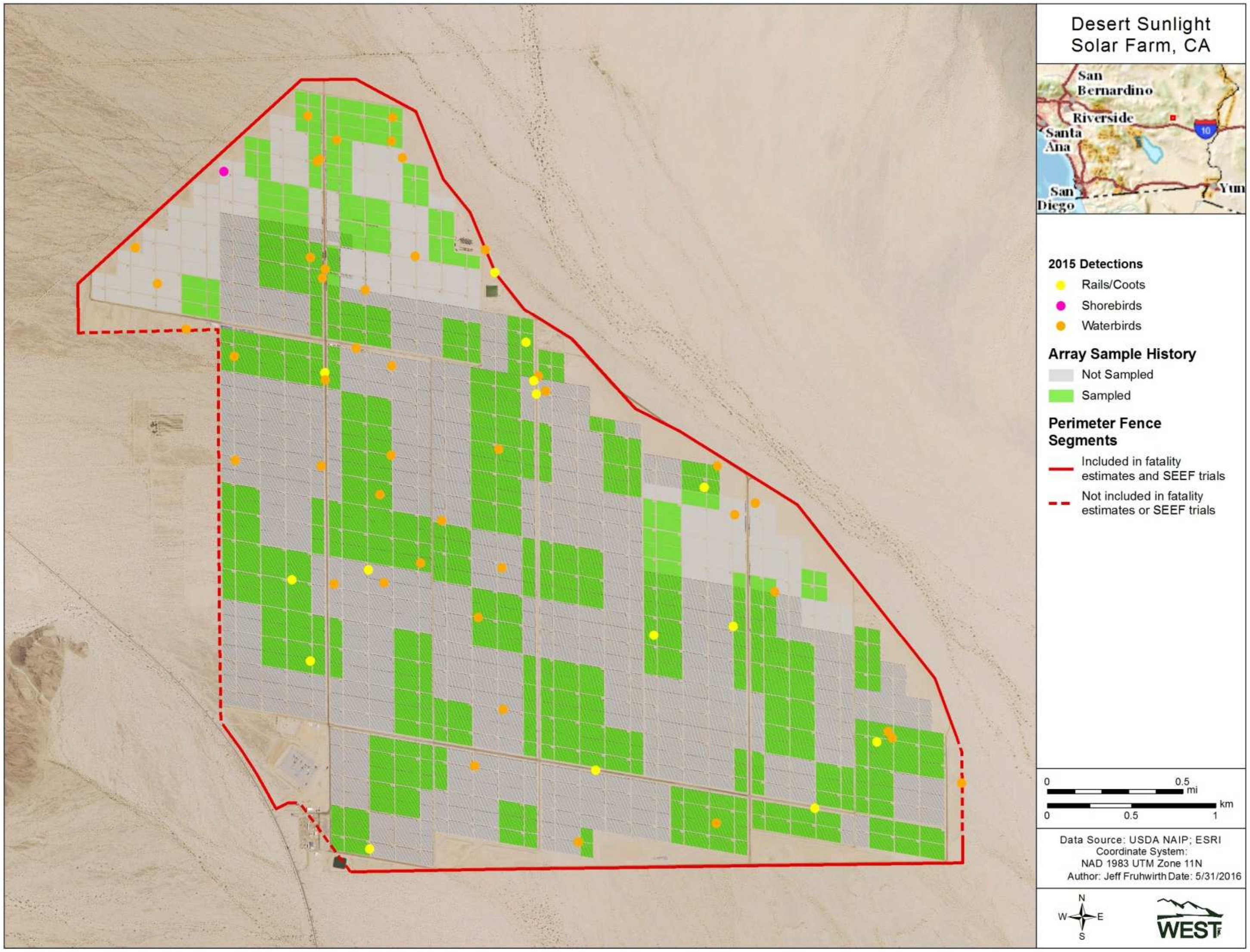


Figure 9. Location of water-associated bird carcass detections throughout the solar field, visitor center, and overhead lines within the fence at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

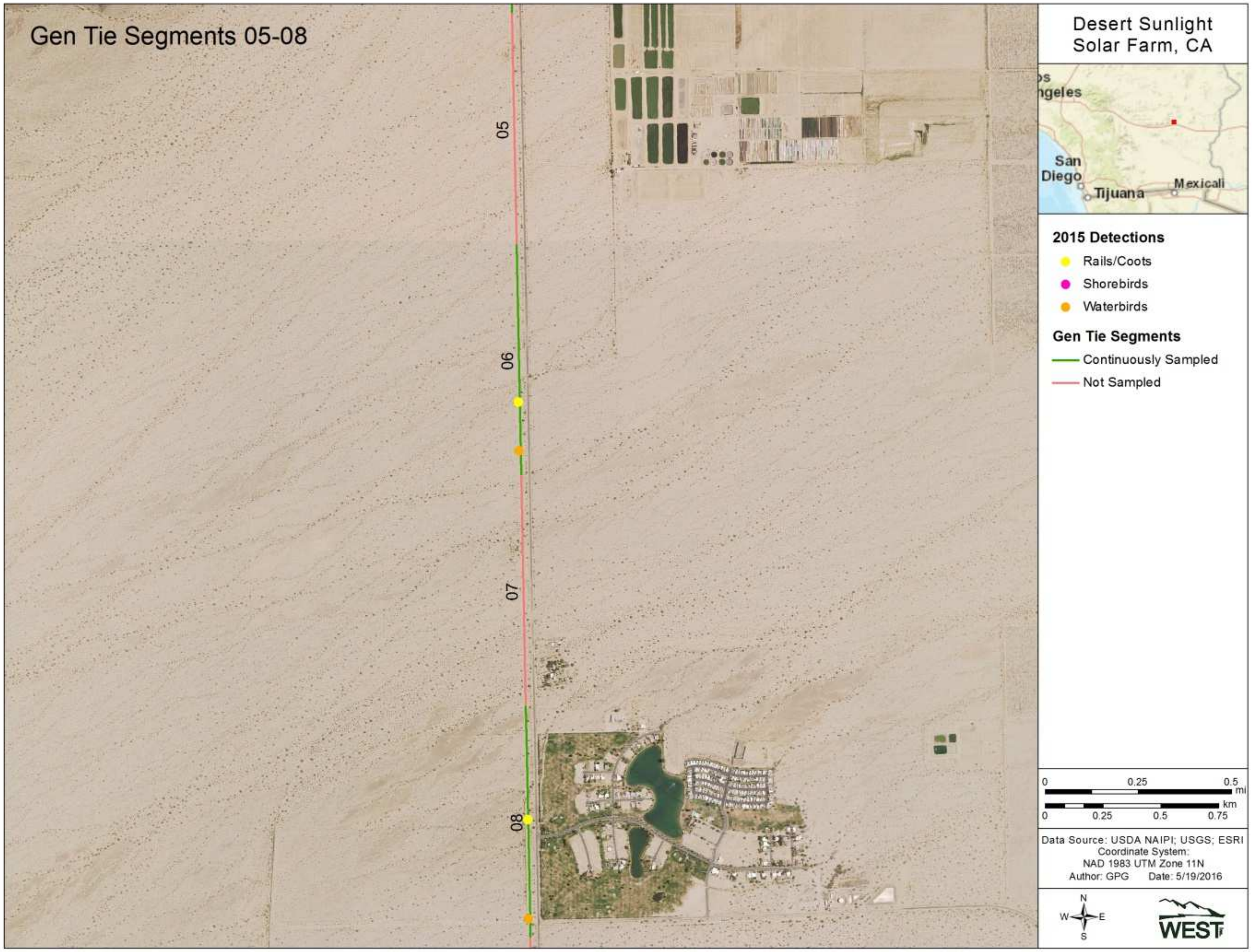


Figure 10. Location of water-associated bird carcass detections along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

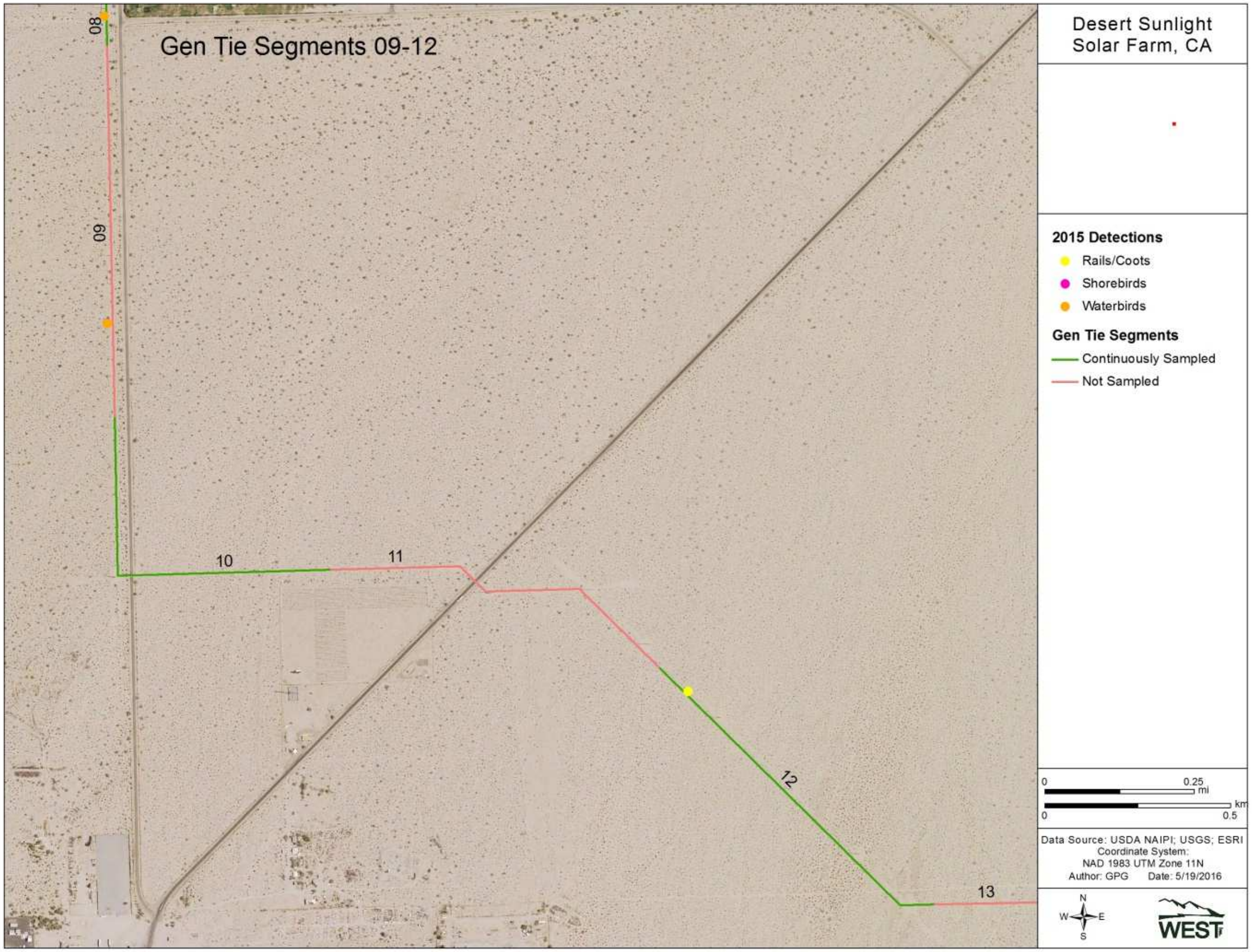


Figure 11. Location of water-associated bird carcass detections along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

Table 4. Number of individual bird detections, by species, found during scheduled searches and incidentally during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

Common Name	Scientific Name	Migration Behavior*	Guild	Solar Array	Fence	Gen-tie Line	Visitor Center	Total
			Water-associated birds					
unidentified grebe	na	na	Waterbirds/Waterfowl	11	1	1	0	13
American coot	*Fulica americana*	nocturnal	Rails/Coots	9	1	2	0	12
unidentified duck	na	na	Waterbirds/Waterfowl	5	1	0	0	6
common loon	*Gavia immer*	diurnal	Waterbirds/Waterfowl	4	1	0	0	5
Western grebe	*Aechmophorus occidentalis*	nocturnal	Waterbirds/Waterfowl	5	0	0	0	5
ruddy duck	*Oxyura jamaicensis*	nocturnal	Waterbirds/Waterfowl	3	0	1	0	4
sora	*Porzana carolina*	nocturnal	Rails/Coots	3	0	1	0	4
mallard	*Anas platyrhynchos*	variable	Waterbirds/Waterfowl	1	1	1	0	3
eared grebe	*Podiceps nigricollis*	nocturnal	Waterbirds/Waterfowl	3	0	0	0	3
unidentified teal	*Anas spp*	na	Waterbirds/Waterfowl	2	0	0	0	2
Virginia rail	*Rallus limicola*	nocturnal	Rails/Coots	2	0	0	0	2
northern shoveler	*Anas clypeata*	both	Waterbirds/Waterfowl	1	0	0	0	1
northern pintail	*Anas acuta*	nocturnal	Waterbirds/Waterfowl	1	0	0	0	1
cinnamon teal	*Anas cyanoptera*	nocturnal	Waterbirds/Waterfowl	1	0	0	0	1
blue-winged teal	*Anas discors*	nocturnal	Waterbirds/Waterfowl	1	0	0	0	1
pied-billed grebe	*Podilymbus podiceps*	nocturnal	Waterbirds/Waterfowl	1	0	0	0	1
least sandpiper	*Calidris minutilla*	both	Shorebirds	1	0	0	0	1
double-crested cormorant	*Phalacrocorax auritus*	diurnal	Waterbirds/Waterfowl	1	0	0	0	1
Subtotal (waterbirds)				**55**	**5**	**6**	**0**	**66**

Table 4. Number of individual bird detections, by species, found during scheduled searches and incidentally during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

Common Name	Scientific Name	Migration Behavior*	Guild	Solar Array	Fence	Gen-tie Line	Visitor Center	Total
			Non-water-associated birds					
mourning dove	*Zenaida macroura*	variable	Doves/Pigeons	4	0	1	1	6
common raven	*Corvus corax*	resident	Corvids	4	1	0	0	5
western meadowlark	*Sturnella neglecta*	diurnal	Blackbirds/Orioles	2	0	2	0	4
Eurasian collared-dove	*Streptopelia decaocto*	resident	Doves/Pigeons	0	0	4	0	4
white-winged dove	*Zenaida asiatica*	variable	Doves/Pigeons	1	1	2	0	4
Savannah sparrow	*Passerculus sandwichensis*	nocturnal	Grassland/Sparrows	2	0	2	0	4
unidentified bird (small)	na	na	Unidentified Birds	3	0	1	0	4
unidentified bird (unknown size)	na	na	Unidentified Birds	3	0	1	0	4
orange-crowned warbler	*Oreothlypis celata*	nocturnal	Warblers	0	0	3	0	3
lesser goldfinch	*Spinus psaltria*	resident	Finches/Crossbills	2	0	0	0	2
black-throated sparrow	*Amphispiza bilineata*	diurnal	Grassland/Sparrows	0	0	2	0	2
unidentified sparrow	na	na	Grassland/Sparrows	1	0	1	0	2
Lincoln's sparrow	*Melospiza lincolnii*	nocturnal	Grassland/Sparrows	0	0	2	0	2
white-crowned sparrow	*Zonotrichia leucophrys*	nocturnal	Grassland/Sparrows	0	0	2	0	2
loggerhead shrike	*Lanius ludovicianus*	diurnal	Shrikes	2	0	0	0	2
ring-necked pheasant	*Phasianus colchicus*	resident	Upland Game Birds	2	0	0	0	2

Table 4. Number of individual bird detections, by species, found during scheduled searches and incidentally during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

Common Name	Scientific Name	Migration Behavior*	Guild	Solar Array	Fence	Gen-tie Line	Visitor Center	Total
Wilson's warbler	*Cardellina pusilla*	nocturnal	Warblers	1	0	1	0	2
yellow-rumped warbler	*Setophaga coronata*	nocturnal	Warblers	2	0	0	0	2
black-throated gray warbler	*Setophaga nigrescens*	nocturnal	Warblers	1	0	1	0	2
house wren	*Troglodytes aedon*	nocturnal	Wrens	1	0	1	0	2
Cooper's hawk	*Accipiter cooperii*	diurnal	Accipiters	1	0	0	0	1
great-tailed grackle	*Quiscalus mexicanus*	resident	Blackbirds/Orioles	1	0	0	0	1
Brewer's blackbird	*Euphagus cyanocephalus*	diurnal	Blackbirds/Orioles	0	0	0	1	1
brown-headed cowbird	*Molothrus ater*	diurnal	Blackbirds/Orioles	0	0	1	0	1
greater roadrunner	*Geococcyx californianus*	resident	Cuckoos	0	0	1	0	1
unidentified dove	na	na	Doves/Pigeons	0	0	1	0	1
Say's phoebe	*Sayornis saya*	diurnal	Flycatchers	1	0	0	0	1
western wood-pewee	*Contopus sordidulus*	nocturnal	Flycatchers	0	0	0	1	1
American pipit	*Anthus rubescens*	diurnal	Grassland/Sparrows	1	0	0	0	1
Sagebrush sparrow	*Artemisiospiza nevadensis*	nocturnal	Grassland/Sparrows	0	0	1	0	1
vesper sparrow	*Pooecetes gramineus*	nocturnal	Grassland/Sparrows	0	0	1	0	1
Brewer's sparrow	*Spizella breweri*	nocturnal	Grassland/Sparrows	1	0	0	0	1
horned lark	*Eremophila alpestris*	resident	Grassland/Sparrows	1	0	0	0	1
northern mockingbird	*Mimus polyglottos*	resident	Mimids	1	0	0	0	1

Table 4. Number of individual bird detections, by species, found during scheduled searches and incidentally during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

Common Name	Scientific Name	Migration Behavior*	Guild	Solar Array	Fence	Gen-tie Line	Visitor Center	Total
northern rough-winged swallow	*Stelgidopteryx serripennis*	diurnal	Swallows	1	0	0	0	1
unidentified hummingbird	na	na	Swifts/Hummingbirds	1	0	0	0	1
western tanager	*Piranga ludoviciana*	nocturnal	Tanagers	0	0	1	0	1
Gambel's quail	*Callipepla gambelii*	resident	Upland Game Birds	0	0	1	0	1
common yellowthroat	*Geothlypis trichas*	nocturnal	Warblers	0	0	1	0	1
Nashville warbler	*Oreothlypis ruficapilla*	nocturnal	Warblers	0	0	1	0	1
yellow warbler	*Setophaga petechia*	nocturnal	Warblers	1	0	0	0	1
Townsend's warbler	*Setophaga townsendi*	unresolved	Warblers	1	0	0	0	1
northern flicker	*Colaptes auratus*	both	Woodpeckers	1	0	0	0	1
Subtotal non-waterbirds				35	2	35	3	83
Subtotal all birds				**78**	**7**	**41**	**3**	**149**

[1] Ring-necked pheasants are used for bias trials and the two detections were likely from trial carcasses; however, ring-necked pheasants have been reported in Riverside County, CA south of the Project area near the Salton Sea (eBird 2015). Thus, we cannot be certain that these detections were exclusively from trial carcasses.

[2] See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in The Birds of North America website (BNA 2016); where information on migration behavior was lacking in BNA accounts, Newton (2008) or Murray (2004) were used.

3.2 Suspected Cause of Avian Mortality

Most carcasses observed do not show clear signs of cause of death (Table 5 and 6). Evidence of collision as cause of death could include broken neck or beak, or bird imprint in the dust on a solar panel, but only a few carcass incidents had such evidence. There were 149 birds detected during the 2015 – 2016 monitoring year. Most of the detections were assigned an unknown cause of death; however 19.5% were suspected to be due to collision (with gen-tie, fence and solar arrays), 5.4% stranded, and 1.3% were due to predation (Table 5). There were 66 water-associated birds detected during the 2015 – 2016 monitoring year. Most were assigned unknown cause of death; however 10.6% were stranded, and 9.1% were likely collision-caused (Table 6).

Table 5. Total bird detections (including incidentals) by Project component and suspected cause of death during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

	Suspected Cause of Death*				
Project Component	**Collision**	**Predation**	**Stranded**	**Unknown**	**Percent of Total Avian Fatalities**
Fence	1	0	0	6	4.7
Building	0	0	0	3	2.0
Gen-tie line	15	2	0	24	27.5
Solar arrays	13	0	8	77	65.8
Percent of Total	**19.5**	**1.3**	**5.4**	**73.8**	**100.0**

* Suspected cause of death was assigned based on evidence available on the detection, evidence available on Project infrastructure, and proximity of detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it cannot be determined whether the event was caused by predation or interaction with Project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, there is substantial uncertainty associated with cause of death assignments because no events were directly observed.

Table 6. Total waterbird detections (including incidentals) by Project component and suspected cause of death during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

	Suspected Cause of Death*				
Project Component	**Collision**	**Predation**	**Stranded**	**Unknown**	**Percent of Total Avian Fatalities**
Fence	0	0	0	5	9.4
Building	0	0	0	0	0
Gen-tie line	2	0	0	4	7.5
Solar arrays	4	0	7	44	83.0
Percent of Total	**9.1**	**0**	**10.6**	**80.3**	**100.0**

* Suspected cause of death was assigned based on evidence available on the detection, evidence available on Project infrastructure, and proximity of detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it cannot be determined whether the event was caused by predation or interaction with Project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, there is substantial uncertainty associated with cause of death assignments because no events were directly observed.

3.3 Temporal Patterns of Avian Detections

Both spring and fall migration seasons were seven-day searches, while summer and winter had a 21-day average search interval, so interpretations of temporal patterns should keep those differences in mind. The number of detections recorded per day represents those discovered during standardized carcass searches as well as those discovered incidentally. For each day in which there were six or more detections made, an Avian Injury & Mortality Report form (in accordance with Special Utilities Permit Condition H.1(c)) was submitted within 24 hours to the USFWS, BLM, and CDFW. The 2015 – 2016 monitoring year was characterized by a peak in avian detections during the fall season. The number of avian detections recorded daily during the 2015 – 2016 monitoring year ranged from zero to six (Figure 12). On September 22, 2015, six detections were reported. During all other survey days, five or fewer birds were detected.

The highest peaks in avian detections at the arrays and along the gen-tie occurred during the fall season, while there was no apparent pattern observed along the fence or at buildings as only a few were detected at these locations (Figure 13). The greatest number of avian detections occurred during the month of October (Figure 13; n = 44) followed by September (n = 38), with waterbird and waterfowl detections greatest during the same two months (Figure 13).

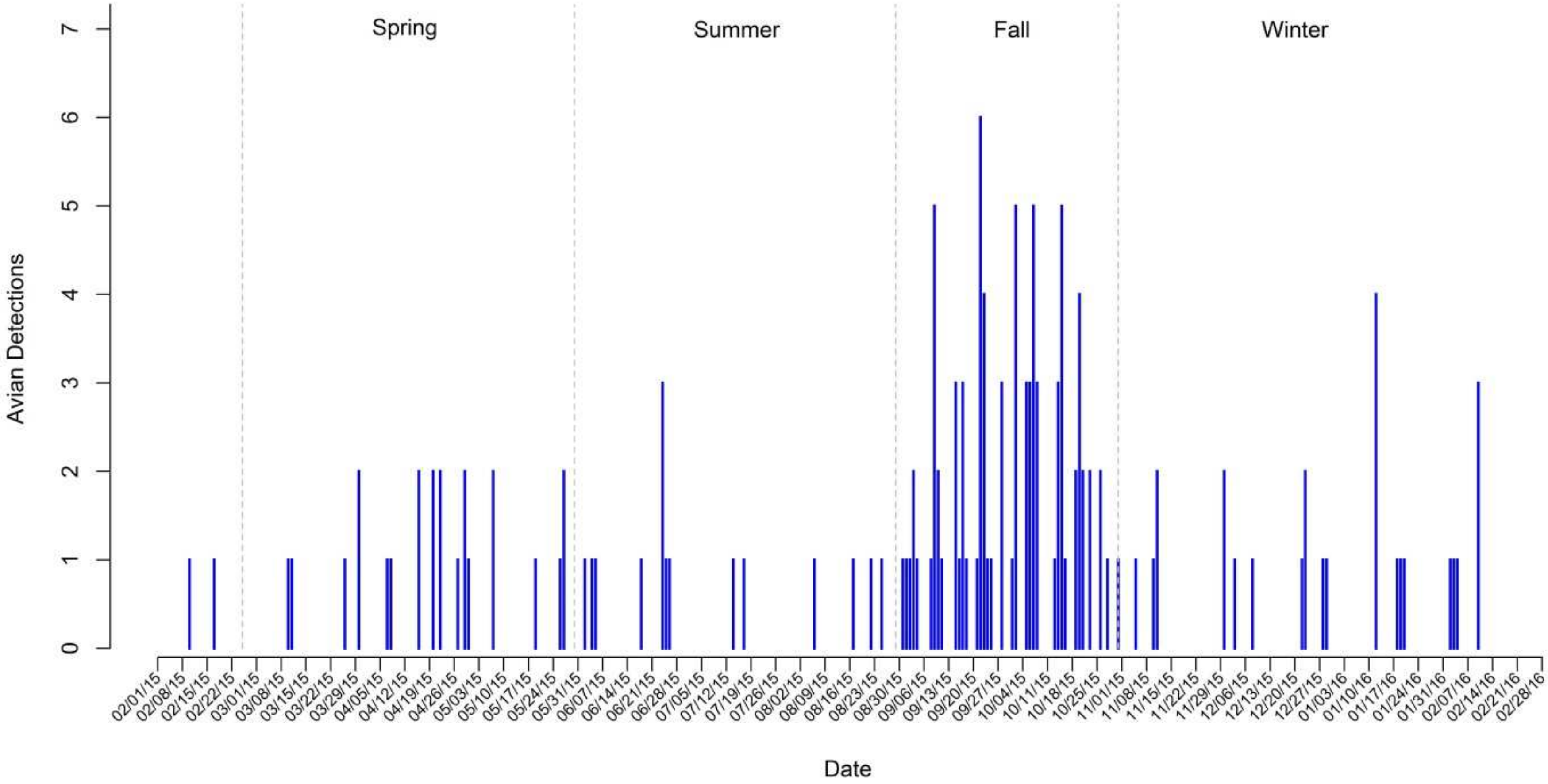


Figure 12. Total count of detections (including incidentals) by date during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

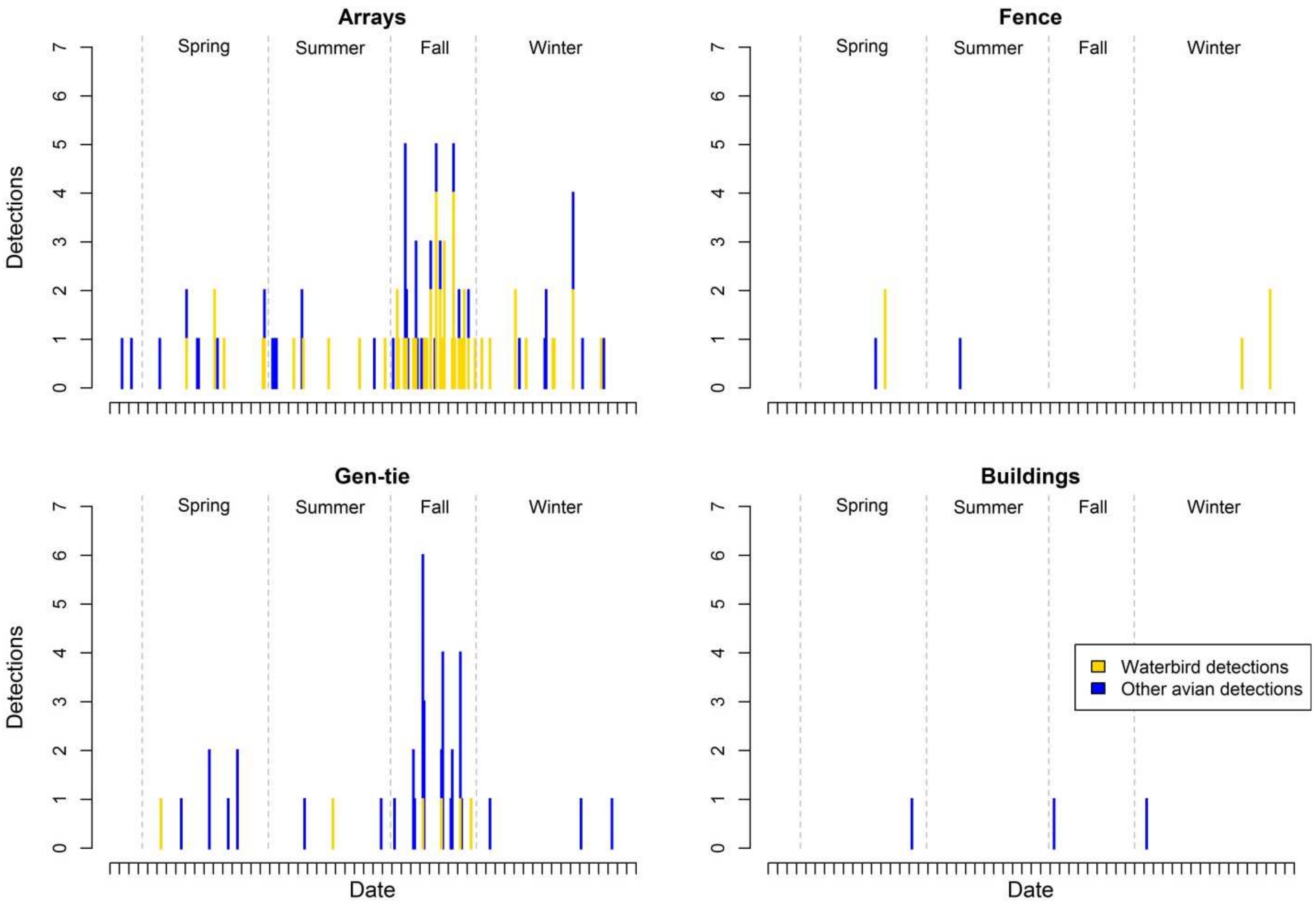


Figure 13. Total count of detections (including incidentals) by date for both waterbirds/waterfowl detections and all avian detections during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.4 Spatial Distribution of Avian Detections

3.4.1 Detections by Project Component

During the 2015 – 2016 monitoring year, detections were documented from the solar arrays, the Visitor Center, the fence, and the gen-tie line (Tables 4 and 5). There were 98 detections (65.8% of all detections) at the solar arrays. Forty-one detections (27.5% of annual total) were along the gen-tie line, seven were along the fence (4.7% of annual total) and three detections (2.0% of annual total) were at the Visitor Center. The majority of non-water-associated birds (n = 43; Table 7) and water associated birds (n = 55; Table 8) were detected at the solar arrays, and is not unexpected given the large spatial extent of the arrays (over 4000 acres).

Table 7. Total non-waterbird detections by Project component and detection category during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California. Only carcasses found within search areas were included in fatality estimates.

Project Component	Inside carcass search area		Outside carcass search area	
	Carcass search	Incidental	Carcass search	Incidental
Fence	1	0	1	0
Buildings	0	0	0	3
Gen-tie line	28	1	5	1
Solar arrays	31	2	2	8
Total	**60**	**3**	**8**	**12**

Table 8. Total waterbird detections by Project component and detection category during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California. Only carcasses found within search areas were included in fatality estimates.

Project Component	Inside carcass search area		Outside carcass search area	
	Carcass search	Incidental	Carcass search	Incidental
Fence	3	0	1	1
Buildings	0	0	0	0
Gen-tie line	5	0	0	1
Solar arrays	34	6	2	13
Total	**42**	**6**	**3**	**15**

3.4.2 Detections at solar collector assemblies

Upon ocular examination, fatalities among the solar arrays appear evenly dispersed throughout the Project site (Figure 14). The distance between the average location of the search areas and the average location of fatalities found inside search areas is 73 meters suggesting no obvious concentration of fatalities in a particular direction (e.g. more fatalities towards the west or towards the south side of the facility).

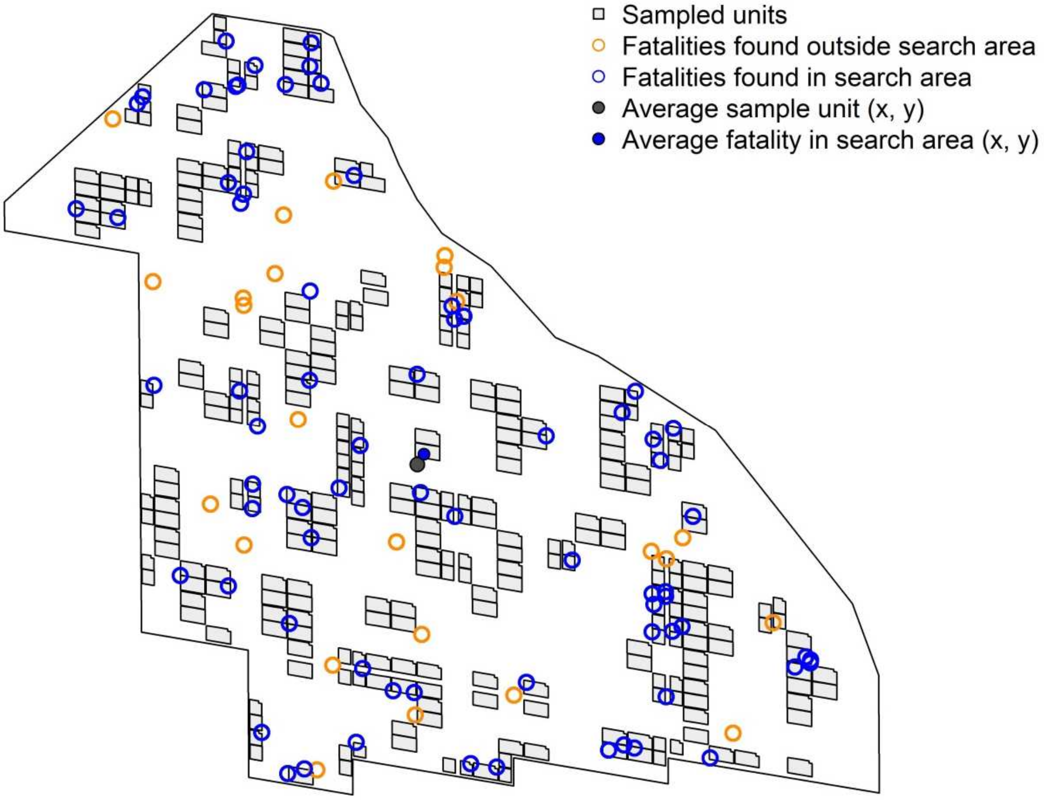


Figure 14. Spatial distribution of carcass search and incidental detections from SCAs during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.4.3 Feather Spot Detections

Thirty-eight (25.5%) of the 149 detections made during the 2015 – 2016 monitoring year consisted only of feather spots. Along the gen-tie, 14 of 41 detections (34.1%) were feather spots. Twenty-two of 98 detections (22.5%) in the solar arrays were feather spots. Along the fence, two of seven total detections (28.6%) were feather spots.

3.5 Detections of Injured or Stranded Birds

There were six detections of stranded or injured birds during the 2015 – 2016 monitoring year, each of which occurred during the fall monitoring period. Three injured birds were detected within the solar arrays (ruddy duck [*Oxyura jamaicensis*], western grebe [*Aechmophorus occidentalis*], and mourning dove [*Zenaida macroura*]). Three stranded but uninjured birds were detected in the arrays (common loon [*Gavia immer*]) and ruddy duck and eared grebe [*Podiceps nigricollis*]). The injured mourning dove and ruddy duck were transported to wildlife rehabilitation facilities; the ruddy duck was released by the rehabilitator on the same day. The injured western grebe died before it got to a rehabilitation facility. The stranded ruddy duck, eared grebe, and common loon were evaluated for a short period for injuries and general stress and when none were observed, released at Lake Tamarisk.

3.6 Summary of Bat Detections

No bats were detected during the 2015 – 2016 monitoring year.

3.7 Carcass Persistence Trials

Data from carcass persistence trials were available from all four seasonal monitoring periods within the solar arrays and along the gen-tie line. A total of 275 carcasses were available for fitting the model.

Using carcass persistence data from the 2015 – 2016 monitoring year, survival models were fitted separately for each size class for relative quality using the corrected AICc score, as suggested in Huso (2010). The model with the lowest AICc is typically chosen as the “best” model relative to other models tested; however, any model within two AICc points of the best model is considered competitive with the best model (Burnham and Anderson 2004).

Models were fit to each size class separately to allow for the selection of different model distributions and covariate combinations to achieve the best fit for each size class. Model comparisons using AICc suggested that season and Project component location (whether at the solar field or at the overhead lines) are important predictors of carcass persistence for small, medium and large birds.

Both Project component location and season were important in the large bird persistence model. For large birds, the AICc suggested that a seasonal covariate with two categories, spring and fall data pooled and winter and summer data pooled together was not the top rated model, but within two AICc points from the top model. This model was chosen because it has similar predictive ability as the top model but also has fewer parameters to estimate. For medium birds, the best predictive model included the main effects of Project component location and season. The AICc suggested that a seasonal covariate with two categories, spring and summer data pooled and fall and winter data pooled together was the best predictive model for medium birds. The best model for small birds included the main effects of Project component location, season (with no pooling), and an interaction between Project component location and season. The best models for small, medium, and large birds followed a lognormal, Weibull, and loglogistic distribution respectively (Table 9).

Table 9. Top five carcass persistence models for each size class from the AICc model selection process. (bold) indicates chosen model. Sp = spring, Su = summer, Fa = fall, Wi = winter, and Δ = change. The covariate 'season' has no seasonal grouping.

Size	Model Predictors	Distribution	AICc	ΔAICc
Small Birds	**Project (Proj.) Location + season + Proj. Location * season**	**Lognormal**	**596.66**	**0**
	Proj. Location + season + Proj. Location * season	Exponential	597.04	0.38
	Proj. Location + season + Proj. Location * season	Loglogistic	597.07	0.41
	Proj. Location + season + Proj. Location * season	Weibull	598.76	2.10
	Proj. Location + season	Lognormal	600.00	3.34
Medium Birds	**Proj. Location + Sp/Su & Fa/Wi**	**Weibull**	**466.35**	**0**
	Proj. Location + Sp/Su & Fa/Wi	Loglogistic	467.59	1.24
	Proj. Location + Sp/Su & Fa/Wi	Lognormal	467.74	1.39
	Proj. Location + Sp/Su & Fa/Wi + Proj. Location * Sp/Su & Fa/Wi	Weibull	468.54	2.19
	Proj. Location season + Proj. Location * season	Weibull	469.65	3.30
Large Birds	**Proj. Location + season + Proj. Location * season**	**Loglogistic**	**258.71**	**0**
	Proj. Location + season + Proj. Location * season	Lognormal	259.29	0.58
	Proj. Location + Sp/Fa & Su/Wi	Loglogistic	259.34	0.63
	Proj. Location + Sp/Fa & Su/Wi	Lognormal	260.40	1.69
	Proj. Location + Sp & Su/Fa/Wi	Loglogistic	260.91	2.20

The sample size for the intercept of each of the three models was 135, 90 and 50 for small, medium, and large trial carcasses respectively.

The average probability that a carcass at the solar field or a carcass along the gen-tie persists for an average search interval (approximately 7 days for spring and fall; 21 days for summer and winter), is provided for each season and size class in Table 10. Mean (median) removal time within the solar field was 4.9 (6.0) days during spring, 12.7 (12.6) during summer, 2.5 (1.5) during fall, and 6.5 (6.0) during winter for small carcasses; 36.0 (27.8) days during spring, 36.0 (24.3) during summer, 12.2 (18.0) during fall, and 12.2 (6.8) during winter for medium carcasses; and 58.3 (31.0) days during spring, 13.7 (30.0) during summer, 58.3 (30.0) during fall, and 13.7 (5.1) during winter (Table 11). At the overhead lines, removal time was 0.8 (0.5), 0.8 (0.5), 0.4 (0.5), and 2.3 (2.5) for small birds during spring, summer, fall, and winter respectively. For medium birds, mean (median) removal time at the overhead lines was 14.4 (2.0), 14.4 (15.8), 4.9 (1.5), and 4.9 (2.5) days during spring, summer, fall, and winter respectively. Mean (median) removal time for large birds was 5.8 (19.0), 1.4 (0.5), 5.8 (3.5), and 1.4 (3.5) days during spring, summer, fall, and winter respectively (Table 11). Figure 15 shows the proportion of trial carcasses remaining as a function of days since placement and carcass model covariate (component location and/or season).

Table 10. Average probability of carcass persistence to the next search (search interval approximately 7 days during spring and fall migration periods, and 21 days during summer and winter non-migration periods)

	Small Birds		Medium Birds		Large Birds	
	$\hat{r}$	CI	$\hat{r}$	CI	$\hat{r}$	CI
Solar Field						
Spring	0.64	0.52 - 0.74	0.80	0.72 - 0.88	0.95	0.90 - 0.98
Summer	0.62	0.47 - 0.76	0.66	0.56 - 0.78	0.62	0.43 - 0.76
Fall	0.44	0.25 - 0.66	0.65	0.56 - 0.73	0.95	0.90 - 0.98
Winter	0.43	0.35 - 0.51	0.46	0.37 - 0.55	0.62	0.43 - 0.76
Gen-tie						
Spring	0.19	0.09 - 0.30	0.68	0.56 - 0.78	0.65	0.47 - 0.81
Summer	0.07	0.04 - 0.10	0.49	0.36 - 0.62	0.18	0.09 - 0.29
Fall	0.09	0.04 - 0.15	0.48	0.36 - 0.59	0.65	0.47 - 0.81
Winter	0.19	0.14 - 0.25	0.27	0.17 - 0.36	0.18	0.09 - 0.29

Table 11. Mean and median carcass removal time and probability of a carcass persisting through the effective search interval during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

	Small Birds		Medium Birds		Large Birds	
	Mean	Median	Mean	Median	Mean	Median
Solar Field						
Spring	4.9	6.0	36.0	27.8	58.3	31.0
Summer	12.7	12.6	36.0	24.3	13.7	30.0
Fall	2.5	1.5	12.2	18.0	58.3	30.0
Winter	6.5	6.0	12.2	6.8	13.7	5.1
Overhead lines						
Spring	0.8	0.5	14.4	2.0	5.8	19.0
Summer	0.8	0.5	14.4	15.8	1.4	0.5
Fall	0.4	0.5	4.9	1.5	5.8	3.5
Winter	2.3	2.5	4.9	2.5	1.4	3.5

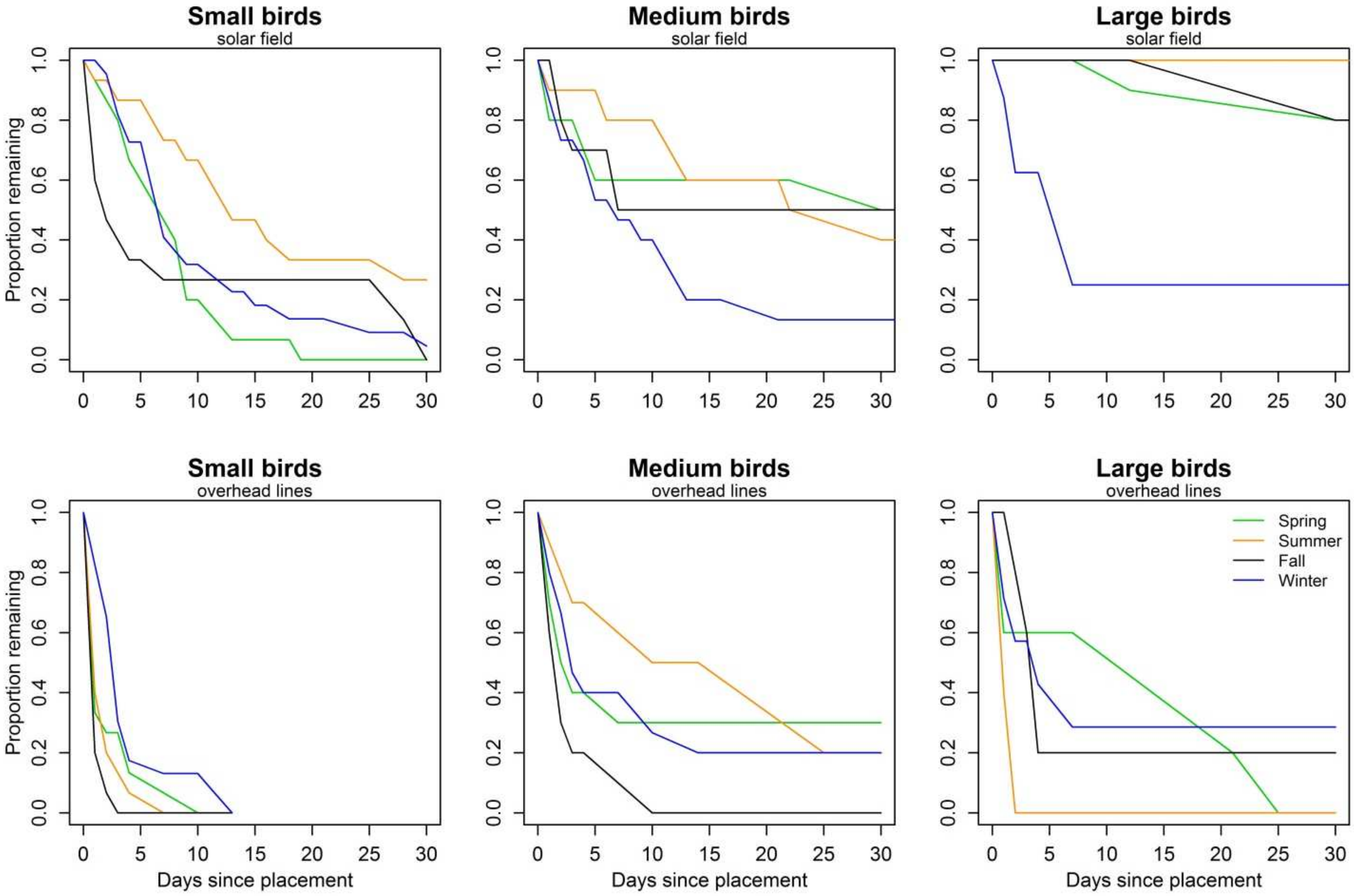


Figure 15. Proportion of trial carcasses remaining as a function of days since placement and carcass size class during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California. Sample size used to produce each panel of the above figure was n = 67, 45, and 28 for small, medium, and large birds at the solar field and 68, 45, and 22 small, medium, and large birds at the overhead lines.

3.8 Searcher Efficiency Trials

During the reporting period, a total of 810 searcher efficiency trials were placed at the Project. Most trials were available to be found, but some disappeared before or during the trial. Overall, 360 trials were placed in the solar arrays and 336 were available to be found; 150 trials were placed along the perimeter fence (inner perimeter only) and 148 were available to be found; and 300 trials were placed along the gen-tie line and 270 were available to be found. Three observers conducted searches at the Project during fall. Searcher efficiency trials were conducted on each observer in approximate proportion to the number of searches they conducted at the Project, as follows: Sarah N. (number of trials available to be found: 281), Jennifer J. (223), Wanda B. (77), Darin B. (71), David G. (58), Pamela B. (27), Anika M. (nine), and Frank M. (eight). All trials were included in estimation of searcher efficiency. These numbers were generally in proportion to the amount of searching conducted by these biologists.

For the solar arrays, searcher efficiency was modeled separately for small, medium, and large birds. The best model for each carcass size is presented in Table 12 below. Within the solar arrays, searcher efficiency for small birds was influenced by cobble cover and season: small birds in high cobble cover in the fall had a searcher efficiency of 33.2% (CI: 13.3 – 63.9%; n = 15) and small birds in low cobble cover in the fall had a searcher efficiency of 57.8% (CI: 39.0 – 77.7%; n = 27; Table 13). Searcher efficiency for small birds in high cobble cover during winter, spring and summer was 36.0% (CI: 21.1 – 45.4%; n = 50), and small birds in low cobble cover during winter, spring and summer had a searcher efficiency of 64.5% (CI: 44.5 – 63.4%; n = 70). For medium birds, searcher efficiency within the solar arrays was similar across cobble cover classes but differed by season: in winter, medium bird searcher efficiency was 94.0% (CI 87.5 – 98.5%; n = 45), and in spring, summer and fall, medium bird searcher efficiency was 83.2% (CI: 76.5 – 89.8%; n = 63). For large birds, searcher efficiency among the solar arrays differed between migration seasons (spring and fall) and non -migration seasons (summer and winter). Searcher efficiency during spring and fall for large birds was 83.9% (CI: 72.0 – 94.3%; n = 31). Searcher efficiency for large birds during summer and winter was 100% with no variance (n = 35). Sample sizes refer to numbers of trial carcasses that were available to be found, not numbers of trial carcasses that were placed (Figure 5 - 7).

For the fence, the model that included an effect of carcass size, and season (with data from spring and winter pooled and summer and fall pooled) was chosen as the most supported model to estimate searcher efficiency (Table 14). Along the fence, searcher efficiency was 65% (CI: 52 – 77%), 94% (CI: 88 - 100%), and 100%, for small, medium, and large carcasses, respectively during spring and winter and 87% (CI: 77 – 97%), 98% (CI: 96 – 100%), and 100% for small, medium, and large carcasses respectively during summer and fall (Table 13).

For the gen-tie line, the chosen model included main effects of size, season (with data from spring and summer data pooled and fall and winter pooled), and visibility class, with an interaction between visibility class and season (Table 14). It ranked second by AICc but was only 0.59 AICc points from the top model. It was chosen because it has similar predictive performance as the top model, but with fewer parameters to estimate. For the easy visibility class, searcher efficiency was 67% (CI: 53 – 81%), 89% (CI: 80 – 95%), and 89% (CI: 80 – 96%) for small, medium, and large carcasses, respectively during spring and summer and 57% (CI:46 – 68%), 84% (CI: 75 – 91%), and 85% (CI: 73 – 93%) for small, medium, and large birds respectively during fall and winter (Table 13). For the difficult visibility class, searcher efficiency was 75% (CI: 62 – 86%), 92% (CI: 86 – 97%), and 92% (CI: 84 – 97%) for small, medium, and large birds respectively during spring and summer and 33% (CI: 22 – 44%), 65% (CI: 53 – 77%), and 67% (CI: 51 – 82 %) for small, medium, and large birds respectively during fall and winter (Table 13). A summary of searcher efficiency estimates are reported in Appendix C.

Table 12. Top five searcher efficiency models from model selection for the solar arrays. (bold text) indicates chosen model form. Sp = spring, Su = summer, Fa = fall, Wi = winter and Δ = change.

Size	Model Predictors	Distribution	AICc	ΔAICc
Small Birds	**cobble + Fa & Sp/Su/Wi + cobble*Fa & Sp/Su/Wi**	**Hazard Rate**	**205.30**	**0.00**
	cobble + Sp & Su/Fa/Wi	Exponential	206.46	1.16
	cobble + Sp/Wi & Su/Fa	Hazard Rate	207.10	1.80
	Cobble	Exponential	207.58	2.28
	cobble + Sp/Su & Fa/Wi	Exponential	208.26	2.96
Medium Birds	**Wi & Sp/Su/Fa**	**Exponential**	**85.20**	**0.00**
	Sp/Fa & Su/Wi	Exponential	86.64	1.44
	Intercept Only	Exponential	86.70	1.50
	Found ~ cobble + Wi & Sp/Su/Fa	Exponential	86.78	1.58
	Sp/Wi & Su/Fa	Exponential	86.96	1.76
Large Birds	**Sp/Fa & Su/Wi**	**Uniform**	**31.58**	**0.00**
	cobble + Sp/Fa & Su/Wi + cobble*Sp/Fa & Su/Wi	Uniform	34.23	2.65
	cobble + Sp/Fa & Su/Wi	Uniform	34.55	2.97
	Wi & Sp/Su/Fa	Uniform	34.60	3.01
	cobble + Wi & Sp/Su/Fa + cobble*Wi & Sp/Su/Fa	Uniform	35.75	4.17

Table 13. Searcher efficiency estimates by Project component.

	Small Birds		Medium Birds		Large Birds	
	Seef	**90% CI**	**Seef**	**90% CI**	**Seef**	**90% CI**
Fence						
Spring & Winter	0.65	0.52 - 0.77	0.94	0.88 - 1.00	1.00	1.00 - 1.00
Summer & Fall	0.87	0.77 - 0.97	0.98	0.96 - 1.00	1.00	1.00 - 1.00
Gen-tie Line						
Easy Visibility						
Spring & Summer	0.67	0.53 - 0.81	0.89	0.80 - 0.95	0.89	0.80 - 0.96
Fall & Winter	0.57	0.46 - 0.68	0.84	0.75 - 0.91	0.85	0.73 - 0.93
Difficult Visibility						
Spring & Summer	0.75	0.62 - 0.86	0.92	0.86 - 0.97	0.92	0.84 - 0.97
Fall & Winter	0.33	0.22 - 0.44	0.65	0.53 - 0.77	0.67	0.51 - 0.82
Solar Arrays						
Low cobble						
Spring	0.65	0.45 - 0.63	0.83	0.77 - 0.90	0.84	0.72 - 0.94
Summer	0.65	0.45 - 0.63	0.83	0.77 - 0.90	1.00	1.00 - 1.00
Fall	0.58	0.39 - 0.78	0.83	0.77 - 0.90	0.84	0.72 - 0.94
Winter	0.65	0.45 - 0.63	0.94	0.87 - 0.99	1.00	1.00 - 1.00
High cobble						
Spring	0.36	0.21 - 0.45	0.83	0.77 - 0.90	0.84	0.72 - 0.94
Summer	0.36	0.21 - 0.45	0.83	0.77 - 0.90	1.00	1.00 - 1.00
Fall	0.33	0.13 - 0.64	0.83	0.77 - 0.90	0.84	0.72 - 0.94
Winter	0.36	0.21 - 0.45	0.94	0.87 - 0.99	1.00	1.00 - 1.00

Table 14. Top five searcher efficiency models from model selection for the fence and gen-tie line. (bold text) indicates chosen model form. Sp = spring, Su = summer, Fa = fall, Wi = winter and Δ = change.

Model Form – Fence	AICc	ΔAICc
size + Sp/Wi & Su/Fa	**103.45**	**0.00**
size + Su & Sp/Fa/Wi	106.46	3.01
Size	106.67	3.22
size + Sp/Wi & Su/Fa + size * Sp/Wi & Su/Fa	107.03	3.57
season + size	107.75	4.29
Model Form - Gen-tie Line	**AICc**	**ΔAICc**
size + Sp/Su & Fa/Wi + visibility + size * Sp/Su & Fa/Wi + visibility * Sp/Su & Fa/Wi	301.53	0.00
size + Sp/Su & Fa/Wi + visibility + visibility * Sp/Su & Fa/Wi	302.13	0.59
size + Sp/Su & Fa/Wi + visibility + size * Sp/Su & Fa/Wi	304.29	2.76
size + Sp/Su & Fa/Wi + visibility	305.03	3.50
size + Sp/Su & Fa/Wi + size * Sp/Su & Fa/Wi	306.17	4.64

3.9 Fatality Estimates

Fatality estimates were calculated separately for each component (solar arrays, fence, and overhead lines). There were 149 detections during the 2015 – 2016 monitoring year. Fatalities found in the sample standardized search areas that were estimated not less than twice the length of the search interval were included. This conservative definition was used due to uncertainty in aging carcasses and should result in a positive (overestimate) bias. Detections used in the analysis, bias corrections, fatality estimates, and 90% confidence intervals are detailed in Appendix C.

Using the Huso (2010) fatality estimator, during the 2015 – 2016 monitoring year, there were an estimated total of 1,328 bird carcasses (CI: 1,007 – 2,303) at the Project (all components combined). There were an estimated 53 (CI: 28 – 85) large birds, 336 (CI: 246 – 449) medium birds, 881 (CI: 566 – 1,843) small birds, and 58 (CI: 22 – 143) birds of unknown size at the Project (all components combined; Table 15).

The model estimates 628 (CI: 496 – 951) bird carcasses (152/1000 acres, 1.16/nameplateMW) at the solar arrays, 688 (CI: 364 – 1,567) along the gen-tie line and 11 (CI: 2 – 26) at the fence. Estimates of fatalities along the gen-tie are heavily influenced by the high rates of scavenging observed during the limited trials at the gen-tie (i.e., large correction factors) and are likely very unreliable. Adjusted fatality estimates for each Project component are provided by guild in Table 16. A complete list of estimates by Project component and carcass size class with confidence intervals is presented in Appendix C.

Table 15. Adjusted fatality estimates by size and guild during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California

Size	Actual Fatalities	Total Adjusted Fatalities	90% CI
Large Birds	21	53	28 – 85
Medium Birds	68	336	246 – 449
Small Birds	56	881	566 – 1,843
Unknown size	4	58	22 - 143
Guild		**Total Adjusted Fatalities**	**90% CI**
Passerines	56	879	576 – 1,811
All water-associated birds	66	210	148 - 289
Doves/Pigeons	15	60	30 - 98
Diurnal Raptors	1	1	na

Table 16. Adjusted fatality estimates by guild and component during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at the Desert Sunlight Solar Farm Project, Riverside County, California.

Guild	Solar array	90% CI	Fence	90% CI	Gen-tie	90% CI	Overall	90% CI
Passerines	310	206 - 580	-	-	571	267 - 1406	881	588 - 1804
All water-associated birds	272	191 - 391	9	3 - 24	67	9 - 185	348	242 - 529
Waterbirds/Waterfowl	194	129 – 273	6	3 - 16	10	4 - 25	210	148 - 289
Rails/Coots	56	24 - 100	3	3 - 10	57	5 - 175	116	42 - 243
Doves/Pigeons	21	5 – 40	2	2 - 6	37	14 - 71	60	30 - 99
Shorebirds	22	11 - 98	-	-	-	-	22	11 - 98
All Birds	**628**	496 – 952	11	3 – 26	688	364 – 1567	1328	1007 – 2303

Note: confidence interval (CI)

4 DISCUSSION

The 2015 – 2016 monitoring year represented the first full year of standardized monitoring at Desert Sunlight. Searcher efficiency and carcass persistence trials were conducted concurrently at the solar arrays, fence lines, and along the gen-tie line. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. The results provided in each seasonal report were considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. For this annual report, the analysis is comprehensive, with data from all four seasons included in the analysis.

4.1 Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, the frequency of flooding events, and other factors. Carcass persistence was low along the gen-tie line, while persistence rates were longer within the Project fence. Overall, carcass persistence rates were longer for medium and large birds compared to smaller birds but there was variation by season and Project component. The longer persistence rates for larger sized birds is a consistent result seen in many other studies (Smallwood et al. 2010, and Morrison 2002).

The experimental bias trials themselves may influence scavenging on site. The large number of carcasses used in trials may be attracting scavengers to the Project site and negatively influencing the bias adjustments for the fatality estimates. Scavengers may learn from visual and olfactory cues that carcasses are being placed for trials. Placing carcasses in the early morning, placing fake cameras at locations without carcasses, and varying the clothes of the biologists placing the carcasses are all methods that were used to try to reduce this bias.

Searcher efficiency was influenced by carcass size, season, and cobble cover within the solar arrays. Some of the relationships that were apparent were not always explainable and expected from a biological perspective (e.g. some of the seasonal effects), but were still included in the final models. Consideration for simplifying the models will be given for the 2nd year monitoring data analysis and reporting.

4.2 Fatalities Timing and Guild/Species Composition, and Other Fatality Characteristics

There were no large mortality events (e.g., >30 birds found on a day) during this 2015 – 2016 monitoring period. More detections occurred during the fall season, beginning in early September and continuing through late October. This peak in detections coincides with the fall bird migration period as well as the time when population sizes are typically highest during fledging in the summer. The increased detections in the fall were primarily due to detections of water-associated birds, especially during the month of October. The peak observed during the fall was apparent within both the solar arrays and along the gen-tie. At the solar arrays, the increase in the fall was mostly waterbird species, whereas the fall increase observed along the gen-tie was primarily non-water associated species.

During the 2015 – 2016 monitoring year, the 149 avian detections (including all stranded and injured birds and incidental detections) consisted of 19 guilds and included 53 identified species. The most numerous detection of an identified species was American coot with 12 detections, most of which were at the solar arrays. Mourning dove (n = 6) was the next most commonly detected species. The most numerous detection in the solar arrays was American coot (n = 9), followed by western grebe, with no other species with more than four detections. The only species observed along the fence were American coot (n = 1), common raven (n = 1), common loon (n = 1), white-winged dove (n = 1), and mallard (n = 1). Eurasian collared-dove (n = 4) and orange-crowned warbler (n = 3) were the species with the most detections along the gen-tie/road.

There were no strong spatial patterns observed within the solar arrays or along the fenceline. Along the gen-tie line, there were a few clusters of detections, the majority of which were small bird species.

4.3 Causation

Detections attributed to an unknown cause accounted for approximately 74% of all detections during the 2015 – 2016 monitoring year. Determining a cause of mortality from a feather spot or scavenged bird is challenging because there is rarely visible evidence available on which to determine a cause of death. Especially for passerine species found on the Project, an unknown but potentially measurable number of the carcasses might have been caused by factors other than collision with the Project facilities. Due to this uncertainty of causation, some studies have estimated background fatality estimates at reference or control areas. There have been two studies of background mortality at solar facilities: CVSR and Topaz had conducted background avian fatality monitoring in an effort to assess causation (H.T Harvey and Associates 2014; Althouse and Mead Inc. 2014). These studies were designed to try and quantify the potential degree to which fatalities were likely the result of interactions with facility infrastructure (PV panels, etc.) or whether some of the fatalities might be unrelated to the presence of the facility. Mortality at these two Project sites was not unlike the estimates of background mortality observed on nearby reference sites. Given the low density of carcasses found within the solar arrays (<0.2/acre/year), a large field effort would likely be required to characterize background mortality with reasonable levels of precision if background rates were similar to the rates in the arrays.

In addition to issues associated with background mortality, multiple feather spots found on site may be from the same detection. Game cameras trained on carcasses for carcass persistence trials at the Project have documented the potential for multiple feather spots originating from a single trial carcass. Ravens and turkey vultures, and possibly roadrunners, dislodge feathers from their attachment to the skin of the carcass during the scavenging process. There are a very large number of potential feather spots present from a single bird carcass. This large number occurs because a feather spot is defined as at least two or more primary flight feathers, at least five or more tail feathers, or two primaries within five m (16.4 ft) or less of each other, or a total of 10 or more feathers of any type concentrated together in an area of three square m. Thus, the presence of feather spots among the detections for the Project would inflate the fatality estimate based on the potential for multiple feather spots, resulting from one fatality being counted as separate detections if feathers are either blown around the site, scattered by predators (e.g., plucking by ravens), resulting from predation not associated with the facility, or resulting from other unrelated causes. Nonetheless, feather spots are included in the analysis here to provide a more conservative estimate of fatality. If feather spots were excluded from the analysis, the overall estimates would be reduced by approximately 25%.

4.4 Fatality Estimates

The estimated density of carcasses for the Project components within the fence (solar arrays and fence) is only 0.15 carcasses/acre/year. More carcasses were estimated for the gen-tie than the solar arrays; however, the estimates for the gen-tie are unreliable due to very high carcass removal rates along that Project component. Approximately 270 water-associated carcasses (or 0.06 per acre) were estimated for the solar arrays.

5 LITERATURE CITED

Akaike, H. 1973. Information Theory and an Extension of the Maximum Likelihood Principle. Presented at the Proceedings of the Second International Symposium on Information Theory. B. N. Petrov and F. Csaki, eds. Pp. 267-281. Akademiai Kiado. 1973.

Althouse and Meade, Inc. 2014. Topaz Solar Farms 2013 Fourth Quarter/Second Annual Report for Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. Prepared for Topaz Solar Farms LLC, Santa Margarita, California. Prepared by Althouse and Mead Inc., Paso Robles, California. March 2014.

Birds of North America (BNA). 2016. The Birds of North America Online. Cornell Lab of Ornithology and the American Ornithologists' Union. Accessed December 2012. BNA homepage at: http://bna.birds.cornell.edu/bnaBuckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. Distance Sampling: Estimating Abundance of Biological Populations. Chapman & Hall, London, United Kingdom.

Burnham, K. P. and D. R. Anderson. 2004. Multimodel Inference: Understanding Aic and Bic in Model Selection. Sociological Methods and Research 33(2): 261-304.

eBird. 2015. eBird: An Online Database of Bird Distribution and Abundance (Web Application). eBird, Cornell Lab of Ornithology, Ithaca, New York. Accessed March 25, 2015. Available online at: http://ebird.org/content/ebird/

H.T. Harvey and Associates. 2014. California Valley Solar Ranch Project Avian and Bat Protection Plan Annual Postconstruction Fatality Report: 16 August 2012 - 15 August 2013. Project # 3326-03. Prepared for HPR II, LLC, California Valley Solar Ranch, Santa Margarita, California. Prepared by H.T. Harvey and Associates, San Luis Obispo, California. March 28, 2014.

Huso, M. 2010. An Estimator of Wildlife Fatality from Observed Carcasses. Environmetrics 22(3): 318–329. doi: 10.1002/env.1052.

Huso, M., N. Som, and L. Ladd. 2012. Fatality Estimator User's Guide. US Geological Survey (USGS) Data Series 729. 22 pp. Available online at: http://pubs.usgs.gov/ds/729/pdf/ds729.pdf

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A New Method to Determine Bird and Bat Fatality at Wind Energy Turbines from Carcass Searches. Wildlife Biology 17: 350-363.

Manly, B. F. J. 1997. Randomization, Bootstrap, and Monte Carlo Methods in Biology. 2nd Edition. Chapman and Hall, London.

Morrison, M. 2002. Searcher Bias and Scavenging Rates in Bird/Wind Energy Studies. NREL/SR-500-30876. National Renewable Energy Laboratory. Golden, Colorado.

Murray, J. M. 2004. Nocturnal Flight Call Analysis as a Method for Monitoring Density and Species Composition of Migratory Songbirds (Order Passeriformes) across Southern Vancouver Island, British Columbia, 2004. Available online at: http://rpbo.org/acousticmonjjm.pdf

Newton, I. 2008. The Migration Ecology of Birds. Academic Press, London.

Smallwood, K. S. 2007. Estimating Wind Turbine-Caused Bird Mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K. S., D. A. Bell, S. A. Snyder, and J. E. DiDonato. 2010. Novel Scavenger Removal Trials Increase Wind Turbine-Caused Avian Fatality Estimates. Journal of Wildlife Management 74: 1089-1097. doi: 10.2193/2009-266.

Therneau, T. and T. Lumley. 2015. A Package for Survival Analysis in S. Version 2.38. Information available at: http://CRAN.R-project.org/package=survival

Therneau, T. M., and P. M. Grambsch. 2000. Modeling Survival Data: Extending the Cox Model. Springer-Verlag, New York.

Appendix A. Detailed Areas of Carcass Locations along the Generation Tie Line of the Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016

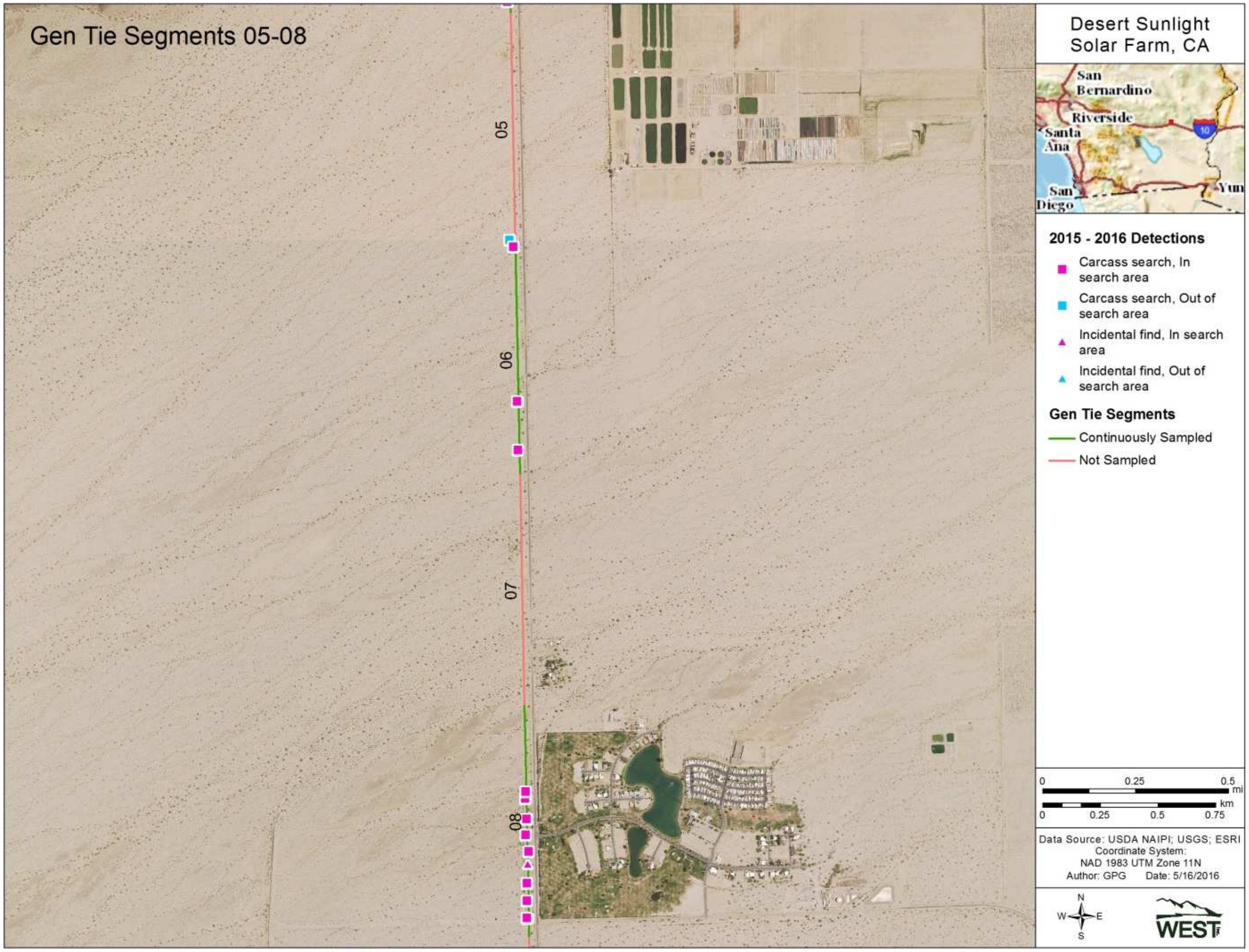


Figure A-1. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

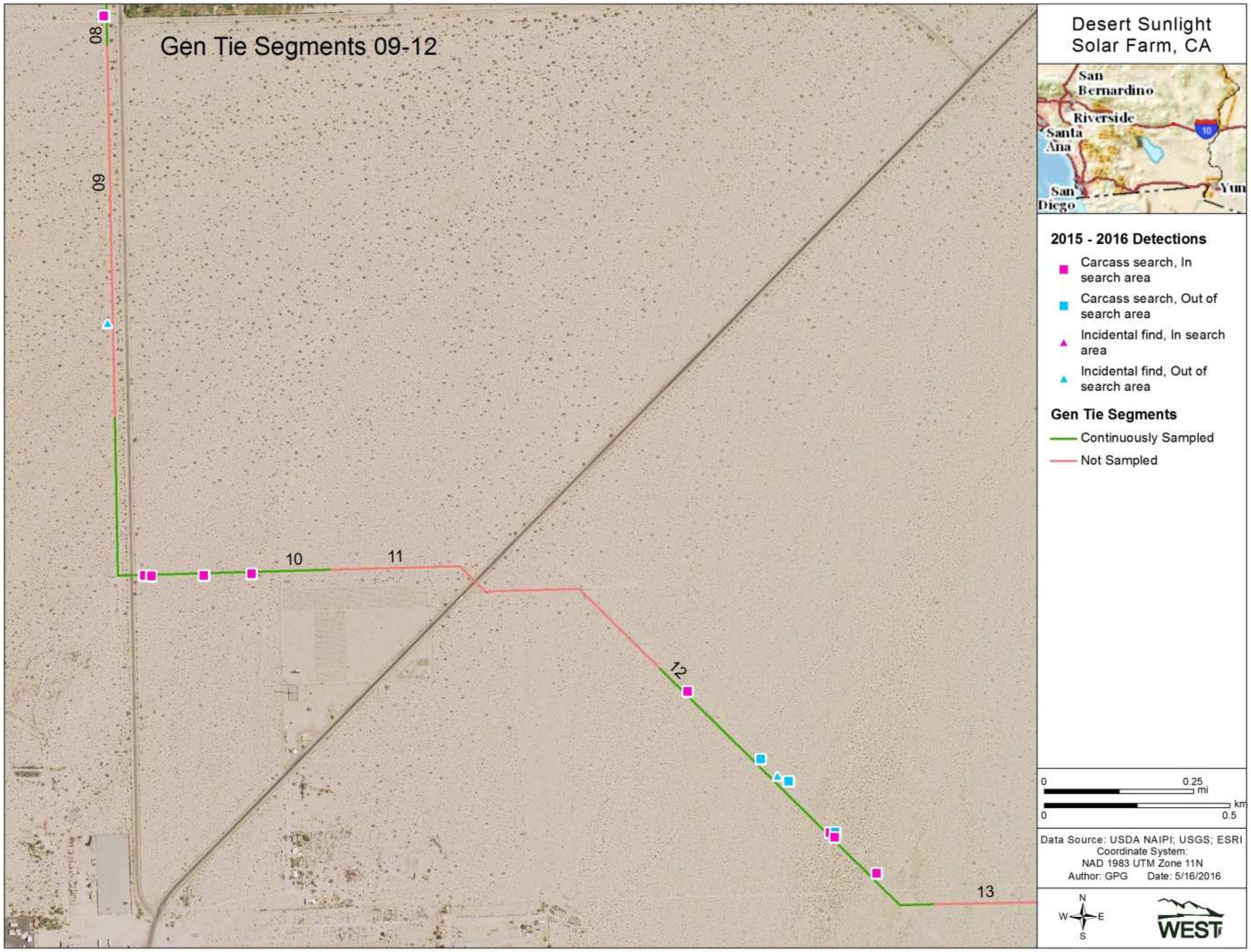


Figure A-2. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

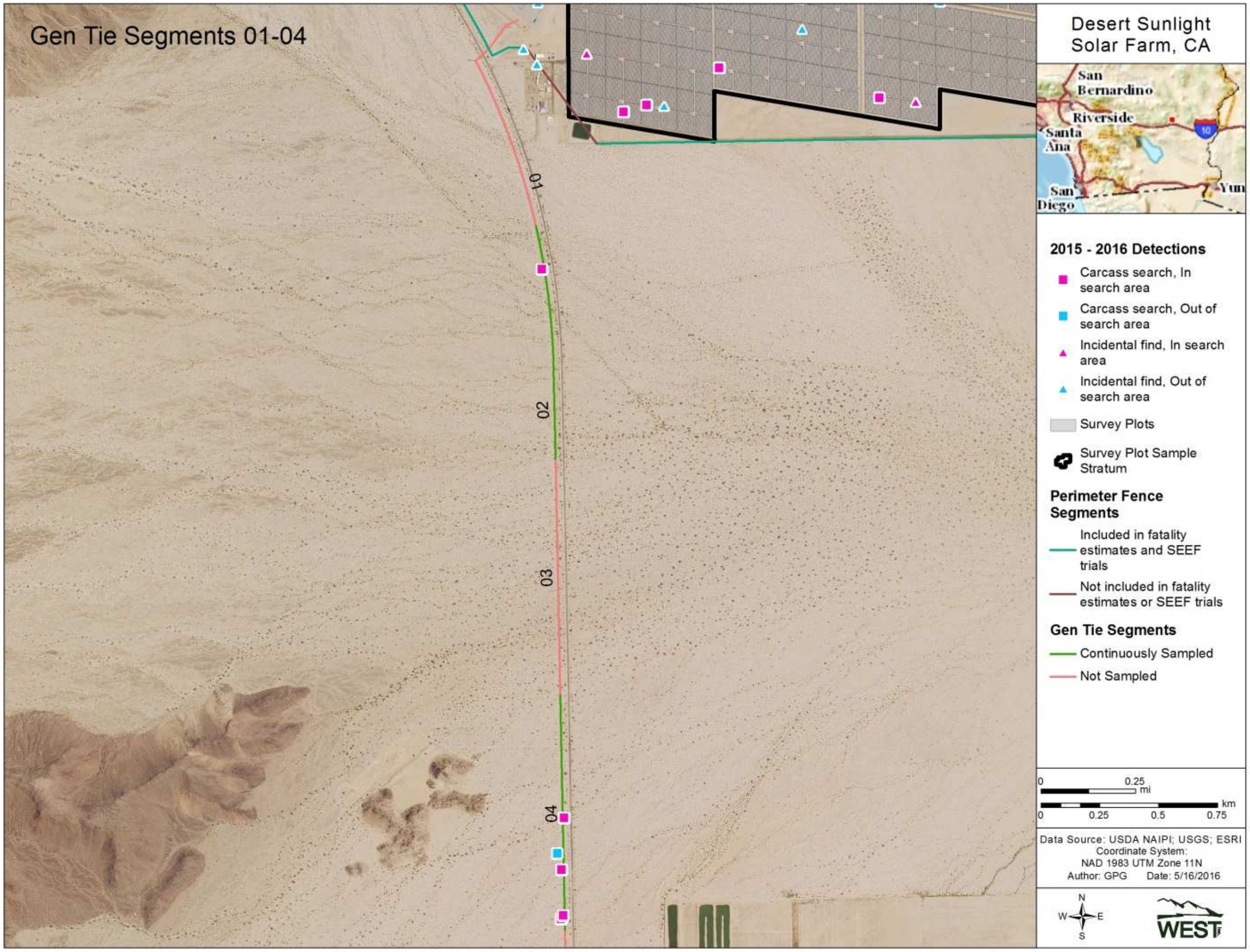
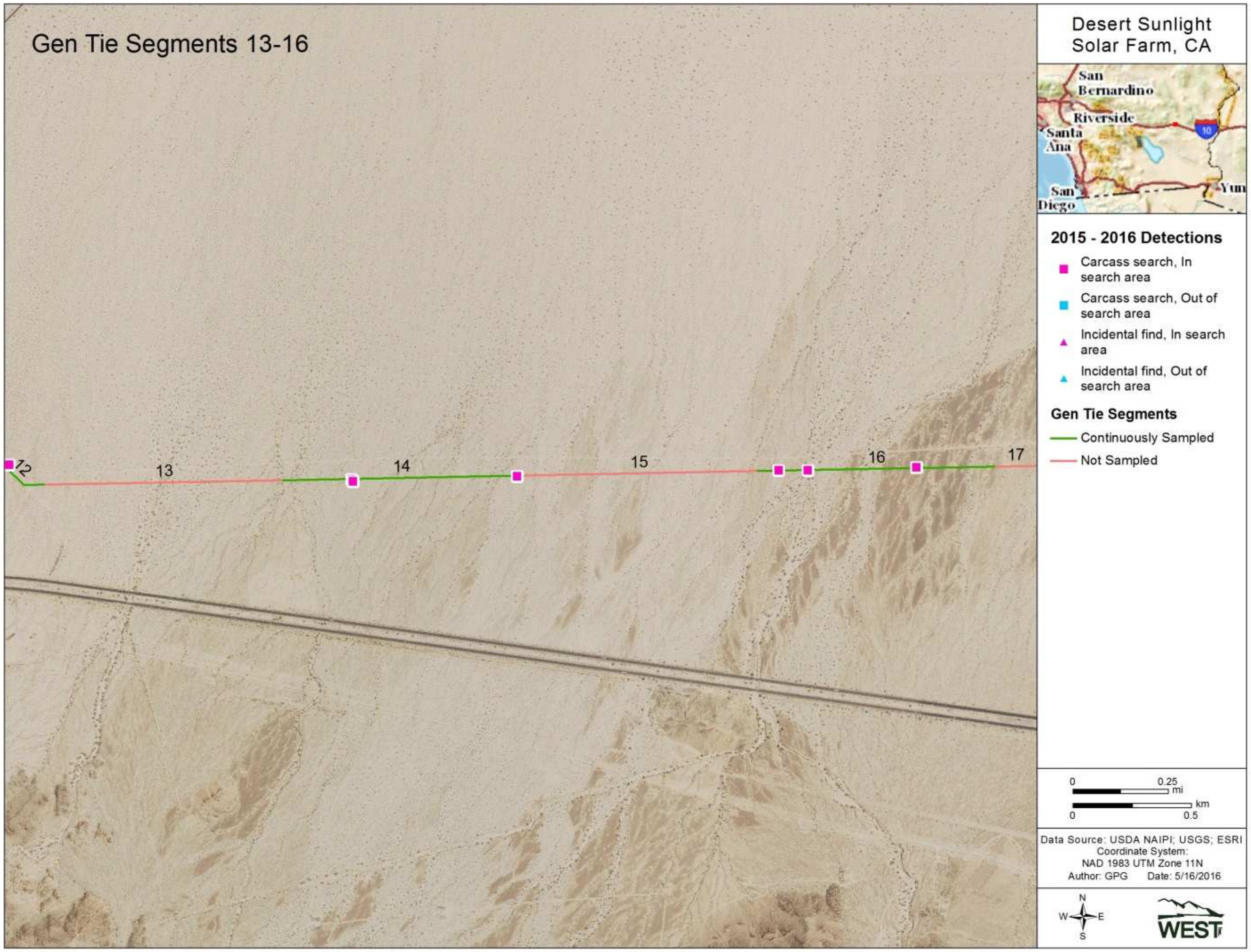


Figure A-3. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).



Data Source: USDA NAIPI; USGS; ESRI
Coordinate System:
NAD 1983 UTM Zone 11N
Author: GPG Date: 5/16/2016

Figure A-4. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

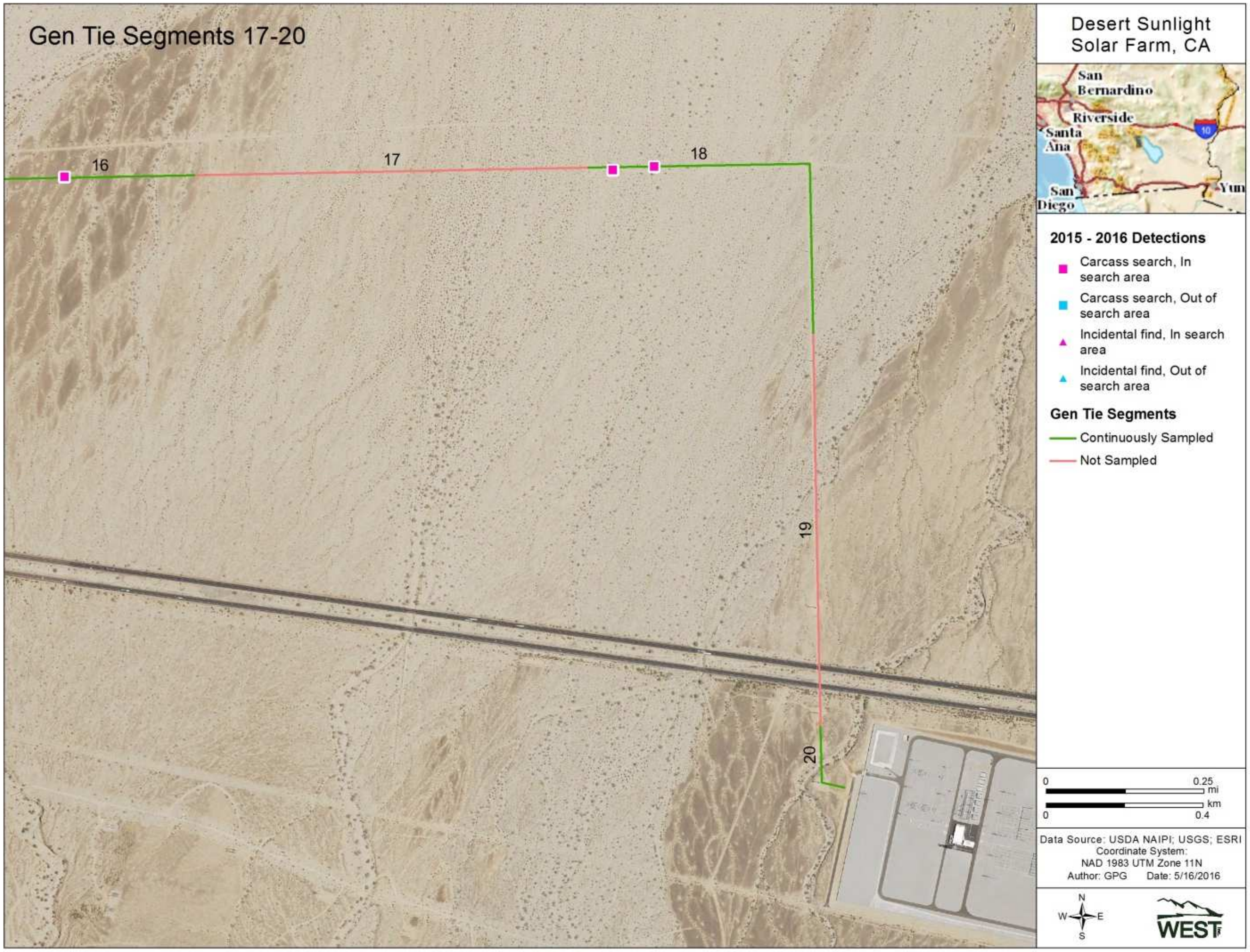


Figure A-5. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016).

Appendix B. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016)

Table B-1. Weather conditions and body weights associated with detections estimated to be less than 24 hours old during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hours)	Species	Weight (g)[1]	Weather Summary for Preceding 24 hours
040715-TOWA-13-27A-MVOH-01	4/7/2015	8-24hrs	Townsend's warbler	NA	na
042215-WWDO-FENCE-NORTH-15-01	4/22/2015	0-8hrs	white-winged dove	NA	tornado
042215-WWDO-18-19A-MVOH-1-01	4/22/2015	8-24hrs	white-winged dove	NA	na
043015-WIWA-GENTIE-08-01	4/30/2015	8-24hrs	Wilson's warbler	NA	temp high 97 degrees, 2-5 pm overnight low was 67 degrees, winds < 10 mph
050715-WETA-GENTIE-12-01	5/7/2015	8-24hrs	western tanager	NA	na
051915-WEWP-O&MBUILDING-01	5/19/2015	0-8hrs	western wood-pewee	7	clear overnight, relatively calm winds, max 8mph
062415-HOWR-01-16MVOH-02	6/24/2015	8-24hrs	house wren	7	jun 23, max temp 114, avg wind speed 10mph-ssw, max wind speed 16mph. max gust 21mph. vis 10 miles, clear until 3pm then partly cloudy until 7pm, then clear through noght. moon phase: waxing cresent. clear all day 6/24. temp 99 deg F when bird found
071715-SORA-GENTIE-06-01	7/17/2015	0-8hrs	sora	63	average wind speed of 9mph to the south, clear 10 mile visibility, max temperature is 107 degrees, minimum is 79 degrees, new moon 1% illuminated
091015-BTYW-02-21-A-MVOH-04	9/9/2015	8-24hrs	black-throated gray warbler	8	max wind speed- 34. avg wind speed-10. wind direction- sse. moon phase- waning crescent. max temp 108. clear until 2pm on 09/08
090915-YWAR-18-11-A-MVOH-03	9/9/2015	8-24hrs	yellow warbler	8	max wind speed- 34 mph. ang wind speed- 10. wind direction- sse. moon phase- waning crescent. max temp- 108. clear until 2pm on 9/08. haze/thunderstorm until 5pm, then clear.
091115-MODO-17-05-B-19W-01	9/11/2015	0-8hrs	mourning dove	NA	max wind speed-17. avg wind speed- 11. wind direction- SSW. moon phase- waning crescent. some rain
091615-UNSP-GENTIE12-01	9/16/2015	0-8hrs	black-throated sparrow	14	14 max wind. 8 average wind. sse wind direction. maxing crescent moon phase. no clouds. very sunny and a very nice breeze ~95 degrees F.
092215-LISP-GENTIE-10-01	9/22/2015	8-24hrs	Lincoln's sparrow	13	6-16mph SE wind, 9.21 max temp 91F, clear until 4pm, partly cloudy until 5pm, clear until 3am then clear/partly cloudy/overcast until bird found
092315-VIRA-11-15-MVOH-01	9/23/2015	0-8hrs	Virginia rail	60	14 max wind speed. 3 average wind speed. nne wind direction. waxing gibbous moon phase. max temp. 94. clear until bird found.
092315-SAVS-GENTIE-12-03	9/23/2015	8-24hrs	Savannah sparrow	18	3-14 mph NNE wind, waxing gibbous moon, max temp 94, clear
092515-RUDU-19-05-B-2W-01	9/25/2015	8-24hrs	ruddy duck	NA	4-14mph NE wind, waxing gibbous moon, clear until bird found
092815-WEGR-10-24-A-PCS-02	9/28/2015	8-24hrs	western grebe	630	12 max wind speed. gusts 16. 4 avg wind speed. ese wind direction. full moon phase. max temp 105 F. clear until bird found, according to weather underground. 40-55% clouds morning bird found as seen in field.

Table B-1. Weather conditions and body weights associated with detections estimated to be less than 24 hours old during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hours)	Species	Weight (g)[1]	Weather Summary for Preceding 24 hours
092815-YRWA-10-19-B-01W-03	9/28/2015	8-24hrs	yellow-rumped warbler	10	12 max wind speed. gusts 16. 4 avg wind speed. ese wind direction. full moon phase. max temp 105 F. according to weather underground clear until bird found. however 40-55% clouds in field on morning of 09/28 until bird found.
100615-AMCO-GENTIE-8-01	10/6/2015	0-8hrs	American coot	465	20 mph max wind speed. 9 mph avg wind speed. WSW wind direction. last quarter moon phase.
100615-LISP-GENTIE-06-01	10/6/2015	0-8hrs	Lincoln's sparrow	14	max wind speed: 20. ang wind speed: 9. wind direction: wsw. moon phase: last quarter. mostly cloudy
100715-SAVS-GENTIE-12-01	10/7/2015	8-24hrs	Savannah sparrow	16	max wind speed: 13. avg wind speed: 6. wind direction: NNW. gusts 17. moon phase: waning crescent. high temp 89 F. clear until 4 pm on 10/06, then overcast/ mostly cloudy. clear again from 7pm until bird found on 10/07.
100715-VESP-GENTIE-16-03	10/7/2015	8-24hrs	vesper sparrow	23	max wind speed: 13. avg wind speed: 6. wind direction: nnw. moon phase: waning crescent. high temp 89 deg F. clear until 4 pm on 0\10/06, then overcast/ mostly cloudy. clear again from 7 pm until bird found on 10/07.
100715-HOWR-GENTIE-18-04	10/7/2015	8-24hrs	house wren	9	max wind speed: 13. avg wind speed: 6. wind direction: NNW. gusts: 17. moon phase: waning crescent. high temp 89 def F. clear until 4pm on 10/06, the overcast/mostly cloudy. clear again from 7pm until bird found on 10/07.
100715-WCSP-GENTIE-14-02	10/7/2015	8-24hrs	white-crowned sparrow	24	max wind speed: 13. avg wind speed: 6. wind direction: NNW. moon phase: waning crescent. high temp 89 deg F. clear until 4 pm on 10/06, then overcast/ mostly cloudy. clear again from 7 pm until bird found on 10/07.
100815-EAGR-05-16-MAINROAD-02	10/8/2015	0-8hrs	eared grebe	NA	max wind speed: 10. avg wind speed: 4. wind direction: wsw. moon phase: waning crescent. clear.
101315-WEME-GENTIE-10-01	10/13/2015	8-24hrs	western meadowlark	72	max wind speed: 9. avg wind speed: 5. wind direction: SW. moon phase: waning crescent. clear.
101415-WEGR-07-15-A-34-01	10/14/2015	0-8hrs	western grebe	670	max wind speed: 13. avg wind speed: 5. wind direction: NE. moon phase: new moon. clear.
101515-RUDU-06-15-A-10E-02	10/15/2015	0-8hrs	ruddy duck	NA	max wind speed: 6 mph. avg wind speed: 3 mph. wind direction: ENE. moon phase: waxing crescent. 10 mile visibility
101515-RUDU-08-01-B-14-E-01	10/15/2015	0-8hrs	ruddy duck	NA	max wind speed: 13 mph. avg wind speed: 4 mph. wind direction: NW. moon phase: waxing crescent. mostly cloudy, light sprinkles, avg temo 90 deg F

Table B-1. Weather conditions and body weights associated with detections estimated to be less than 24 hours old during the 2015 – 2016 monitoring year (March 1, 2015 – February 28, 2016) at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hours)	Species	Weight (g)[1]	Weather Summary for Preceding 24 hours
101615-AMCO-20-08-A-7-E-01	10/16/2015	8-24hrs	American coot	NA	max wind speed: 21 mph. avg wind speed: 6 mph. wind direction: NNW. moon phase: waxing crescent. heavy cloud cover greater than 80%. t-storm previous night, on 101515 (with rain and lightening)
102015-BHCO-GENTIE-10-01	10/20/2015	0-8hrs	brown-headed cowbird	43	10-18 NNW wind, gusts to 25 mph, waxing crescent moon, max temp 85, clear until 6pm then partly cloudy/overcast until midnight then clear until bird found
102115-WCSP-GENTIE-14-01	10/21/2015	8-24hrs	white-crowned sparrow	27	8-33 mph NNW wind, waxing crescent moon, rain, thunderstorm
102315-COLO-04-05-A-02	10/23/2015	0-8hrs	common loon	NA	max wind speed: 7. avg wind speed: 3. wind direction: ene. moon phase: waxing gibbous. max temp on 10/22 84 deg F. clear, visibility 10 miles on 10/22 and 10/23

[1] Weight recorded only for intact carcasses with no evidence of scavenging.

Appendix C. Correction Factors and Bird Fatality Rates at the Desert Sunlight Solar Farm Project during the 2015 – 2016 Monitoring Period

(March 1, 2015 – February 28, 2016)

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during the 2015 – 2016 (February 2, 2015 – February 28, 2016) monitoring year. *Distribution of easy and difficult visibility on the gen-tie line was 50% and 50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

Parameter	Small birds		Medium birds		Large birds		Unknown size	
	Mean	90% CI	Mean	90% CI	Mean	90% CI	Mean	90% CI
Proportion of area searched by component								
Fence	0.74	-	0.74	-	0.74	-	0.74	-
Gen-tie line	0.48	-	0.48	-	0.48	-	0.48	-
Solar arrays	0.30	-	0.30	-	0.30	-	0.30	-
Searcher efficiency by component and visibility class								
Fence								
Spring & Winter	0.65	0.52 - 0.77	0.94	0.88 - 1.00	1.00	1.00 - 1.00	0.65	0.52 - 0.77
Summer & Fall	0.87	0.77 - 0.97	0.98	0.96 - 1.00	1.00	1.00 - 1.00	0.87	0.77 - 0.97
Gen-tie line								
Easy visibility								
Spring & Summer	0.67	0.53 - 0.82	0.89	0.80 - 0.95	0.89	0.80 - 0.96	0.67	0.53 - 0.81
Fall & Winter	0.57	0.46 - 0.68	0.84	0.75 - 0.91	0.85	0.73 - 0.93	0.57	0.46 - 0.681
Difficult visibility								
Spring & Summer	0.75	0.62 - 0.86	0.92	0.86 - 0.97	0.92	0.84 - 0.97	0.75	0.62 - 0.86
Fall & Winter	0.33	0.22 - 0.44	0.65	0.53 - 0.77	0.67	0.51 - 0.82	0.33	0.22 - 0.44
Solar arrays								
Low cobble								
Spring	0.65	0.45 - 0.63	0.83	0.77 - 0.90	0.84	0.72 - 0.94	0.65	0.45 - 0.63
Summer	0.65	0.45 - 0.63	0.83	0.77 - 0.90	1.00	1.00 - 1.00	0.65	0.45 - 0.63
Fall	0.58	0.39 - 0.78	0.83	0.77 - 0.90	0.84	0.72 - 0.94	0.58	0.39 - 0.78
Winter	0.65	0.45 - 0.63	0.94	0.87 - 0.99	1.00	1.00 - 1.00	0.65	0.45 - 0.63
High cobble								
Spring	0.36	0.21 - 0.45	0.83	0.77 - 0.90	0.84	0.72 - 0.94	0.36	0.21 - 0.45
Summer	0.36	0.21 - 0.45	0.83	0.77 - 0.90	1.00	1.00 - 1.00	0.36	0.21 - 0.45
Fall	0.33	0.13 - 0.64	0.83	0.77 - 0.90	0.84	0.72 - 0.94	0.33	0.13 - 0.64
Winter	0.36	0.21 - 0.45	0.94	0.87 - 0.99	1.00	1.00 - 1.00	0.36	0.21 - 0.45
Average probability of carcass persistence through the effective search interval								
Gen-tie lines								
Spring	0.19	0.09 - 0.30	0.68	0.56 - 0.78	0.65	0.47 - 0.81	0.19	0.09 - 0.30
Summer	0.07	0.03 - 0.10	0.49	0.36 - 0.62	0.18	0.09 - 0.29	0.07	0.03 - 0.10
Fall	0.09	0.04 - 0.15	0.48	0.36 - 0.59	0.65	0.47 - 0.81	0.09	0.04 - 0.15

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during the 2015 – 2016 (February 2, 2015 – February 28, 2016) monitoring year. *Distribution of easy and difficult visibility on the gen-tie line was 50% and 50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

Parameter	Small birds		Medium birds		Large birds		Unknown size	
	Mean	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Winter	0.19	0.14 - 0.25	0.27	0.17 - 0.36	0.18	0.09 - 0.29	0.19	0.14 - 0.25
Solar arrays & fence								
Spring	0.64	0.52 - 0.74	0.80	0.72 - 0.88	0.95	0.90 - 0.98	0.64	0.52 - 0.74
Summer	0.62	0.47 - 0.76	0.66	0.56 - 0.78	0.62	0.43 - 0.76	0.62	0.47 - 0.76
Fall	0.44	0.25 - 0.66	0.65	0.56 - 0.73	0.95	0.90 - 0.98	0.44	0.25 - 0.66
Winter	0.43	0.35 - 0.51	0.46	0.37 - 0.55	0.62	0.43 - 0.76	0.43	0.35 - 0.51
Adjustment for effective search interval (proportion of nominal search interval; all others not listed are 1)								
Gen-tie line: Fall	0.66	0.29 - 1.00	1.00	-	1.00	-	1.00	-
Gen-tie line: Summer	0.49	0.23 - 0.74	1.00	-	1.00	-	1.00	-
Carcass counts by component								
Fence								
Spring	0	-	1	0 - 3	0	-	0	-
Summer	0	-	0	-	0	-	0	-
Fall	0	-	0	-	0	-	0	-
Winter	0	-	3	0 - 7	0	-	0	-
Gen-tie								
Spring	3	1 - 6	2	0 - 5	0	-	1	0 - 3
Summer	1	0 - 3	1	0 - 3	0	-	0	-
Fall	13	5 - 22	10	3 - 19	0	-	0	-
Winter	1	0 - 3	2	0 - 5	0	-	0	-
Solar arrays								
Spring	2	0 - 5	3	0 - 6	2	0 - 5	2	0 - 5
Summer	1	0 - 3	4	0 - 10	3	0 - 6	0	-
Fall	10	5 - 16	21	14 - 29	7	3 - 12	0	-
Winter	7	0 - 12	9	4 - 14	0	-	1	0 - 3
Average probability of carcass availability and detected (searcher efficiency * average probability of carcass persistence)								
Fence								
Spring	0.41	0.30 - 0.52	0.76	0.67 - 0.84	0.95	0.90 - 0.98	0.41	0.30 - 0.52
Summer	0.54	0.40 - 0.68	0.65	0.55 - 0.77	0.62	0.43 - 0.76	0.54	0.40 - 0.68
Fall	0.38	0.21 - 0.59	0.64	0.55 - 0.72	0.95	0.90 - 0.98	0.38	0.21 - 0.59
Winter	0.28	0.21 - 0.36	0.43	0.34 - 0.53	0.62	0.43 - 0.76	0.28	0.21 - 0.36
Gen-tie								
Easy visibility								
Spring	0.13	0.06 -	0.60	0.49 -	0.58	0.43 -	0.13	0.06 -

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during the 2015 – 2016 (February 2, 2015 – February 28, 2016) monitoring year. *Distribution of easy and difficult visibility on the gen-tie line was 50% and 50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

Parameter	**Small birds**		**Medium birds**		**Large birds**		**Unknown size**	
	Mean	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
		0.21		0.70		0.75		0.21
Summer	0.04	0.02 - 0.07	0.44	0.31 - 0.55	0.16	0.09 - 0.27	0.04	0.02 - 0.07
Fall	0.05	0.02 - 0.09	0.40	0.29 - 0.50	0.55	0.29 - 0.59	0.05	0.02 - 0.09
Winter	0.11	0.07 - 0.15	0.23	0.14 - 0.31	0.15	0.06 - 0.20	0.11	0.07 - 0.15
Difficult visibility								
Spring	0.14	0.07 - 0.22	0.62	0.51 - 0.72	0.60	0.41 - 0.73	0.14	0.07 - 0.22
Summer	0.05	0.03 - 0.08	0.45	0.33 - 0.57	0.16	0.08 - 0.25	0.05	0.03 - 0.08
Fall	0.03	0.01 - 0.05	0.31	0.22 - 0.40	0.43	0.38 - 0.70	0.03	0.01 - 0.05
Winter	0.06	0.04 - 0.09	0.18	0.11 - 0.25	0.12	0.08 - 0.24	0.06	0.04 - 0.09
Solar arrays								
Low cobble								
Spring	0.41	0.26 - 0.43	0.67	0.59 - 0.75	0.80	0.68 - 0.91	0.41	0.26 - 0.43
Summer	0.40	0.24 - 0.43	0.55	0.46 - 0.65	0.62	0.43 - 0.76	0.40	0.24 - 0.43
Fall	0.25	0.13 - 0.42	0.54	0.46 - 0.62	0.80	0.68 - 0.91	0.25	0.13 - 0.42
Winter	0.28	0.17 - 0.29	0.43	0.34 - 0.52	0.62	0.43 - 0.76	0.28	0.17 - 0.29
High cobble								
Spring	0.23	0.13 - 0.30	0.67	0.59 - 0.75	0.80	0.68 - 0.91	0.23	0.13 - 0.30
Summer	0.22	0.12 - 0.31	0.55	0.46 - 0.65	0.62	0.43 - 0.76	0.22	0.12 - 0.31
Fall	0.15	0.05 - 0.35	0.54	0.46 - 0.62	0.80	0.68 - 0.91	0.15	0.05 - 0.35
Winter	0.15	0.09 - 0.21	0.43	0.34 - 0.52	0.62	0.43 - 0.76	0.15	0.09 - 0.21
Adjusted fatality estimates (fatalities/season; values in italics are considered unreliable due to low counts of carcasses: carcass count / (proportion of area searched * average probability of carcass availability and detected)**								
Fence	-	-	**11.31**	2.58 - 26.09	**-**	-	-	**-**
Spring	-	-	1.76	1.62 - 5.87	-	-	-	-
Summer	-	-	-	-	-	-	-	-
Fall	-	-	-	-	-	-	-	-
Winter	-	-	9.55	2.93 - 24.45	-	-	-	-
Gen-tie	**590.82**	266.27 - 1426.64	**82.14**	35.91 - 149.79	-	-	**15.24**	9.88 - 63.10
Spring	45.72	13.14 -	6.60	3.04 -	-	-	15.24	9.88 -

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during the 2015 – 2016 (February 2, 2015 – February 28, 2016) monitoring year. *Distribution of easy and difficult visibility on the gen-tie line was 50% and 50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

Parameter	Small birds		Medium birds		Large birds		Unknown size	
	Mean	90% CI	Mean	90% CI	Mean	90% CI	Mean	90% CI
		125.68		15.84				63.10
Summer	47.21	30.32 - 192.93	4.68	3.87 - 15.85	-	-	-	-
Fall	479.02	171.10 - 1276.61	54.55	14.40 - 111.10	-	-	-	-
Winter	18.87	14.56 - 64.02	16.31	6.54 - 44.76	-	-	-	-
Solar arrays	**289.72**	181.58 - 574.38	**242.6**	166.44 - 333.35	**52.96**	28.00 - 84.82	**41.40**	12.39 – 115.44
Spring	16.05	8.41 - 46.45	15.21	4.83 - 31.21	8.50	3.90 - 20.70	20.54	10.60 - 62.73
Summer	8.59	8.37 - 36.13	23.60	5.86 - 61.89	13.47	4.13 - 28.17	-	-
Fall	148.51	61.70 - 352.34	132.69	84.10 - 187.84	31.00	11.92 - 54.96	-	-
Winter	116.57	51.30 - 260.42	71.10	34.10 - 120.04	-	-	22.35	17.45 – 88.83
Facility Total	**880.532**	566.33 - 1843.05	**336.05**	246.44 - 448.58	**52.96**	28.00 - 84.82	**58.13**	22.32 - 143.95

Table C-2. Carcasses excluded from the 2015 – 2016 monitoring year fatality analysis at the Desert Sunlight Solar Farm due to 1) having been detected outside of a regular search area or 2) having an estimated carcass age that is greater than the actual search interval and hence violating assumptions of the Huso estimator.

Parameter	Small birds	Medium birds	Large birds	Unknown size	Bats
Building	0	1	2	0	0
Fence	3	0	0	0	0
Gen-tie	1	0	6	0	0
Solar Array	5	11	10	0	0

Bird and Bat Conservation Strategy
Desert Sunlight Solar Farm Project - Riverside County, California

Prepared for:

Desert Sunlight 250, LLC and
Desert Sunlight 300, LLC
700 Universe Blvd., Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.

415 West 17th Street, Suite 200
Cheyenne, Wyoming 82001

February 26, 2015 (Final)

LIST OF ACRONYMS

BBCM	Bird and Bat Conservation Measure
BBCS	Bird and Bat Conservation Strategy
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
CDFW	California Department of Fish and Wildlife
CVSR	California Valley Solar Ranch
EIS	Environmental Impact Statement
Gen-tie	Generation Tie-Line
MBTA	Migratory Bird Treaty Act
MW	Megawatt
NEPA	National Environmental Policy Act
O&M	Operations and Maintenance
PV	Photovoltaic
ROD	Record of Decision
USFWS	United States Fish and Wildlife Service
FEIS	Final Environmental Impact Statement
APLIC	Avian and Power Line Interaction Committee
Project	Desert Sunlight Solar Farm Project
Ha	Hectare
ESA	Endangered Species Act
HEA	Habitat Equivalency Analysis
M	Meter
Ft	Foot
Km	Kilometer
SE	standard error
kV	Kilovolt

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC (collectively, Desert Sunlight), has constructed and will operate the Desert Sunlight Solar Farm Project (Project), which consists of two main components: 1) a 550-megawatt (MW) photovoltaic (PV) generating facility; and 2) a 220-kilovolt (kV) generation interconnection (Gen-tie) line. The Project comprises approximately 1,700 hectares (ha; 4,200 acres) of land administered by the Bureau of Land Management (BLM) six miles north of Desert Center in Riverside County, California (Figure 1).

Information on pre-construction site conditions, avian and bat species present at the Project, risk assessment, and conservation measures implemented during pre-construction and construction phases are found in the Project's "Avian and Bat Protection Plan, Desert Sunlight Solar Farm Project, BLM Case File Number CACA-48649, Riverside County, California" (Ironwood Consulting 2011). The Avian and Bat Protection Plan (ABPP) was included as part of Appendix H in the Desert Sunlight Solar Farm Project, California Desert Conservation Area Plan Amendment and Final Environmental Impact Statement (USDI BLM 2011) and the Project received a Record of Decision from the Secretary of the Department of the Interior on August 09, 2011. Avian and Bat Protection Plans have since been renamed, and are presently known as Bird and Bat Conservation Strategies (BBCS). This BBCS replaces the ABPP and was developed in coordination with BLM to provide a written record of the Project's post-construction efforts to monitor potential project impacts to birds and bats and to document conservation measures that have been or will be taken to avoid, minimize, and/or mitigate for potential impacts. After introductory material on project description, the BBCS purpose, and regulatory framework, this BBCS addresses post-construction monitoring and adaptive management.

Figure 1. Location of the Desert Sunlight Solar Farm Project, Riverside County, California.

1.1 Purpose

The primary purpose of this BBCS is to describe post-construction monitoring protocols that will identify the extent of mortality and injury to bird and bat species and guide the adaptive management process intended to avoid, minimize, and/or mitigate impacts consistent with the Project's approval documentation. This BBCS includes the following objectives:

- Identify operational activities that may increase potential adverse effects to avian and bat species on and adjacent to Project components;
- Describe measures that were taken before and during construction to minimize and document mortality;
- Provide details for an avian fatality monitoring plan to be conducted post-construction, including applicable approved protocols that would be used for any surveys and/or monitoring;
- Specify the adaptive management process that will be used to address potential adverse effects on these species.

1.2 Regulatory Setting

Several federal and state laws and regulations, including National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Migratory Bird Treaty Act (MBTA), the Bald and Golden Eagle Protection Act (BGEPA), and California Endangered Species Act, provide the foundation for the development of this BBCS.

1.2.1 National Environmental Policy Act

Under NEPA (42 United States Code [USC] §§ 4321-4370h), federal agencies are required to prepare an environmental impact statement (EIS) for any major federal action significantly affecting the quality of the human environment. An EIS must include an examination of the environmental impacts of a proposed project, a reasonable range of alternatives for a project, and other related matters. The environmental impacts of the Project have been addressed in the Final EIS and ROD (BLM 2011a,b). This BBCS implements Mitigation Measure (MM) WIL-5 in the Project's ROD.

1.2.2 Endangered Species Act

Certain species at risk of extinction, including many birds and bats, are protected under the federal ESA. The ESA defines and lists species as "endangered" and "threatened" and provides regulatory protection for the listed species. The ESA provides a program for conservation and recovery of threatened and endangered species. Section 7(a)(2) of the ESA directs all federal agencies to insure that any action they authorize, fund, or carry-out does not jeopardize the continued existence of an endangered or threatened species or destroy or adversely modify designated or proposed critical habitat (collectively, referred to as protected resources).

1.2.3 Migratory Bird Treaty Act

The MBTA (16 USC §§ 703, *et seq.*), makes it unlawful to "pursue, hunt, take, capture or kill; attempt to take capture or kill; possess; offer to or sell, barter, purchase, or deliver; or cause to be shipped, exported, imported, transported, or received any native migratory bird, part, nest, egg, or product." The MBTA, enforced by USFWS, protects all MBTA-listed migratory birds within the United States. In the continental U.S., native non-covered species generally belong to the Order Galliformes. Common non-native species not protected by the MBTA include rock pigeon (*Columba livia*), Eurasian collared-doves (*Streptopelia decaocto*), European starling (*Sturnus vulgaris*), and house sparrow (*Passer domesticus*; USFWS 2005). Although permits may be obtained to collect MBTA-listed birds for scientific purposes or to destroy depredating migratory birds, the MBTA does not provide any permit mechanism authorizing the incidental take of migratory birds in connection with otherwise lawful activities. Nevertheless, federal agencies such as the BLM have been directed to evaluate the effects of its actions on migratory birds, with an emphasis on species of concern (per Executive Order 13186).

1.2.4 Bald and Golden Eagle Protection Act

The BGEPA (16 USC §§ 668-668d) prohibits the take, defined as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb," of any bald eagle (*Haliaeetus leucocephalus*) or golden eagle (*Aquila chrysaetos*). Through recent regulation (50 Code of Federal Regulations [CFR] § 22.26; USFWS 2009), the USFWS can authorize take of bald and golden eagles when the take is associated with, but not the purpose of, an otherwise lawful activity and cannot practicably be avoided. The USFWS has issued Eagle Conservation Plan Guidance (USFWS 2013a) for land-based wind energy projects to help project proponents avoid unanticipated take of bald and golden eagles and comply with the BGEPA. Although the guidelines were developed for land-based wind energy projects, certain components of eagle surveys and monitoring are applicable to other renewable energy projects, including PV solar plants, and have been incorporated into this BBCS as appropriate.

1.2.5 California Department of Fish and Game Codes

<u>CDFG Code Sections 2050-2085</u> – These codes encompass the applicable declarations and definitions of the California Endangered Species Act (CESA).

<u>CDFG Code Sections 3503 and 3503.5</u> – These codes state that it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird (including birds of prey) or take, possess, or destroy birds of prey, except as otherwise provided by this code or any regulation made pursuant thereto.

<u>CDFG Code Sections 3511, 4700, 5050, and 5515</u> – These state laws classify and prohibit the take of "fully protected" bird, mammal, amphibian/reptile, and fish species in California.

<u>CDFG Code Section 3513</u> – This code prohibits any take or possession of birds that are designated by the MBTA as migratory non-game birds except as allowed by federal rules and regulations promulgated pursuant to the MBTA.

CDFG Code Section 4150 – This code defines all mammals that naturally occur in California as non-game mammals with exceptions for those defined as game mammals, fully protected mammals, or fur-bearing mammals. Non-game mammals or parts thereof may not be taken or possessed except as otherwise provided by this code or any regulation made pursuant thereto.

1.3 Corporate Policy and Coordination

Desert Sunlight maintains a commitment to work cooperatively to minimize adverse impacts to protected bird and bat species. Through the planning and construction stages of the Project, Desert Sunlight and its contractors and consultants worked in coordination with federal and state agency personnel regarding necessary wildlife surveys, siting considerations, mitigation measures and adaptive management to ensure that potential issues that could affect bird and bat species were identified as early as possible in the planning process and addressed through appropriate design, mitigation and adaptive management measures. Desert Sunlight will continue to work with the agencies to implement conservation measures intended to avoid, minimize, and/or mitigate potential impacts to bird and bat species, including those measures identified in this BBCS.

2.0 PROJECT DESCRIPTION

The Project is a PV solar power plant being developed on approximately 1,700 ha (4,200 acres) of public land administered by the BLM in Riverside County, California, approximately 9.7 km (six miles) north of the rural community of Desert Center (Figure 1). Project construction is anticipated to be concluded on or about January 2015. The Project consists of two main components: 1) a 550 MW PV generating facility (Solar Farm) of solar equipment; and 2) a 220 kV Gen-tie Line. More specifically, the Solar Farm consists of 466 individual PV arrays, with each array occupying 2.4 to 2.8 ha (6 to 7 acres) and consisting of rows of PV panels supported on steel posts, a power conversion station, and a transformer. High-capacity 34-kV collection lines will transfer power output from the PV arrays to the onsite substation via overhead lines. The total acreage of the Project (including the Gen-tie Line) is 4,085 acres (1,653 ha). A chain-link fence topped with barbed wire encloses the entire Solar Farm, including support facilities (encompassing approximately 3,697 acres [1,496 ha]). The solar arrays cover 2,984 acres (1,208 ha).

In addition to the PV generating facility, other primary Project features include an operations and maintenance (O&M) building, visitor center, parking areas, access roads, fiber-optic lines, water wells, wastewater treatment facilities, an onsite electrical substation, and the 220 kV Gen-tie Line connecting the Project to the power grid.

Project features -- including solar panels, overhead electrical feeder and distribution lines, the Gen-tie Line, temporary retention basins, and the perimeter security fence -- pose potential mortality and injury risks to birds and bats. This BBCS focuses on permanent Project infrastructure elements including the solar panel arrays, perimeter fence and the Gen-tie Line. To minimize the threat of electrocution and collision, the Project's electrical distribution infrastructure is being built to avian-safe standards following Avian Power Line Interaction

Committee (APLIC) guidelines (APLIC 2005, 2006, 2012). Should birds or bats collide with the on-site distribution powerlines, injuries and fatalities will be documented during sampling of the solar arrays, as well as incidentally by Project staff during other activities.

3.0 SITE CHARACTERIZATION

The Project site is located in a relatively flat, previously undeveloped area of Chuckwalla Valley in eastern Riverside County. It is approximately 9.6 km (5.9 mi) north of Interstate 10 and the rural community of Desert Center, between the cities of Coachella to the west and Blythe to the east. Joshua Tree National Park wraps around the Project site to the west, north, and east; at its closest point, the Project is approximately 2.2 km (1.4 miles) southwest of the park boundary. Lake Tamarisk, a small golf-resort community, is approximately 6.4 km (four miles) to the south. The inactive Kaiser Eagle Mountain Mine is approximately 1.6 km (one mile) to the west.

The Project site is in the Colorado Desert Bioregion, which is the western extension of the Sonoran Desert of southern Arizona and northwestern Mexico. The Mojave Desert, which includes portions of Joshua Tree National Park, lies immediately north of the Project area. Chuckwalla Valley encompasses a series of alluvial fans that gently slope toward the southwest and southeast.

The 2011 FEIS prepared for the Project (BLM 2011a) describes the biological setting of the Project area. The FEIS included the results of biological surveys conducted in areas of potential impact associated with the Solar Farm, Gen-tie Line, Red Bluff Substation, and possible alternative sites (all collectively referred to as the Biological Study Area [BSA]). Before construction began on the Project, vegetation in the BSA consisted of Sonoran creosote (*Larrea tridentata*) bush scrub and desert dry wash woodland communities. To prepare for installation of the solar arrays, the Solar Farm site was disked and rolled, such that the Project landscape is now relatively flat and uniform, with vegetation re-establishing on the site. Stabilized sand sheets and pockets of sand dune deposits are located to the east of the Project area, but the Solar Farm site lacks wind-blown sand formations. Disturbed and developed areas that are either barren or dominated by ruderal vegetation occur primarily along roadsides. Agricultural areas, mostly fallow jojoba (*Simmondsia chinensis*) farms, are located southeast of the Project site.

Two temporary 0.4-ha (1-acre) ponds provided water during construction of the Project. One of the ponds was removed, and the second pond will be removed by the end of 2014. Several retention basins, which may hold water for some time after a storm event, are located within the Project’s perimeter security fence, along the western upstream boundary and on the southeastern downstream boundary. An open portion of the Colorado River Aqueduct runs around the north end of Chuckwalla Valley, from about six to 10 km (four to six miles) north of the Project site. An aquaculture facility, covering approximately 24 ha (60 acres), lies about three km (two miles) south of the Project site and contains perennially open water. The community of Lake Tamarisk includes homes, a golf course, and a small lake complex. The habitat structure and available water in this community routinely attract resident and migratory birds. All of these water features (when watered, in the case of the retention basins) can attract water-associated birds and shorebirds, either during migration stopover periods or in the course of local and intraregional movements.

4.0 CONSERVATION MEASURES IMPLEMENTED BEFORE AND DURING CONSTRUCTION

4.1 Pre-Siting Data Collection

In an effort to place the Project infrastructure in locations that would result in the least risk to populations of birds and bats, data on site characteristics and wildlife occurrence was collected and evaluated.

4.1.1 Coarse Site Assessment

In accordance with USFWS guidance, a siting evaluation of the solar farm site, Gen-tie line, and substation was completed. The Project conducted the equivalent of a Potential Impact Index (USFWS 2003) by evaluating suitability of the site proposed for development and estimating use of the site by selected wildlife species as an indicator of potential impact (USFWS 2010). Initial biological assessments conducted in 2007 recommended avoidance of Pinto Wash as potential habitat for special status species, and this assessment was supported during a site visit in 2010. Several modifications to Project design occurred that reduced the proposed Project footprint and moved it away from areas suspected to contain high-quality habitats for birds or bats. Alternative sites for the solar farm, Gen-tie line route, and substation were confirmed to occur outside any Important Bird Areas, Western Hemisphere Shorebird Reserve Network sites, and areas designated by the Convention on Wetlands of International Importance. The Gen-tie line and substation alternatives are located within the Chuckwalla Desert Wildlife Management Area and Critical Habitat Unit designated as management areas for desert tortoise.

4.1.2 Habitat Equivalency Analysis

A Habitat Equivalency Analysis (HEA) was conducted to quantify potential temporary disturbance versus permanent loss of habitat and to guide the habitat compensation process. The most significant step the Proponent took to promote wildlife conservation during this process was to coordinate with the BLM to determine suitability of habitat remaining within the solar application as area to be excluded from future development due to biological concerns.

4.1.3 Site-Specific Wildlife Surveys

As recommended by USFWS (2010), multiple survey techniques were used to collect baseline data on wildlife populations at the Project. Specific survey methods included:

- Diurnal point counts, conducted in April, May, and October 2010
- Raptor nest searches including golden eagle surveys (Pagel et al. 2010), conducted in April and May 2010

- Reconnaissance-level survey of Project components to determine which bat species could occur at the site
- Incidental data collection conducted during all biological surveys in 2010; additionally, incidental observations were collected over four years of activity at the Project

Thirty-eight passerines were recorded during baseline surveys. The only special-status species recorded were Brewer's sparrow (*Spizella breweri*), Costa's hummingbird (*Calypte costae*), and Le Conte's thrasher (*Toxostoma lecontei*). All three species are listed as USFWS Birds of Conservation Concern (BCC; USFWS 2008). Thirteen raptor species were documented, including California Species of Special Concern: burrowing owl (*Athene cunicularia*), loggerhead shrike (*Lanius ludovicianus*), and northern harrier (*Circus cyaneus*; CDFW 2008). Swainson's hawk (*Buteo swainsoni*) was also recorded, which is state-listed as threatened (CDFW 2014), along with federally-protected golden eagle (*Aquila chrysaetos;* BGEPA 1940). Surveys for bat habitat suggested that pallid bat (*Antrozous pallidus*), canyon bat (*Parastrellus hesperus*), hoary bat (*Lasiurus cinereus*), and California leaf-nosed bat (*Macrotus californicus*) could potentially occur at alternative sites given the habitat present. The list of most common species observed is found in Figure 2.

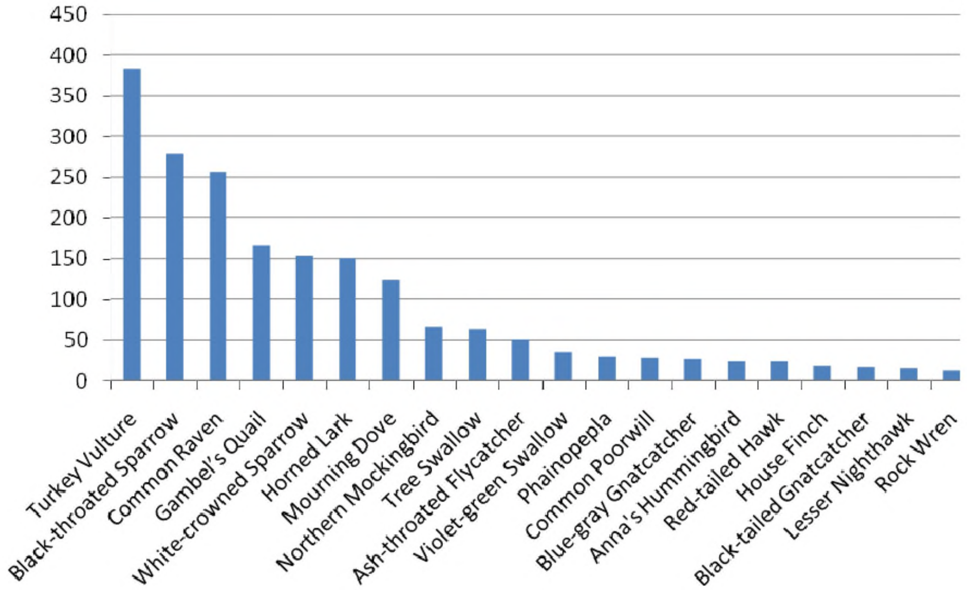


Figure 2. Avian species most frequently encountered during baseline surveys at Desert Sunlight Solar Farm Project, Riverside County, California.

5.0 CONSERVATION MEASURES

5.1 Project Siting

The process of siting the Project components included both macro- and micro-siting considerations. Macro-siting considerations occurred in 2007 during initial site surveys and were refined in 2008 after review of data. During this process, Pinto Wash and other larger areas of desert wash woodland were removed from Project consideration because they were deemed likely to support greater numbers of species or individuals than other habitats in the Right-of-Way area. Macro-siting considerations also included avoidance of:

- Locations with special status species and areas managed for the conservation of listed species
- Areas frequently used for daily bird and bat movements (e.g., areas between roosting and feeding sites)
- Breeding and wintering eagle use areas
- Known migration flyways for birds and bats
- Areas near known bat hibernacula, breeding, and maternity/nursery colonies
- Fragmentation of large, contiguous tracts of wildlife habitat

Micro-siting consideration for the Project components began in 2008 and continued as wildlife surveys were conducted and through informal meetings with the BLM, USFWS, and CDFW throughout the Project's planning process. Siting was also refined in response to concerns from the public and agencies involved in the process. Additional considerations of micro-siting included:

- Avoiding features that attract raptors (i.e., areas supporting tall perching structures including trees, utility poles, etc.)
- Avoiding features that attract migrant birds (e.g., water sources and vegetation)
- Minimizing the potential for enhancing habitats suitable for raptor prey such as rodents that would potentially attract raptors to the site.

5.2 Facility Design

Many conservation measures were incorporated into the design of Project facilities to reduce the potential effects of Project infrastructure on bird and bat populations, including:

- Avoidance of lattice-type structure or placing external ladders and platforms on towers to minimize perching and nesting
- Avoidance of meteorological towers with guy wires
- Minimal lighting and where lighting was necessary, facility lighting focused down ward to reduce sky illumination
- Power lines built in accordance with guidelines from the Avian Power Line Interaction Committee

- Minimal creation of new roads

5.3 Construction Phase Conservation Measures

Conservation measure implemented by the Project during construction included:

- Minimization of permanent disturbance area by minimizing creation of roads, avoidance of excessive clearing of vegetation, and grading whenever possible
- To the extent practicable, clearing of vegetation took place outside the bird breeding season. When not practicable, the Desert Sunlight communicated reasons to BLM, USFWS, and CDFG and provided a biological monitor to locate active nests, establish buffers, and stop construction when necessary when Project activity threatened a nest. Buffer distances of 100 m (330 ft), 152 m (500 ft), or one mile were used for active passerine, raptor, and golden eagle nests, respectively.
- Clearance surveys to locate and identify active nests or bat colonies
- Surveys for golden eagle nests conducted during each year there were construction activities within the nesting season
- Clearance surveys for burrowing owls completed in each construction unit and including a 150-m buffer area
- Mandatory site training for all construction personnel regarding avoidance of nests and bat colonies
- Following APLIC guidelines for overhead utilities
- Conducting construction activities in a manner consistent with reducing fire danger
- Trash promptly removed and disposed of to avoid creating attractions for birds or bats
- Established and implemented an Integrated Weed Management Plan (Ironwood Consulting 2010a)
- Used native species for seeding and planting during re-vegetation efforts

6.0 Incidental Avian Mortality Information during Construction and Early Operation

As of Oct 31, 2014, 198 avian and bat injuries or mortalities have been documented on-site during construction of the Project (Appendix A, First Solar 2014). Avian mortalities are being reported by construction workers and other staff incidental to their work activities. Consequently, the incidental nature of the data needs to be considered when evaluating the information reported to date. Data collected incidentally do not provide enough information to accurately quantify the scope of actual avian mortalities on a project site. However, these data can provide important information such as the composition of species which may be at risk in the future. In addition, the data provide insights into project features and types of injuries that may be associated with fatalities (U.S. Fish and Wildlife Service 2014). The majority of fatalities documented on the Project site are water-associated taxa (SPUT data). However, whether this pattern is representative of overall composition of fatalities at the Project remains to be determined through standardized monitoring.

7.0 POST-CONSTRUCTION MONITORING PLAN

This section outlines a standardized approach to document known and projected bird and bat fatalities and injuries, and to estimate seasonal and annual post-construction fatality rates associated with Project features. The Plan includes an approach to determine whether there are spatial patterns of fatality rates within the solar field (i.e., different fatality rates near panels on the edge of the solar arrays vs. the interior area of the arrays). The Plan is consistent with the Bird Monitoring and Avoidance Plan outlined in the Project's FEIS (BLM 2011a), and builds on standards and guidelines developed for the electric-utility and renewable-energy industries to quantify the risk of fatality and injury for birds and bats that may result from interactions with energy-related infrastructure (e.g., Anderson et al. 1999; APLIC 2005, 2006, 2012; California Energy Commission [CEC] and CDFG 2007; USFWS 2010, 2012). In particular, the Plan outlines a statistically sound spatial and temporal sampling plan, including protocols for independently estimating and correcting for quarterly searcher-efficiency and seasonal (i.e., at least quarterly) scavenger (avian and mammalian) removal rates. It describes specific data to be collected during scheduled carcass searches, protocols for handling any dead or injured birds and bats that are found, and procedures for reporting incidents to relevant government agencies. The study design is compatible with the BLM (2011b) Record of Decision requirement (MM-WIL-05) that, after the study is complete, Desert Sunlight will ultimately submit a description of the study design and monitoring results to peer-reviewed scientific journals.

7.1 Goals and Objectives

Primary goals of the post-construction fatality monitoring program are to:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the Gen-tie Line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
3. Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.

4. Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

These goals are structured in a way that provides information on seasonal differences in fatality rates, and information about which taxonomic groups are most vulnerable. Fatality estimates will be adjusted to address carcass persistence and searcher efficiency as they change through seasons. Additionally, carcass persistence trials will inform search intervals.

Consistent with the above goals, the specific objectives of this Plan are as follows:

2. Conduct fatality searches for a minimum of 2 years according to a spatial and temporal sampling plan that provides representative and statistically sound coverage of the solar arrays, consistent with monitoring required of other industries. The need for additional monitoring beyond the second year will depend on an evaluation of the survey results from the first 2 years to determine if the goals of the monitoring program have been met (see Section 10.0, Adaptive Management). The need to extend the monitoring period will be determined by the BLM in consultation with the USFWS. To the extent possible, standardized monitoring, as approved by the BLM in consultation with the USFWS, will commence within 30 days of 1) date a final BBCS has been approved, and 2) the commercial operation delivery (COD) date (anticipated January 2015). Implementation of any agency required pre-monitoring meetings, training and searcher efficiency/carcass removal trials may extend the start of monitoring beyond 30 days after the BBCS is deemed final.
3. Conduct statistically sound, seasonal assessments to quantify and evaluate carcass removal rates (i.e., carcass removal, destruction including dismemberment, or burial in sand due to scavengers, decay, or other abiotic [e.g., wind] or human [e.g., vehicle activity] factors) and support calculation of adjusted fatality rates that account for variation in carcass removal rates by season and carcass type/size classes. These assessments will also be used to guide search intervals.
4. Use current, scientifically validated and accepted methods for calculating fatality rates adjusted for searcher-efficiency, carcass removal rates, and spatial and temporal sampling intensity. At present, the best methods are distance sampling combined with searcher efficiency and carcass removal bias adjustments and a fatality estimator such as the Shoenfeld (2004) or Huso (2012) estimators, but it should be noted that fatality estimation is an area of active research and ‘best methods’ are changing rapidly. Therefore, as data are collected, adaptive management of the study design and monitoring protocol may be necessary and will follow the process in Section 10.0.
5. Summarize the species composition of fatalities according to taxonomic family, and ecological guild (e.g., raptors, water-associated birds, passerines, etc.) to aid in understanding species or groups at risk.
6. To the extent possible, summarize the composition of fatalities according to their likely propensity to collide with project components during the day vs. during the night based on known migratory patterns for the particular species.

7. Aid in identifying potential fatality causes and correlates by including additional information that is readily available beyond that which is under the SPUT such as the weight of fresh whole birds, or summaries of preceding weather conditions which would have made migration likely (e.g., low pressure systems moving cross continent to the north of the project area, followed by periods of high pressure systems).
8. Data summaries, and accompanying raw data, and any GIS shapefiles will be reported to the BLM with each seasonal report.

7.2 Monitoring Methods

A monitoring program will be implemented for at least 2 years post-construction as specified below. Survey results and analysis will inform adaptive management decisions regarding any additional appropriate and practicable BBCMs to avoid, minimize, and/or mitigate for observed impacts.

7.2.1 Post-Construction Monitoring of Solar Arrays

The fundamental characteristics of a sampling program designed to produce valid estimates of fatality rates for a solar farm (including the number of arrays to be searched, the search interval, the seasonal extent of coverage, and the number of years of sampling) are determined based on several factors. These factors include the questions of interest; the species of interest (e.g., resident, migratory, and/or wintering species) in the Project area, desired precision, best estimates of carcass-removal rates, searcher efficiency, the Project size and layout, and other relevant environmental (i.e., seasonal patterns), landscape, and habitat characteristics.

The following hierarchical terminology is useful for describing the spatial and temporal sampling design used to monitor solar arrays:

1) **Panel Cartridge:** An engineered assembly of solar panels installed as a single unit (approximately 2.5 x 2.9 meters [m; 8.2 x 9.5 feet (ft)]).
2) **Row:** A collection of panel cartridges arrayed side-by-side on a common, linear support structure (variable lengths ranging from approximately 71 to 142 m [232 to 464 ft]).
3) **Section or Subarray:** A collection of usually 20 commonly energized rows that represent one quarter of a typical array; dimensions (on the order of 71 x 84 m [232 x 274 ft]) are mostly uniform within blocks, but vary slightly among blocks; in most cases, structurally continuous rows span sections of two adjacent arrays.
4) **Array:** A collection of four sections connected to a common power converter station (PCS) and transformer, encompassing 2.4–2.8 ha (5.9-6.9 ac), depending on subsection dimensions and spacing between subsections (i.e., 466 total units in the Solar Farm).
5) **Block:** Collections of commonly energized arrays (20 blocks, each composed of 11–32 arrays).

7.2.2 Survey Strategy

Sampling strategies used in carcass searches have typically involved transect sampling, whereby searchers walk or drive along pre-defined transects and search for carcasses in a swath where width depends on visibility, target taxa, and other factors. The layout of PV facilities presents problems for a transect-sampling approach because rows of panels are close together (i.e., less than 5 m [16 ft] at the Project). Because the panels are mounted off-horizontal, a searcher walking or driving a transect between two rows can only effectively search one side of the transect (a 2.5-m [8.2-ft] swath), and the other side is obscured by the edge of a PV cartridge. However, traveling perpendicular to panel rows along the edges of the rows allows observers to see a greater distance of the ground beneath the panels. Surveyors will walk or drive the lines in air-conditioned vehicles. Should driving surveys be used, searcher efficiency trials will be conducted prior to implementation; results will be submitted and evaluated by the BLM and FWS within 2-weeks of completion of the trials to determine if conducting surveys using vehicles is acceptable. Other accommodations may be required to enable completion of surveys during high temperatures, such as shifting surveys to dawn and dusk.

The layout of PV facilities is well-suited to a distance-sampling approach. Distance sampling involves searching a transect line and assumes that searcher efficiency decreases (possibly dramatically) as a function of distance from the observer, and is ideally suited to situations in which animals (or carcasses) are sparsely distributed across a landscape (Buckland et al. 1993). The landscape at the Project is flat and relatively clear of vegetation, which should support a distance sampling design.

Distance sampling adjusts carcass counts for variable searcher efficiency by accounting for the *effective* area searched along a transect. Effective area is the total area searched multiplied by the average probability of detection in the searched area. As a highly simplified example, if a searcher walks a 10-m long transect line and detects 90% of all carcasses within 10-m of the line, and 60% of carcasses that are 10 to 20 m (33 to 66 ft) from the line, then the effective area between zero and 10 m would be $10\,m \times 10\,m \times 0.9 = 90\,m^2$ and the effective area searched between 10 and 20 m would be $10\,m \times 10\,m \times 0.6 = 60\,m^2$. For the total 10 by 20-m area searched, the adjustment factor would be $\frac{90\,m^2 + 60\,m^2}{100\,m^2 + 100\,m^2} = 0.75$. In practice, searcher efficiency is modeled as a continuous function of distance, and the detection function is estimated from the carcass data (as opposed to a bias trial). The searcher efficiency bias trials can be used to augment carcass data for the detection function. If the detection function calculated from the bias trials differs from the detection function calculated from the carcass data, this suggests non-random distribution of carcasses within the arrays, and simultaneously provides an adjustment factor to account for non-random distribution of carcasses. Preliminary data from the California Valley Solar Ranch (CVSR) suggests that non-random carcass distribution may not be a problem at PV solar facilities (H.T. Harvey and Associates 2014). One advantage to a data-driven detection function is that it is not necessary to specify a transect width: the detection function includes information about the distance at which searcher efficiency drops to zero. The detection function is used to determine the overall probability of detection as well as to inform the approximate effective view shed of non-zero detection probability for observers.

7.2.3 Spatial Sampling Design

The sampling design is intended to follow to the USFWS Land-Based Wind Energy Guidelines (2012), which states that “the carcass searching protocol should be adequate to answer applicable Tier 4 questions at an appropriate level of precision to make *general* conclusions about the project*, and is not intended to provide highly precise measurements of fatalities*” (p. 45; emphasis added). Under the proposed sampling plan, precision is expected to vary based on carcass detectability: less precision is expected for estimates of small-bird fatality compared to estimates of large-bird fatality. However, monitoring programs at two other PV solar facilities (CVSR and Topaz) suggest that the level of impact for small birds due to PV was not very extensive, and was similar in composition and rates than what was found on control plots for passerines.

The sampling design is based on a statistical precision analysis using data from CVSR, as well as a simulation-based analysis that was informed by searcher efficiency and carcass removal rates in the Mojave desert region (Appendix B). Sampling effort that includes 20% of the solar arrays is expected to produce a reasonable coefficient of variation (CV = 100% * standard deviation / mean) (~20%) if fatality rates are greater than 1.0 fatality / MW / year, and the search interval is at most 21 days. This level of precision is generally considered adequate for answering the primary questions of interest in fatality monitoring studies (Strickland et al 2011).
Based on the simulation analyses, data from CVSR, consultation with relevant permitting and wildlife agencies, and consideration of the characteristics of this particular Project, sampling will encompass approximately 30% of the completed solar arrays as summarized in Table 1.

Table 1. Solar array sampling area characteristics.

Total area	1,208 ha
Proportion sampled	30%
Sampling unit	~2.6-ha spatial equivalent of 1 array
Number of sampling units (whole facility)	466
Migration season search interval (March 1 thru May 31, September 1 thru October 31)	7 days unless adjusted by BLM in consultation with the Wildlife agencies based on results carcass persistence trials.
Non-migration season search interval (June 1 thru August 31, November 1 through Feb 28)	21 days unless adjusted by BLM in consultation with the Wildlife agencies based on results of carcass persistence trials.
Anticipated surveys per year	31
Duration of sampling	Minimum of 2 years

Because both the layout of the solar arrays and the landscape of the Solar Farm (i.e., mostly flat and free of vegetation) are largely uniform, a relatively simple random sampling design is likely to be adequate for sampling the arrays. However, in the absence of data, a spatially balanced sampling design will be used. Because spatially balanced designs ensure that sample effort is distributed over the whole study area, they help to ensure that spatially organized trends in mortality–should they exist-- can be extracted from the data. The drivers of spatial variation in avian activity may be important to the statistical sampling design if avian use patterns affect the distribution of mortalities on the project site. As an example, factors that may affect avian use patterns include: 1) habitat variation around the Project site; 2) the possibility that distinct movement corridors variably concentrate birds over certain areas of the Project site (e.g., migrating or commuting water-associated birds); or 3) use of distribution lines (and other transmission line infrastructure) as roosting sites. Distribution lines within the solar field may also pose a collision risk to birds. To achieve spatially balanced sampling, the site will be divided into 10 approximately equal-sized sampling areas and sampling will be stratified among those areas. Sampling will also be stratified proportionally among areas with distribution lines and those without.

The sampling units for the surveys consist of areas equivalent in size to a single array, but because of the concatenation of panel rows across arrays, they may include conjoined sections from multiple individual arrays (Figure 3). Within sampling areas, individual sampling units will be randomly selected to compose a 30% sample (± 1–2%).

Observers will survey sampling units from the outer edges of collections of continuous solar panel rows and scanning between each row for fatalities, with each side-specific survey covering half the width of the sampling unit (Figures 3 and 4). Surveys will occur along roadways that run approximately north–south (consistent with the “Bio Blitz” report; USFWS

2013) through the middle of most arrays and along the outer edges of some arrays. Most sampling units consist of combined array sections from four adjacent arrays. In most cases, the four sections run together both north to south and east to west, forming a continuous block composed of 40 continuous panel rows that are approximately 140 m- (460-ft) long. In these cases, two north-south routes will comprise the sampling-unit survey, with each route involving scanning across a maximum of 70 m (230 ft; Figure 3). Other sampling units have an additional roadway and powerline corridor running through the middle, such that the sampling unit consists of two subsections, each composed of 40 panel rows that are approximately 70 m long. In these cases, four north-south routes will comprise the sampling unit survey, with each route involving a maximum scanning distance of 35 m (115 ft) covering half the width of a subsection (Figure 3). For a few other sampling units with different layouts along the perimeter of the Solar Farm, the analysis will need to take into account the potentially different row lengths. Distance sampling and resulting data will be used to calculate detectability curves to calculate the average detection probabilities, and taking into account the potential for different detection curves depending on the direction of the survey viewshed.

Given the results of an initial detectability field trial (see below), the expectation is that effective sampling for larger birds (1000+ grams) will extend the full width of all sampling units, whether composed of 140-m or 70-m long panel rows. For smaller and possibly medium sized birds (0-100 grams and 101-999 grams) and bats, however, effective sampling is expected to be constrained to less than the maximum viewing distance. Density estimation using distance sampling techniques is easier, and can be accomplished with greater precision if the data are truncated at a distance beyond which the probability of detection is low (Buckland et al. 1993). Accordingly, data will be truncated and the density of carcasses in the effective search area will be used to calculate the density of carcasses in the whole solar facility.

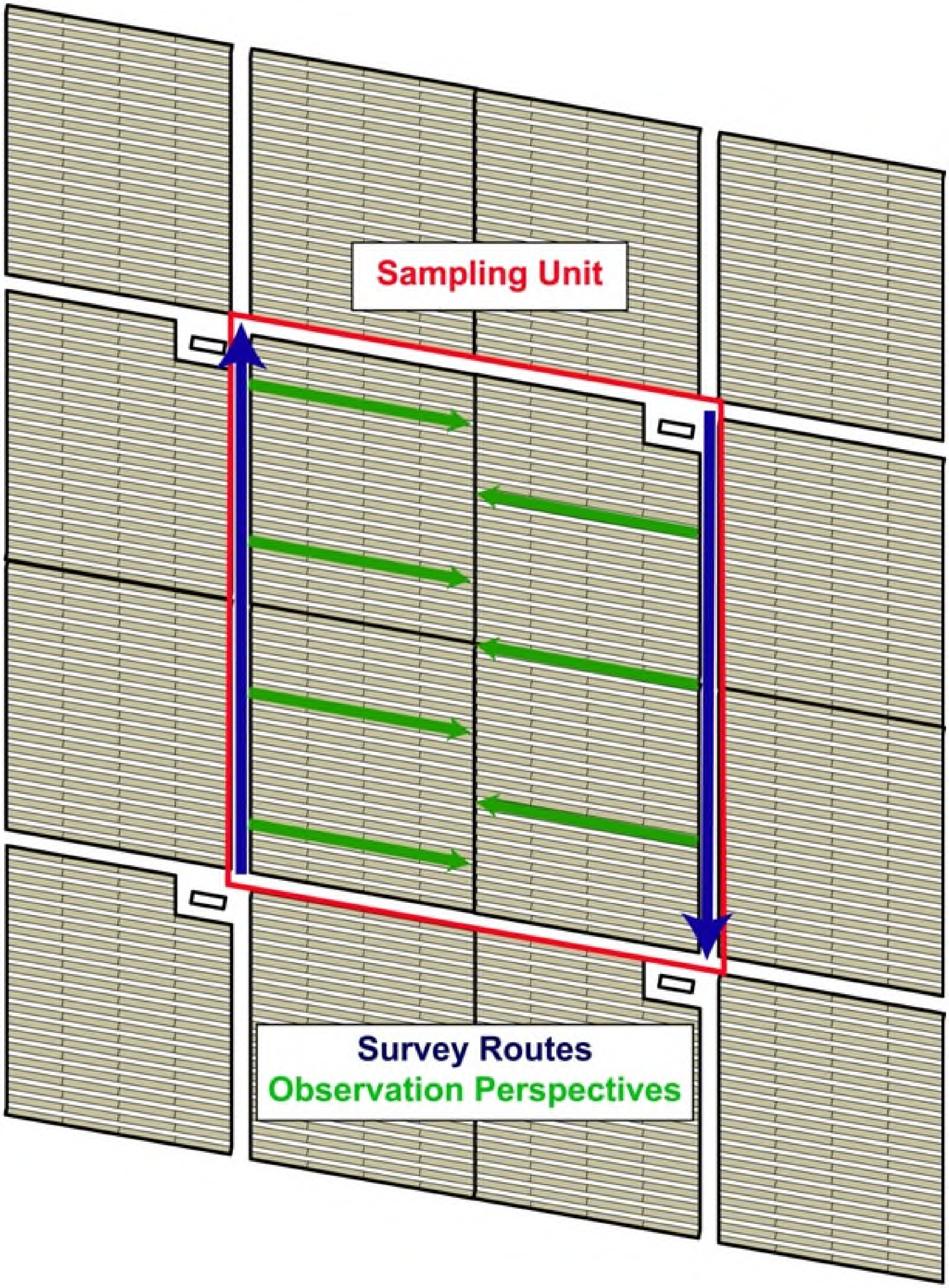


Figure 3. Illustration of a typical sampling unit and perimeter survey with travel routes and search areas ('observation perspectives').

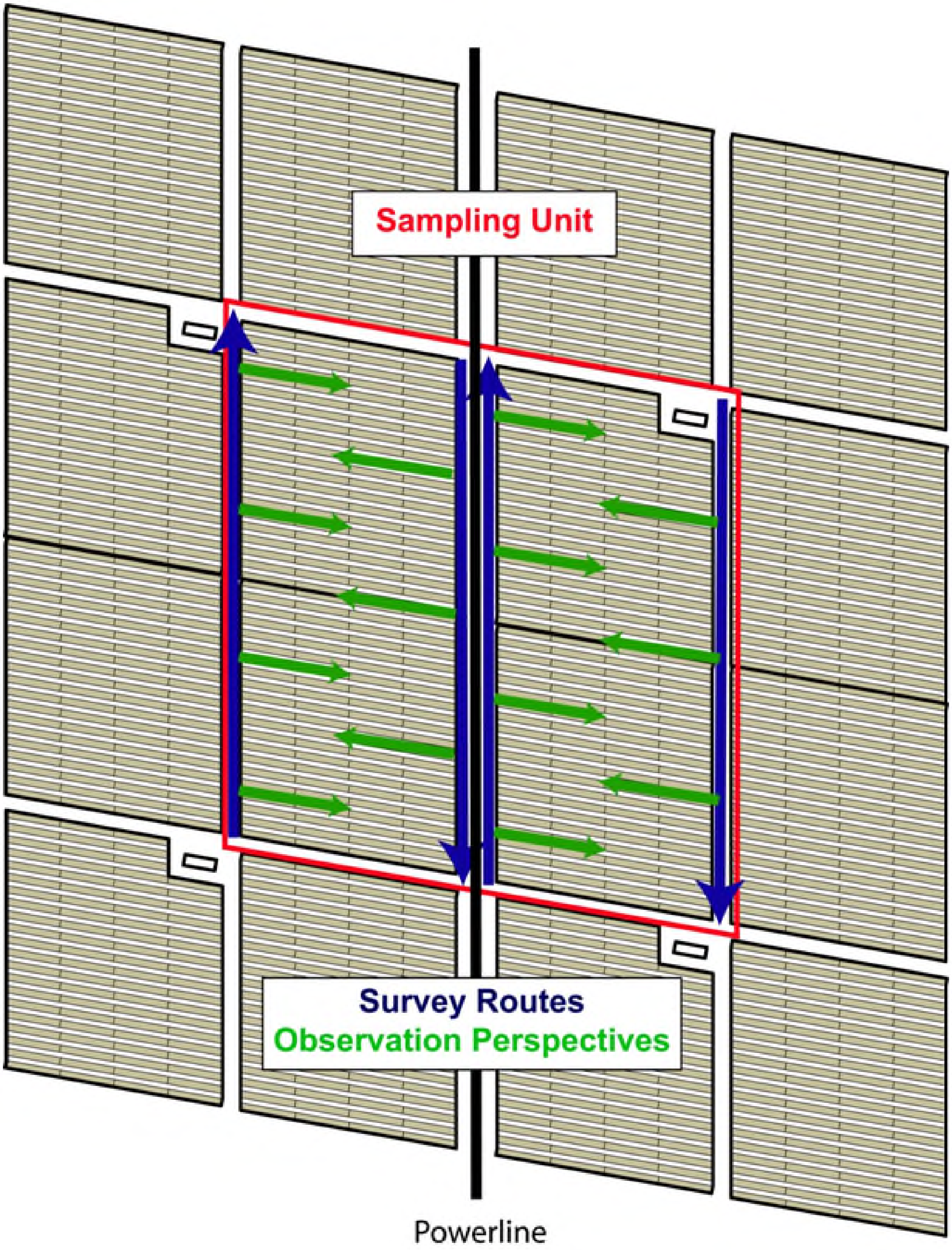


Figure 4. Illustration of a sampling unit survey including a distribution powerline with travel routes and search areas ('observation perspectives').

The perimeter-only survey design reflects two concerns: 1) minimizing movement between rows of solar panels. Because the area between electrified panel rows is an area of elevated risk, best practices dictate that personnel do not enter elevated risk zones unnecessarily; and 2) achieving an effective balance between logistic efficiency and sampling rigor given the constraints of transect spacing due to the width of panel rows. In support of the latter objective, a field trial was conducted to evaluate the ability of observers to detect carcasses of different types and sizes based on perimeter-only surveys that did not require walking between the rows of panels (H.T. Harvey and Associates 2013c). The field-trial surveys involved walking along the north-south edges of array sections perpendicular to the rows of panels and using naked-eye and binocular-aided scanning to search for placed carcasses of five non-native bird species, ranging in size from small house sparrows (*Passer domesticus*) to large ring-necked pheasants (*Phasianus colchicus*).

The field trial confirmed that, given the relatively flat, sandy, and uncluttered substrate that characterizes most of this solar facility, relatively large carcasses, such as rock pigeons (*Columba livia*) and pheasants, can be reliably detected (average detection probability over a 70–m wide transect > 0.75; Figure 5) using perimeter-only surveys, even when the continuous span of the solar-panel rows is 140 m, which applies across most of the facility. For smaller carcasses up to the size of small quail (*Coturnix japonica* in this case), however, detection probabilities will be much more strongly a function of distance (average detection probability over a 70–m wide transect > 0.35; Figure 5). Distance sampling is well-equipped to estimate population sizes, even when the detection function indicates a rapid decay in detectability with distance (Buckland et al. 1993).

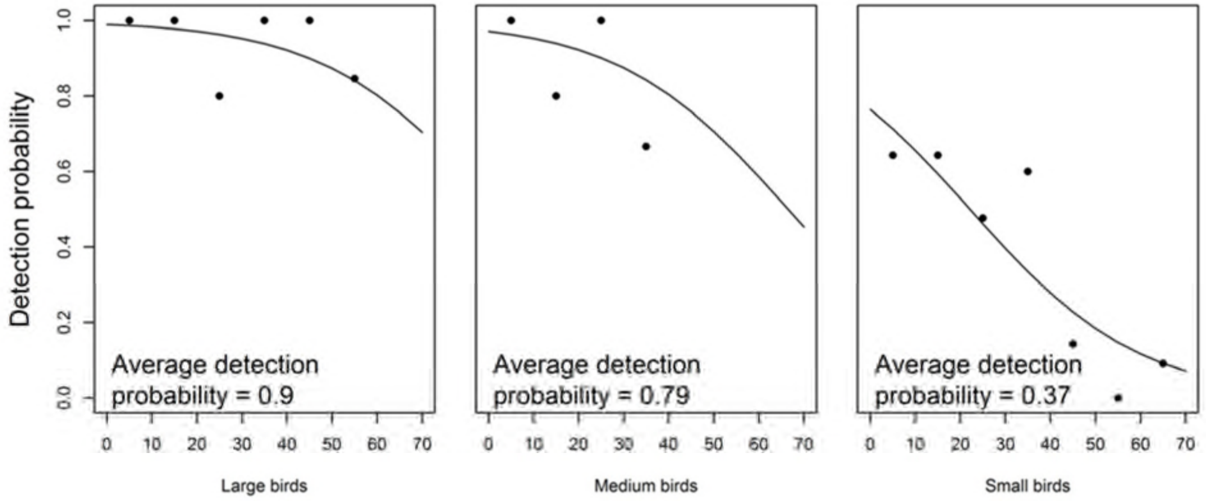


Figure 5. Logistic regression lines were fitted to detection data from the distance sampling trials at Desert Sunlight (HT Harvey 2013c). Data were binned into 10-m intervals prior to analysis. Fitted regression lines and observed proportions are shown. The fit for medium birds may be unreliable due to sparse data, but is probably intermediate between the fits for large and small birds.

Not being able to detect most small to many medium-sized carcasses over a substantial portion of the solar facility would comprise a problematic bias if the probability of carcass occurrence was non-random within arrays (i.e., within sample units). In other words, the bias would create a problem for achieving representative sampling if the probability of mortality due to panel collisions varied in some predictable fashion relative to the distance from array edges, or if there was a tendency for fatalities to be clustered in the interior of the panel areas. Whether or not such conditions may apply to this facility is currently unknown; however, initial post-construction monitoring at another large photovoltaic solar facility in central California has not demonstrated any particular spatial bias in the distribution of fatalities documented there (H.T. Harvey and Associates 2014).

On this basis, fatality sampling will proceed using distance-sampling survey techniques and analytical methods, which include estimating and accounting for distance-related variation in the probability of detection based on the carcass data and bias trial data. In addition, searcher-efficiency trials that are tailored to include evaluating the influence of distance on the probability of detection will be conducted to assess and adjust for the possibility of a spatial bias in the distribution of fatalities. This can be accomplished by comparing the detection function derived from independent searcher-efficiency trials with the detection function derived from the actual fatality data (as it is calculated based on standard distance-sampling techniques). If the two independently derived functions suggest divergent relationships between distance and the probability of detection, the pattern of divergence between them can be used to adjust results of the distance-sampling-based fatality estimate

7.2.4 Temporal Sampling Design

The appropriate frequency of fatality surveys depends on the species of interest and average carcass persistence times (Smallwood 2007, Strickland et al. 2011, USFWS 2012). Large raptors tend to persist and remain detectable for extended periods (weeks to months) due to low scavenging rates and relatively slow decay rates. If only large species were of interest, extended search intervals of 30–45 days might be appropriate; however, smaller birds and bats typically disappear at much faster rates, so shorter search intervals are required to ensure effective documentation of fatality rates among these species.

Publically accessible data from three wind-energy studies in the nearby Mojave Desert region of California and western Arizona provide additional, relevant insight (Chatfield et al. 2009, 2010; Thompson and Bay 2012). These studies recorded average persistence times of 17.5–46.8 days for large birds (average 29.0 days, median 22.6 days) and from 5.6–17.4 days (average 9.9 days, median 6.5 days) for small birds. If the median carcass-persistence time for small and medium birds and bats on the Project site is low a 7-day search interval may be required to effectively document fatality rates for small birds and bats. If, however, median small-bird and bat carcass-persistence rates are greater than 7 days, then a longer search interval may be more appropriate. The initial indications of rapid scavenging by ravens at the Project site suggested that a shorter search interval may be needed to provide precise fatality estimates for small bird and bat carcasses. Later data from Corvus (2014) suggests that there is a period of rapid initial removal, particularly for small and medium carcasses with 50% of carcasses in these size classes removed in 8 and 5 days, respectively. Overall, mean carcass persistence in May and June was greater than 10 days for any size of carcass, and greater than 24 days for large carcasses.

Based on these considerations and preliminary data, and based on the simulation analyses discussed previously, the search interval for fatality monitoring will be variable depending on season (Table 2). Searches will be conducted every 7 days during standard spring and fall migration periods (March 1 – May 31, and September 1 – October 31), and every 21 days during summer and winter (June 1 to August 31, and November 1 to February 28/29). After the first 6 months of fatality monitoring and concurrent carcass-removal trials (see below) have been conducted, the search interval may be adjusted based on estimates of carcass persistence. Some migration for some species may occur outside these periods and this will be considered when evaluating the data regarding timing of mortality for species.

Adjusting fatality counts for carcass removal works best when the search interval remains constant through time (Huso 2010); however, within survey periods, season-specific estimates of carcass persistence can be calculated and incorporated in the overall estimation process when variable search intervals are used in different seasons (Shoenfeld 2004; Huso 2010, 2012; and other estimators all have facility to accommodate season-specific estimates). In addition, survey schedules will ensure that fatality surveys are evenly spaced in time to maximize detection of potential, unusual fatality events (Strickland et al. 2011). For these reasons, a standard schedule for completing the surveys will be developed and followed, such that some surveys will occur during most weeks of the year and all sampling units are surveyed on a regular schedule, as dictated by the season.

7.2.5 Survey and Data Collection Protocols

Fatality surveys will be conducted with the observers striving for a consistent pace/speed and approach, and a uniform search effort throughout the search. Searchers will use binoculars at their discretion to survey for carcasses between each row of panels. The Project has rigorous safety protocols in place that address heat and other safety issues. When a potential carcass is detected, the observer will immediately proceed down the row to confirm the detection and, if valid, fully document and bag it according to standard protocols (see below). Depending on the size and nature of the carcass, the observer will either immediately collect the carcass (smaller, easily collected and transported packages) or flag it for pick-up once the sampling-unit survey is completed (larger, messier, or otherwise complicated collections) or to identify it to species. All carcasses will be stored in freezers on-site until the BLM and FWS determine the ultimate disposition.

All bird and bat injuries and fatalities discovered during, or incidental to, the standard carcass surveys will be documented according to the requirements and standards reflected in the USFWS Avian Injury and Mortality Reporting Form. The form is a reporting requirement of the USFWS Special Utility (SPUT) Permit issued to the Project to authorize the handling of dead or injured birds. In addition, finds will be classified as a fatality according to standards commonly applied in California (Altamont Pass Monitoring Team 2007, CEC and CDFG 2007), which dictate that when only feathers are found, to be classified as a fatality, each find must include a feather spot of at least five tail feathers or two primaries within 5 m (16.4 ft) or less of each other, or a total of 10 feathers. Searchers will make their best attempt to classify feather spots by size according to the sizes or identifying features of the feathers. A separate fatality estimate will be made for feather spots for which size classification is impossible. Digital photographs will be taken to document all incidents, and when possible, plausible cause of death will be indicated on data sheets based on evidence (such as blood or fecal smears on solar panels, burns that may indicate electrocution or blunt trauma that may indicate collisions). All carcasses will be examined and where possible cause of death will be recorded (e.g. burns may indicate electrocution, and blunt trauma may indicate collisions). An avian biologist will make decisions on likely cause of death and this will be reviewed by the Biologist overseeing the program.

All fatalities will be assigned to a size class, a taxonomic family, and an ecological guild and weight categories (e.g., 0-100 grams; 101-999 grams; and 1000+ grams). Species will also be classified as resident, overwintering, or whether they are diurnal or nocturnal migrants (or both). It is necessary to know size classes to appropriately correct for searcher efficiency and scavenging, and information about taxonomic family, ecological guild, and time of day when active are relevant to the specific USFWS and project goals of the monitoring plan.

To ensure accurate documentation of the fatality locations, the observer will record the array number, Global Positioning System (GPS) coordinates in latitude/longitude of the carcass location using a handheld device accurate to ± 3 to 4 m (9.8 to 13.1 ft), and a measurement of the distance from the fatality location to the end of the panel row from which the carcass was detected. When an observer proceeds down panel rows to confirm and document detected fatalities, they may detect other fatalities that they did not observe based on the perimeter-only survey. Including such detections in the fatality estimate will confound estimation of fatality density based on application of standard distance-sampling analytical methodology. Therefore, all such supplementary detections will be classified as “incidental” finds (discussed further below). Carcasses that are found within standardized search areas but incidental to the distance sampling searches can be used as an additional validation of the detection functions: the detection function specifies the distribution of found carcasses, but it also specifies the distribution of missed carcasses, and incidentals should follow the latter distribution.

Data records for each survey will also include: 1) full first and last names of all relevant surveyors in case of future questions; 2) start and stop times for each individual sampling-unit survey; 3) a description of the weather conditions during each search; 4) a standardized description of the current habitat and visibility classes represented within each sampling unit; and 5) a description of any search-area access issues, if relevant. Data collected will also include all appropriate fields contained in the SPUT permit.

All personnel involved in implementing this Plan will be included as sub-permittees under the Project’s USFWS SPUT Permit, issued either to the Project or a consultant authorized by the Project. If the CDFW does not consider coverage under the USFWS SPUT permit sufficient, all personnel implementing this plan will also be covered under any applicable CDFW Scientific

Collecting Permit if provided and issued either to the Project or its consultant. Ideally, the relevant state and federal permits will allow fatalities discovered during the study to be removed from the field, stored on-site in a freezer, and used in searcher-efficiency and carcass-removal bias trials. Necessary exceptions will apply to all special-status species (see below). Otherwise, surveyors will place all discovered carcasses or body parts that are not of a special-status species and are not part of an ongoing bias trial in zip-locked plastic bags, clearly label each bag with the incident number, and deliver the bags for storage in the designated freezer at the Project facility.

4.2.6 Fence Line Monitoring

The perimeter fence is subject to inspections approximately once every 7 days during spring and fall migration, and approximately once every 21 days during winter and summer periods with intervals adjusted as necessary based on the carcass persistence trials. A searcher will drive the areas accessible by vehicle close to the inner perimeter of the fence, scanning for fatalities within an approximate 6-m strip transect centered on the fence. Some sections along the fence cannot be driven close to the fence line. The fence line along the western edge of the Project is drivable but the road is approximately 15 m away from the fence and the road and fence are separated by a drainage ditch. The fence along this section is currently covered with a tan tarp to block and trees and shrubs have been planted to reduce visibility of the project from the west. Additions of vegetation and the tarp likely reduce potential for bird collision with the fence. This section of the fence will be driven to document carcasses, but will not be included in adjusted fatality estimates because detection rates are expected to be low. A separate section of the fence in the southeastern corner of the Project cannot be driven because the eastern edge of the berm that bounded construction ponds is too narrow for a vehicle. In this case, the observer will stop at both north and south ends of the berm and use binoculars to search for carcasses. Finally, the road along a portion of the southwest fence line near the entrance gate is approximately 30 to 50 m from the road and is separated from the fence by an area that has recently undergone vegetation restoration. This area will be eliminated from sampling. Fatality rates estimated for sections of the fence that are sampled will be extrapolated to sections of the fence where the standard monitoring protocol cannot be used. Travel speed will be no greater than 5 miles per hour (8 kilometers per hour) while searching to ensure quality detection, and safety. Personnel conducting fence checks will document bird and bat injuries and fatalities discovered along the inner fence line. Injuries and fatalities along the fence line will be documented in the same manner as used for those discovered during the array carcass surveys, and will be reported to the USFWS and CDFW as part of the same overall reporting process. Searcher efficiency trials will be conducted along the inside of the fence in a similar fashion to the trials at the solar arrays. Carcass removal trials conducted at solar arrays will include areas near the inside of the fence as well.

4.2.7 Power Line Monitoring

Power lines are built to APLIC (2005, 2006, 2012) guidelines; however, there is still a collision risk for many bird species. Consequently, a 50% sample of the Gen-tie Line will be monitored every 7 days during spring and fall migration and approximately every 21 days during summer and winter with intervals adjusted as necessary based on the carcass persistence trials.

Searchers will drive or walk 50% of the Gen-tie Line during each visit, scanning for birds within 15 m from the line. Injuries and fatalities along the Gen-tie Line will be documented in the same manner as used for those discovered during the array carcass surveys, and will be reported to the USFWS and CDFW as part of the same overall reporting process.

Some overhead electrical feeder and distribution power lines are co-located within the solar arrays and these co-located power lines may be searched as part of the regular monitoring schedule at arrays. Fatalities that are determined to have been caused by the power lines (as determined by the nature of injuries) will be reported as such to the USFWS and CDFW as part of the same overall reporting process and included in overall fatality estimates. In addition, portions of the Gen-tie Line are co-located with third-party structures and facilities, including other transmission infrastructure and roadways and, therefore, the source of a particular fatality may not be attributable to the Project's facilities.

4.2.8 Clearance Surveys

Depending on when fatality surveys commence, a one-time clearance survey will be conducted beginning approximately 21 days before the first round of official surveys begins in all areas planned for survey (fence line, gen-tie sample areas and solar arrays). The purpose of this survey will be to clear the survey area of any accumulated carcasses that may be present. The sequence of clearance surveys will mirror the schedule for the first official survey to ensure that the interval between the clearance survey and the first standard survey is the same for all sampling units. This is necessary to ensure that carcasses detected during the first round of surveys represent only fatalities that occurred during a preceding interval equivalent to the search interval that will apply afterward. Carcasses that are missed during the clearance survey will cause an upward (conservative) bias in the fatality estimate. Additionally, some estimators (such as the Huso estimator described above) become biased if carcasses that are not detected during a trial are still available during subsequent trials. This 'bleed through' effect can be ameliorated by including only fresh carcasses in the fatality estimate, where 'fresh' means a carcass that has arrived since the previous search. Carcasses that cannot reliably be aged (probably most carcasses) will be assumed to be fresh; this will cause an upward (conservative) bias in the fatality estimate.

7.3 Bird Rescue

Surveyors will record any injured or rescued birds or bats located during surveys. Birds will be assessed by a qualified biologist to determine if it is appropriate to transport the individual to the nearest permitted rehabilitation facility for proper care, or to release them. Injured raptors will be handled only by experienced personnel and will be taken only to rehabilitation facilities that are permitted to handle raptors; this provision is particularly important for eagles. From the Project site, the closest rehabilitation facilities capable of handling all avian species are:

- Coachella Valley Wild Bird Center, 46500 Van Buren, Indio, California, 92201; Phone: 760-347-2647; Contact: Linda York, Executive Director; Hours of Operation: 9:00am-12:00pm, 7 days a week. http://coachellavalleywildbirdcenter.org/

- The Living Desert Zoo & Gardens, 47900 Portola Avenue, Palm Desert, California, 92260; Phone: 760-346-5694 x8 x1; Contact: Sheila Lindquist, North American Manager; Hours of operation: 8:00am-1:30pm (June-September), 9:00am-5:00pm (October-May), 7 days a week (closed Christmas Day). http://www.livingdesert.org/animals/wildlife-rehabilitation/
- Hope Wildlife Rescue, 18950 Consul Avenue, Corona, CA 92881; Phone: 951-279-3232; Contact: Bill Anderson or Cyndi Floreno; **must call first (this is a CA-licensed rehabilitator working out of a personal residence)**.
- All God's Creatures Wildlife Rescue & Rehabilitation, Chino Hills, CA; Phone: 909-393-1590; Contact: Lori Bayour; http://www.allgodscreatures.net/index.html; no address available, contact by phone.
- International Bird Rescue, Los Angeles Center, San Pedro, CA, 90731; Phone: 310-514-2573; Hours: 8:00am - 5:00pm.
- A list of wildlife rehabilitators maintained by California Department of Fish and Wildlife: http://www.dfg.ca.gov/wildlife/WIL/rehab/facilities.html
- The California Council for Wildlife Rehabilitators: http://www.ccwr.org/resources/rehabilitation-facilities-region-6.html

If stranded, but apparently uninjured, water-associated birds are discovered at any time during surveys, the surveyor will take immediate steps to notify an on-call biologist, and assist with efforts to secure the bird and have it transferred as expediently as possible to Lake Tamarisk for release into the water. Injured water-associated birds may be taken to International Bird Rescue, which specializes in the care and rehabilitation of water-associated birds. If a mass event involving many such birds is observed, the surveyor will immediately notify on-call biologist or other biological personnel working on the site about the details and request their assistance identifying injured versus non-injured birds and transporting injured birds to the nearest rehabilitation facility. International Bird Rescue can also assist with mass stranding events. Rehabilitation facilities should be compensated for the costs associated with each bird put under their care.

If a surveyor discovers a dead individual of a species that is fully protected by the state or federally or state-listed as threatened or endangered, and for which handling is not specifically authorized under the applicable salvage permits, he/she will collect data and photos as for any other fatality, but then flag the carcass to mark its location and leave it in place. If it has been confirmed as a federally listed species under the Endangered Species Act, the surveyor will immediately call a USFWS Office of Law Enforcement special agent to determine the appropriate follow-up action.

7.4 Searcher Efficiency Trials

Estimating searcher-efficiency (distance-related detection functions) is a standard component of the distance-sampling approach. Moreover, because estimating detection functions is applied to all survey data and can be organized to variably adjust in relation to covariates of interest (e.g., season, habitat, and carcass size classes), application of this approach will account for typical factors of interest for fatality studies (CEC and CDFG 2007, Huso 2010, Korner-Nievergelt et al. 2011, USFWS 2012, Smallwood 2013). In this case, independent searcher-efficiency trials per season will be conducted to help assess and adjust for potential spatial bias in the distribution of fatalities among arrays. Separate trials will be conducted to assess detection probability associated with fence and gen-tie line searches.

The desert landscape in which this Project is located generally changes little with the seasons, save for brief periods following winter and spring rains when floods may occur and blooming plants may flourish. A recent meta-analysis involving data from more than 70 wind-energy projects suggested that including habitat visibility class as a predictive variable generally eliminated any otherwise apparent seasonal effects on searcher efficiency (Smallwood 2013). Nevertheless, the supplementary searcher efficiency trials for this Project will be repeated seasonally (winter, spring, summer, and fall) and trials will be organized so that all search personnel participate in bias trials. Placement of trial specimens will be timed to limit the number of trial carcasses placed on the landscape at any one time (minimizing the chance of artificially attracting scavengers or, conversely, scavenger swamping; Smallwood 2007). This approach will also ensure that any new surveyors that join the crew participate in searcher efficiency trials. The trials will also be managed to ensure effective quantification of searcher efficiency in relation to predefined habitat visibility classes (low, medium, and high, if relevant), size classes of birds (small and large), and detection distance.

The bias-trial sample sizes required to produce precise, adjusted fatality estimates are not well established, in part because needs may vary substantially depending on actual project-specific searcher efficiency, carcass removal, and fatality rates. However, using searcher-efficiency trials to help evaluate the efficacy of perimeter-only surveys and the distance-sampling approach used in this investigation will require larger sample sizes to produce a sampling design that effectively accounts for distance as a key covariate of interest. In addition, if growth of new ruderal vegetation, or substrate heterogeneity caused by flood events, is sufficient to create a new visibility class under the arrays, the specimen numbers would need to increase to effectively account for this factor. It will also be necessary to ensure that the estimates of searcher efficiency encompass variation among multiple surveyors. The influence of individual surveyors will not be accounted for in a formal, statistical sense by including “surveyor” as a covariate in the estimation model; however, all surveyors will be tested similarly. Each surveyor will be exposed to multiple test specimens of each size class, and at similar repeated levels if testing in different habitat visibility classes is required. A minimum of 15 carcass samples per small size class, 10 for medium, and 5 for large is anticipated within the fence line, solar array, and gen-tie sampling areas per season. Searcher efficiency will be summarized for each individual searcher but to avoid needlessly inflating the variance of the estimate, individual searcher effects will not be included in the fatality estimation model.

Besides representing birds of different sizes, another important factor to consider in searcher-efficiency and carcass-removal trials is the bird species to use as trial specimens. Ideally, all carcasses used for both searcher-efficiency and carcass-removal trials should reflect the range of species likely to be encountered as fatalities in the Project area (CEC and CDFG 2007). Because obtaining sufficient samples of "natural" carcasses often is difficult, researchers frequently resort to using readily available, non-native surrogate species in bias trails; however, this practice may result in biased results when compared to studies that use only "natural" specimens (Smallwood 2007). For all bias trials, this program will maximize use of representative native or naturalized species authorized by permits, either found during the study or gathered elsewhere, as needed, and from diverse sources where possible, but all trial carcasses will be obtained and deployed in a manner that are consistent with applicable regulatory requirements.

Another factor that influences carcass detectability is how fresh and intact the carcass is (Smallwood 2007, 2013). If multiple pieces of a depredated or scavenged carcass are scattered over a modest area, in some cases the fatality may be more easily detected; however, detectability generally decreases when only remnants of a carcass are present, or when the carcass is aged and degraded. Nevertheless, in contrast to wind-energy projects, there is little expectation that this Project will cause injuries and fatalities that result in dismembered carcasses, so this factor is not expected to influence searcher-efficiency or carcass-removal rates (Smallwood 2013). Therefore, bias trials conducted in this study will involve primarily intact carcasses. The searcher-efficiency trial specimens may range from freshly thawed to partially decayed (i.e., selected, subject to availability, to mimic the range of carcass decay that typically accrues over 7-day periods).

A field supervisor or other technician not involved in the standard surveys will place the trial specimens and will recover any specimens missed by the surveyors. All trial specimens will be placed according to a sampling plan that randomly allocates carcasses of different sizes among survey plots and survey days within the assessment areas, but is stratified to ensure equitable representation of different surveyors, fence line vs. solar arrays vs. gen-tie and seasons. To minimize the possibility of unnecessarily attracting scavengers or, conversely, contributing to scavenger swamping, which could affect ongoing carcass-removal trials (Smallwood 2007, Smallwood et al. 2010), placement of searcher-efficiency trial specimens will be distributed throughout the year (appropriately organized to provide season-specific estimates with adequate samples to provide a robust estimate of searcher efficiency), with few specimens placed at any one time. Carcasses will be placed carefully to minimize disturbance of substrates that may bias carcass detection. Sample size and frequency of trials in the second year may be reduced if the TAG deems appropriate (see section 10.0).

All trial specimens will be inconspicuously marked with a piece of black electrical tape wrapped around one leg, in a manner that allows the surveyor to readily distinguish trial specimens from new fatalities, but without rendering the specimen unnaturally conspicuous (Smallwood 2007, USFWS 2012). To ensure a degree of "natural" placement, carcasses need to be represented by placing between rows of panels, under panels, near i-beams supporting the panels, or in the open. Therefore, carcasses will be tossed towards the designated, randomly chosen placement spot from a distance of three to six m. Documentation of each location will include GPS coordinates, notes about the substrate and carcass placement, and a digital photo of the placement location.

Surveyors will have only one opportunity to discover placed specimens. Any missed specimens will be recovered as quickly as possible after surveys have been completed in a given area, and after the surveyor(s) have become aware of the trial through discovery of one or more specimens. Some researchers have argued for leaving missed specimens in place to enable possible discovery in a subsequent survey and thereby mimic the natural situation in which “bleed-through” is possible (e.g., Smallwood 2013, Warren-Hicks et al. 2013; discussed further below). Although this approach may have merit in some situations, its potential value for this Project is offset by the need to avoid attracting ravens, which represent a threat to desert tortoises living in the area (Ironwood Consulting 2010b).

7.5 Carcass Persistence Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal variation in landscape/climatic conditions and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. Seasonally variable climatic conditions also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Therefore, to ensure accurate treatment of this bias factor, carcass-persistence rates will be assessed on a quarterly or at least semi-annual basis during the first year that fatality surveys are conducted (CEC and CDFG 2007, USFWS 2012, Smallwood 2013), and during the second year as needed. It is also imperative that carcass-persistence trials effectively account for the influence of carcass type/size, given that persistence times may vary widely depending on the species and size class involved (Smallwood 2013).

To quantify carcass persistence, 15 small, 10 medium, and 5 large carcasses will be randomly placed and monitored within the solar arrays (including the fence line), and along 50% of the Gen-tie Line each season. A minimum of ½ of the carcasses in the solar arrays will be monitored, using motion-triggered, digital trail cameras (e.g., see Smallwood et al. 2010) while the remaining will be visited on foot, for 30 days or until the carcass has deteriorated to a point where it would no longer qualify as a documentable fatality. Some of the carcasses along the gen-tie line will be monitored with cameras if theft and vandalism concerns can be resolved. For carcasses not set up with cameras, the carcass will be visited once a day for the first 4 days, and then every 3 to 5 days until 30 days is reached. Fake cameras or cameras without bias trial carcasses will also be placed to avoid training ravens to recognize cameras as “feeding stations”. Periodic ground-based checking of carcasses also will occur to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera’s field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens will be distributed across the entire Solar Farm, not just in areas subject to standard surveys, and new specimens will be placed every two to three weeks in small numbers. Sample size and frequency of trials in the second year may be reduced if the TAG deems appropriate.

Trial specimens will include only intact, fresh (i.e., estimated to be no more than one or two days old and not noticeably desiccated) bird carcasses that are either discovered during the study or are acquired from other sources after having been frozen immediately following death. If permits allow, preference will be to use carcasses of species that occur in the area. Surrogates, such as game birds and waterfowl, that are similar in size and appearance to species that occur in the area, will be obtained from commercial sources and used if necessary to meet the required sample sizes. However, domestic waterfowl or gamebirds that are white or brightly colored (e.g. male pheasants) will not be used. Scavenging rates for surrogates may be artificially high, at least when compared to raptors (Smallwood 2007, 2013) and may lead to conservative fatality estimates (i.e., an overestimate) for some taxa/groups.

To reduce possible biases related to leaving scent traces or visual cues that may unnecessarily alert potential scavengers, all carcasses used in carcass-persistence trials will be handled with latex gloves, and handling time will be minimized. All trial specimens will be inconspicuously marked with a small piece of green electrical tape wrapped around a leg to distinguish them from both unmarked fatalities and searcher-efficiency trial specimens.

Upon conclusion of the relevant monitoring period, each trial specimen will be classified into one of the following categories:

Intact: Whole and un-scavenged other than by insects

Scavenged/depredated: Carcass present but incomplete, dismembered, or flesh removed

Feather spot: Carcass scavenged and removed, but sufficient feathers remain to qualify as a fatality, as defined above

Removed: Not enough remains to be considered a fatality during standard surveys, as defined above

7.6 Estimating Adjusted Fatality Rates

The sampling design will enable calculation of fatality estimates adjusted for searcher-efficiency, carcass-removal rates, and proportion of area sampled. The adjustment for searcher efficiency will occur by virtue of applying standard methods for analyzing detection data collected using distance-sampling methods, with the data partitioned by season and standardized carcass size classes.

The fatality estimates will be adjusted for variation in carcass persistence, by applying seasonal and carcass-size-specific correction factors to the fatality estimates that have been adjusted for distance-related variation in the probability of detection.

The analytical approach used to calculate adjusted fatality estimates will be similar to that applied in cases where the fatality estimates are derived from strip transects.

For illustrative purposes, we summarize here the basic formulation of the Huso estimator, the first part of which pertains to fatality estimation for different strata, or groups. Essentially, the smallest group for which fatalities are estimated can be considered a stratum, with stratum *k* representing, for example, a set of similarly sized birds within a defined habitat visibility class. Note that strata should be defined to ensure minimum variance in detection probabilities within individual strata, whereas probabilities may vary considerably among strata (e.g., for small versus large birds, or in habitats of low versus high visibility). Depending on the circumstances, there can be strata based on species groups, size classes, seasons, habitats, and/or infrastructure types (also could conceivably model distance categories as another covariate).

For a particular stratum *k* for a given survey plot and search interval, fatality can be estimated as:

$$\hat{F}_k = \frac{c_k}{g_k},$$

where c_k is the number of observed carcasses and g_k is the probability of detecting a carcass. The detection probability *g* typically is the product of three variables: the probability of a carcass persisting (*r*), the probability of a carcass being observed given that it persists (*p*), and the effective proportion of the interval sampled (*v*):

$$\hat{g} = \hat{p} * \hat{r} * \hat{v}.$$

The probability of a carcass being observed given that it persists (i.e., searcher efficiency) is estimated as:

$$\hat{p} = \frac{number\_observed}{number\_available},$$

with data for calculating this metric derived from searcher-efficiency trials where known numbers of carcasses are distributed over the search area and carcass detection rates are quantified.

The probability of a carcass persisting is estimated as:

$$\hat{r} = \frac{\bar{t}(1-e^{-I/\bar{t}})}{I},$$

where $\bar{t}$ is the estimated mean carcass persistence time and I is estimated as:

$$I = \min(I_a, \tilde{I}),$$

where I_a is the minimum actual time between searches and $\tilde{I}$ is the effective search interval, defined as:

$$\tilde{I} = -\log(0.01) \cdot \bar{t}.$$

The effective proportion of the interval sampled is estimated as:

$$\hat{v} = \min(1, \tilde{I} / I_a).$$

For this investigation, the formulation for calculating $\hat{F}_j$ would differ from that outlined above, in that "c_k" would represent the estimated number of fatalities already adjusted for searcher efficiency, based on application of distance-sampling methodology, and then g_k would represent the product of only the estimated carcass persistence (r) and the effective proportion of the interval sampled (v). With this modification, the rest of the formulation would be similar.

For a given plot in search interval j, the adjusted total number of fatalities is calculated as:

$$\hat{F}_j = \sum_{k=1}^{K} \hat{F}_{jk},$$

where $\hat{F}_{jk}$ is the estimated number of fatalities within stratum k of search interval j.

Finally, the estimate of Project-wide total fatalities during a given search interval is estimated as:

$$\hat{F} = \frac{1}{a} \times \left(\sum_{i=1}^{n} \frac{1}{\pi_i} \sum_{j=1}^{J} \hat{F}_{ij} \right),$$

where $\hat{F}_{ij}$ is the number of fatalities on plot i in search interval j, a is the proportion of area that was searched and π_i represents a modified weight associated with an unequal probability sample (Huso 2010), and is the product of the probability of selecting plot i and the proportion of fatalities contained in plot i. The total number of search intervals is J, assuming that there is the same number of search intervals for each plot. In practice, one need not assume that J is constant, but presenting it this way simplifies the notation.

Adjusted fatality estimates for the Solar Farm will be expressed per unit area (e.g., acres and arrays) per year.

7.7 Incidental Mortality Documentation

Once post-construction fatality monitoring begins, all subsequent bird and bat injuries and fatalities detected incidental to the standardized, post-construction monitoring program will be classified as “incidental finds,” documented using similar procedures as are used for specimens discovered during the standardized surveys, and integrated with records from the standardized surveys for summary reporting and evaluation purposes. Incidental finds that occur outside of standard search areas will not be included in calculations of adjusted post-construction fatality estimates, but will be summarized within seasonal and annual reports (discussed below).

From a statistical standpoint, a bias will occur if carcasses that are found in standard search areas but not during standardized surveys are recorded and removed prior to the next search of that array. Per USFWS direction, and to be consistent with the raven management plan, these carcasses will be reported directly to an authorized Biologist. These incidental finds will be documented using the same procedures as those discovered during standardized surveys. Data from incidental finds within standardized search areas will be included in analyses to estimate mortality within the solar arrays to be conservative. Appropriate caveats can be included within the seasonal and annual reports to document the potential magnitude of any biases created by recovering these carcasses.

8.0 MINIMUM CREDENTIALS OF MONITORING PERSONNEL AND TRAINING

The fatality monitoring program will be overseen by an Avian Biologist approved by BLM in consultation with Wildlife agencies that has demonstrated the ability to accurately identify the species of birds and bats potentially impacted by the project. Additional Biologists will be approved by the BLM in consultation with the Wildlife agencies for the purpose of accurately identifying species of birds and bats potentially impacted by the project. The approved biologists will assist with fatality monitoring and will be available to respond to incidents at the Project that require expert assistance (e.g. uncertain species identification, possible listed species, or injuries) within 24 hours. In addition, a biologist (minimum of B.S. in wildlife sciences) will be on-site during days of standardized monitoring.

Monitoring personnel may include solar facility staff. Monitors will be trained in distance-sampling search methodology, correct identification and documentation of carcasses, implementation of carcass removal trials and notification of a rehabilitation center in the event of injured birds or bats. Only staff/technicians that are listed under the SPUT and CDFW Scientific Collecting Permits will be allowed to handle carcasses. Accurate identification of rare, special status species will be emphasized during training. All surveyors will have photo cards to classify specimens and will take photographs of all finds. All data collection will be standardized and the Approved Avian Biologist will decide which to report as survey observations; however, all observations that were not conclusive will be reported.

The trainer, curriculum and training materials for training of non-biologist personnel in monitoring methods will be approved by BLM in consultation with the Wildlife agencies and will be conducted by The Approved Avian Biologist prior to initiation of the study. Training materials may be augmented by wildlife agency input. Components of the training program will include:

- A classroom-based portion with lecture and handout materials, and photographic or specimen-based (if available) species identification;
- A field-based portion that allows trainees the opportunity to practice and receive feedback on conducting carcass searches and trials, identification of species, completing data forms, and following protocols for assessing and assisting injured birds and bats;
- Assessment of learning outcomes for each participant;
- A training log to be updated with each trainee's name and contact information upon successful completion of the course.

The Avian Biologist that will conduct the training will, minimally, have a master's degree in biological sciences, zoology, botany, ecology, or a related field, and at least one year of field experience with avian or bat research or monitoring in the region. All reference material should be maintained and provided to the agencies in the event that there are questions about species identification.

9.0 REPORTING

9.1 USFWS Bird Fatality/Injury Reporting Program

The Project will report all documented bird injuries and fatalities to the USFWS using the required Avian Injury and Mortality Reporting Form that is a reporting requirement of the USFWS SPUT Permit issued to the Project to authorize the handling of dead or injured birds. SPUT reporting will be submitted monthly or in accordance with the terms of the permit. Similar reporting to the CDFW will be accomplished as a condition of any relevant Scientific Collecting Permit that the CDFW may issue to authorize the handling of dead or injured birds under state law.

9.2 Incidental Bird Injury/Fatality Reporting

All injury and fatality incidents discovered outside of the standardized carcass surveys will be documented in the same manner as used for those discovered during the carcass surveys, and will be reported to the USFWS and CDFW as part of the SPUT process. Special status or listed species will also be handled in a way that is consistent with project-specific SPUT permit conditions. Additional details on reporting are found in the Desert Sunlight Wildlife Incident Reporting System (Appendix C).

9.3 Summary Reports

Seasonal electronic summaries of all biological monitoring activities will be submitted to BLM, USFWS, and CDFW throughout the monitoring period. After the fourth quarter of each year of monitoring, a biologist representing the Project will assist the Project in preparing and submitting to the CDFW, BLM, and USFWS an annual report that summarizes dates, durations, and results of all fatality monitoring conducted to date.

To address the specific objectives of the monitoring plan, summary reports will include overall fatality estimates with confidence intervals, and fatality estimates by season. In addition, to the extent possible, fatality rates will be estimated and reported for likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines). Summary reports will also include spatial analyses of the data that address whether fatalities are randomly distributed throughout the facility. All raw field notes, field data, photographs, and GIS data will be submitted to the agencies.

10.0 TECHNICAL ADVISORY GROUP AND ADAPTIVE MANAGEMENT

A Technical Advisory Group (TAG) will monitor Project activities, including fatality data, to provide recommendations to the BLM on the need for any adaptive management, including the adoption of avoidance and minimization measures and methods for assessing their effectiveness. The TAG will consist of resource specialists and project biologists from the BLM, USFWS, and CDFW. Persons with scientific expertise may be invited by TAG. In addition, representatives from the Project and the consultants involved in the conduct of the studies will attend and participate in meetings. The TAG will provide advice and recommendations, consistent with the principles below, to the BLM Authorized Officer on developing and implementing effective measures to monitor, avoid, minimize, and mitigate impacts to wildlife species and their habitats related to operations. The BLM Authorized Officer will evaluate any recommendations of the TAG, including discussions with Desert Sunlight concerning new measures or measures that are not completely detailed in this BBCS and make a decision on what measure(s) and monitoring to require for implementation.

A TAG Lead from the Project will be designated for the group whose duties will include disseminating Project data, including data on fatality events, setting up and moderating meetings, reviewing of fatality data, and documenting adaptive management recommendations for the Project. Because the Project occurs on BLM land and BLM is the federal decision-maker, BLM will provide a designated TAG Lead for the Project. It is the TAG Lead’s responsibility to coordinate meetings and involve all team members.

The guiding principles, duties, and responsibilities of the TAG include the following:

- The TAG is only an advisory group.

- Recommendations will be made based on best available science and existing approvals and permits to address specific issues resulting from the Project.
- Recommendations will generally be made by consensus. Where consensus cannot be reached, multiple recommendations will be put forth to the BLM for a final decision.
- Provide sufficient flexibility to adapt as more is learned about the Project as well as strategies to reduce avian impacts if warranted.
- Review results of fatality monitoring.
- In accordance with Mitigation Measure (MM) WIL-5 of the Project's Record of Decision (ROD), if BLM, in consultation with the Wildlife agencies, determine, based on post-construction monitoring, that bird mortality caused by solar facilities is substantial and is having potentially adverse impacts on special-status bird populations, the TAG may recommend adaptive management strategies such as installing additional bird flight diverters, alterations to project components that have been identified as key mortality features, or implementing other appropriate actions to address the relevant findings based on the data.
- Review annual report on status of compliance with mitigation measures and permit conditions and provide recommendations to the BLM Authorized Officer, as necessary.
- Evaluate effectiveness of implemented adaptive management strategies and provide the BLM Authorized Officer with recommendations based on findings.
- The TAG will terminate when the BLM Authorized Officer determines that it is no longer a necessary pathway in reducing avian and bat impacts.

The TAG shall hold the first meeting prior to commencement of post-construction monitoring to review any final details of the monitoring plan. Subsequent meetings will be held following each monitoring season and after the end of each annual monitoring cycle.

After the initial 3-month period, the TAG will review the findings for each monitoring season to determine if adjustments to the monitoring frequency are warranted based on carcass persistence trial results. Desert Sunlight and the agencies will also meet at the end of the second year of monitoring to determine if continued/focused monitoring is warranted. Continued/focused monitoring may be warranted if data indicate that bird mortality caused by solar facilities is substantial and is having potential adverse impacts on special-status bird populations or there are other special circumstances. Such monitoring will be designed to address specific concerns that are identified after review of the data.

11.0 REFERENCES

Anderson, et al. 1999. Studying wind energy/bird interactions: a guidance document. Metrics and methods for determining or monitoring potential impacts on birds at existing and proposed wind energy sites. Avian Subcommittee, National Wind Coordinating Committee, 93 pp.

Avian Power Line Interaction Committee (APLIC). 2005. Avian Protection Plan (APP) Guidelines. A Joint Document prepared by the Edison Electric Institute’s Avian Power Line Interaction Committee (APLIC) and the US Fish and Wildlife Service (USFWS).

Avian Power Line Interaction Committee (APLIC). 2006. Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006. Public Interest Energy Research Program (PIER) Final Project Report CEC-500-2006-022. Edison Electric Institute, APLIC, and the California Energy Commission. Washington D.C. and Sacramento, California.

Avian Power Line Interaction Committee (APLIC). 2012. Reducing Avian Collisions with Power Lines: The State of the Art in 2012. Edison Electric Institute and APLIC, Washington D.C.

Buckland, S, D.R. Anderson, K. P. Burnham, and J.L. Laake. 1993. Distance Sampling: estimating abundance of biological populations. Chapman & Hall, London. 446 pp.

Bald and Golden Eagle Protection Act (BGEPA). 1940. 16 United States Code (USC) § 668-668d. Bald Eagle Protection Act of 1940, June 8, 1940, Chapter 278, § 2, 54 Statute (Stat.) 251; Expanded to include the related species of the golden eagle October 24, 1962, Public Law (PL) 87-884, 76 Stat. 1246. As amended: October 23, 1972, PL 92-535, § 2, 86 Stat. 1065; Nov. 8, 1978, PL 95-616, § 9, 92 Stat. 3114.Bureau of Land Management (BLM) and US Department of the Interior (DOI). 2011a. Desert Sunlight Solar Farm Project, California Desert Conservation Area Plan Amendment and Final Environmental Impact Statement. http://www.blm.gov/ca/st/en/fo/palmsprings/Solar_Projects/Desert_Sunlight.html

Bureau of Land Management (BLM) and US Department of the Interior (DOI). 2011b. Record of Decision, Desert Sunlight Solar Farm Project and Amendment to the California Desert Conservation Area Land Use Management Plan, Riverside County, California.

California Department of Fish and Wildlife (CDFW). 2008. California Bird Species of Special Concern. http://www.dfg.ca.gov/wildlife/nongame/ssc/birds.html.

California Department of Fish and Wildlife, Natural Diversity Database. September 2014. Special Animals List. Periodic publication. 52 pp.

California Energy Commission and California Department of Fish and Game. 2007. California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development. Commission Final Report. California Energy Commission, Renewables Committee, and Energy Facilities Siting Division, and California Department of Fish and Game, Resources Management and Policy Division. CEC-700-2007-008-CMF.

ESRI. 2014. Geographic Information System (GIS) Online Topographic Base Map. ESRI, producers of ArcGIS software. Redlands, California.

Ironwood Consulting Inc. 2010a. Revised Biological Resources Technical Report, Desert Sunlight Holdings, LLC Desert Sunlight Solar Farm Project.

Ironwood Consulting Inc. 2010b. Common Raven Management Plan, Desert Sunlight Solar Farm Project. BLM Case File Number CACA-48649, Riverside County, California.

Ironwood Consulting Inc. 2011. Avian and Bat Protection Plan, Desert Sunlight Solar Farm Project, BLM Case File Number CACA-48649, Riverside County, California.

Migratory Bird Treaty Act (MBTA). 1918. 16 United States Code (USC) § 703-712. July 13, 1918.

National Environmental Policy Act (NEPA). 1970. 42 United States Code (USC) 4321-4370h. Pub. L. 91–190, § 2, Jan. 1, 1970, 83 Stat. 852

Pagel, J. E., D. M. Whittington, and G. T. Allen. 2010. Interim Golden Eagle Technical Guidance: Inventory and Monitoring Protocols; and Other Recommendations in Support of Golden Eagle Management and Permit Issuance. US Fish and Wildlife Service (USFWS). February 2010. Available online at: http://steinadlerschutz.lbv.de/fileadmin/www.steinadlerschutz.de/terimGoldenEagleTechnicalGuidanceProtocols25March2010_1_.pdf

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonata. 2010. Novel scavenger removal trials increase wind turbine-caused avian fatality estimates. Journal of Wildlife Management 74: 1089-1096.

Smallwood, K.S. 2013. Comparing bird and bat fatality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37: 19-33.

US Fish and Wildlife Service (USFWS). 2003. Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines. http://www.fws.gov/habitatconservation/wind.html.

US Fish and Wildlife Service (USFWS). 2008. Birds of Conservation Concern 2008. December 2008. Division of Migratory Bird Management. Arlington, Virginia. http://www.fws.gov/migratorybirds/NewReportsPublications/SpecialTopics/BCC2008/BCC2008.pdf

US Fish and Wildlife Service (USFWS). 2010. Interim Guidance for Solar Energy Facilities.

US Fish and Wildlife Service (USFWS). 2012. U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines.

Appendix A. Incidental bird and bat mortalities and injuries previously reported during construction of Desert Sunlight Solar Farm Project as of October 31, 2014 (First Solar 2014).

Bird Species Common Name (AOU English Name)	**Count**
Western Grebe	25
Eared Grebe	16
American Coot	10
American Avocet	7
Unidentified Bird	7
Loggerhead Shrike	6
Mourning Dove	6
Common Loon	5
Sora	5
Wilson's Warbler	5
Brown Pelican	4
Common Raven	4
Double-crested Cormorant	4
Great-tailed Grackle	4
Ruddy Duck	4
Ash-throated Flycatcher	3
Brown-headed Cowbird	3
Common Poorwill	3
Horned Lark	3
Sagebrush Sparrow	3
Townsend's Warbler	3
Western Tanager	3
White-crowned Sparrow	3
Yellow-headed Blackbird	3
Black-headed Grosbeak	2
Brewer's Blackbird	2
Common Yellowthroat	2
Costa's Hummingbird	2
House Finch	2
Lesser Nighthawk	2
Pied-billed Grebe	2
Say's Phoebe	2
Unidentified Sparrow	2
Virginia Rail	2
Yellow-rumped Warbler	2
American Kestrel	1

Bird Species Common Name (AOU English Name)	**Count**
American White Pelican	1
Barn Owl	1
Black-crowned Night-Heron	1
Black-tailed Gnatcatcher	1
Blue-winged Teal	1
Burrowing Owl	1
Clapper Rail	1
Common Merganser	1
Great Egret	1
Lesser Scaup	1
Long-eared Owl	1
Mallard	1
Northern Mockingbird	1
Prairie Falcon	1
Red-breasted Merganser	1
Redhead	1
Red-necked Phalarope	1
Red-winged Blackbird	1
Savannah Sparrow	1
Surf Scoter	1
Tree Swallow	1
Unidentified Blackbird	1
Unidentified Duck	1
Unidentified Empidonax Flycatcher	1
Unidentified Hummingbird	1
Unidentified Jaeger	1
Verdin	1
Western Meadowlark	1
White-faced Ibis	1
White-winged Dove	1
Wilson's Snipe	1
Yellow Warbler	1
Bird Total	194
Bat Species	
California Myotis	1
Pallid Bat	1
Townsend's Big -eared Bat	1
Western Mastiff Bat	1

Bird Species Common Name (AOU English Name)	**Count**
Bat Total	4
Grand Total	198

Appendix B
Summary of Statistical Simulations for Experimental Design from CVSR

Recent statistical power and precision analyses conducted for another solar project being built roughly 193 km (120 miles) north of the Project site provides some guidance for developing a spatial sampling regime (TerraStat Consulting Group 2013). These simulations were based on projected sampling across an entire 392-MW solar thermal facility, so the results may not accurately reflect the expectation at facilities of different sizes or where sampling is constrained to smaller portions of a large facility; nevertheless, the general guidance they provide is useful. The simulation analyses were parameterized based on several wind-energy studies conducted in the Mojave Desert, and incorporated one of several well-studied mathematical approaches for estimating fatality rates adjusted for proportion of area sampled, search interval, searcher efficiency, and carcass persistence (Shoenfeld 2004). The power analyses assessed the effect of varying the proportion of area sampled from 1% to 30%, using search intervals of 7, 21, and 25 days, and simulating four hypothetical mortality rates (0.5, 1.0, 5.0, and 10 fatalities/MW/year), assuming exponentially distributed carcass removal rates with means of 7.4 or 21.8 days and searcher efficiencies of 0.55 and 0.69 for small and large birds, respectively. The simulation results indicated that the 90% confidence interval for the facility-wide fatality estimate narrowed as the survey area increased, as the search interval decreased, and as the simulated mortality rate increased. The coefficient of variation (CV: $100\% \times$) provides a way to evaluate the relative amount of imprecision in an estimate. The CV is useful because it doesn’t depend on the size of the estimate and so can be compared between large and small estimates. Larger values of CV are associated with estimates that are less precise: a CV of 100% indicates an estimate with a standard deviation that is equal to the mean. At all of the simulated mortality rates, and based on a 21-day search interval, the CV for the fatality estimates approached an asymptote once the proportion of area searched reached about 20%. In addition, at the 20% sample level, the CV for the fatality estimates was less than 25% for mortality rates that exceeded 1.0 fatality/MW/year. This level of precision generally is considered adequate for answering the primary questions of interest in such fatality studies (Strickland et al. 2011), and is consistent with guidance from the USFWS Land-Based Wind Energy Guidelines (2012), which states that “the carcass searching protocol should be adequate to answer applicable Tier 4 questions at an appropriate level of precision to make *general* conclusions about the project*, and is not intended to provide highly precise measurements of fatalities*” (p. 45; emphasis added). At the lowest simulated mortality rate, with a 21-day search interval, the coefficient of variation was above 50% at 20% of area sampled, which would be considered a marginal precision level for answering the questions of interest. From a practical standpoint, the importance of precision is diminished if impacts are low. For example, if the take estimate is 0.1 bird per year with 200% CV, this suggests a 90% confidence interval of about (0, 0.4), or a range of less than half a bird per year. On the other hand, if the take estimate is 100 birds per year and the CV is 20%, the 90% confidence interval is (61, 139), or a range of 78 birds per year.

At the lower simulated mortality rates, increasing the proportion of area sampled from 20% to 30% had less impact on the precision compared to decreasing the search interval from 21 days to 7 days. For the two highest simulated mortality rates, however, varying the search interval had less effect on the precision of the adjusted fatality estimates, whether based on 20% or 30% of area sampled, with the CVs remaining between about 8% - 19%. At the 1.0

fatality/MW/year mortality rate with 20% of the area sampled, the CV increased from about 25% with a 7-day search interval to about 40% with a 21-day search interval. At the 0.5 fatalities/MW/year mortality rate with 20% of the area sampled, the relevant change in the CV was from 37% to 57%.

Analysis of data from the CVSR in San Luis Obispo County, California (H.T. Harvey and Associates 2014) corroborates the simulation results. The CVSR is a recently completed 250-MW facility comprising nine discrete photovoltaic solar arrays, which collectively cover approximately 642 ha (1,586 acres) of primarily degraded annual grassland. Beginning in fall 2012, 100% of two arrays were surveyed weekly for bird and bat fatalities using 50-foot transects for large birds and 20-foot transects for bats and small birds. A total of 175 avian fatalities were found during standardized surveys in the two arrays over 10 months. The Huso (2010) estimator was used to estimate the number of fatalities based on documented fatalities adjusted for searcher efficiency and carcass persistence.

Two methods were used to evaluate the potential effects of reduced search area on fatality estimates at CVSR. Spatial clustering of fatalities was evaluated using Global Moran’s I index, which indicates whether objects are clumped, uniform, or random in their spatial distribution (ESRI ArcInfo 10.0, geographic statistical toolbox). Spatial clumping of fatalities within the individual arrays would introduce additional uncertainty into the fatality estimates if sampling covered considerably less than 100% of the survey area. The second method involved resampling the observed fatality data to generate distributions of fatality estimates that would have resulted from searching less than 100% of the study area. Sample sizes varied from one sample unit up to the total number of sample units in the study area (180). (At CVSR, a sample unit was one “tracker unit,” a group of 18 rows of solar panels covering approximately 0.34 ha (0.85 acres); sample units at CVSR were about a quarter the size of the proposed sample units at Desert Sunlight.) For each sample size, 2,000 simulated datasets were generated from the original data. Then, for each simulated dataset, the total number of fatalities for the study area was calculated by scaling the sample count according to the proportion of area represented in the sample. This procedure resulted in a distribution of possible fatality estimates for each level of area sampled. Based on these distributions, means, 90% confidence intervals (CI), and CVs were calculated for each sample size to evaluate the effect of sampling variation on the magnitude and precision of the fatality estimates.

The geospatial analysis indicated that the distribution of fatalities in the two, 100% searched arrays did not differ significantly from a random distribution (H.T. Harvey and Associates 2014). Results of the resampling analysis indicated that the mean fatality estimates and the 90% CIs for those estimates stabilized at about 20% of area sampled (Figure 1). Examined in a different way, the results indicated that the CVs of the sample distributions declined with increasing sample size and that, again beyond about 20% of area sampled, further increases in area sampled resulted in only small increases in precision (Figure 2). Moreover, at the 20% sample level, the CV for the fatality estimates was well below 20%, which is a level of precision that is considered adequate for answering the primary questions of interest in such fatality studies (Strickland et al. 2011, USFWS 2012). With regard to applying these results to other sites, it is important to note that the results may be sensitive to: 1) the relative proportions of large and small birds represented in the fatality sample, which were combined for this analysis; 2) the number and distribution of fatalities across the site; and 3) the influence of variation in searcher efficiency and carcass persistence.

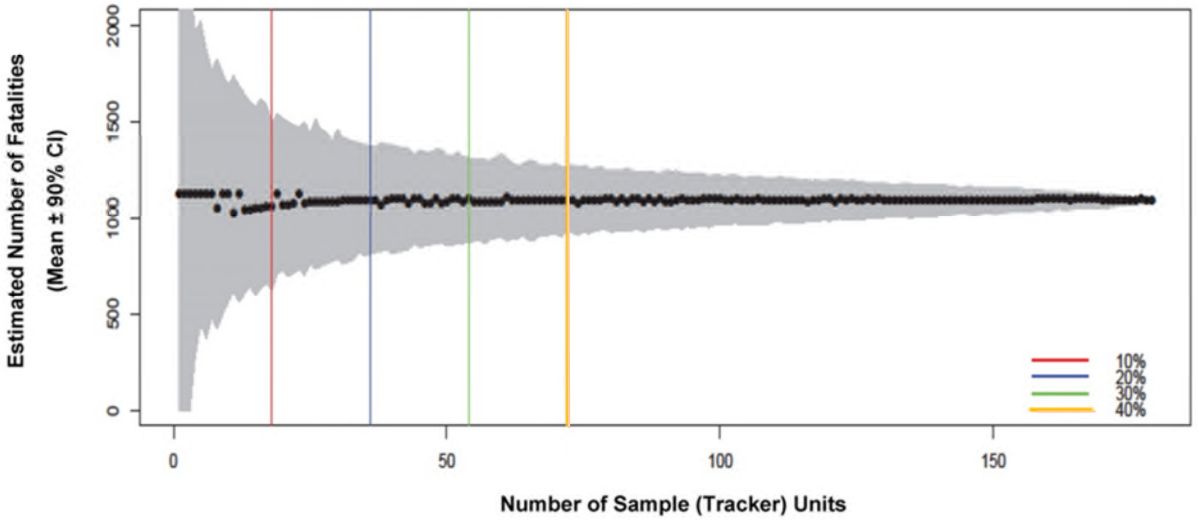


Figure 1. Resampling results from the California Valley Solar Ranch illustrating how the accuracy and precision of fatality estimates and varies with proportion of area sampled.

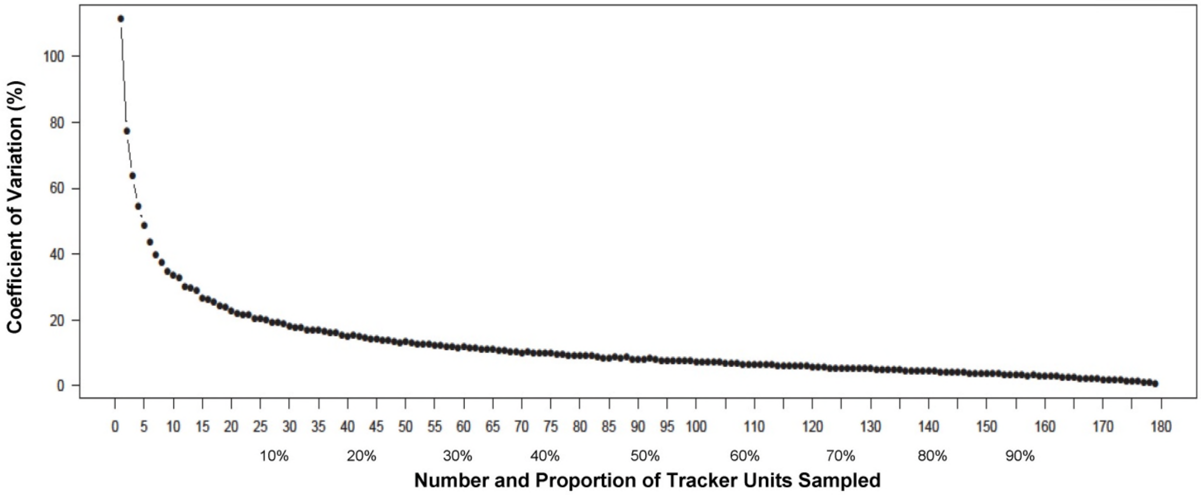


Figure 2. Resampling results from the California Valley Solar Ranch illustrating how the coefficient of variation for fatality estimates varies with proportion of area sampled.

Appendix C
Desert Sunlight Wildlife Incident Reporting System (WIRS)

DESERT SUNLIGHT
WILDLIFE INCIDENT REPORTING SYSTEM (WIRS)

BACKGROUND AND INTRODUCTION

Desert Sunlight will voluntarily implement a wildlife incident response and reporting system. Desert Sunlight will record and report all dead and injured wildlife including but not limited to birds found incidentally in the project areas over the entire life of the project as part of the project operations and monitoring efforts. The purpose of this Wildlife Incident Reporting System (WIRS) is to standardize the actions taken by site personnel in response to wildlife incidents found within project boundaries. The WIRS provides direction for site personnel who may encounter a wildlife incident in an effort to fulfill obligations in reporting wildlife incidents. Wildlife fatalities or injuries found by project personnel or others will be reported and processed following the protocols described in this document.

DESERT SUNLIGHT WIRS POLICY

This WIRS will be active for the life of the solar projects. All employees, contractors and subcontractors of Desert Sunlight have a responsibility to comply with all environmental laws and regulations. Most birds are protected by the federal MBTA, and eagles are further protected by the BGEPA. In addition, the state of California has an Endangered Species Act (CESA). Under the federal statutes, it is illegal to harm, harass, kill, or collect birds that may be found in the solar facility. A summary of these statutes is presented below. It is recognized that other wildlife including bats are generally not protected by federal or state law unless listed as a threatened or endangered species. However, it is the policy of FS to treat all wildlife incidents the same as avian incidents and include them in the WIRS.

It is illegal to collect an injured or dead bird without appropriate federal and state permits. **THE TOUCHING, POSSESSION, TRANSFER, OR TAMPERING WITH ANY WILDLIFE SPECIES (ALIVE OR DEAD) BY DESERT SUNLIGHT EMPLOYEES OR SUBCONTRACTORS IS STRICTLY PROHIBITED UNLESS CONSISTENT WITH PERMITS.** The WIRS is designed to provide a means of recording and collecting data about wildlife species found in the solar facilities to increase the understanding of solar and wildlife interactions. Desert Sunlight maintains an ongoing commitment to investigate wildlife incidents involving company facilities and to work cooperatively with federal and state agencies in an effort to minimize the potential for future bird and wildlife fatalities. The objective of this policy is to insure that the best available information about wildlife incidents found in Desert Sunlight facilities is recorded and the proper authorities are notified. It is the responsibility of Desert Sunlight employees, contractors and subcontractors to report all wildlife incidents as outlined in this WIRS.

APPLICABLE LAWS AND REGULATIONS

Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918 (MBTA) (16 USC 703-712) is the cornerstone of migratory bird conservation and protection in the United States. The MBTA implements four treaties that provide for international protection of migratory birds. It is a strict liability statute wherein proof of intent is not an element of a "taking" violation. Wording is clear that most actions resulting in a taking or possession (permanent or temporary) of a protected species can be a violation, regardless of intent.

Specifically, the MBTA states: “Unless and except as permitted by regulations...it shall be unlawful at any time, by any means or in any manner, to pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess…any migratory bird, any part, nest, or egg of any such bird…(The Act) prohibits the taking, killing possession, transportation, and importation of migratory birds, their eggs, parts, and nests, expect when specifically authorized by the Department of the Interior." The word "take" is defined as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap capture, or collect."

The MBTA protects 836 species of migratory birds (listed in 50 CFR 10.13), including waterfowl, shorebirds, seabirds, wading birds, raptors, and passerines. Generally, the MBTA protects all birds in the U.S. except upland gamebirds (e.g., pheasant, quail, etc), rock doves (pigeons), European starlings, and English house sparrows. Nearly all birds found at Desert Sunlight are protected under the MBTA.

Bald and Golden Eagle Protection Act

In June 1940, Congress signed into law the Bald and Golden Eagle Protection Act (BGEPA) (16 USC 668-688d) which affords additional protection to the bald and golden eagle. Specifically, the BGEPA states: “Whoever, with the United States or any place subject to the jurisdiction thereof, without being permitted to do so as provided…shall knowingly or with wanton disregard for the consequences of his act take, possess, transport…at any time or in any manner, any bald or golden eagle, alive or dead, or any part, nest or egg thereof shall be fined…that the commission of each taking or other act prohibited by this section, with respect to a bald or golden eagle, shall constitute a separate violation of this section." Penalties for violations of the BGEPA are up to $250,000 and/or 2 years imprisonment for a felony (violations are defined as a felony), with fines doubled for organizations. FS

Endangered Species Act

In 1973, the Endangered Species Act (ESA) (16 USC 1513-1543) was passed to protect endangered and threatened species and to provide a means to conserve their ecosystems. Under the ESA, Federal agencies are directed to utilize their authorities to conserve listed species, as well as "Candidate" species that may be listed in the near future, and make sure that federal agencies' actions do not jeopardize the continued existence of these species. As with the MBTA and the BGEPA, the ESA as amended prohibits the taking of species listed under the act as threatened or endangered.

BLM Sensitive Species

BLM Sensitive Species are species designated by the State Director and includes only those species that are not already federal listed proposed, or candidate species, or State listed because of potential endangerment. BLM's policy is to "ensure that actions authorized, funded, or carried out do not contribute to the need to list any of these species as threatened or endangered."

California Fish and Game Code

Sections 3511, 4700, 5050, and 5515 of the California Fish and Game Code outline protection for fully protected species of mammals, birds, reptiles, amphibians, and fish. Species that are fully protected by these sections may not be taken or possessed at any time. CDFW cannot issue permits or licenses that authorize the "take" of any fully protected species, except under certain circumstances such as scientific research and live capture and relocation of such species pursuant to a permit for the protection of livestock. Furthermore, is the responsibility of the CDFW to maintain viable populations of all native species. To that end, the CDFW has designated certain vertebrate species as Species of Special Concern because declining population levels, limited ranges, and/or continuing threats have made them vulnerable to extinction**.**

DESERT SUNLIGHT WILDLIFE INCIDENT REPORTING

The following procedures are to be followed when Desert Sunlight personnel or subcontractors discover a wildlife fatality or injury while on site. These procedures are intended to be in place for the life of the project and are independent of the post-construction monitoring studies. Prior to the initiation of operations, on-site training will be provided to Desert Sunlight personnel and subcontractors regarding the implementation of this WIRS.

When To Use The WIRS - What Constitutes A Reportable Incident?

For the purposes of this reporting system, *incident* is a general term that refers to any wildlife species, or evidence thereof, that is found dead or injured within the wind project. Note that an incident may include an injured animal and does not necessarily refer only to a carcass or fatality.

An intact carcass, carcass parts, bones, scattered feathers, or an injured wildlife species all represent reportable incidents. Desert Sunlight personnel and subcontractors shall report all such discoveries even if you are uncertain if the carcass or parts are associated with the facility.

> A ***fatality*** is any find where death occurred, such as a carcass, carcass parts, bones, or feather spot (10 or more feathers).
>
> An ***injury*** or injured animal is any wildlife species with an apparent injury, or that exhibits signs of distress to the point where it cannot move under normal means or does not display normal escape or defense behavior.

Prior to assuming a wildlife species is injured, it should be observed to determine if it cannot or does not display normal behaviors. For example, raptors will occasionally walk on the ground, especially if they have captured a prey item. Raptors also "mantle" or hold their wings out and down to cover a prey item. These types of behaviors may make the wings appear broken or the animal injured. Identification of specific behaviors typical to the life cycles and distress behaviors of wildlife will be part of the Desert Sunlight wildlife training program. Always exercise caution before approaching an injured wildlife species. **<u>Under no circumstances are site personnel that are not included in the SPUT permit allowed to handle carcasses or injured animals.</u>**

Note: *Any incident involving a federally or state listed threatened or endangered species, bald eagle, or golden eagle must be reported to USFWS and/or California Department of Fish and Wildlife (CDFW) <u>within 24 hours of identification</u>. See project personnel listing for contact information.*

<u>MATERIALS NEEDED TO REPORT AN INCIDENT</u>

1. A copy of this WIRS

2. A Wildlife Incident Report Form (see Attachment 1)
3. Project Personnel Listing and Contact Information
4. Pencil, Pen
5. Camera
6. Flagging

DESERT SUNLIGHT WILDLIFE INCIDENT REPORTING PROCEDURES

The following procedures apply if the incident involves a **Wildlife Fatality** or **Injured Wildlife Species**:

- **Leave the subject animal in place**. A flag may be used to mark its location for easy finding while the data sheet is being completed. It is recommended that any flagging be marked with the date, time, and initials of the recorder. **DO NOT HANDLE THE CARCASS.**
- **Report** the find to the Site Operations Manager immediately.
- The Site Operations Manager shall complete the following steps:
    - **Photograph** the incident as it was found in the field. Take at least two pictures: a close up shot of the animal as it lays in the field and a broader view of the animal (marked by a flag) with the road, turbines, or other local features in the view. For the close up picture, place an object (e.g., radio, pencil, coin, etc.) next to the carcass for a scale of size.
    - **Prepare a Wildlife Incident Report Form.** The form and associated instructions are presented below.
    - **Report** the find to Desert Sunlight's Environmental Department.

The following procedures apply if the incident involves an **Injured Wildlife Species**:

- **Move** to a distance far enough away that it is not visibly disturbed or uneasy due to your presence. **DO NOT ATTEMPT TO CAPTURE OR HANDLE AN INJURED ANIMAL.**
- **Report** the find immediately to the Operations Site Manager
- The Site Operations Manager shall complete the following steps:
    - **Report** the find to the Environmental Affairs Lead immediately.
    - **Contact** a local rehabilitation center (*see contact list below*) for further instructions on handling and transport/pickup of the injured animal.
    - **Prepare a Wildlife Incident Report Form.** The form and instructions for filling out the form are provided below.

*** Any incident involving a federally or state listed threatened or endangered species or a bald or golden eagle must be reported to the USFWS and/or CDFW within 24 hours of identification. These**

incidents will be reported to the agency verbally by the Operations Manager or Desert Sunlight's Environmental Department.

DESERT SUNLIGHT
WILDLIFE INCIDENT REPORTING FORM

INCIDENT DETAILS

Project Location/Name:

Name of Observer/s:_________________________ Date: ______________ Time: _________

Type of Incident: ☐ Injury ☐ Fatality

Carcass Condition: ☐ Intact Carcass ☐ Partial Carcass ☐ Feathers Only

Age of Remains (days): ☐ 1-2 (fluid filled eyes) ☐ 2-4 (maggots) ☐ 5+ (dried bones/feathers)

Photos Taken: ☐ Yes ☐ No (Take photos of - Birds: beak, legs, feathers, body. Wildlife: face and ears, tail and feet, body)

Who was notified of incident? (see contact list below)____

Comments on Carcass Condition or Behavior of Injured Animal:____
____

____
____

LOCATION

Where Found: ☐ On Access Road ☐ Solar Array ☐ Under Power Line ☐ Substation

GPS Coordinates: UTM N:__________________ UTM E:__________________ DATUM:__________

Comments on Location:____

____
____

IDENTIFICATION

☐ Bird ☐ Bat ☐ Mammal ☐ Other:___________________________

Species (to best of ability):____

Description of Color/Markings:____

Does Animal Resemble a Species of Concern discussed at Training? ☐ Yes ☐ No

Identification Remarks:____
____
_

(Describe details of - Birds: beak size, color, and shape; leg size, color, and shape; feather color; body size. Bats: color of fur and wings; muzzle long or short, tail attached or extending; ear color and shape); Other Wildlife: color of fur, any markings, and body size.

____
____

ENVIRONMENTAL CONDITIONS

Weather (Check all that apply): ☐ Clear ☐ Cloudy ☐ Rain ☐ Dust Storm

Approximate Temperature (F°):_________

Wind: ☐ Calm ☐ Breezy/Gusty ☐ Strong Winds

Habitat where found: ☐ Gravel (access road/turbine pad) ☐ Bare Ground ☐ Wash ☐ Desert scrub

OTHER NOTES/COMMENTS:____
____

CONTACT LIST (Immediately notify one of these individuals of incident)

1. Operations Manager:
2. Environmental Affairs Lead:

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Post-Construction Monitoring at the Desert Sunlight Solar Project Riverside County, California

---

2015 Fall Quarterly Interim Report

Prepared for:

Desert Sunlight 250, LLC and
Desert Sunlight 300, LLC
700 Universe Blvd.,
Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.

415 West 17th Street, Suite 2000
Cheyenne, Wyoming

February 2, 2016 rev. 2

WEST Inc.

Draft Pre-Decisional Document – Business Confidential

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from August 31 to October 31, 2015 (the fall reporting period) at Desert Sunlight Solar Farm Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the third seasonal report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS. This report and the other interim quarterly reports are considered preliminary summaries of data and information. Data and final information from all four quarterly monitoring periods will be included in a comprehensive final annual report.

Included in this report are data from standardized carcass searches conducted during the fall season at the Project, defined as August 31 to October 31, 2015. For logistical reasons, fall monitoring began on Monday, August 31, 2015. Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 29.5% sample of solar photovoltaic (PV) panels, 2) along inner portions of the fenceline, resulting in 74.4% of the length of the perimeter fence, and 3) along 47.9% of the total length of generation-tie (gen-tie) line from the Project fence to the Red Bluff Substation located south of Interstate 10 (I-10). Searches conducted within the fall season had intervals of approximately seven days.

All bird and bat fatalities and injuries that were discovered by observers, referred to as "detections" in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, there were 83 avian detections, and there were no detections of bats.

According to specifications of the BBCS, avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were applied to a fatality estimator model (Huso 2010) to provide a preliminary estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias. The estimate is considered preliminary because the annual report may pool information from bias trials and other data across seasons which could affect seasonal estimates.

During the reporting period, carcass persistence was influenced by carcass size and Project component. Small carcasses (0-100 g) in the arrays and along the fence (combined) had a 46% chance (90% confidence interval [CI]: 30 – 63%) of persisting through the effective search interval, medium carcasses (101 – 999 g) had a 80% (64 – 92%) chance, and large carcasses (1000+ g) had a 98% (95 – 100%) chance. Mean removal time within the arrays for small, medium, and large carcasses was 2.2, 17.4, and 203.3 days, respectively. Along the gen-tie line, chances of persistence for small, medium, and large carcasses were 8% (3 – 14%), 30% (17 – 43%), and 72% (58 – 87%), respectively; mean removal time for small, medium, and large

Comentado [FWS1]: Please include median removal times and n for each size class.

Comentado [FWS2]: Add median removal times and n for each size class.

carcasses was 0.1, 0.8, and 9.7 days, respectively. Within the solar arrays, searcher efficiency was influenced by carcass size: 55.7% for small birds, 82.1% for medium birds, and 82.9% for large birds. Along the interior of the fence, searcher efficiency ranged was 90.1% (CI: 78.1 – 100%), 94.9% (CI: 86.2 – 100%), and 98.0% (CI: 92.6 – 100%) for small, medium, and large carcasses, respectively. Along the gen-tie line, searcher efficiency ranged from 44.7% (CI: 27.4 – 62.4%), 62.5% (CI: 45.5 – 80%), and 81.0% (CI: 60.0 – 100%) for small, medium, and large carcasses, respectively.

Comentado [FWS3]: Please include n for each size class.

Composition of detections during fall 2015 included 13 avian guilds. Waterbirds and waterfowl comprised the majority of detections (n = 21), followed by rails and coots (n = 13), grassland birds and sparrows (n = 12), and warblers (n = 10). All other guilds were represented by fewer than ten detections. No bats have been detected since monitoring began at the Project. Species that migrate nocturnally were detected most frequently during fall (n = 21 species).

During fall 2015, 296 carcasses (90% CI: 198 – 461) were estimated for the solar arrays. There were an estimated 0.115 carcasses per acre (within the solar field only; 296 estimated carcasses/2,585 acres) and an estimated 0.538 carcasses per nameplate MW (296 estimated carcasses/550 MW) within the solar field.

Estimates of fatalities along the gen-tie are heavily influenced by the high rates of scavenging observed during the limited trials at the gen-tie (ie. large correction factors) and are likely very unreliable. The estimate along the gen-tie was 894 carcasses (90% CI: 362 – 2,948). No carcasses were estimated for the perimeter fenceline because there were no detections made along the fence.

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Tracey Johnson	Research Biologist
Lacey Jeroue	Statistician
Sarah Nichols	Designated Biologist
Pam Bullard	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2016. Post-construction monitoring at the Desert Sunlight Solar Farm Project, Riverside County, California. 2015 Fall Report. 28 pp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Project Background

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC (collectively, Desert Sunlight) constructed and operates the Desert Sunlight Solar Farm Project (referred to in this report as "Project"), which consists of two main components: 1) a 550-megawatt (MW) photovoltaic (PV) generating facility; and 2) a 220-kilovolt (kV) generation interconnection (gen-tie) line. The Project comprises approximately 1,700 hectares (ha; 4,200 acres) of land administered by the Bureau of Land Management (BLM) six miles north of Desert Center in Riverside County, California (Figure 1).

1.2 Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (2014; “BBCS”) was prepared by the Project proponent in collaboration with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and BLM to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency approval of the BBCS occurred in December 2014. Amendments to the sampling protocol along some portions of the Project fenceline were made by Desert Sunlight and approved by the BLM on February 11, 2015.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Desert Sunlight in collaboration with the USFWS, CDFW, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the gen-tie line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
3. Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

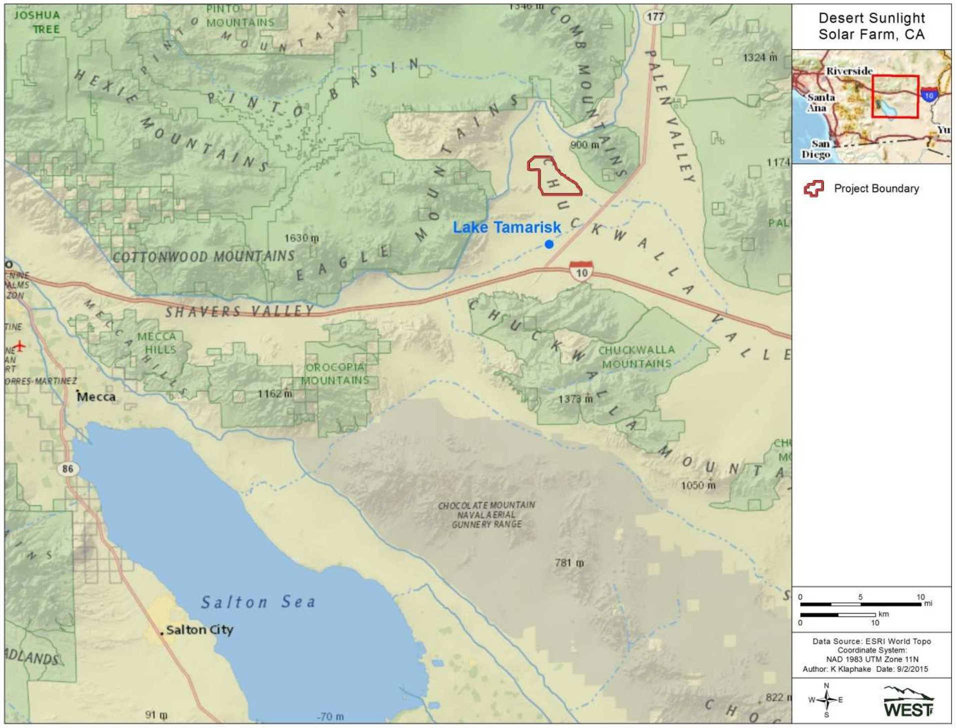


Figure 1. Desert Sunlight Solar Farm Project vicinity map, Riverside County, California.

1.3 Purpose of This Report

This report represents the third seasonal report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS. This and the other interim quarterly reports are considered preliminary summaries of data and information. Data and final information from all four quarterly monitoring periods will be included in a comprehensive final annual report.

This report covers the period August 31 to October 31, 2015, or the 2015 fall season. For logistical reasons, fall monitoring began on Monday, August 31, 2015. All carcasses and injuries that were discovered by observers are referred to as “detections” in this report. As stated in the approved BBCS, this seasonal report includes the observed detections for likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and suspected causes of death. Species composition of detections and the results of the bias trials are also reported. This report presents information related to the spatial distribution of detections, but no formal statistical analysis of the spatial distribution of carcasses will be conducted until the end of the monitoring year, given the limited data presently available.

2.0 METHODS

The BBCS describes the methods by which monitoring and certain analyses, including compilation of the overall fatality estimate, will occur. Below is an abridged description (see BBCS for detailed methods).

2.1 Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. Dead or injured birds and bats are called detections in this report to provide consistency in naming. This section also describes the methods for conducting carcass removal and searcher efficiency trials; how data were reported and analyzed; and the methods for producing fatality estimates for the Project.

2.1.1 *Areas Surveyed*

Standardized carcass searches were conducted at sampling units, which include the solar arrays (Table 1, 2; Figure 2); the “fenceline” defined as the perimeter fence for the Project (Table 1, Figure 2); and the gen-tie line (from the Project fence to the Red Bluff Substation on the south side of I-10; Table 1, Figure 3). Some overhead lines co-occur with solar arrays (medium voltage overhead lines [MVOH]). The MVOH were part of standardized carcass searches to the extent that they co-occured with solar arrays included in the sample (Table 2; Figure 2).

Table 1. Areas included in standardized carcass searches at the Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015.

Project Component	Total Size	Units	% of Component Searched
Solar arrays	1045.9	Hectares	29.5[1]
Fence	16.7	Kilometers	99.0[2]
Gen-tie line	19.2	Kilometers	47.9[3]

[1] Percent area that was searched in fall 2015. Slightly less than 30% total because of unequally-sized arrays.

[2] 74.4% of the fence is fully accessible and surveyed following the standard protocol, while approximately 25% of the fence is surveyed from a distance. Fatality rates estimated for sections of the fence that are sampled were extrapolated to sections of the fence where the standard monitoring protocol cannot be used, as described in section 4.2.6 of the approved Desert Sunlight BBCS. A very short segment near the gate is not sampled due to restoration activities.

[3] 52.1% of the gen-tie will be sampled in 2016.

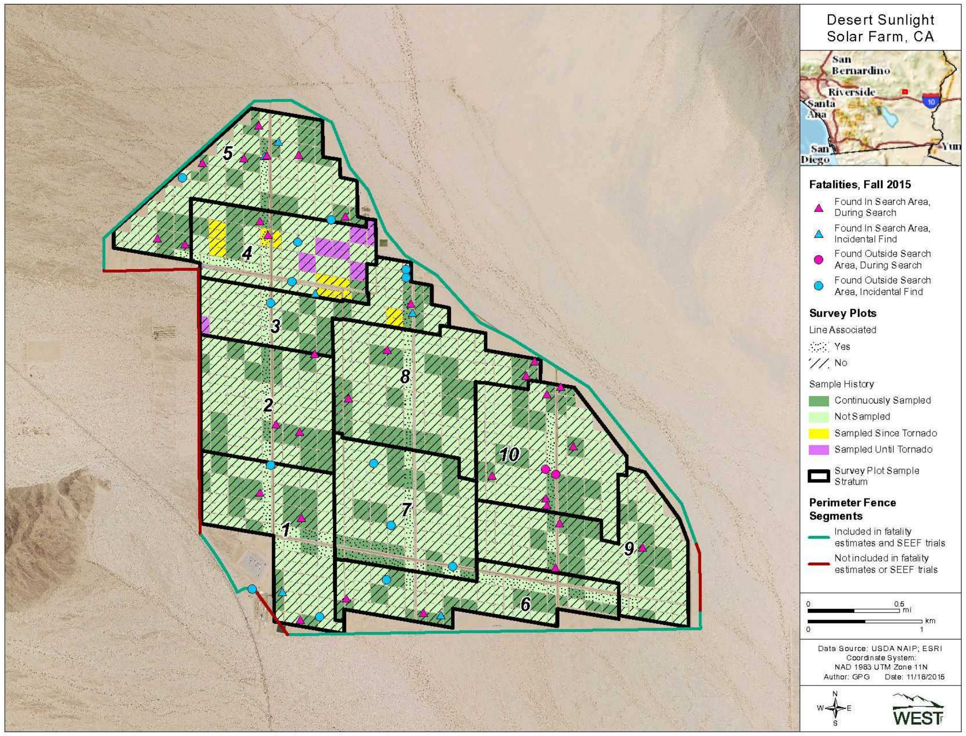


Figure 2. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at the solar field, visitor center, and overhead lines within the fence at Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015. No detections occurred along the fence during fall 2015. The detection that appears at the fence in the map was located at the visitor center.

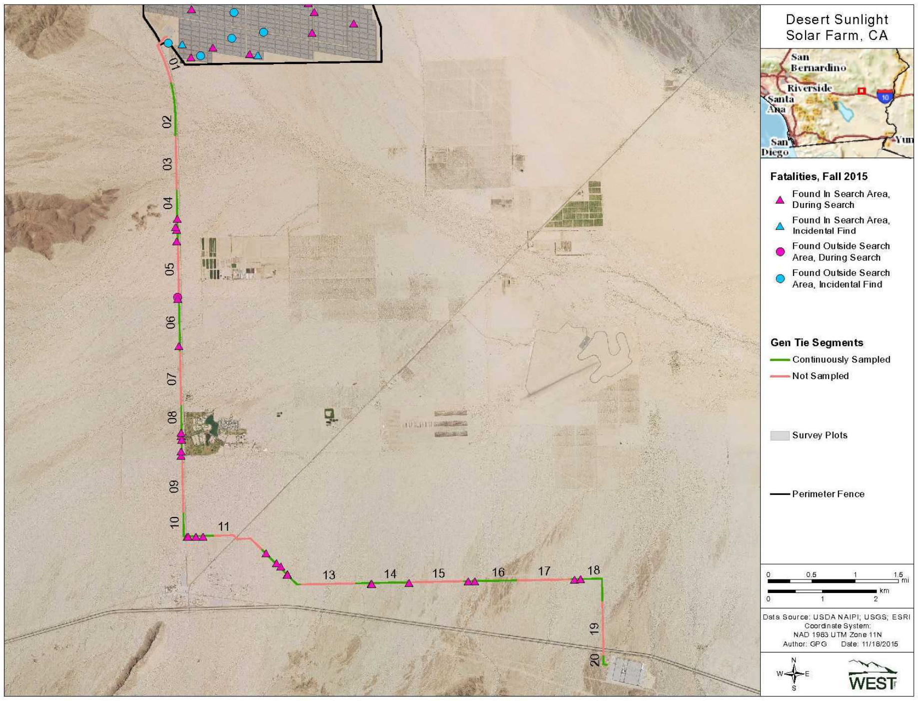


Figure 3. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance activities) along the generation tie line at the Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015. Detailed maps of detections along the line are presented in Appendix A.

To ensure a balanced distribution of sample units in the solar field (defined as the collection of all photovoltaic [PV] solar panels), the entire field was divided into ten strata, and individual sampling units were randomly selected within each stratum to compose an approximately 30% sample. This sampling design ensures that units included in the sample were not spatially clumped within the solar field. The solar field consists of arrays of solar panels (referred to as a solar array) that are either 70-m or 140-m wide. The sample includes 133 of each type of array. There are 2,580 70-m rows, and 3,900 140-m rows in the sample.

2.1.1 *Search Frequency and Timing*

Standardized searches occurred during the fall survey season, which includes the period from August 31 through October 31, 2015. All project components included in standardized searches were surveyed nine times during fall. All searches took place during daylight hours from 06:30 to 17:00.

As specified in the approved Desert Sunlight BBCS, the average search interval for all Project components included in standardized carcass searches during fall was 7.0 days (median 7.0 days). Slight variation in search interval was anticipated due to weather and logistical delays.

Table 2. Area and proportion of solar arrays that are and are not associated with overhead lines at the Desert Sunlight Solar Farm Project, Riverside County, CA.

	Line-associated[1]	Not line-associated	Proportion line-associated
Entire facility	89.4 ha	956.5 ha	0.09
Standardized searches	32.2 ha	291.0 ha	0.10

[1] Line-associated area was estimated as the area of any array that fell within the 30-m strip transect below the MVOH.

2.1.2 *Search Methods*

Standardized carcass searches were performed by BLM-approved biologists, in accordance with methods outlined in the BBCS.

Within the solar field, arrays of solar panels were surveyed by observers traveling on foot. A distance sampling approach was used, whereby biologists slowly walked a transect line along the ends of rows of solar panels in a direction perpendicular to the rows, searching ahead and to the side within the array for bird and bat detections. Biologists scanned out to a maximum perpendicular distance of approximately 70 m from the transect. Biologists carried binoculars to allow them to verify the presence of a detection versus rocks or vegetation. Once a detection was confirmed, the distance of the detection to the transect line was estimated using laser range finders. Each array included in the sample was searched by observers walking two transects – one on the west side and one on the east side of the array with observers looking toward the center of the array.

Once a carcass was detected, it was photographed, and data were recorded according to specifications outlined in section 7.2.5 of the approved Desert Sunlight BBCS. Carcasses were then retrieved from their location on the ground, labeled, and placed in a freezer on site.

Most (74.4%) of the length of fenceline (approximately 10 miles; Figure 2) was searched from a vehicle using the standard protocol. Biologists searched a 6-m wide strip transect centered on the fence from the inner perimeter. Travel speed was below five miles per hour (mph) while searching. Some sections along the fence cannot be driven close to the fence line. The fence line along the western edge of the Project is drivable but the road is approximately 15 m away from the fence and the road and fence are separated by a drainage ditch. The fence along this section is covered with a tan tarp and trees and shrubs have been planted to reduce visibility of the project from the west. Additions of vegetation and the tarp likely reduce potential for bird collision with the fence. This section of the fence was driven to document carcasses, but detections along this portion of the fence are not included in adjusted fatality estimates because detection rates are likely very low. As specified in section 4.2.6 in the approved Desert Sunlight

BBCS, we assume that fatality rates are similar between the portion of fence that was searched and the portion that was not. A separate section of the fence in the southeastern corner of the Project cannot be driven because the eastern edge of the berm that bounded construction ponds is too narrow for a vehicle. Along this portion of the fence, the observer stopped at both north and south ends of the berm and used binoculars to search for carcasses. Finally, the road along a portion of the southwest fence line near the entrance gate is approximately 30 to 50 m from the road and is separated from the fence by an area that has recently undergone vegetation restoration. This area was eliminated from sampling. Fatality rates estimated for sections of the fence that were sampled were adjusted to account for the proportion of fence not sampled with the standard monitoring protocol, as specified in section 4.2.6 of the approved Desert Sunlight BBCS.

Comentado [FWS4]: Is there a reason that this can't be done using an estimator based on the fraction that was searched?

The gen-tie line was searched using a 30-m wide strip transect (i.e., 15 m of ground on either side of the overhead line). Sample units along the gen-tie line were chosen by dividing the total length of line from the Project fence south to the Red Bluff Substation just south of I-10 into 1-km segments. Thus, a 47.9% sample of the total length of the line was searched (Figure 3). Biologists slowly walked every other 1-km segment of the line, meandering the width of the strip transect, scanning for dead or injured birds or bats within 15 m (49.2 ft) of the overhead line.

For each detection, a suspected cause of death or injury was assigned based on evidence available from the detection, evidence available on Project infrastructure, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as "unknown" because it cannot be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed. Detections assigned to the "unknown" category were included in fatality estimates if they were located within standardized carcass search areas, and all detections made during the fall season are reported here.

2.2 Carcass Persistence Trials

Carcass persistence trials were conducted throughout the fall period. Carcasses from three size classes (small [0-100 g], medium [101-999], and large [1000+ g]) were used for trials. The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), chukar (*Alectoris chukar*), and adult coturnix quail, and the large size class comprised hen mallard (*Anas platyrhynchos*) and hen ring-necked pheasant (*Phasianus colchicus*).

2.2.1 *Carcass Persistence Data Collection*

To quantify carcass persistence rates, 15 small, 10 medium, and 5 large carcasses were randomly placed and monitored along the gen-tie line during fall 2015. Within the solar arrays the same numbers of each size category were placed, for a total of 60 carcass persistence trials at Desert Sunlight during the fall season, as specified in the approved Desert Sunlight BBCS. By placing carcasses inside (within arrays and along inner perimeter of the fence) and outside (along the gen-tie) the project fence, the possibility that there are different carcass persistence rates inside and outside the project fence is accounted for. Fifteen carcasses within the Project fence (within solar arrays and along the fence) were monitored using motion-triggered digital trail cameras, while the remaining carcasses were visited on foot, for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality. No carcasses along the gen-tie line were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as “feeding stations”, trail cameras were installed five days before specimens were placed, and two fake cameras without bias trial carcasses were also placed within the Project fence and periodically moved to new locations within the fence. Periodic ground-based checking of carcasses with trail cameras also occurred to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera’s field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire Project, not just in areas subject to standard searches, and trials were initiated in smaller numbers on two different dates throughout the fall season.

Comentado [FWS5]: By placing carcasses in unsearched areas, doesn’t this introduce an unnecessary assumption that carcass persistence is the same in searched and unsearched areas? Have you tested that carcass persistence is the same in searched and unsearched areas?

Comentado [FWS6]: This isn’t clear. Is it possible to only distribute carcasses on two dates and have small numbers? Is it possible to distribute the carcass on more dates, so there are fewer “arriving” at any one time?

2.2.2 *Estimating Carcass Persistence Times*

Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g. days a carcass is present before being removed) may not be known exactly, but is known to be within a finite range. For example, suppose a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass became unavailable at some point between 7 and 10 days. This carcass would be considered “interval censored”. Similarly, if a carcass lasts the entire 30-day trial period, that carcass is “right censored”— it is known that the carcass lasted at least 30 days, but it may have persisted longer. Because carcass persistence data were censored, persistence was analyzed using methods that can accommodate censored data and still produce unbiased estimates of the probability of persistence (Therneau 2015, Therneau and Grambsch 2000). It is beyond the scope of this document to provide statistical foundations of censored-data survival models but functions identical to those provided with the USGS-developed fatality estimator software (Huso et al 2012) were used to fit survival models to the censored carcass persistence data, and some background is available in the documentation provided with that software.

USGS-developed fatality estimator software (Huso et al 2012) was used to fit survival models to the censored carcass persistence data. The USGS software used to estimate carcass persistence calculates the period over which there is less than a 1% chance for a carcass to persist. The 'effective search interval' is defined as the shorter of a) the length of time beyond which there is less than a 1% probability that a carcass persists, and b) the actual search interval (Huso 2010). The probability of persistence is given for the effective search interval, and the probability that a carcass persists through the actual search interval is equal to *p* (persist through effective search interval) * effective search interval / actual search interval.

There were four distributions implemented in survival models used to estimate the probability a carcass is unscavenged and available to be found at the end of the search interval (*r*): exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike's Information Criterion adjusted for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model with combinations of the covariates carcass size, Project component, season, and visibility, to observed carcass persistence data.

2.3 Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the fall period. Carcasses from three size classes (small, medium, and large) were used for trials. The small size class comprised house sparrows and 2-3 week old coturnix quail, the medium size class comprised rock pigeons, chukar, and older coturnix quail, and the large size class comprised hen mallards and hen ring-necked pheasants.

2.3.1 *Searcher Efficiency Data Collection*

Training of biologists on the Project-specific protocol and early assessments of habitat conditions within the solar arrays suggested that the amount of cobble present in the soil may be an important factor influencing searcher efficiency. To satisfy requirements regarding consideration of visibility class per the BBCS and address the influence of cobble cover on searcher efficiency, sample units in the solar arrays and along the gen-tie were stratified by cobble cover and assigned to one of two classes (<15% and >15% cobble cover). Classes were determined by making ocular estimates of cobble cover at each sample unit and then evaluating the frequency histogram of sample units across the range of estimated cobble cover (Figure 4). A natural break point was identified at 15% cobble cover, so the same value was chosen as the break point that defined the two cobble cover classes. Thus, in the solar arrays, two sets of searcher efficiency trials were conducted (one set in each cobble cover class; total *n* = 45 small birds, 30 medium birds, and 15 large birds as agreed upon in section 7.4 of the approved Desert Sunlight BBCS). Along the gen-tie, visibility was expected to be related to vegetation and rock cover. Thus, searcher efficiency trials along the gen-tie occurred in two visibility classes (*n* for each class = 15 small birds, 10 medium birds, and 5 large birds (easy: ≥90% bare ground, vegetation <6" tall; and more difficult: <90% bare ground, vegetation ≥6" tall). Thirty searcher efficiency trials (*n* = 15 small birds, 10 medium birds, and 5 large birds) occurred along the fence in the only visibility class present on the fence (easy visibility). During fall, a total of 180 searcher efficiency trials occurred at the Project. Locations for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches.

Comentado [FWS7]: This isn't very clear. two sets of trials should be n= 30 (s); 20 (m); 10 (l). Trial carcasses of 45, 30, 15 sounds like a multiple of three. Please clarify.

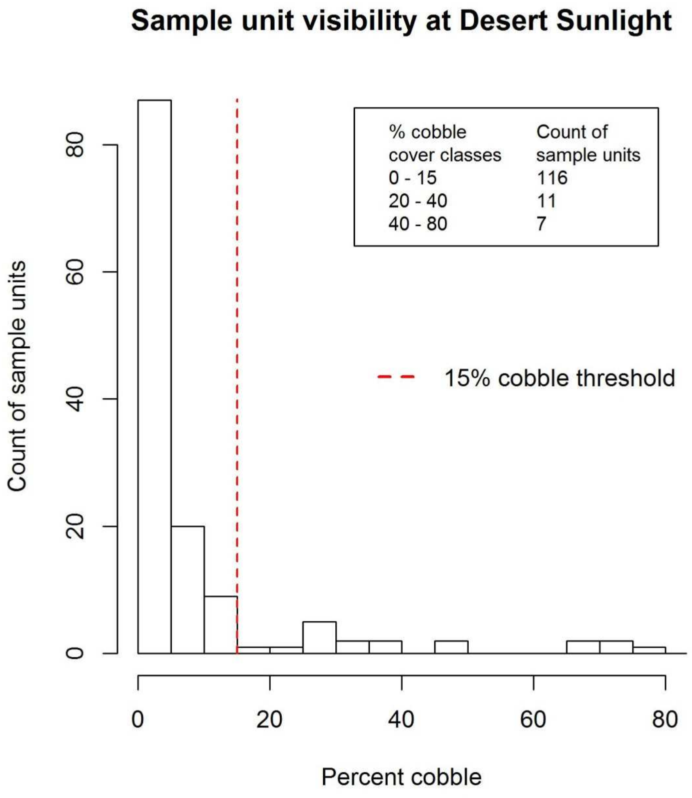


Figure 4. Frequency histogram of sample units (in the arrays only) at Desert Sunlight Solar Farm Project by estimates of cobble cover. Based on this distribution, each sample unit was assigned to one of two classes of cobble cover (<15%; >15%).

2.3.2 *Estimating Searcher Efficiency*

Searcher efficiency at Desert Sunlight was estimated separately for linear features (the project fence and the gen-tie line), and the solar arrays, reflecting the different search methods used on arrays and linear features. For linear features, logistic regression models were fit to searcher efficiency data and AICc was used to compare models. Models including effects of carcass size (three classes), visibility (two classes; gen-tie only), and season were compared to each other and the null model. Model selection indicated that the most supported model included main effects of Project component, carcass size, and season and an interaction between season and component. Once the analysis was focused on fall data only (because of the seasonal effect), the most supported model was reduced to main effects of Project component and carcass size.

Once the most supported model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, *p*, was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from the fall 2015 season.

For the solar arrays, searcher efficiency was evaluated using a distance sampling approach (Buckland et al. 1993). Distance sampling assumes perfect detection on the transect line (at distance = 0), an assumption that is likely valid in the solar arrays given the relatively flat & vegetation-free nature of the soil surface. A curve is fitted to the observed carcass data that predicts probability of detection as a function of distance from the transect line. The mean value of this function over a specified distance, *w,* is equal to the average searcher efficiency for a transect of width *w*. The mean value of the detection curve is the integral of the detection function calculated between 0-m and the maximum survey distance (*w;* half the width of the solar array row), divided by the maximum survey distance:

$$p = \frac{\int_0^w f(x)dx}{w},$$

where f(x) is the detection function evaluated at distance, *x*.

One departure in the methods used here, relative to the methods presented in Buckland et al. (1993), was that for this study the detection function was estimated using trial carcasses, which meant that there were both presence (detected) and absence (not detected) data available to fit the detection function (Figure 5). The availability of both presence and absence data means that the detection function can be estimated using only trial carcasses whose distribution is known. Therefore the detection function, the average searcher efficiency among the arrays, and the final fatality estimate within the arrays are all insensitive to the spatial distribution of carcasses within individual arrays, and the overall searcher efficiency estimate is valid even if the distribution of carcasses among the arrays is not uniform.

Distances of trial carcasses (trials both found and missed) from the transect line were used to fit half-normal, exponential, and hazard rate distribution detection functions for searches among the arrays, which are all commonly used functions for distance sampling surveys (Buckland et al. 1993). The fit of detection functions were compared using AICc and each model was fit with covariates (season, carcass size, cobble cover class), and without. The most supported detection function had an exponential distribution and the most supported among these models included an interactive effect of carcass size and season.

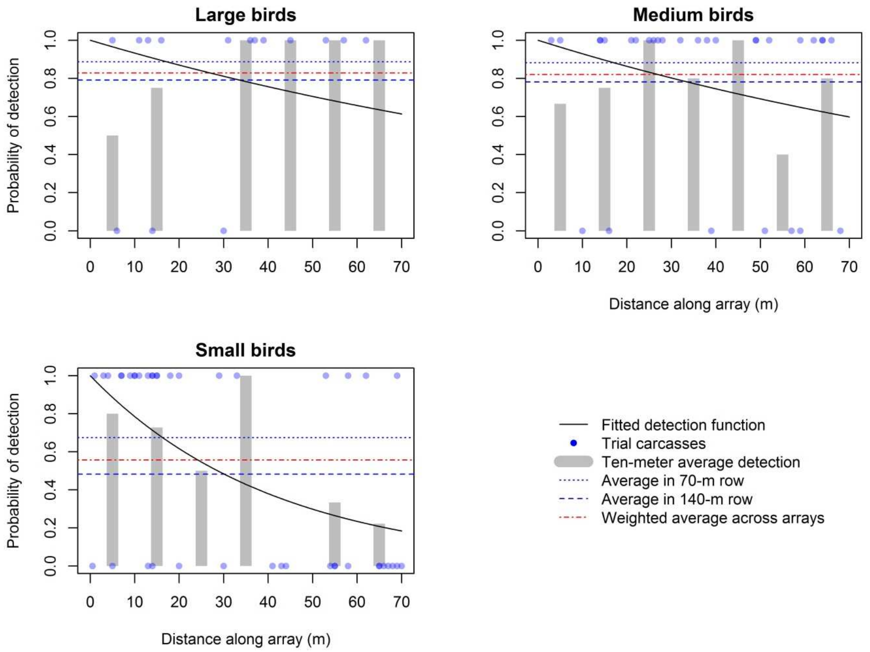


Figure 5. Estimated detection probabilities for bird carcasses by size class during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented.

Comentado [FWS8]: Please include n for each figure.

Because the solar arrays were surveyed by searchers who walked down both sides of the rows of panels, the width of the search transect was specified as half the width of the rows of panels. For larger birds, there is almost certainly a non-zero detection probability beyond this distance but the bias that occurs by ignoring this non-zero detection probability is conservative (i.e. the searcher efficiency is underestimated). Some solar arrays have row widths of 70 m (search transect width of 35 m) and some have row widths of 140 m (search transect width of 70 m). The weighted average searcher efficiency is calculated based on the number of panel rows of each length in the survey sample:

$$p_{weighted\ average} = \frac{n_{70}}{n} \times \frac{\int_0^{35} f(x)dx}{35} + \frac{n_{140}}{n} \times \frac{\int_0^{70} f(x)dx}{70},$$

where n_{70} is the number of 70-m rows in the sample, n_{140} is the number of 140-m rows in the sample, and *n* is the total number of rows in the sample. Searcher efficiency was higher for the arrays with a width of 70 m, and overall searcher efficiency was estimated as a weighted average based on the proportions of 70-m arrays and 140-m arrays in the sample units.

2.4 Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots are also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie line versus cleared areas beneath solar panels). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where F is the total number of fatalities, C is the number fatalities detected and included in fatality estimation, r is the probability a carcass is unscavenged and available to be found at the end of the search interval, and p is the probability of detecting a carcass (Huso 2010). Huso (2010) describes the use of a binomial model to estimate the probability of carcass detection; in the present study, the binomial carcass detection model was used to calculate fatalities at project linear features (fence, overhead lines), and the weighted average probability of detection based on distance sampling (described above) was used to estimate probability of detection within the solar arrays.

.

All fatality estimates were calculated using the Huso estimator estimator (modified to accommodate the distance-sampling based estimate of searcher efficiency in the solar arrays), as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates was used for each variable including of searcher efficiency (p), probability of a carcass persisting to the next search $(\hat{r})$, adjusted search interval and observed fatalities. From these bootstrap samples, the probability of available and detected was calculated and applied to the bootstrapped observed fatalities. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

2.5 Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by WEST avian biologists and operational personnel and were considered "incidental" detections. When found by operational personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the Desert

Sunlight SPUT Avian Injury and Mortality Report Forms August - October 2015. All detections made in search areas during the reporting period were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

3.0 MONITORING RESULTS

3.1 Summary of Avian Detections

During fall 2015, a total of 83 avian detections (including incidentals) of 38 identified species were recorded (Table 3). The most common identified species was American coot (*Fulica americana*) with 11 detections. Most detections (n = 54, or 65.1% of total detections) occurred in the solar arrays (Figures 2 and 3; Tables 4, 5, and 6). Sixty-two (74.7%) detections occurred during standardized carcass searches and 21 (25.3%) were documented as incidentals. No bats were detected during the fall season. For fresh carcasses, body weights and weather conditions the preceding nights are described in Appendix B.

Table 3. Number of individual bird detections, by species, during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Common Name	Scientific Name	Migration Behavior[2]	Guild	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Visitor Center	Total
American coot	*Fulica americana*	Nocturnal	Rails/Coots	2	7	0	2	0	11
mourning dove	*Zenaida macroura*	Variable	Doves/ Pigeons	0	2	0	1	1	4
unidentified bird (uknown size)	-	-	-	0	3	0	1	0	4
western grebe	*Aechmophorus occidentalis*	Nocturnal	Waterbirds/ Waterfowl	0	4	0	0	0	4
ruddy duck	*Oxyura jamaicensis*	Nocturnal	Waterbirds/ Waterfowl	1	2	0	1	0	4
western meadowlark	*Sturnella neglecta*	Diurnal	Blackbirds/ Orioles	0	2	0	1	0	3
Eurasian collared-dove	*Streptopelia decaocto*	Resident	Doves/ Pigeons	0	0	0	3	0	3
Savannah sparrow	*Passerculus sandwichensis*	Nocturnal	Grassland/ Sparrows	0	1	0	2	0	3
orange-crowned warbler	*Oreothlypis celata*	Nocturnal	Warblers	0	0	0	3	0	3
lesser goldfinch	*Spinus psaltria*	Resident	Finches/ Crossbills	0	2	0	0	0	2
Lincoln's sparrow	*Melospiza lincolnii*	Nocturnal	Grassland/ Sparrows	0	0	0	2	0	2
white-crowned sparrow	*Zonotrichia leucophrys*	Nocturnal	Grassland/ Sparrows	0	0	0	2	0	2
ring-necked pheasant[1]	*Phasianus colchicus*	Resident	Upland Game Birds	0	2	0	0	0	2
yellow-rumped warbler	*Setophaga coronata*	Nocturnal	Warblers	0	2	0	0	0	2

Comentado [FWS9]: Please specify that this includes carcasses found during searches and those found incidentally. Also, please include the size category for each species.

Table 3. Number of individual bird detections, by species, during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Comentado [FWS9]: Please specify that this includes carcasses found during searches and those found incidentally. Also, please include the size category for each species.

Common Name	Scientific Name	Migration Behavior[2]	Guild	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Visitor Center	Total
black-throated gray warbler	*Setophaga nigrescens*	Nocturnal	Warblers	1	0	0	1	0	2
unidentified teal	*Anas sp.*	-	Waterbirds/ Waterfowl	0	2	0	0	0	2
eared grebe	*Podiceps nigricollis*	Nocturnal	Waterbirds/ Waterfowl	0	2	0	0	0	2
Cooper's hawk	*Accipiter cooperii*	Diurnal	Accipiters	0	1	0	0	0	1
brown-headed cowbird	*Molothrus ater*	Diurnal	Blackbirds/ Orioles	0	0	0	1	0	1
common raven	*Corvus corax*	Resident	Corvids	0	1	0	0	0	1
black-throated sparrow	*Amphispiza bilineata*	Diurnal	Grassland/ Sparrows	0	0	0	1	0	1
American pipit	*Anthus rubescens*	Diurnal	Grassland/ Sparrows	0	1	0	0	0	1
unidentified sparrow	-	-	Grassland/ Sparrows	0	0	0	1	0	1
vesper sparrow	*Pooecetes gramineus*	Nocturnal	Grassland/ Sparrows	0	0	0	1	0	1
Brewer's sparrow	*Spizella breweri*	Nocturnal	Grassland/ Sparrows	1	0	0	0	0	1
northern mockingbird	*Mimus polyglottos*	Resident	Mimids	0	1	0	0	0	1
sora	*Porzana carolina*	Nocturnal	Rails/Coots	0	1	0	0	0	1
Virginia rail	*Rallus limicola*	Nocturnal	Rails/Coots	1	0	0	0	0	1

Table 3. Number of individual bird detections, by species, during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Common Name	Scientific Name	Migration Behavior[2]	Guild	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Visitor Center	Total
least sandpiper	*Calidris minutilla*	Both	Shorebirds	0	1	0	0	0	1
Unidentified bird (medium)	-	-	-	0	0	0	1	0	1
Unidentified bird (small)	-	-	-	0	0	0	1	0	1
Gambel's quail	*Callipepla gambelii*	Resident	Upland Game Birds	0	0	0	1	0	1
Wilson's warbler	*Cardellina pusilla*	Nocturnal	Warblers	0	1	0	0	0	1
common yellowthroat	*Geothlypis trichas*	Nocturnal	Warblers	0	0	0	1	0	1
yellow warbler	*Setophaga petechia*	Nocturnal	Warblers	1	0	0	0	0	1
northern shoveler	*Anas clypeata*	Both	Waterbirds/ Waterfowl	0	1	0	0	0	1
common loon	*Gavia immer*	Diurnal	Waterbirds/ Waterfowl	1	0	0	0	0	1
double-crested cormorant	*Phalacrocorax auritus*	Diurnal	Waterbirds/ Waterfowl	0	1	0	0	0	1
unidenitifed duck	-	-	Waterbirds/ Waterfowl	0	1	0	0	0	1
unidentified grebe	-	-	Waterbirds/ Waterfowl	0	1	0	0	0	1
northern pintail	*Anas acuta*	Nocturnal	Waterbirds/ Waterfowl	0	1	0	0	0	1
cinnamon teal	*Anas cyanoptera*	Nocturnal	Waterbirds/ Waterfowl	0	1	0	0	0	1

Comentado [FWS9]: Please specify that this includes carcasses found during searches and those found incidentally. Also, please include the size category for each species.

Table 3. Number of individual bird detections, by species, during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Common Name	Scientific Name	Migration Behavior[2]	Guild	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Visitor Center	Total
blue-winged teal	*Anas discors*	Nocturnal	Waterbirds/ Waterfowl	0	1	0	0	0	1
mallard	*Anas platyrhynchos*	Variable	Waterbirds/ Waterfowl	1	0	0	0	0	1
house wren	*Troglodytes aedon*	Nocturnal	Wrens	0	0	0	1	0	1
Total				**9**	**45**	**0**	**28**	**1**	**83**

[1] Ring-necked pheasants are used for bias trials and these two detections were likely from trial carcasses; however, ring-necked pheasants have been reported in Riverside County, CA south of the Project area near the Salton Sea (eBird 2015). Thus, we cannot be certain that these detections were exclusively from trial carcasses.

[2] See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in Birds of North America (BNA) Online (http://bna.birds.cornell.edu/bna/); where information on migration behavior was lacking in BNA accounts, Newton (2008) or Murray (2004) were used.

Comentado [FWS9]: Please specify that this includes carcasses found during searches and those found incidentally. Also, please include the size category for each species.

Comentado [FWS10]: Can you mark trial carcasses so there is no confusion? You can tie a small inconspicuous but distinctive piece of string on one leg to identify trial carcasses.

Table 4. Total avian detections by Project component and detection category during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. Only carcasses found within search areas were included in fatality estimates.

	Inside carcass search area		Outside carcass search area	
Project Component	**Carcass search**	**Incidental**	**Carcass search**	**Incidental**
Fence	0	0	0	0
Visitor Center	0	0	0	1
Gen-tie line	23	0	5	0
Solar arrays				
Line-associated	4	1	1	3
Non-line associated	28	5	1	11
Total	**55**	**6**	**7**	**15**

Table 5. Total avian detections (including incidentals) by Project component and suspected cause of death during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

	Suspected Cause of Death*				
Project Component	**Collision**	**Predation**	**Other**	**Unknown**	**Percent of Total**
Fence	0	0	0	0	0.0
Visitor Center	0	0	0	1	1.2
Gen-tie line	9	1	0	18	33.7
Solar arrays					
Line-associated	2	0	0	7	10.8
Non-line associated	6	0	1	38	54.2
Percent of Total	**20.5**	**1.2**	**1.2**	**77.1**	**100.0**

* Suspected cause of death was assigned based on evidence available on the detection, evidence available on Project infrastructure, and proximity of detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it can’t be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, there is substantial uncertainy associated with cause of death assignments because no events were directly observed.

3.2 Temporal Patterns of Avian Detections

The number of detections recorded daily during the reporting period ranged from zero to six, and were more or less evenly distributed throughout the season (Figure 6). Daily detections peaked on September 22 and this event was reported to the agencies per Special Purpose Utilities Permit Condition H(c). The number of detections per day represents those discovered during standardized carcass searches and incidentally.

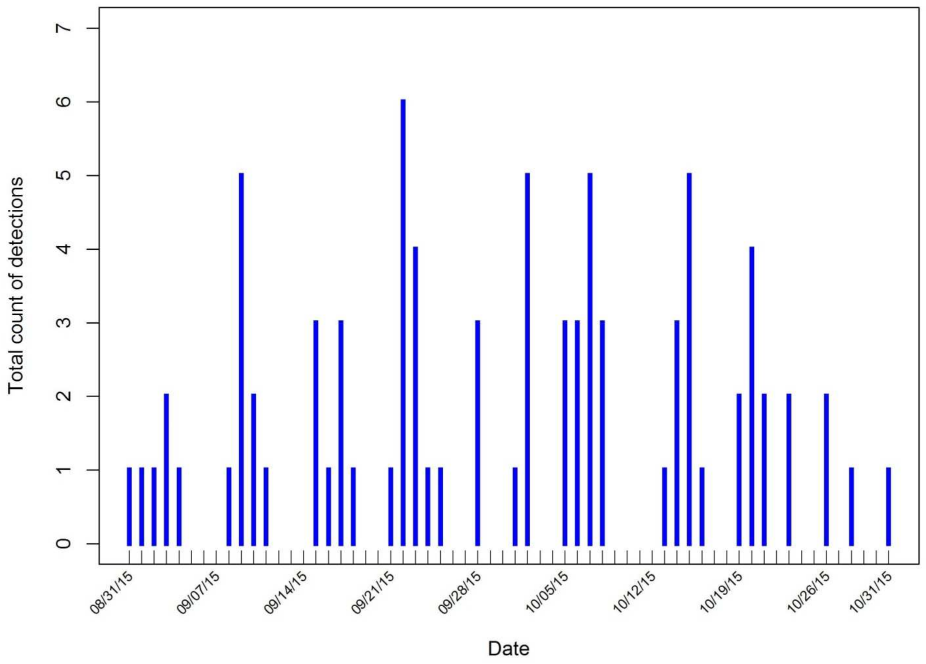


Figure 6. Total count of detections (including incidentals) by date during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.3 Spatial Distribution of Avian Detections

3.3.1 *Detections by Project Component*

During the reporting period, detections were documented from the solar arrays, the Visitor Center, and the gen-tie line; no detections occurred at the Visitor center or along the fence (Tables 3, 4, and 5). Of the 54 detections within the solar arrays, 16.7% (9) were associated either with overhead lines or arrays that co-occurred with overhead lines. Twenty-eight detections (33.7% of season total) were along the gen-tie line, and one detection (1.2% of season total) was at the Visitor Center.

3.3.2 *Feather Spot Detections*

Fourteen (16.9%) of the 83 detections made during fall consisted only of feather spots. Along the gen-tie, nine of 28 detections (32.1%) were feather spots. Five of 54 detections (9.3%) in the solar arrays were feather spots. There were no detections along the fence during fall.

3.4 Detections of Injured or Stranded Birds

There were six injured or stranded birds detected during fall 2015. Three injured birds were detected at line-associated (ruddy duck [*Oxyura jamaicensis*]) and non-line associated arrays (2; mourning dove [*Zenaida macroura*] and western grebe [*Aechmophorus occidentalis*]). Three stranded but uninjured birds were detected at line-associated (common loon [*Gavia immer*]) and non-line associated (ruddy duck and eared grebe [*Podiceps nigricollis*]) arrays. The injured mourning dove and ruddy duck were transported to wildlife rehabilitation facilities; the ruddy duck was released by the rehabilitator on the same day. The injured western grebe died before it got to a rehabilitation facility. The stranded ruddy duck, eared grebe, and common loon were evaluated for a short period for injuries and general stress and when none were observed, released at Lake Tamarisk. Three detections of injured or stranded birds were included in fall fatality estimates; three were excluded because they were found outside of a standardized carcass search area.

3.5 Summary of Bat Detections

No bats were detected during the fall 2015 season.

3.6 Carcass Persistence Trials

Data from carcass persistence trials were available from late winter, spring, summer, and fall at the solar field and gen-tie line (n = 215 total). Based on carcass persistence data from all seasons so far in 2015, survival models were compared for relative quality using the corrected AICc score, as suggested in Huso (2010). The AICc score provides a relative measure of model fit and parsimony among a selection of candidate models, and provides a framework for testing hypotheses regarding which factors contribute to carcass persistence rates. Carcass size was tested as a potentially important variable, as larger carcasses tend to persist longer and may be more likely to leave feather spots which persist for long durations, whereas smaller carcasses may be more likely to be completely removed. Project component (solar arrays, gen-tie line) was also included as a potentially important variable, as was season.

The model with lowest AICc score is typically chosen as the “most supported” model relative to other models tested; however, any model within two AICc points of the most supported model is considered competitive with the most supported model (Burnham and Anderson 2004). Preliminary modeling suggested a main effect of season, so further modeling efforts were restricted to data collected in fall only. The most supported model using only the fall data included main effects of carcass size and Project component, with a removal time that was lognormally-distributed (Appendix C). Estimates of carcass removal time and persistence probabilities from the most supported model are reported in Table 6, and estimates of proportion of carcasses remaining as a function of days since carcass placement are provided in Figure 7. Detailed estimates of carcass removal and associated confidence intervals are provided in Appendix C.

Table 6. Mean and median carcass removal time and probability of a carcass persisting through the effective search interval during the fall (August 31 – October 31) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass size	Project component	Mean removal time (days)	Median removal time (days)	Probability of persistence
Small	Arrays/fence	2.2	1.5	0.46
Small	Overhead lines	0.1	0.5	0.08
Medium	Arrays/fence	17.4	16	0.80
Medium	Overhead lines	0.8	1.5	0.30
Large	Arrays/fence	203.3	30	0.98
Large	Overhead lines	9.7	3.5	0.72

Comentado [FWS11]: Also include the Time until 50% of the carcasses have been removed.

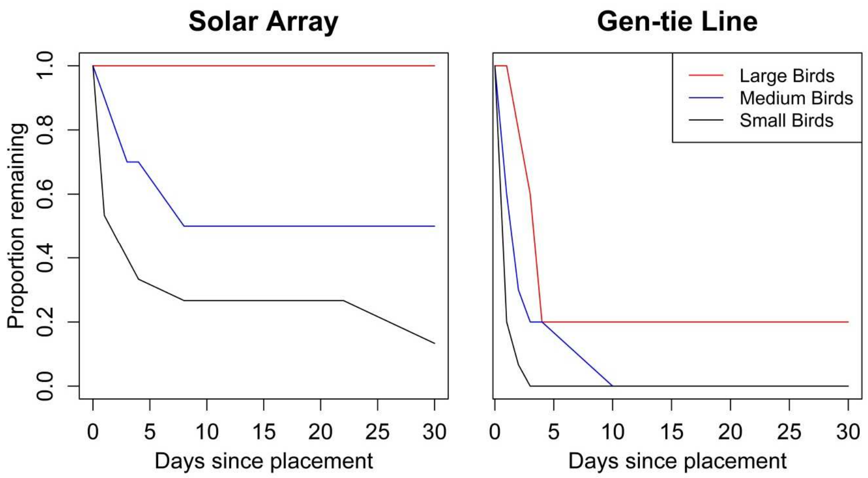


Figure 7. Proportion of trial carcasses remaining as a function of days since placement and carcass size class (n = 30, 20, and 10 for small, medium, and large size classes, respectively) during the fall (August 31 – October 31) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.7 Searcher Efficiency Trials

During the reporting period, a total of 180 searcher efficiency trials were placed at the Project. Most trials were available to be found, but some disappeared before or during the trial. Overall, 90 trials were placed in the solar arrays and 87 were available to be found; 30 trials were placed along the perimeter fence (inner perimeter only) and 29 were available to be found; and 60 trials were placed along the gen-tie line and 51 were available to be found. Three observers conducted searches at the Project during fall. Searcher efficiency trials were conducted on each observer in approximate proportion to the number of searches they conducted at the Project, as follows: Sarah Nichols (number of trials available to be found: 28), Darin Blood (62), and Wanda Bruhns (77). All trials were included in estimation of searcher efficiency.

In the solar arrays, the model that included an effect of carcass size was chosen as the most supported model to estimate searcher efficiency (Appendix C). Within the solar arrays, searcher efficiency was: 55.7% for small birds, 82.1% for medium birds, and 82.9% for large birds (Figure 5; Appendix C).

For linear Project components, the model that included an effect of carcass size, Project component, and season was chosen as the most supported model to estimate searcher efficiency. Along the fence, searcher efficiency was 90.1% (CI: 78.1 – 100%), 94.9% (CI: 86.2 – 100%), and 98.0% (CI: 92.6 – 100%) for small, medium, and large carcasses, respectively. Along the gen-tie, searcher efficiency was 44.7% (CI: 27.4 – 62.4%), 62.5% (CI: 45.5 – 80.0%), 81.0% (CI: 60.0 – 100%) for small, medium, and large carcasses, respectively. Detailed estimates of searcher efficiency estimates specific to each component and carcass size are reported in Appendix C.

3.8 Fatality Estimates

Fatality estimates were calculated separately for each component (solar arrays, fence, and overhead lines). Ultimately, 22 detections were excluded from the fatality analysis because they were found outside standardized search areas (Table 47; Appendix C). All 83 detections ~~made~~ that occurred during fall are reported in Table 3.

Table 7. Status of detections during the fall (August 31 – October 31) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California. All detections outside the search area were excluded from the fatality analysis, regardless of whether they occurred during a standardized carcass search or incidentally.

	Carcass search	**Incidental detection**	***Pushed to next season’s fatality estimate**	***Pulled from previous season’s fatality estimate**
Inside search area	55	6	0	0
Outside search area	7	15	0	0

* Incidental detections occurring after the last standardized carcass search in a season are considered for inclusion in the fatality analysis for the following season. This is consistent with the assumption we make throughout the monitoring seasons; that carcasses found incidentally would have been available to be found on the next scheduled search. This assumption may result in some carcasses found during one season but considered in the following season’s fatality analysis. Once a carcass has been moved to a different season’s analysis it is still subject to the same criteria for inclusion or exclusion based on location (in versus out of a searched area) and carcass age (greater than versus less than the search interval).

During fall 2015, 296 carcasses (90% CI: 198 – 461) were estimated for the solar arrays. There were an estimated 0.115 carcasses per acre (within the solar field only; 296 estimated carcasses/2,585 acres) and an estimated 0.538 carcasses per nameplate MW (296 estimated carcasses/550 MW) within the solar field.

Estimates of fatalities along the gen-tie are heavily influenced by the high rates of scavenging observed during the limited trials at the gen-tie (i.e., large correction factors) and are likely very unreliable. The estimate along the gen-tie was 894 carcasses (90% CI: 362 – 2,948). No carcasses were estimated for the perimeter fenceline because there were no detections made along the fence. A complete list of estimates for each Project component and carcass size class with confidence intervals is presented in Appendix C.

4.0 DISCUSSION

The 2015 fall season represented the third full season of standardized monitoring at Desert Sunlight per the BBCS. Searcher efficiency and carcass persistence trials were conducted concurrently at the solar arrays, fencelines, and along the gen-tie line. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. Although these estimates were produced from a statistically robust sample, only limited inference may be drawn from three seasons of data. These results should be considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. As more data are collected throughout the monitoring year (and additional quality assurance/quality control measures occur, for example characterizing feather spots to species or size class), data from all seasons may be pooled. At that time, data will be tested for seasonal differences retrospectively, but because seasonal estimates will be produced from the much larger annual data set, they may differ from what is reported here because they are based on a larger, more informative sample.

4.1 Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Thus, rates of carcass persistence reported here should be interpreted cautiously as they may change over the coming months.

Fatality estimates are influenced by the relationship between carcass removal dynamics and search intervals. In practical terms, longer search intervals reduce average probability that a carcass persists until the next search. In terms of the analysis, this can manifest as a lower probability of persistence through the effective search interval, or an effective search interval that is shorter than the nominal search interval. In either case, the adjustment to carcass counts due to carcass removal dynamics is calculated as

$$\frac{length\ of\ effective\ search\ interval}{length\ of\ nominal\ search\ interval * average\ probability\ of\ persistence\ through\ the\ effective\ search\ interval}$$

The adjustment to estimated fatality for carcass removal increases with longer search intervals, and the variance in the estimate may increase, also.

Carcass persistence at the Project is clearly influenced by whether a carcass is located in the solar field (inside the perimeter fence) or along the gen-tie (outside the perimeter fence), with higher removal rates occurring along the gen-tie. Although the same scavenger species may occur at both Project components, a difference in scavenger density or activity between the components could possibly be responsible for the different rates of carcass persistence. If there are differences in scavenging rates between the trial carcasses and naturally-occurring carcasses, it is possible that the high scavenging rates observed along the gen-tie have resulted in inflated fatality estimates. This hypothesis may be evaluated in the annual report by comparing persistence rates of trial carcasses to the age of carcasses detected by observers. Given the very high scavenging rates along the gen-tie line, fatality estimates for the gen-tie are unreliable.

Searcher efficiency was influenced by Project component, carcass size, and season. In the solar arrays, searcher efficiency was high (>0.5) for all carcass size classes and this is likely influenced by the limited vegetation cover beneath solar panels. Beneath the gen-tie line, vegetation cover is higher in some portions of the strip transects, but results reported here support the hypothesis that visibility class was not a factor in searcher efficiency along the gen-tie line during fall. Placement of trial carcasses in both difficult and easy visibility classes ensures that the adjustment due to searcher efficiency accounts for both visibility classes, even if there is a real difference in searcher efficiency that cannot be detected with the trial data.

4.2 Distribution of Fatalities and Fatality Estimates

Detections were distributed throughout the fall season, and there were no clear peaks in detections associated with a particular date or range of dates. Tapering of daily detections at the beginning and end of the fall season (Figure 6) suggests that the current dates that define the season likely capture the majority of fall migration at the Project.

Most (65.1%) of the 83 detections made during fall were in the solar field. Approximately 13% of the carcasses found in search plots had overhead lines associated with those plots and 10% of the plots searched had lines associated with them, suggesting overhead lines within the solar field may not influence mortality. The absence of any detections along the fence in fall coupled with the very low number of detections in previous seasons (spring: 2; summer: 1) and relatively high carcass persistence rates inside the fence suggest the perimeter fence at the Project may not be an important source of mortality.

Composition of detections during fall 2015 included 13 avian guilds. Waterbirds and waterfowl comprised the majority of detections (n = 21), followed by rails and coots (n = 13), grassland birds and sparrows (n = 12), and warblers (n = 10). All other guilds were represented by fewer than ten detections. No bats have been detected since monitoring began at the Project. Species that migrate nocturnally were detected most frequently during fall (n = 21 species). Ring-necked pheasants were included in the list of detected birds (Table 3), but these detections were most likely from trial carcasses. However, because ring-necked pheasant have been reported in

Riverside County, CA (eBird 2015) south of the Project area near the Salton Sea, we could not be certain that both detections were from trial carcasses.

Detections attributed to an unknown cause accounted for 77.1% of all detections during the reporting period, and most of those attributed to an unknown cause were found in the solar arrays. Of the 54 detections made in the solar arrays, 11.1% were feather spots. Determining a cause of mortality from a feather spot is challenging because there is rarely visible evidence available on which to determine a cause of death. Thus, feather spots with an unknown cause of mortality could be encountered anywhere birds occur, and an unknown cause of a sizeable proportion of the carcasses is not unique to the Project. Further, the relatively large proportion of feather spots (18.1%) among the detections for the Project as a whole may inflate the fatality estimate based on the potential for multiple feather spots resulting from one fatality, feather spots resulting from predation not associated with the facility, or other causes.

5.0 LITERATURE CITED

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in 2nd International Symposium on Information Theory (B. N. Petran and F. Csaki, Eds.). Akademiai Kiado, Budapest, Hungary.

Ammon, Elisabeth M. and William M. Gilbert. 1999. Wilson's warbler (*Cardellina pusilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/478

Boarman, William I. and Bernd Heinrich. 1999. Common raven (*Corvus corax*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/476 doi:10.2173/bna.476

Buckland, S, D.R. Anderson, K. P. Burnham, and J.L. Laake. 1993. Distance sampling: estimating abundance of biological populations. Chapman & Hall, London. 446 pp.

Burnham, K.P., and D.R. Anderson. 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociological Methods & Research 33: 261-304.

Evers, David C., James D. Paruk, Judith W. Mcintyre and Jack F. Barr. 2010. Common loon (*Gavia immer*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/313 doi:10.2173/bna.313

Hudon, Jocelyn. 1999. Western tanager (*Piranga ludoviciana*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/432 doi:10.2173/bna.432

Hughes, Janice M. 2011. Greater roadrunner (*Geococcyx californianus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/244 doi:10.2173/bna.244

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. doi: 10.1002/env.1052

Huso, Manuela, Som, Nicholas, and Ladd, Lew, 2012, Fatality estimator user's guide: U.S. Geological Survey Data Series 729, 22 p.

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A new method to determine bird and bat fatality at wind energy turbines from carcass searches. Wildlife Biology 17: 350-363.

Lowther, Peter E. and Janet McI. Williams. 2011. Nashville warbler (*Oreothlypis ruficapilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/205 doi:10.2173/bna.205

Manly, B.F.J.1997. Randomization, bootstrap and Monte Carlo methods in biology. Second Edition. CRC Press, LLC, Boca Raton, Florida, 455 pp.

Melvin, Scott M. and James P. Gibbs. 2012. Sora (*Porzana carolina*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/250 doi:10.2173/bna.250

Muller, Martin J. and Robert W. Storer. 1999. Pied-billed grebe (*Podilymbus podiceps*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/410 doi:10.2173/bna.410

Murray, J. 2004. Nocturnal flight call analysis as a method for monitoring density and species composition of migratory songbirds (Order Passeriformes) across southern Vancouver Island, British Columbia in 2004. Rocky Point Bird Observatory, 16 pp.

Newton, I. 2008. The migration ecology of birds. Academic Press, London.

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine-cause avian fatality estimates. Journal of Wildlife Management 74(5): 1089-1096.

Smallwood, K. S. 2013. Comparing bird and bat ratality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37(1): 19-33.

Therneau, T. 2015. _A Package for Survival Analysis in S. version 2.38, <URL: http://CRAN.R-project.org/package=survival>.

Therneau, T.M. and P. M. Grambsch 2000. Modeling Survival Data: Extending the Cox Model. Springer, New York. ISBN 0-387-98784-3.

Western Ecosystems Technology (WEST), Inc. 2014. Bird and bat conservation strategy, Desert Sunlight Solar Farm Project, Riverside County, California. 57 pp.

Wheelwright, N. T. and J. D. Rising. 2008. Savannah sparrow (*Passerculus sandwichensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/045 doi:10.2173/bna.45

Appendix A. Detailed Areas of Carcass Locations along the Generation Tie Line of the Desert Sunlight Solar Farm Project during Fall (August 31 – October 31) 2015

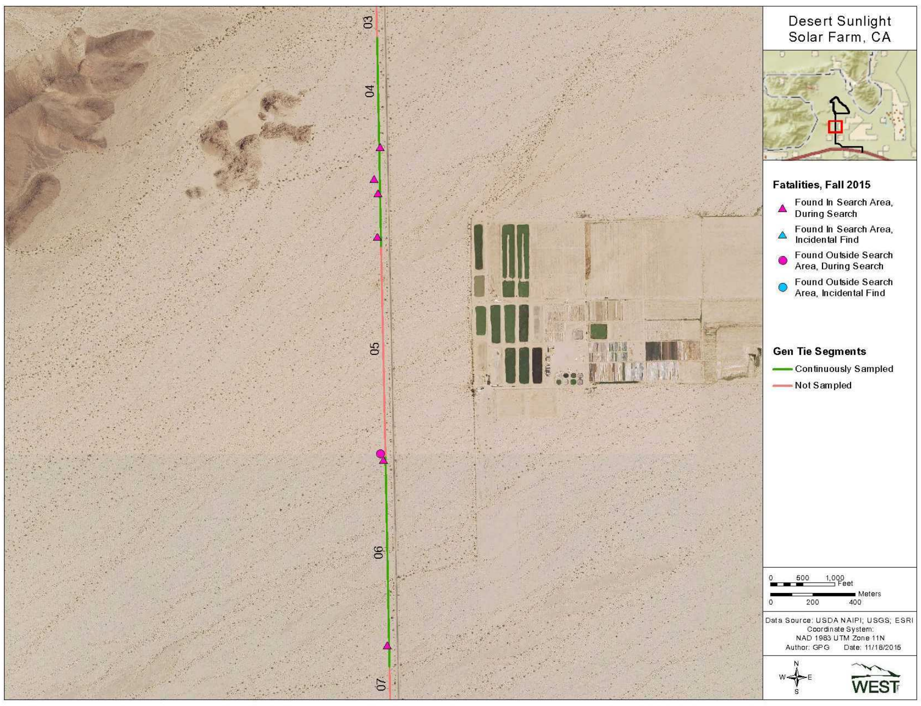


Figure A-1. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during fall (August 31 – Ocotber 31) 2015.

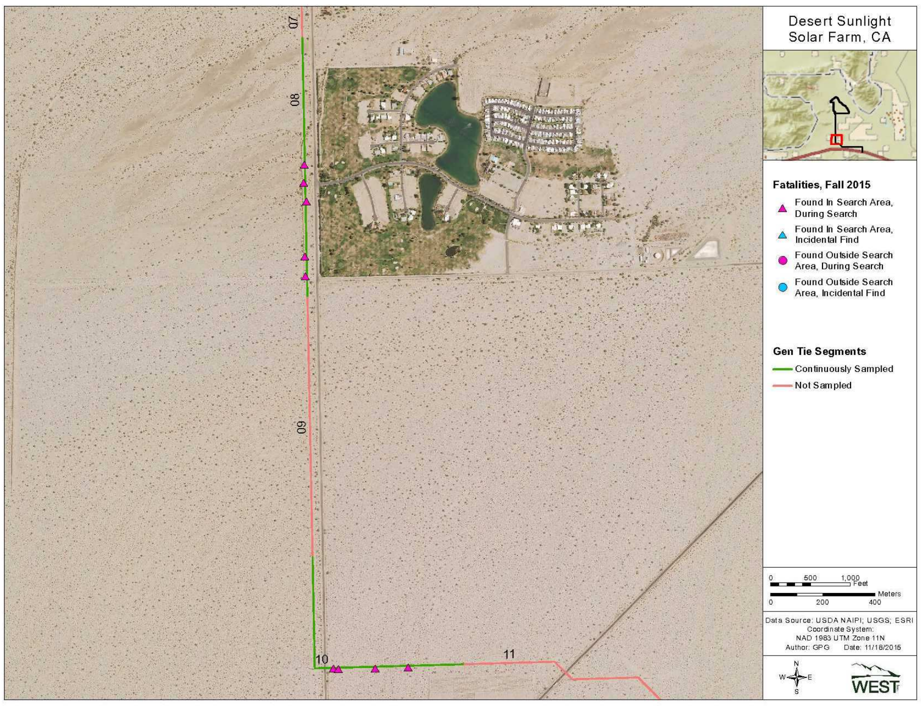


Figure A-2. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015.

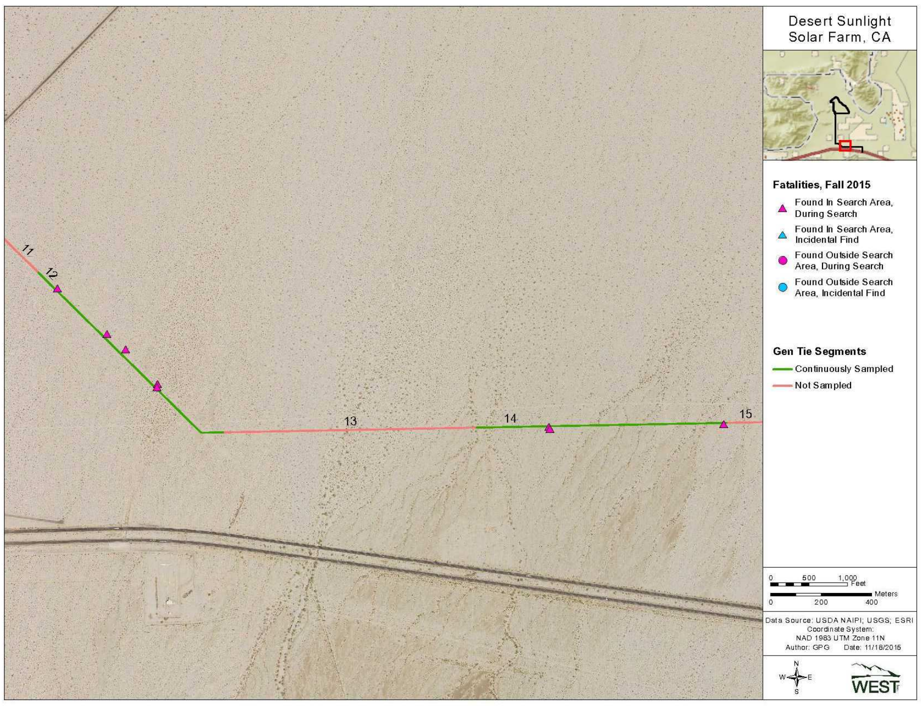


Figure A-3. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015.

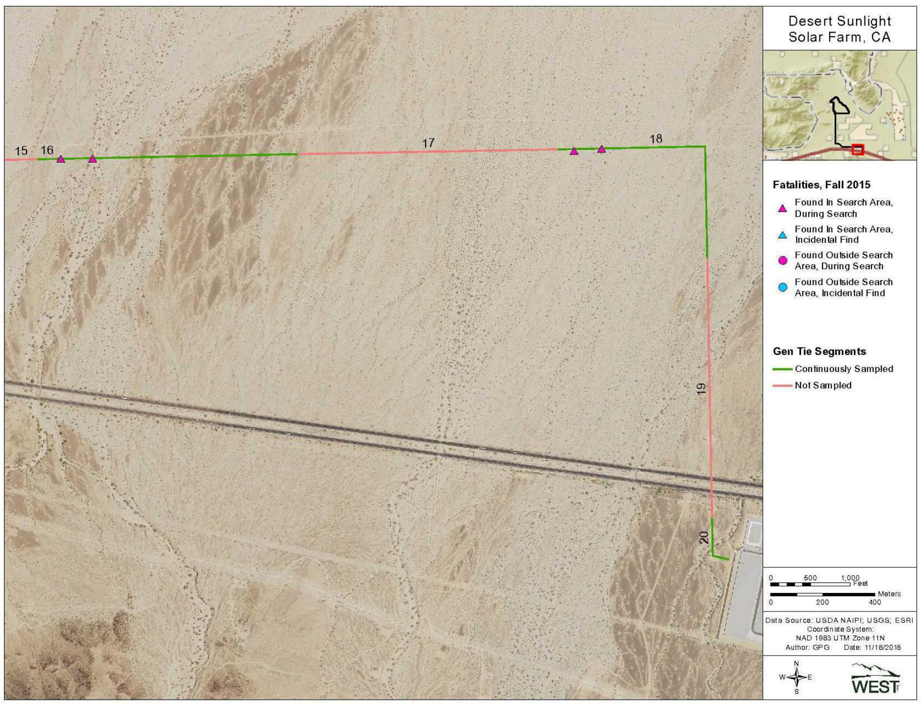


Figure A-4. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015.

Appendix B. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during Fall (August 31 – October 31) 2015

Table B-1. Weather conditions and body weights associated with detections estimated to be less than 24 hours old during fall (August 31 – October 31) 2015 at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hrs)	Species	Weight (g)[1]	Weather Summary for Preceding 24 hrs
091615-UNSP-GENTIE12-01	9/16/2015	0-8	black-throated sparrow	14	14 max wind. 8 average wind. SSE wind direction. Waxing crescent moon phase. No clouds. Very sunny and a very nice breeze ~95 degrees F.
092315-VIRA-11-15-MVOH-01	9/23/2015	0-8	Virginia rail	60	14 max wind speed. 3 average wind speed. NNE wind direction. Waxing gibbous moon phase. Max temp. 94. Clear until bird found.
100615-AMCO-GENTIE-8-01	10/6/2015	0-8	American coot	465	20 mph max wind speed. 9 mph avg wind speed. WSW wind direction. Last quarter moon phase.
100615-LISP-GENTIE-06-01	10/6/2015	0-8	Lincoln's sparrow	14	MAX WIND SPEED: 20. AVG WIND SPEED: 9. WIND DIRECTION: WSW. MOON PHASE: LAST QUARTER. MOSTLY CLOUDY
100815-EAGR-05-16-MAINROAD-02	10/8/2015	0-8	eared grebe	-	MAX WIND SPEED: 10. AVG WIND SPEED: 4. WIND DIRECTION: WSW. MOON PHASE: WANING CRESCENT. CLEAR.
101415-WEGR-07-15-A-34-01	10/14/2015	0-8	western grebe	670	MAX WIND SPEED: 13. AVG WIND SPEED: 5. WIND DIRECTION: NE. MOON PHASE: NEW MOON. CLEAR.
101515-RUDU-06-15-A-10E-02	10/15/2015	0-8	ruddy duck	-	MAX WIND SPEED: 6 MPH. AVG WIND SPEED: 3 MPH. WIND DIRECTION: ENE. MOON PHASE: WAXING CRESCENT. 10 MILE VISIBILITY
101515-RUDU-08-01-B-14-E-01	10/15/2015	0-8	ruddy duck	-	MAX WIND SPEED: 13 MPH. AVG WIND SPEED: 4 MPH. WIND DIRECTION: NW. MOON PHASE: WAXING CRESCENT. MOSTLY CLOUDY, LIGHT SPRINKLES, AVG TEMP 90 DEG F
102015-BHCO-GENTIE-10-01	10/20/2015	0-8	brown-headed cowbird	43	10-18NNW Wind, gusts to 25 MPH, waxing crescent moon, max temp 85, clear until 6pm then partly cloudy/overcast until midnight then clear until bird found
102315-COLO-04-05-A-02	10/23/2015	0-8	common loon	-	MAX WIND SPEED: 7. AVG WIND SPEED: 3. WIND DIRECTION: ENE. MOON PHASE: WAXING GIBBOUS. MAX TEMP ON 10/22 84 DEG F. CLEAR, VISIBILITY 10 MILES ON 10/22 AND 10/23
091015-BTYW-02-21-A-MVOH-04	9/9/2015	8-24	black-throated gray warbler	8	MAX WIND SPEED- 34. AVG WIND SPEED- 10. WIND DIRECTION- SSE. MOON PHASE- WANING CRESCENT. MAX TEMP 108. CLEAR UNTIL 2PM ON 09/08
090915-YWAR-18-11-A-MVOH-03	9/9/2015	8-24	yellow warbler	8	MAX WIND SPEED- 34 MPH. ANG WIND SPEED- 10. WIND DIRECTION- SSE. MOON PHASE- WANING CRESCENT. MAX TEMP- 108. CLEAR UNTIL 2PM ON

					9/08. HAZE/THUNDERSTORM UNTIL 5PM, THEN CLEAR.
092215-LISP-GENTIE-10-01	9/22/2015	8-24	Lincoln's sparrow	13	6-16mph SE wind, 9.21 max temp 91F, clear until 4pm, partly cloudy until 5pm, clear until 3am then clear/partly cloudy/overcast until bird found
092315-SAVS-GENTIE-12-03	9/23/2015	8-24	Savannah sparrow	18	3-14 mph NNE wind, waxing gibbous moon, max temp 94, clear
092515-RUDU-19-05-B-2W-01	9/25/2015	8-24	ruddy duck	-	4-14mph NE wind, waxing gibbous moon, clear until bird found
092815-WEGR-10-24-A-PCS-02	9/28/2015	8-24	western grebe	630	12 max wind speed. Gusts 16. 4 avg wind speed. ESE wind direction. Full moon phase. Max temp 105 F. Clear until bird found, according to Weather Underground. 40-55% clouds morning bird found as seen in field.
092815-YRWA-10-19-B-01W-03	9/28/2015	8-24	yellow-rumped warbler	10	12 max wind speed. Gusts 16. 4 avg wind speed. ESE wind direction. Full moon phase. Max temp 105 F. According to weather underground clear until bird found. However 40-55% clouds in field on morning of 09/28 until bird found.
100715-SAVS-GENTIE-12-01	10/7/2015	8-24	Savannah sparrow	16	MAX WIND SPEED: 13. AVG WIND SPEED: 6. WIND DIRECTION: NNW. GUSTS 17. MOON PHASE: WANING CRESCENT. HIGH TEMP 89F. CLEAR UNTIL 4 PM ON 10/06, THEN OVERCAST/ MOSTLY CLOUDY. CLEAR AGAIN FROM 7PM UNTIL BIRD FOUND ON 10/07.
100715-VESP-GENTIE-16-03	10/7/2015	8-24	vesper sparrow	23	MAX WIND SPEED: 13. ANG WIND SPEED: 6. WIND DIRECTION: NNW. MOON PHASE: WANING CRESCENT. HIGH TEMP 89 DEG F. CLEAR UNTIL 4 PM ON 10/06, THEN OVERCAST/ MOSTLY CLOUDY. CLEAR AGAIN FROM 7 PM UNTIL BIRD FOUND ON 10/07.
100715-HOWR-GENTIE-18-04	10/7/2015	8-24	house wren	9	MAX WIND SPEED: 13. AVG WIND SPEED: 6. WIND DIRECTION: NNW. GUSTS: 17. MOON PHASE: WANING CRESCENT. HIGH TEMP 89 DEF F. CLEAR UNTIL 4PM ON 10/06, THEN OVERCAST/MOSTLY CLOUDY. CLEAR AGAIN FROM 7PM UNTIL BIRD FOUND ON 10/07.
100715-WCSP-GENTIE-14-02	10/7/2015	8-24	white-crowned sparrow	24	MAX WIND SPEED: 13. AVG WIND SPEED: 6. WIND DIRECTION: NNW. MOON PHASE: WANING CRESCENT. HIGH TEMP 89 DEG F. CLEAR UNTIL 4 PM ON 10/06, THEN OVERCAST/ MOSTLY CLOUDY. CLEAR AGAIN FROM 7 PM UNTIL BIRD FOUND ON 10/07.
101315-WEME-GENTIE-10-01	10/13/2015	8-24	western meadowlark	72	MAX WIND SPEED: 9. AVG WIND SPEED: 5. WIND DIRECTION: SW. MOON PHASE: WANING CRESCENT. CLEAR.
101615-AMCO-20-08-A-7-E-01	10/16/2015	8-24	American coot		MAX WIND SPEED: 21 MPH. AVG WIND SPEED: 6 MPH. WIND DIRECTION: NNW.

102115-WCSP-GENTIE-14-01	10/21/2015	8-24	white-crowned sparrow	27	MOON PHASE: WAXING CRESCENT. HEAVY CLOUD COVER GREATER THAN 80%. T-STORM PREVIOUS NIGHT, ON 101515 (WITH RAIN AND LIGHTENING) 8-33 MPH NNW wind, waxing crescent moon, rain, thunderstorm

---

[1] Weight recorded only for intact carcasses with no evidence of scavenging.

Appendix C. Correction Factors and Bird Fatality Rates at the Desert Sunlight Solar Farm Project during Fall (August 31 – October 31) 2015.

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during fall (August 31 – October 31) 2015. *Distribution of easy and difficult visibility on the gen-tie line was 50% and 50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Proportion of area searched by component								
Gen-tie line	0.479	-	0.479	-	0.479	-	0.479	-
Fence	0.744	-	0.744	-	0.744	-	0.744	-
Solar arrays	0.295	-	0.295	-	0.295	-	0.295	-
Searcher efficiency by component and visibility class								
Gen-tie line: Easy vis.*	0.447	0.274 - 0.624	0.625	0.455 - 0.8	0.810	0.6 - 1	0.447	0.274 - 0.624
Gen-tie line: Difficult vis.*	0.447	0.274 - 0.624	0.625	0.455 - 0.8	0.810	0.6 - 1	0.447	0.274 - 0.624
Gen-tie line	0.447	0.274 - 0.624	0.625	0.455 - 0.8	0.810	0.6 - 1	0.447	0.274 - 0.624
Fence	0.901	0.781 - 1	0.949	0.862 - 1	0.980	0.926 - 1	0.901	0.781 - 1
Solar arrays	0.557	0.439 - 0.665	0.821	0.714 - 0.91	0.828	0.648 - 0.953	0.557	0.439 - 0.665
Average probability of carcass persistence through the effective search interval								
Gen-tie line	0.080	0.027 - 0.141	0.299	0.169 - 0.425	0.719	0.582 - 0.866	0.080	0.027 - 0.141
Solar arrays & fence	0.463	0.295 - 0.632	0.802	0.640 - 0.924	0.977	0.948 - 0.995	0.463	0.295 - 0.632
Carcass counts by component								
Gen-tie line	13	5 - 22	9	3 - 15	0	-	1	0 - 3
Fence	0	-	0	-	0	-	0	-
Solar arrays	10	5 - 16	18	12 - 25	7	3 - 12	3	0 - 6
Average Probability of Carcass Availability and Detected (Searcher efficiency * average probability of carcass persistence)								
Gen-tie line	0.036	0.01 - 0.07	0.187	0.098 - 0.286	0.583	0.395 - 0.771	0.036	0.01 - 0.07
Fence	0.417	0.259 - 0.581	0.761	0.595 - 0.892	0.957	0.897 - 0.988	0.417	0.259 - 0.581
Solar arrays	0.258	0.157 - 0.364	0.658	0.508 - 0.783	0.810	0.631 - 0.939	0.258	0.157 - 0.364
Adjusted Fatality Estimates (Fatalities /Season; values in italics are considered unreliable due to low counts of carcasses: carcass count / (proportion of area searched * average probability of carcass availability and detected)**								
Gen-tie line	729	229 - 2636	109	32 - 223	0	-	*56*	(1) - 243
Fence	0	-	0	-	0	-	0	-
Solar arrays	131	59 - 262	94	58 - 140	30	11 - 54	*40*	(3) - 101
Facility	860	348 - 2830	203	112 – 331	30	11 - 54	*96*	16 - 294

Comentado [FWS12]: These percentages are different than they were in the Summer report (75% and 30%). Please explain the difference.

Table C-2. Carcasses excluded from the fall 2015 fatality analysis at the Desert Sunlight Solar Farm.

Parameter	Small birds	Medium birds	Large birds	Unknown size	Bats
LA solar arrays	3	0	1	0	0
NLA solar arrays	1	8	2	1	0
Visitor Center	0	1	0	0	0
Gentie line	4	1	0	0	0

Comentado [FWS13]: Please provide more contect for this Table including the rationale for why carcasses are being excluded.

Post-Construction Monitoring at the Desert Sunlight Solar Project Riverside County, California

2015 Fall Quarterly Interim Report

Prepared for:

Desert Sunlight 250, LLC and
Desert Sunlight 300, LLC
700 Universe Blvd.,
Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.

415 West 17th Street, Suite 2000
Cheyenne, Wyoming

February 2, 2016 rev. 2

Draft Pre-Decisional Document – Business Confidential

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from August 31 to October 31, 2015 (the fall reporting period) at Desert Sunlight Solar Farm Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the third seasonal report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS. This report and the other interim quarterly reports are considered preliminary summaries of data and information. Data and final information from all four quarterly monitoring periods will be included in a comprehensive final annual report.

Included in this report are data from standardized carcass searches conducted during the fall season at the Project, defined as August 31 to October 31, 2015. For logistical reasons, fall monitoring began on Monday, August 31, 2015. Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 29.5% sample of solar photovoltaic (PV) panels, 2) along inner portions of the fenceline, resulting in 74.4% of the length of the perimeter fence, and 3) along 47.9% of the total length of generation-tie (gen-tie) line from the Project fence to the Red Bluff Substation located south of Interstate 10 (I-10). Searches conducted within the fall season had intervals of approximately seven days.

All bird and bat fatalities and injuries that were discovered by observers, referred to as "detections" in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, there were 83 avian detections, and there were no detections of bats.

According to specifications of the BBCS, avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were applied to a fatality estimator model (Huso 2010) to provide a preliminary estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias. The estimate is considered preliminary because the annual report may pool information from bias trials and other data across seasons which could affect seasonal estimates.

During the reporting period, carcass persistence was influenced by carcass size and Project component. Small carcasses (0-100 g) in the arrays and along the fence (combined) had a 46% chance (90% confidence interval [CI]: 30 – 63%) of persisting through the effective search interval, medium carcasses (101 – 999 g) had a 80% (64 – 92%) chance, and large carcasses (1000+ g) had a 98% (95 – 100%) chance. Mean removal time within the arrays for small, medium, and large carcasses was 2.2, 17.4, and 203.3 days, respectively. Along the gen-tie line, chances of persistence for small, medium, and large carcasses were 8% (3 – 14%), 30% (17 – 43%), and 72% (58 – 87%), respectively; mean removal time for small, medium, and large

carcasses was 0.1, 0.8, and 9.7 days, respectively. Within the solar arrays, searcher efficiency was influenced by carcass size: 55.7% for small birds, 82.1% for medium birds, and 82.9% for large birds. Along the fence, searcher efficiency ranged was 90.1% (CI: 78.1 – 100%), 94.9% (CI: 86.2 – 100%), and 98.0% (CI: 92.6 – 100%) for small, medium, and large carcasses, respectively. Along the gen-tie line, searcher efficiency ranged from 44.7% (CI: 27.4 – 62.4%), 62.5% (CI: 45.5 – 80%), and 81.0% (CI: 60.0 – 100%) for small, medium, and large carcasses, respectively.

Composition of detections during fall 2015 included 13 avian guilds. Waterbirds and waterfowl comprised the majority of detections (n = 21), followed by rails and coots (n = 13), grassland birds and sparrows (n = 12), and warblers (n = 10). All other guilds were represented by fewer than ten detections. No bats have been detected since monitoring began at the Project. Species that migrate nocturnally were detected most frequently during fall (n = 21 species).

During fall 2015, 296 carcasses (90% CI: 198 – 461) were estimated for the solar arrays. There were an estimated 0.115 carcasses per acre (within the solar field only; 296 estimated carcasses/2,585 acres) and an estimated 0.538 carcasses per nameplate MW (296 estimated carcasses/550 MW) within the solar field.

Estimates of fatalities along the gen-tie are heavily influenced by the high rates of scavenging observed during the limited trials at the gen-tie (ie. large correction factors) and are likely very unreliable. The estimate along the gen-tie was 894 carcasses (90% CI: 362 – 2,948). No carcasses were estimated for the perimeter fenceline because there were no detections made along the fence.

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Tracey Johnson	Research Biologist
Lacey Jeroue	Statistician
Sarah Nichols	Designated Biologist
Pam Bullard	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2016. Post-construction monitoring at the Desert Sunlight Solar Farm Project, Riverside County, California. 2015 Fall Report. 28 pp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Project Background

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC (collectively, Desert Sunlight) constructed and operates the Desert Sunlight Solar Farm Project (referred to in this report as "Project"), which consists of two main components: 1) a 550-megawatt (MW) photovoltaic (PV) generating facility; and 2) a 220-kilovolt (kV) generation interconnection (gen-tie) line. The Project comprises approximately 1,700 hectares (ha; 4,200 acres) of land administered by the Bureau of Land Management (BLM) six miles north of Desert Center in Riverside County, California (Figure 1).

1.2 Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (2014; “BBCS”) was prepared by the Project proponent in collaboration with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and BLM to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency approval of the BBCS occurred in December 2014. Amendments to the sampling protocol along some portions of the Project fenceline were made by Desert Sunlight and approved by the BLM on February 11, 2015.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Desert Sunlight in collaboration with the USFWS, CDFW, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the gen-tie line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
3. Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

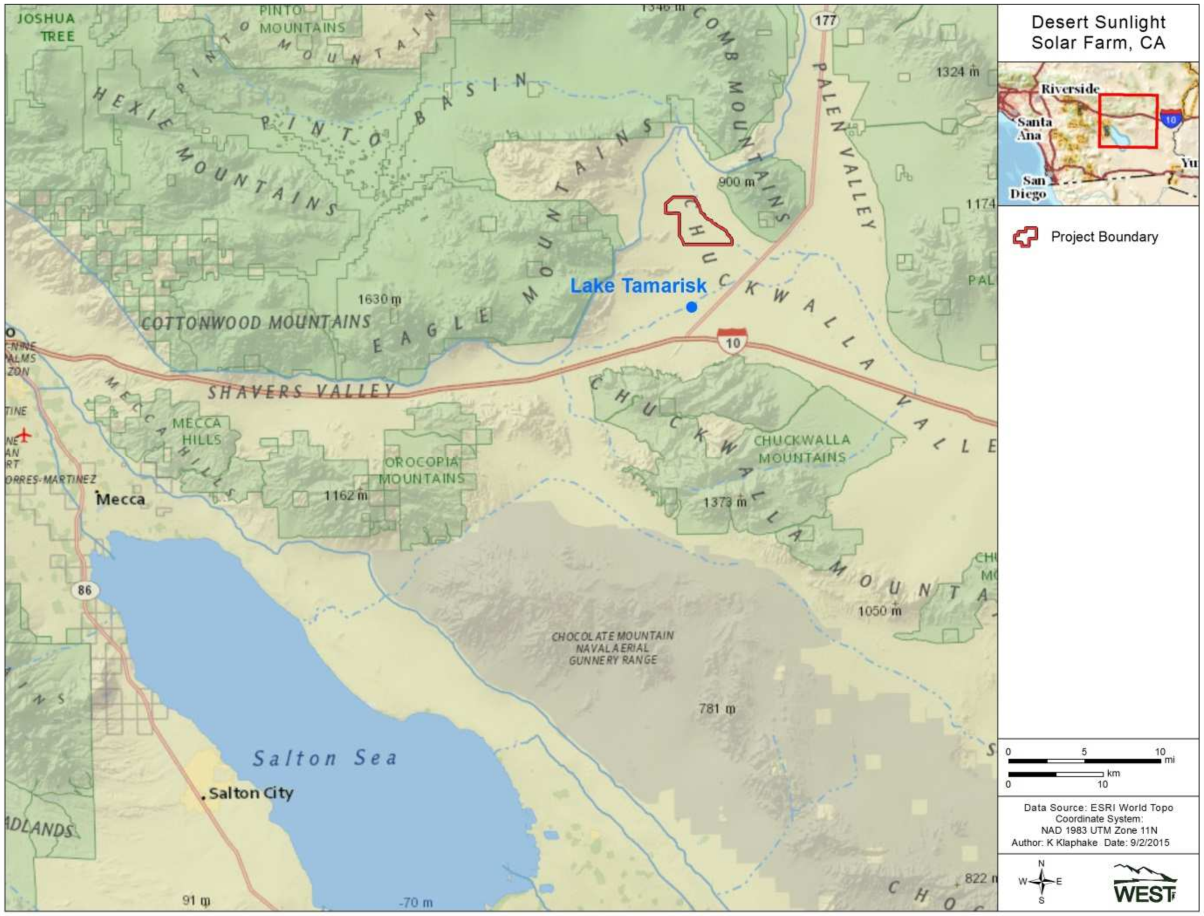


Figure 1. Desert Sunlight Solar Farm Project vicinity map, Riverside County, California.

1.3 Purpose of This Report

This report represents the third seasonal report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS. This and the other interim quarterly reports are considered preliminary summaries of data and information. Data and final information from all four quarterly monitoring periods will be included in a comprehensive final annual report.

This report covers the period August 31 to October 31, 2015, or the 2015 fall season. For logistical reasons, fall monitoring began on Monday, August 31, 2015. All carcasses and injuries that were discovered by observers are referred to as “detections” in this report. As stated in the approved BBCS, this seasonal report includes the observed detections for likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and suspected causes of death. Species composition of detections and the results of the bias trials are also reported. This report presents information related to the spatial distribution of detections, but no formal statistical analysis of the spatial distribution of carcasses will be conducted until the end of the monitoring year, given the limited data presently available.

2.0 METHODS

The BBCS describes the methods by which monitoring and certain analyses, including compilation of the overall fatality estimate, will occur. Below is an abridged description (see BBCS for detailed methods).

2.1 Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. Dead or injured birds and bats are called detections in this report to provide consistency in naming. This section also describes the methods for conducting carcass removal and searcher efficiency trials; how data were reported and analyzed; and the methods for producing fatality estimates for the Project.

2.1.1 *Areas Surveyed*

Standardized carcass searches were conducted at sampling units, which include the solar arrays (Table 1, 2; Figure 2); the "fenceline" defined as the perimeter fence for the Project (Table 1, Figure 2); and the gen-tie line (from the Project fence to the Red Bluff Substation on the south side of I-10; Table 1, Figure 3). Some overhead lines co-occur with solar arrays (medium voltage overhead lines [MVOH]). The MVOH were part of standardized carcass searches to the extent that they co-occured with solar arrays included in the sample (Table 2; Figure 2).

Table 1. Areas included in standardized carcass searches at the Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015.

Project Component	Total Size	Units	% of Component Searched
Solar arrays	1045.9	Hectares	29.5[1]
Fence	16.7	Kilometers	99.0[2]
Gen-tie line	19.2	Kilometers	47.9[3]

[1] Percent area that was searched in fall 2015. Slightly less than 30% total because of unequally-sized arrays.

[2] 74.4% of the fence is fully accessible and surveyed following the standard protocol, while approximately 25% of the fence is surveyed from a distance. Fatality rates estimated for sections of the fence that are sampled were extrapolated to sections of the fence where the standard monitoring protocol cannot be used, as described in section 4.2.6 of the approved Desert Sunlight BBCS. A very short segment near the gate is not sampled due to restoration activities.

[3] 52.1% of the gen-tie will be sampled in 2016.

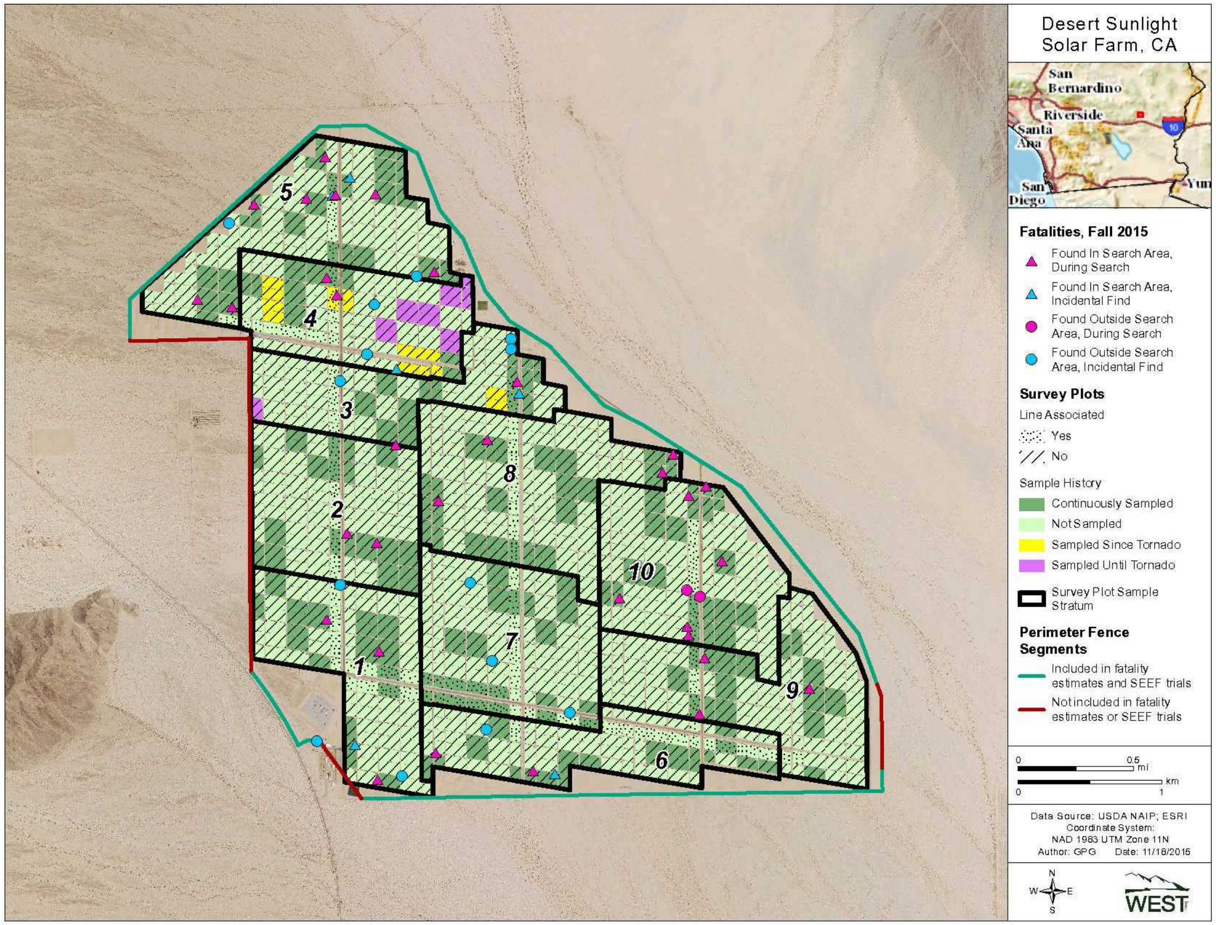


Figure 2. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at the solar field, visitor center, and overhead lines within the fence at Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015. No detections occurred along the fence during fall 2015. The detection that appears at the fence in the map was located at the visitor center.

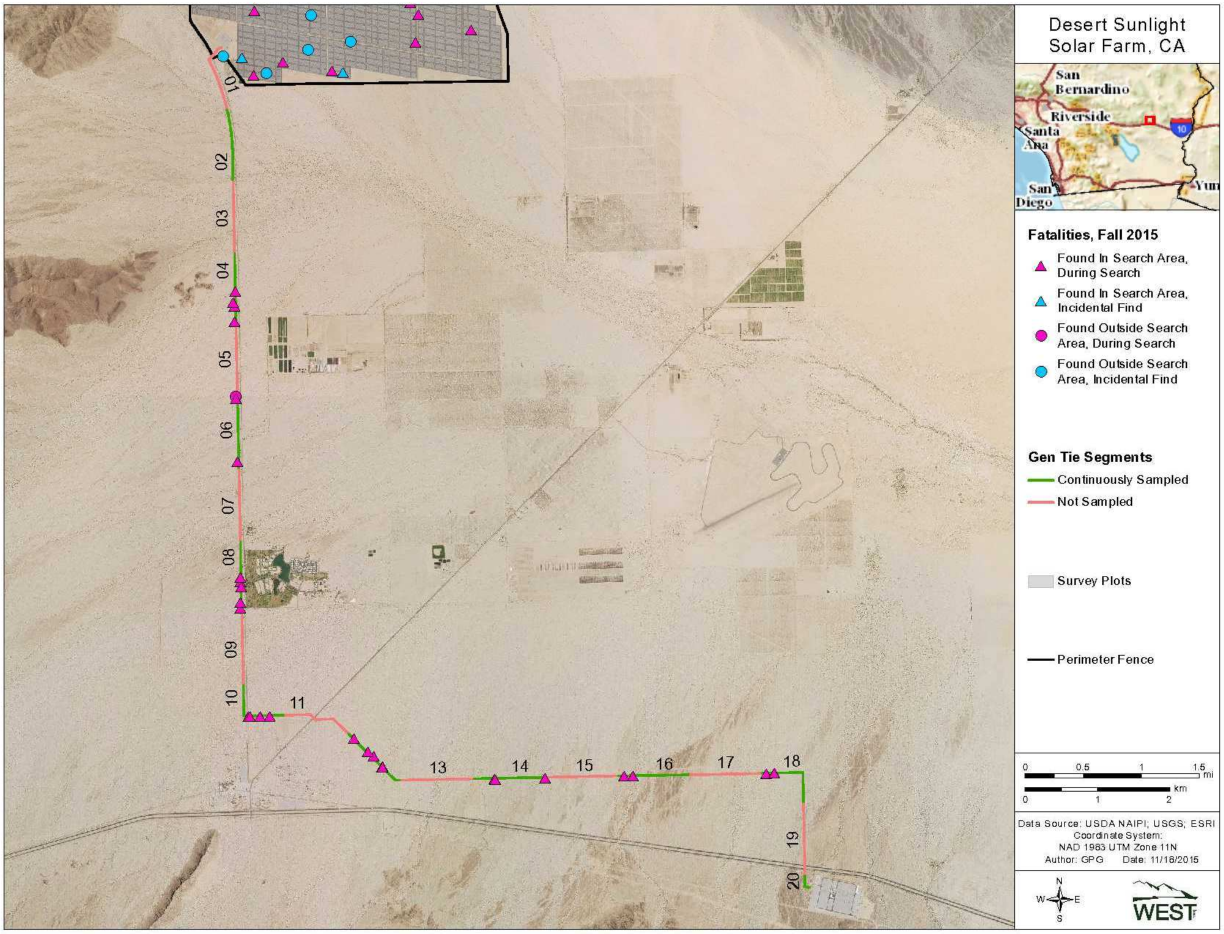


Figure 3. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance activities) along the generation tie line at the Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015. Detailed maps of detections along the line are presented in Appendix A.

To ensure a balanced distribution of sample units in the solar field (defined as the collection of all photovoltaic [PV] solar panels), the entire field was divided into ten strata, and individual sampling units were randomly selected within each stratum to compose an approximately 30% sample. This sampling design ensures that units included in the sample were not spatially clumped within the solar field. The solar field consists of arrays of solar panels (referred to as a solar array) that are either 70-m or 140-m wide. The sample includes 133 of each type of array. There are 2,580 70-m rows, and 3,900 140-m rows in the sample.

2.1.1 *Search Frequency and Timing*

Standardized searches occurred during the fall survey season, which includes the period from August 31 through October 31, 2015. All project components included in standardized searches were surveyed nine times during fall. All searches took place during daylight hours from 06:30 to 17:00.

As specified in the approved Desert Sunlight BBCS, the average search interval for all Project components included in standardized carcass searches during fall was 7.0 days (median 7.0 days). Slight variation in search interval was anticipated due to weather and logistical delays.

Table 2. Area and proportion of solar arrays that are and are not associated with overhead lines at the Desert Sunlight Solar Farm Project, Riverside County, CA.

	Line-associated[1]	Not line-associated	Proportion line-associated
Entire facility	89.4 ha	956.5 ha	0.09
Standardized searches	32.2 ha	291.0 ha	0.10

[1] Line-associated area was estimated as the area of any array that fell within the 30-m strip transect below the MVOH.

2.1.2 *Search Methods*

Standardized carcass searches were performed by BLM-approved biologists, in accordance with methods outlined in the BBCS.

Within the solar field, arrays of solar panels were surveyed by observers traveling on foot. A distance sampling approach was used, whereby biologists slowly walked a transect line along the ends of rows of solar panels in a direction perpendicular to the rows, searching ahead and to the side within the array for bird and bat detections. Biologists scanned out to a maximum perpendicular distance of approximately 70 m from the transect. Biologists carried binoculars to allow them to verify the presence of a detection versus rocks or vegetation. Once a detection was confirmed, the distance of the detection to the transect line was estimated using laser range finders. Each array included in the sample was searched by observers walking two transects – one on the west side and one on the east side of the array with observers looking toward the center of the array.

Once a carcass was detected, it was photographed, and data were recorded according to specifications outlined in section 7.2.5 of the approved Desert Sunlight BBCS. Carcasses were then retrieved from their location on the ground, labeled, and placed in a freezer on site.

Most (74.4%) of the length of fenceline (approximately 10 miles; Figure 2) was searched from a vehicle using the standard protocol. Biologists searched a 6-m wide strip transect centered on the fence from the inner perimeter. Travel speed was below five miles per hour (mph) while searching. Some sections along the fence cannot be driven close to the fence line. The fence line along the western edge of the Project is drivable but the road is approximately 15 m away from the fence and the road and fence are separated by a drainage ditch. The fence along this section is covered with a tan tarp and trees and shrubs have been planted to reduce visibility of the project from the west. Additions of vegetation and the tarp likely reduce potential for bird collision with the fence. This section of the fence was driven to document carcasses, but detections along this portion of the fence are not included in adjusted fatality estimates because detection rates are likely very low. As specified in section 4.2.6 in the approved Desert Sunlight

BBCS, we assume that fatality rates are similar between the portion of fence that was searched and the portion that was not. A separate section of the fence in the southeastern corner of the Project cannot be driven because the eastern edge of the berm that bounded construction ponds is too narrow for a vehicle. Along this portion of the fence, the observer stopped at both north and south ends of the berm and used binoculars to search for carcasses. Finally, the road along a portion of the southwest fence line near the entrance gate is approximately 30 to 50 m from the road and is separated from the fence by an area that has recently undergone vegetation restoration. This area was eliminated from sampling. Fatality rates estimated for sections of the fence that were sampled were adjusted to account for the proportion of fence not sampled with the standard monitoring protocol, as specified in section 4.2.6 of the approved Desert Sunlight BBCS.

The gen-tie line was searched using a 30-m wide strip transect (i.e., 15 m of ground on either side of the overhead line). Sample units along the gen-tie line were chosen by dividing the total length of line from the Project fence south to the Red Bluff Substation just south of I-10 into 1-km segments. Thus, a 47.9% sample of the total length of the line was searched (Figure 3). Biologists slowly walked every other 1-km segment of the line, meandering the width of the strip transect, scanning for dead or injured birds or bats within 15 m (49.2 ft) of the overhead line.

For each detection, a suspected cause of death or injury was assigned based on evidence available from the detection, evidence available on Project infrastructure, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it cannot be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed. Detections assigned to the “unknown” category were included in fatality estimates if they were located within standardized carcass search areas, and all detections made during the fall season are reported here.

2.2 Carcass Persistence Trials

Carcass persistence trials were conducted throughout the fall period. Carcasses from three size classes (small [0-100 g], medium [101-999], and large [1000+ g]) were used for trials. The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), chukar (*Alectoris chukar*), and adult coturnix quail, and the large size class comprised hen mallard (*Anas platyrhynchos*) and hen ring-necked pheasant (*Phasianus colchicus*).

2.2.1 *Carcass Persistence Data Collection*

To quantify carcass persistence rates, 15 small, 10 medium, and 5 large carcasses were randomly placed and monitored along the gen-tie line during fall 2015. Within the solar arrays the same numbers of each size category were placed, for a total of 60 carcass persistence trials at Desert Sunlight during the fall season, as specified in the approved Desert Sunlight BBCS. By placing carcasses inside (within arrays and along inner perimeter of the fence) and outside (along the gen-tie) the project fence, the possibility that there are different carcass persistence rates inside and outside the project fence is accounted for. Fifteen carcasses within the Project fence (within solar arrays and along the fence) were monitored using motion-triggered digital trail cameras, while the remaining carcasses were visited on foot, for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality. No carcasses along the gen-tie line were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as “feeding stations”, trail cameras were installed five days before specimens were placed, and two fake cameras without bias trial carcasses were also placed within the Project fence and periodically moved to new locations within the fence. Periodic ground-based checking of carcasses with trail cameras also occurred to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera’s field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire Project, not just in areas subject to standard searches, and trials were initiated in smaller numbers on two different dates throughout the fall season.

2.2.2 *Estimating Carcass Persistence Times*

Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g. days a carcass is present before being removed) may not be known exactly, but is known to be within a finite range. For example, suppose a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass became unavailable at some point between 7 and 10 days. This carcass would be considered “interval censored”. Similarly, if a carcass lasts the entire 30-day trial period, that carcass is “right censored”— it is known that the carcass lasted at least 30 days, but it may have persisted longer. Because carcass persistence data were censored, persistence was analyzed using methods that can accommodate censored data and still produce unbiased estimates of the probability of persistence (Therneau 2015, Therneau and Grambsch 2000). It is beyond the scope of this document to provide statistical foundations of censored-data survival models but functions identical to those provided with the USGS-developed fatality estimator software (Huso et al 2012) were used to fit survival models to the censored carcass persistence data, and some background is available in the documentation provided with that software.

USGS-developed fatality estimator software (Huso et al 2012) was used to fit survival models to the censored carcass persistence data. The USGS software used to estimate carcass persistence calculates the period over which there is less than a 1% chance for a carcass to persist. The 'effective search interval' is defined as the shorter of a) the length of time beyond which there is less than a 1% probability that a carcass persists, and b) the actual search interval (Huso 2010). The probability of persistence is given for the effective search interval, and the probability that a carcass persists through the actual search interval is equal to *p* (persist through effective search interval) * effective search interval / actual search interval.

There were four distributions implemented in survival models used to estimate the probability a carcass is unscavenged and available to be found at the end of the search interval (*r)*: exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike's Information Criterion adjusted for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model with combinations of the covariates carcass size, Project component, season, and visibility, to observed carcass persistence data.

2.3 Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the fall period. Carcasses from three size classes (small, medium, and large) were used for trials. The small size class comprised house sparrows and 2-3 week old coturnix quail, the medium size class comprised rock pigeons, chukar, and older coturnix quail, and the large size class comprised hen mallards and hen ring-necked pheasants.

2.3.1 *Searcher Efficiency Data Collection*

Training of biologists on the Project-specific protocol and early assessments of habitat conditions within the solar arrays suggested that the amount of cobble present in the soil may be an important factor influencing searcher efficiency. To satisfy requirements regarding consideration of visibility class per the BBCS and address the influence of cobble cover on searcher efficiency, sample units in the solar arrays and along the gen-tie were stratified by cobble cover and assigned to one of two classes (<15% and >15% cobble cover). Classes were determined by making ocular estimates of cobble cover at each sample unit and then evaluating the frequency histogram of sample units across the range of estimated cobble cover (Figure 4). A natural break point was identified at 15% cobble cover, so the same value was chosen as the break point that defined the two cobble cover classes. Thus, in the solar arrays, two sets of searcher efficiency trials were conducted (one set in each cobble cover class; total *n* = 45 small birds, 30 medium birds, and 15 large birds as agreed upon in section 7.4 of the approved Desert Sunlight BBCS). Along the gen-tie, visibility was expected to be related to vegetation and rock cover. Thus, searcher efficiency trials along the gen-tie occurred in two visibility classes (*n* for each class = 15 small birds, 10 medium birds, and 5 large birds (easy: ≥90% bare ground, vegetation <6" tall; and more difficult: <90% bare ground, vegetation ≥6" tall). Thirty searcher efficiency trials (*n* = 15 small birds, 10 medium birds, and 5 large birds) occurred along the fence in the only visibility class present on the fence (easy visibility). During fall, a total of 180 searcher efficiency trials occurred at the Project. Locations for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches.

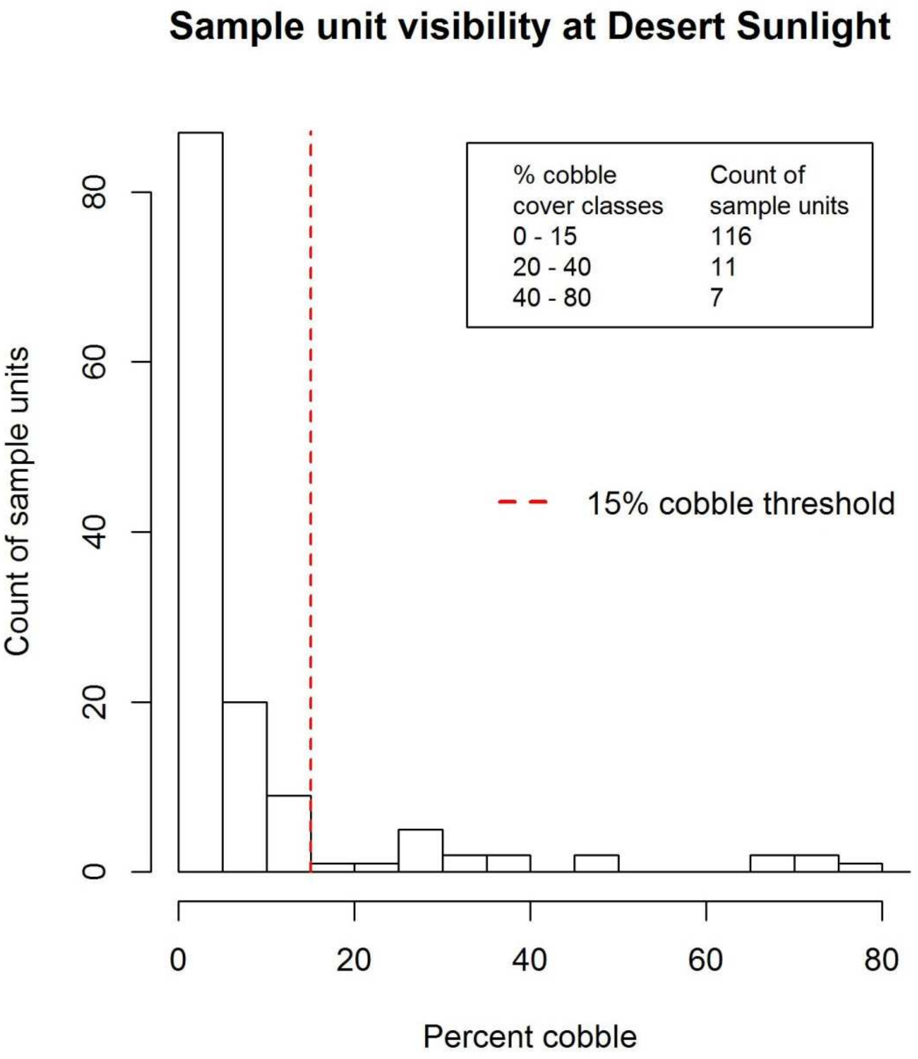


Figure 4. Frequency histogram of sample units (in the arrays only) at Desert Sunlight Solar Farm Project by estimates of cobble cover. Based on this distribution, each sample unit was assigned to one of two classes of cobble cover (<15%; >15%).

2.3.2 *Estimating Searcher Efficiency*

Searcher efficiency at Desert Sunlight was estimated separately for linear features (the project fence and the gen-tie line), and the solar arrays, reflecting the different search methods used on arrays and linear features. For linear features, logistic regression models were fit to searcher efficiency data and AICc was used to compare models. Models including effects of carcass size (three classes), visibility (two classes; gen-tie only), and season were compared to each other and the null model. Model selection indicated that the most supported model included main effects of Project component, carcass size, and season and an interaction between season and component. Once the analysis was focused on fall data only (because of the seasonal effect), the most supported model was reduced to main effects of Project component and carcass size.

Once the most supported model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, *p*, was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from the fall 2015 season.

For the solar arrays, searcher efficiency was evaluated using a distance sampling approach (Buckland et al. 1993). Distance sampling assumes perfect detection on the transect line (at distance = 0), an assumption that is likely valid in the solar arrays given the relatively flat & vegetation-free nature of the soil surface. A curve is fitted to the observed carcass data that predicts probability of detection as a function of distance from the transect line. The mean value of this function over a specified distance, *w,* is equal to the average searcher efficiency for a transect of width *w*. The mean value of the detection curve is the integral of the detection function calculated between 0-m and the maximum survey distance (*w;* half the width of the solar array row), divided by the maximum survey distance:

$$p = \frac{\int_0^w f(x)dx}{w},$$

where f(x) is the detection function evaluated at distance, *x*.

One departure in the methods used here, relative to the methods presented in Buckland et al. (1993), was that for this study the detection function was estimated using trial carcasses, which meant that there were both presence (detected) and absence (not detected) data available to fit the detection function (Figure 5). The availability of both presence and absence data means that the detection function can be estimated using only trial carcasses whose distribution is known. Therefore the detection function, the average searcher efficiency among the arrays, and the final fatality estimate within the arrays are all insensitive to the spatial distribution of carcasses within individual arrays, and the overall searcher efficiency estimate is valid even if the distribution of carcasses among the arrays is not uniform.

Distances of trial carcasses (trials both found and missed) from the transect line were used to fit half-normal, exponential, and hazard rate distribution detection functions for searches among the arrays, which are all commonly used functions for distance sampling surveys (Buckland et al. 1993). The fit of detection functions were compared using AICc and each model was fit with covariates (season, carcass size, cobble cover class), and without. The most supported detection function had an exponential distribution and the most supported among these models included an interactive effect of carcass size and season.

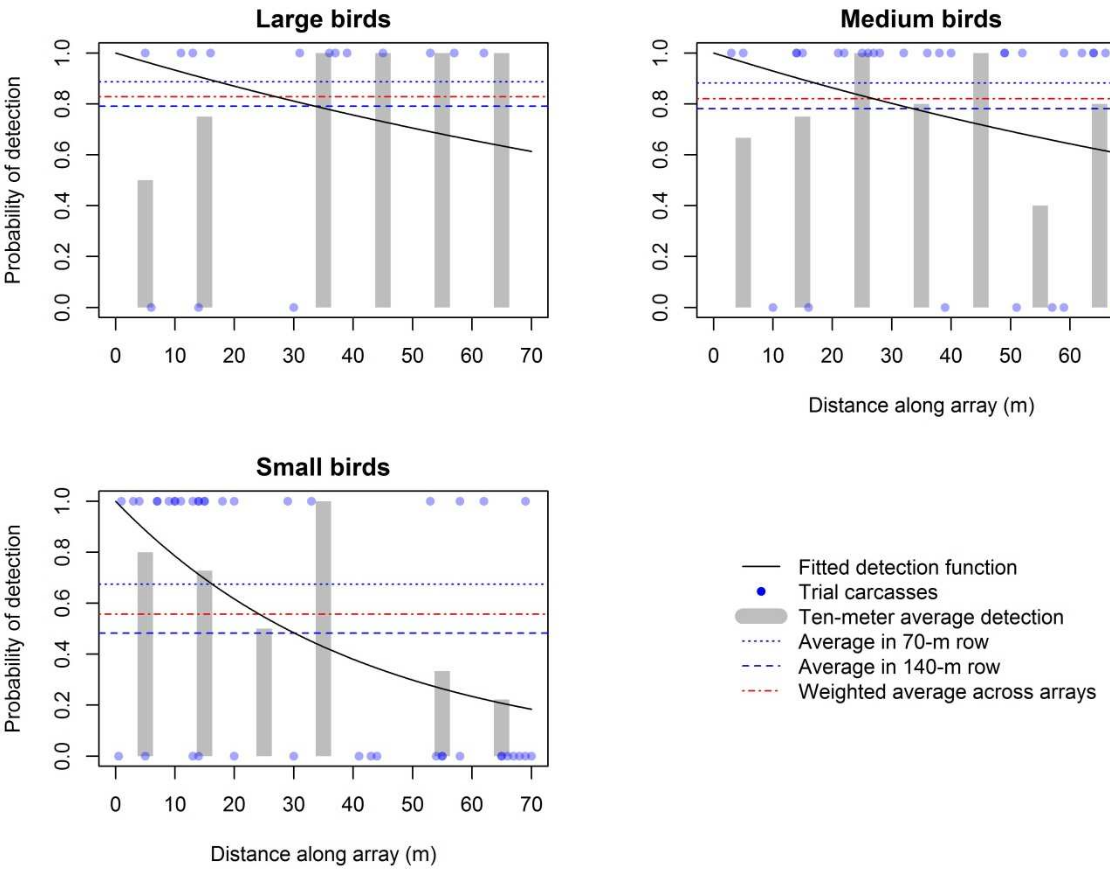


Figure 5. Estimated detection probabilities for bird carcasses by size class during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented.

Because the solar arrays were surveyed by searchers who walked down both sides of the rows of panels, the width of the search transect was specified as half the width of the rows of panels. For larger birds, there is almost certainly a non-zero detection probability beyond this distance but the bias that occurs by ignoring this non-zero detection probability is conservative (i.e. the searcher efficiency is underestimated). Some solar arrays have row widths of 70 m (search transect width of 35 m) and some have row widths of 140 m (search transect width of 70 m). The weighted average searcher efficiency is calculated based on the number of panel rows of each length in the survey sample:

$$p_{weighted\ average} = \frac{n_{70}}{n} \times \frac{\int_0^{35} f(x)dx}{35} + \frac{n_{140}}{n} \times \frac{\int_0^{70} f(x)dx}{70},$$

where n_{70} is the number of 70-m rows in the sample, n_{140} is the number of 140-m rows in the sample, and *n* is the total number of rows in the sample. Searcher efficiency was higher for the arrays with a width of 70 m, and overall searcher efficiency was estimated as a weighted average based on the proportions of 70-m arrays and 140-m arrays in the sample units.

2.4 Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots are also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie line versus cleared areas beneath solar panels). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where F is the total number of fatalities, C is the number fatalities detected and included in fatality estimation, r is the probability a carcass is unscavenged and available to be found at the end of the search interval, and p is the probability of detecting a carcass (Huso 2010). Huso (2010) describes the use of a binomial model to estimate the probability of carcass detection; in the present study, the binomial carcass detection model was used to calculate fatalities at project linear features (fence, overhead lines), and the weighted average probability of detection based on distance sampling (described above) was used to estimate probability of detection within the solar arrays.

.

All fatality estimates were calculated using the Huso estimator estimator (modified to accommodate the distance-sampling based estimate of searcher efficiency in the solar arrays), as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates was used for each variable including of searcher efficiency (p), probability of a carcass persisting to the next search $(\hat{r})$, adjusted search interval and observed fatalities. From these bootstrap samples, the probability of available and detected was calculated and applied to the bootstrapped observed fatalities. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

2.5 Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by WEST avian biologists and operational personnel and were considered “incidental” detections. When found by operational personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the Desert

Sunlight SPUT Avian Injury and Mortality Report Forms August - October 2015. All detections made in search areas during the reporting period were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

3.0 MONITORING RESULTS

3.1 Summary of Avian Detections

During fall 2015, a total of 83 avian detections (including incidentals) of 38 identified species were recorded (Table 3). The most common identified species was American coot (*Fulica americana*) with 11 detections. Most detections (n = 54, or 65.1% of total detections) occurred in the solar arrays (Figures 2 and 3; Tables 4, 5, and 6). Sixty-two (74.7%) detections occurred during standardized carcass searches and 21 (25.3%) were documented as incidentals. No bats were detected during the fall season. For fresh carcasses, body weights and weather conditions the preceding nights are described in Appendix B.

Table 3. Number of individual bird detections, by species, during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Common Name	Scientific Name	Migration Behavior[2]	Guild	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Visitor Center	Total
American coot	*Fulica americana*	Nocturnal	Rails/Coots	2	7	0	2	0	11
mourning dove	*Zenaida macroura*	Variable	Doves/ Pigeons	0	2	0	1	1	4
unidentified bird (uknown size)	-	-	-	0	3	0	1	0	4
western grebe	*Aechmophorus occidentalis*	Nocturnal	Waterbirds/ Waterfowl	0	4	0	0	0	4
ruddy duck	*Oxyura jamaicensis*	Nocturnal	Waterbirds/ Waterfowl	1	2	0	1	0	4
western meadowlark	*Sturnella neglecta*	Diurnal	Blackbirds/ Orioles	0	2	0	1	0	3
Eurasian collared-dove	*Streptopelia decaocto*	Resident	Doves/ Pigeons	0	0	0	3	0	3
Savannah sparrow	*Passerculus sandwichensis*	Nocturnal	Grassland/ Sparrows	0	1	0	2	0	3
orange-crowned warbler	*Oreothlypis celata*	Nocturnal	Warblers	0	0	0	3	0	3
lesser goldfinch	*Spinus psaltria*	Resident	Finches/ Crossbills	0	2	0	0	0	2
Lincoln's sparrow	*Melospiza lincolnii*	Nocturnal	Grassland/ Sparrows	0	0	0	2	0	2
white-crowned sparrow	*Zonotrichia leucophrys*	Nocturnal	Grassland/ Sparrows	0	0	0	2	0	2
ring-necked pheasant[1]	*Phasianus colchicus*	Resident	Upland Game Birds	0	2	0	0	0	2
yellow-rumped warbler	*Setophaga coronata*	Nocturnal	Warblers	0	2	0	0	0	2

Table 3. Number of individual bird detections, by species, during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Common Name	Scientific Name	Migration Behavior[2]	Guild	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Visitor Center	Total
black-throated gray warbler	*Setophaga nigrescens*	Nocturnal	Warblers	1	0	0	1	0	2
unidentified teal	*Anas sp.*	-	Waterbirds/ Waterfowl	0	2	0	0	0	2
eared grebe	*Podiceps nigricollis*	Nocturnal	Waterbirds/ Waterfowl	0	2	0	0	0	2
Cooper's hawk	*Accipiter cooperii*	Diurnal	Accipiters	0	1	0	0	0	1
brown-headed cowbird	*Molothrus ater*	Diurnal	Blackbirds/ Orioles	0	0	0	1	0	1
common raven	*Corvus corax*	Resident	Corvids	0	1	0	0	0	1
black-throated sparrow	*Amphispiza bilineata*	Diurnal	Grassland/ Sparrows	0	0	0	1	0	1
American pipit	*Anthus rubescens*	Diurnal	Grassland/ Sparrows	0	1	0	0	0	1
unidentified sparrow	-	-	Grassland/ Sparrows	0	0	0	1	0	1
vesper sparrow	*Pooecetes gramineus*	Nocturnal	Grassland/ Sparrows	0	0	0	1	0	1
Brewer's sparrow	*Spizella breweri*	Nocturnal	Grassland/ Sparrows	1	0	0	0	0	1
northern mockingbird	*Mimus polyglottos*	Resident	Mimids	0	1	0	0	0	1
sora	*Porzana carolina*	Nocturnal	Rails/Coots	0	1	0	0	0	1
Virginia rail	*Rallus limicola*	Nocturnal	Rails/Coots	1	0	0	0	0	1

Table 3. Number of individual bird detections, by species, during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Common Name	Scientific Name	Migration Behavior[2]	Guild	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Visitor Center	Total
least sandpiper	*Calidris minutilla*	Both	Shorebirds	0	1	0	0	0	1
Unidentified bird (medium)	-	-	-	0	0	0	1	0	1
Unidentified bird (small)	-	-	-	0	0	0	1	0	1
Gambel's quail	*Callipepla gambelii*	Resident	Upland Game Birds	0	0	0	1	0	1
Wilson's warbler	*Cardellina pusilla*	Nocturnal	Warblers	0	1	0	0	0	1
common yellowthroat	*Geothlypis trichas*	Nocturnal	Warblers	0	0	0	1	0	1
yellow warbler	*Setophaga petechia*	Nocturnal	Warblers	1	0	0	0	0	1
northern shoveler	*Anas clypeata*	Both	Waterbirds/ Waterfowl	0	1	0	0	0	1
common loon	*Gavia immer*	Diurnal	Waterbirds/ Waterfowl	1	0	0	0	0	1
double-crested cormorant	*Phalacrocorax auritus*	Diurnal	Waterbirds/ Waterfowl	0	1	0	0	0	1
unidenitifed duck	-	-	Waterbirds/ Waterfowl	0	1	0	0	0	1
unidentified grebe	-	-	Waterbirds/ Waterfowl	0	1	0	0	0	1
northern pintail	*Anas acuta*	Nocturnal	Waterbirds/ Waterfowl	0	1	0	0	0	1
cinnamon teal	*Anas cyanoptera*	Nocturnal	Waterbirds/ Waterfowl	0	1	0	0	0	1

Table 3. Number of individual bird detections, by species, during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Common Name	Scientific Name	Migration Behavior[2]	Guild	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Visitor Center	Total
blue-winged teal	*Anas discors*	Nocturnal	Waterbirds/ Waterfowl	0	1	0	0	0	1
mallard	*Anas platyrhynchos*	Variable	Waterbirds/ Waterfowl	1	0	0	0	0	1
house wren	*Troglodytes aedon*	Nocturnal	Wrens	0	0	0	1	0	1
Total				**9**	**45**	**0**	**28**	**1**	**83**

[1] Ring-necked pheasants are used for bias trials and these two detections were likely from trial carcasses; however, ring-necked pheasants have been reported in Riverside County, CA south of the Project area near the Salton Sea (eBird 2015). Thus, we cannot be certain that these detections were exclusively from trial carcasses.

[2] See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in Birds of North America (BNA) Online (http://bna.birds.cornell.edu/bna/); where information on migration behavior was lacking in BNA accounts, Newton (2008) or Murray (2004) were used.

Table 4. Total avian detections by Project component and detection category during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. Only carcasses found within search areas were included in fatality estimates.

	Inside carcass search area		Outside carcass search area	
Project Component	**Carcass search**	**Incidental**	**Carcass search**	**Incidental**
Fence	0	0	0	0
Visitor Center	0	0	0	1
Gen-tie line	23	0	5	0
Solar arrays				
Line-associated	4	1	1	3
Non-line associated	28	5	1	11
Total	**55**	**6**	**7**	**15**

Table 5. Total avian detections (including incidentals) by Project component and suspected cause of death during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

	Suspected Cause of Death*				
Project Component	**Collision**	**Predation**	**Other**	**Unknown**	**Percent of Total**
Fence	0	0	0	0	0.0
Visitor Center	0	0	0	1	1.2
Gen-tie line	9	1	0	18	33.7
Solar arrays					
Line-associated	2	0	0	7	10.8
Non-line associated	6	0	1	38	54.2
Percent of Total	**20.5**	**1.2**	**1.2**	**77.1**	**100.0**

* Suspected cause of death was assigned based on evidence available on the detection, evidence available on Project infrastructure, and proximity of detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as "unknown" because it can't be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, there is substantial uncertainy associated with cause of death assignments because no events were directly observed.

3.2 Temporal Patterns of Avian Detections

The number of detections recorded daily during the reporting period ranged from zero to six, and were more or less evenly distributed throughout the season (Figure 6). Daily detections peaked on September 22 and this event was reported to the agencies per Special Purpose Utilities Permit Condition H(c). The number of detections per day represents those discovered during standardized carcass searches and incidentally.

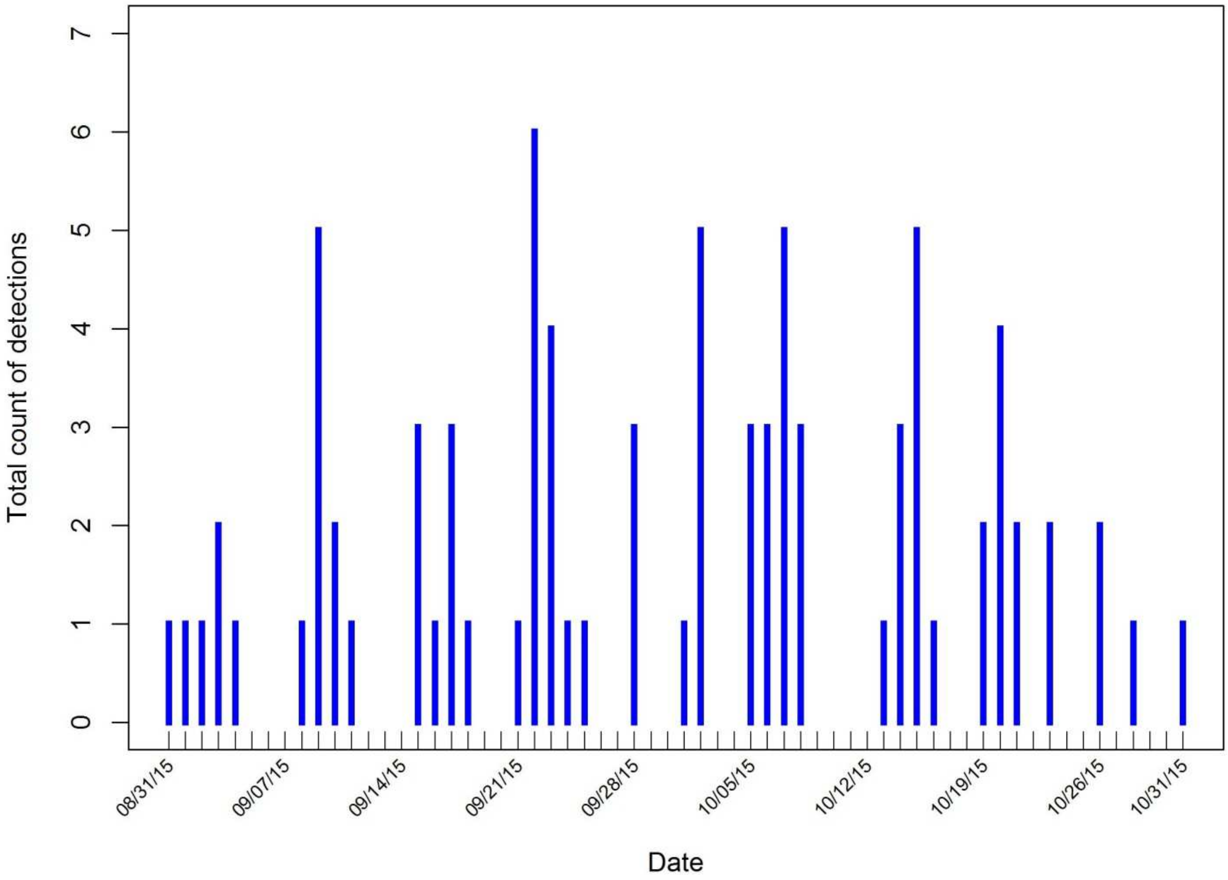


Figure 6. Total count of detections (including incidentals) by date during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.3 Spatial Distribution of Avian Detections

3.3.1 *Detections by Project Component*

During the reporting period, detections were documented from the solar arrays, the Visitor Center, and the gen-tie line; no detections occurred at the Visitor center or along the fence (Tables 3, 4, and 5). Of the 54 detections within the solar arrays, 16.7% (9) were associated either with overhead lines or arrays that co-occurred with overhead lines. Twenty-eight detections (33.7% of season total) were along the gen-tie line, and one detection (1.2% of season total) was at the Visitor Center.

3.3.2 *Feather Spot Detections*

Fourteen (16.9%) of the 83 detections made during fall consisted only of feather spots. Along the gen-tie, nine of 28 detections (32.1%) were feather spots. Five of 54 detections (9.3%) in the solar arrays were feather spots. There were no detections along the fence during fall.

3.4 Detections of Injured or Stranded Birds

There were six injured or stranded birds detected during fall 2015. Three injured birds were detected at line-associated (ruddy duck [*Oxyura jamaicensis*]) and non-line associated arrays (2; mourning dove [*Zenaida macroura*] and western grebe [*Aechmophorus occidentalis*]). Three stranded but uninjured birds were detected at line-associated (common loon [*Gavia immer*]) and non-line associated (ruddy duck and eared grebe [*Podiceps nigricollis*]) arrays. The injured mourning dove and ruddy duck were transported to wildlife rehabilitation facilities; the ruddy duck was released by the rehabilitator on the same day. The injured western grebe died before it got to a rehabilitation facility. The stranded ruddy duck, eared grebe, and common loon were evaluated for a short period for injuries and general stress and when none were observed, released at Lake Tamarisk. Three detections of injured or stranded birds were included in fall fatality estimates; three were excluded because they were found outside of a standardized carcass search area.

3.5 Summary of Bat Detections

No bats were detected during the fall 2015 season.

3.6 Carcass Persistence Trials

Data from carcass persistence trials were available from late winter, spring, summer, and fall at the solar field and gen-tie line (n = 215 total). Based on carcass persistence data from all seasons so far in 2015, survival models were compared for relative quality using the corrected AICc score, as suggested in Huso (2010). The AICc score provides a relative measure of model fit and parsimony among a selection of candidate models, and provides a framework for testing hypotheses regarding which factors contribute to carcass persistence rates. Carcass size was tested as a potentially important variable, as larger carcasses tend to persist longer and may be more likely to leave feather spots which persist for long durations, whereas smaller carcasses may be more likely to be completely removed. Project component (solar arrays, gen-tie line) was also included as a potentially important variable, as was season.

The model with lowest AICc score is typically chosen as the “most supported” model relative to other models tested; however, any model within two AICc points of the most supported model is considered competitive with the most supported model (Burnham and Anderson 2004). Preliminary modeling suggested a main effect of season, so further modeling efforts were restricted to data collected in fall only. The most supported model using only the fall data included main effects of carcass size and Project component, with a removal time that was lognormally-distributed (Appendix C). Estimates of carcass removal time and persistence probabilities from the most supported model are reported in Table 6, and estimates of proportion of carcasses remaining as a function of days since carcass placement are provided in Figure 7. Detailed estimates of carcass removal and associated confidence intervals are provided in Appendix C.

Table 6. Mean and median carcass removal time and probability of a carcass persisting through the effective search interval during the fall (August 31 – October 31) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass size	Project component	Mean removal time (days)	Median removal time (days)	Probability of persistence
Small	Arrays/fence	2.2	1.5	0.46
Small	Overhead lines	0.1	0.5	0.08
Medium	Arrays/fence	17.4	16	0.80
Medium	Overhead lines	0.8	1.5	0.30
Large	Arrays/fence	203.3	30	0.98
Large	Overhead lines	9.7	3.5	0.72

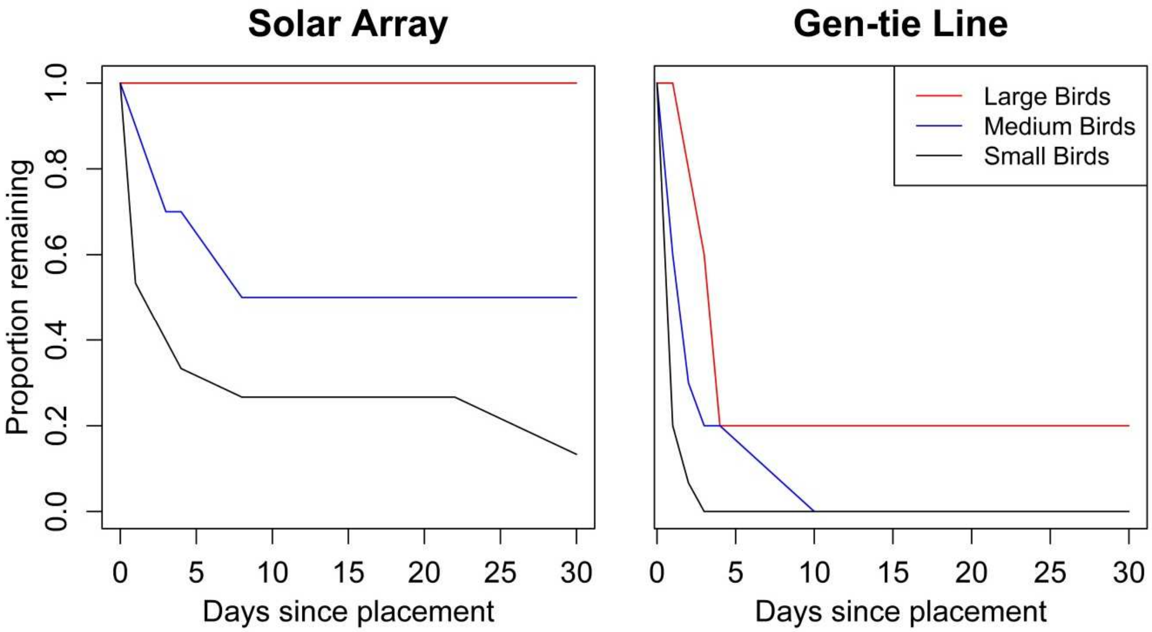


Figure 7. Proportion of trial carcasses remaining as a function of days since placement and carcass size class (n = 30, 20, and 10 for small, medium, and large size classes, respectively) during the fall (August 31 – October 31) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.7 Searcher Efficiency Trials

During the reporting period, a total of 180 searcher efficiency trials were placed at the Project. Most trials were available to be found, but some disappeared before or during the trial. Overall, 90 trials were placed in the solar arrays and 87 were available to be found; 30 trials were placed along the perimeter fence (inner perimeter only) and 29 were available to be found; and 60 trials were placed along the gen-tie line and 51 were available to be found. Three observers conducted searches at the Project during fall. Searcher efficiency trials were conducted on each observer in approximate proportion to the number of searches they conducted at the Project, as follows: Sarah Nichols (number of trials available to be found: 28), Darin Blood (62), and Wanda Bruhns (77). All trials were included in estimation of searcher efficiency.

In the solar arrays, the model that included an effect of carcass size was chosen as the most supported model to estimate searcher efficiency (Appendix C). Within the solar arrays, searcher efficiency was: 55.7% for small birds, 82.1% for medium birds, and 82.9% for large birds (Figure 5; Appendix C).

For linear Project components, the model that included an effect of carcass size, Project component, and season was chosen as the most supported model to estimate searcher efficiency. Along the fence, searcher efficiency was 90.1% (CI: 78.1 – 100%), 94.9% (CI: 86.2 – 100%), and 98.0% (CI: 92.6 – 100%) for small, medium, and large carcasses, respectively. Along the gen-tie, searcher efficiency was 44.7% (CI: 27.4 – 62.4%), 62.5% (CI: 45.5 – 80.0%), 81.0% (CI: 60.0 – 100%) for small, medium, and large carcasses, respectively. Detailed estimates of searcher efficiency estimates specific to each component and carcass size are reported in Appendix C.

3.8 Fatality Estimates

Fatality estimates were calculated separately for each component (solar arrays, fence, and overhead lines). Ultimately, 22 detections were excluded from the fatality analysis because they were found outside standardized search areas (Table 47; Appendix C). All 83 detections ~~made~~ that occurred during fall are reported in Table 3.

Table 7. Status of detections during the fall (August 31 – October 31) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California. All detections outside the search area were excluded from the fatality analysis, regardless of whether they occurred during a standardized carcass search or incidentally.

	Carcass search	Incidental detection	*Pushed to next season's fatality estimate	*Pulled from previous season's fatality estimate
Inside search area	55	6	0	0
Outside search area	7	15	0	0

* Incidental detections occurring after the last standardized carcass search in a season are considered for inclusion in the fatality analysis for the following season. This is consistent with the assumption we make throughout the monitoring seasons; that carcasses found incidentally would have been available to be found on the next scheduled search. This assumption may result in some carcasses found during one season but considered in the following season's fatality analysis. Once a carcass has been moved to a different season's analysis it is still subject to the same criteria for inclusion or exclusion based on location (in versus out of a searched area) and carcass age (greater than versus less than the search interval).

During fall 2015, 296 carcasses (90% CI: 198 – 461) were estimated for the solar arrays. There were an estimated 0.115 carcasses per acre (within the solar field only; 296 estimated carcasses/2,585 acres) and an estimated 0.538 carcasses per nameplate MW (296 estimated carcasses/550 MW) within the solar field.

Estimates of fatalities along the gen-tie are heavily influenced by the high rates of scavenging observed during the limited trials at the gen-tie (i.e., large correction factors) and are likely very unreliable. The estimate along the gen-tie was 894 carcasses (90% CI: 362 – 2,948). No carcasses were estimated for the perimeter fenceline because there were no detections made along the fence. A complete list of estimates for each Project component and carcass size class with confidence intervals is presented in Appendix C.

4.0 DISCUSSION

The 2015 fall season represented the third full season of standardized monitoring at Desert Sunlight per the BBCS. Searcher efficiency and carcass persistence trials were conducted concurrently at the solar arrays, fencelines, and along the gen-tie line. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. Although these estimates were produced from a statistically robust sample, only limited inference may be drawn from three seasons of data. These results should be considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. As more data are collected throughout the monitoring year (and additional quality assurance/quality control measures occur, for example characterizing feather spots to species or size class), data from all seasons may be pooled. At that time, data will be tested for seasonal differences retrospectively, but because seasonal estimates will be produced from the much larger annual data set, they may differ from what is reported here because they are based on a larger, more informative sample.

4.1 Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Thus, rates of carcass persistence reported here should be interpreted cautiously as they may change over the coming months.

Fatality estimates are influenced by the relationship between carcass removal dynamics and search intervals. In practical terms, longer search intervals reduce average probability that a carcass persists until the next search. In terms of the analysis, this can manifest as a lower probability of persistence through the effective search interval, or an effective search interval that is shorter than the nominal search interval. In either case, the adjustment to carcass counts due to carcass removal dynamics is calculated as

$$\frac{length\ of\ effective\ search\ interval}{length\ of\ nominal\ search\ interval * average\ probability\ of\ persistence\ through\ the\ effective\ search\ interval}$$

The adjustment to estimated fatality for carcass removal increases with longer search intervals, and the variance in the estimate may increase, also.

Carcass persistence at the Project is clearly influenced by whether a carcass is located in the solar field (inside the perimeter fence) or along the gen-tie (outside the perimeter fence), with higher removal rates occurring along the gen-tie. Although the same scavenger species may occur at both Project components, a difference in scavenger density or activity between the components could possibly be responsible for the different rates of carcass persistence. If there are differences in scavenging rates between the trial carcasses and naturally-occurring carcasses, it is possible that the high scavenging rates observed along the gen-tie have resulted in inflated fatality estimates. This hypothesis may be evaluated in the annual report by comparing persistence rates of trial carcasses to the age of carcasses detected by observers. Given the very high scavenging rates along the gen-tie line, fatality estimates for the gen-tie are unreliable.

Searcher efficiency was influenced by Project component, carcass size, and season. In the solar arrays, searcher efficiency was high (>0.5) for all carcass size classes and this is likely influenced by the limited vegetation cover beneath solar panels. Beneath the gen-tie line, vegetation cover is higher in some portions of the strip transects, but results reported here support the hypothesis that visibility class was not a factor in searcher efficiency along the gen-tie line during fall. Placement of trial carcasses in both difficult and easy visibility classes ensures that the adjustment due to searcher efficiency accounts for both visibility classes, even if there is a real difference in searcher efficiency that cannot be detected with the trial data.

4.2 Distribution of Fatalities and Fatality Estimates

Detections were distributed throughout the fall season, and there were no clear peaks in detections associated with a particular date or range of dates. Tapering of daily detections at the beginning and end of the fall season (Figure 6) suggests that the current dates that define the season likely capture the majority of fall migration at the Project.

Most (65.1%) of the 83 detections made during fall were in the solar field. Approximately 13% of the carcasses found in search plots had overhead lines associated with those plots and 10% of the plots searched had lines associated with them, suggesting overhead lines within the solar field may not influence mortality. The absence of any detections along the fence in fall coupled with the very low number of detections in previous seasons (spring: 2; summer: 1) and relatively high carcass persistence rates inside the fence suggest the perimeter fence at the Project may not be an important source of mortality.

Composition of detections during fall 2015 included 13 avian guilds. Waterbirds and waterfowl comprised the majority of detections (n = 21), followed by rails and coots (n = 13), grassland birds and sparrows (n = 12), and warblers (n = 10). All other guilds were represented by fewer than ten detections. No bats have been detected since monitoring began at the Project. Species that migrate nocturnally were detected most frequently during fall (n = 21 species). Ring-necked pheasants were included in the list of detected birds (Table 3), but these detections were most likely from trial carcasses. However, because ring-necked pheasant have been reported in

Riverside County, CA (eBird 2015) south of the Project area near the Salton Sea, we could not be certain that both detections were from trial carcasses.

Detections attributed to an unknown cause accounted for 77.1% of all detections during the reporting period, and most of those attributed to an unknown cause were found in the solar arrays. Of the 54 detections made in the solar arrays, 11.1% were feather spots. Determining a cause of mortality from a feather spot is challenging because there is rarely visible evidence available on which to determine a cause of death. Thus, feather spots with an unknown cause of mortality could be encountered anywhere birds occur, and an unknown cause of a sizeable proportion of the carcasses is not unique to the Project. Further, the relatively large proportion of feather spots (18.1%) among the detections for the Project as a whole may inflate the fatality estimate based on the potential for multiple feather spots resulting from one fatality, feather spots resulting from predation not associated with the facility, or other causes.

5.0 LITERATURE CITED

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in 2nd International Symposium on Information Theory (B. N. Petran and F. Csaki, Eds.). Akademiai Kiado, Budapest, Hungary.

Ammon, Elisabeth M. and William M. Gilbert. 1999. Wilson's warbler (*Cardellina pusilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/478

Boarman, William I. and Bernd Heinrich. 1999. Common raven (*Corvus corax*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/476 doi:10.2173/bna.476

Buckland, S, D.R. Anderson, K. P. Burnham, and J.L. Laake. 1993. Distance sampling: estimating abundance of biological populations. Chapman & Hall, London. 446 pp.

Burnham, K.P., and D.R. Anderson. 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociological Methods & Research 33: 261-304.

Evers, David C., James D. Paruk, Judith W. Mcintyre and Jack F. Barr. 2010. Common loon (*Gavia immer*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/313 doi:10.2173/bna.313

Hudon, Jocelyn. 1999. Western tanager (*Piranga ludoviciana*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/432 doi:10.2173/bna.432

Hughes, Janice M. 2011. Greater roadrunner (*Geococcyx californianus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/244 doi:10.2173/bna.244

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. doi: 10.1002/env.1052

Huso, Manuela, Som, Nicholas, and Ladd, Lew, 2012, Fatality estimator user's guide: U.S. Geological Survey Data Series 729, 22 p.

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A new method to determine bird and bat fatality at wind energy turbines from carcass searches. Wildlife Biology 17: 350-363.

Lowther, Peter E. and Janet McI. Williams. 2011. Nashville warbler (*Oreothlypis ruficapilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/205 doi:10.2173/bna.205

Manly, B.F.J.1997. Randomization, bootstrap and Monte Carlo methods in biology. Second Edition. CRC Press, LLC, Boca Raton, Florida, 455 pp.

Melvin, Scott M. and James P. Gibbs. 2012. Sora (*Porzana carolina*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/250 doi:10.2173/bna.250

Muller, Martin J. and Robert W. Storer. 1999. Pied-billed grebe (*Podilymbus podiceps*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/410 doi:10.2173/bna.410

Murray, J. 2004. Nocturnal flight call analysis as a method for monitoring density and species composition of migratory songbirds (Order Passeriformes) across southern Vancouver Island, British Columbia in 2004. Rocky Point Bird Observatory, 16 pp.

Newton, I. 2008. The migration ecology of birds. Academic Press, London.

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine-cause avian fatality estimates. Journal of Wildlife Management 74(5): 1089-1096.

Smallwood, K. S. 2013. Comparing bird and bat ratality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37(1): 19-33.

Therneau, T. 2015. _A Package for Survival Analysis in S. version 2.38, <URL: http://CRAN.R-project.org/package=survival>.

Therneau, T.M. and P. M. Grambsch 2000. Modeling Survival Data: Extending the Cox Model. Springer, New York. ISBN 0-387-98784-3.

Western Ecosystems Technology (WEST), Inc. 2014. Bird and bat conservation strategy, Desert Sunlight Solar Farm Project, Riverside County, California. 57 pp.

Wheelwright, N. T. and J. D. Rising. 2008. Savannah sparrow (*Passerculus sandwichensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/045 doi:10.2173/bna.45

Appendix A. Detailed Areas of Carcass Locations along the Generation Tie Line of the Desert Sunlight Solar Farm Project during Fall (August 31 – October 31) 2015

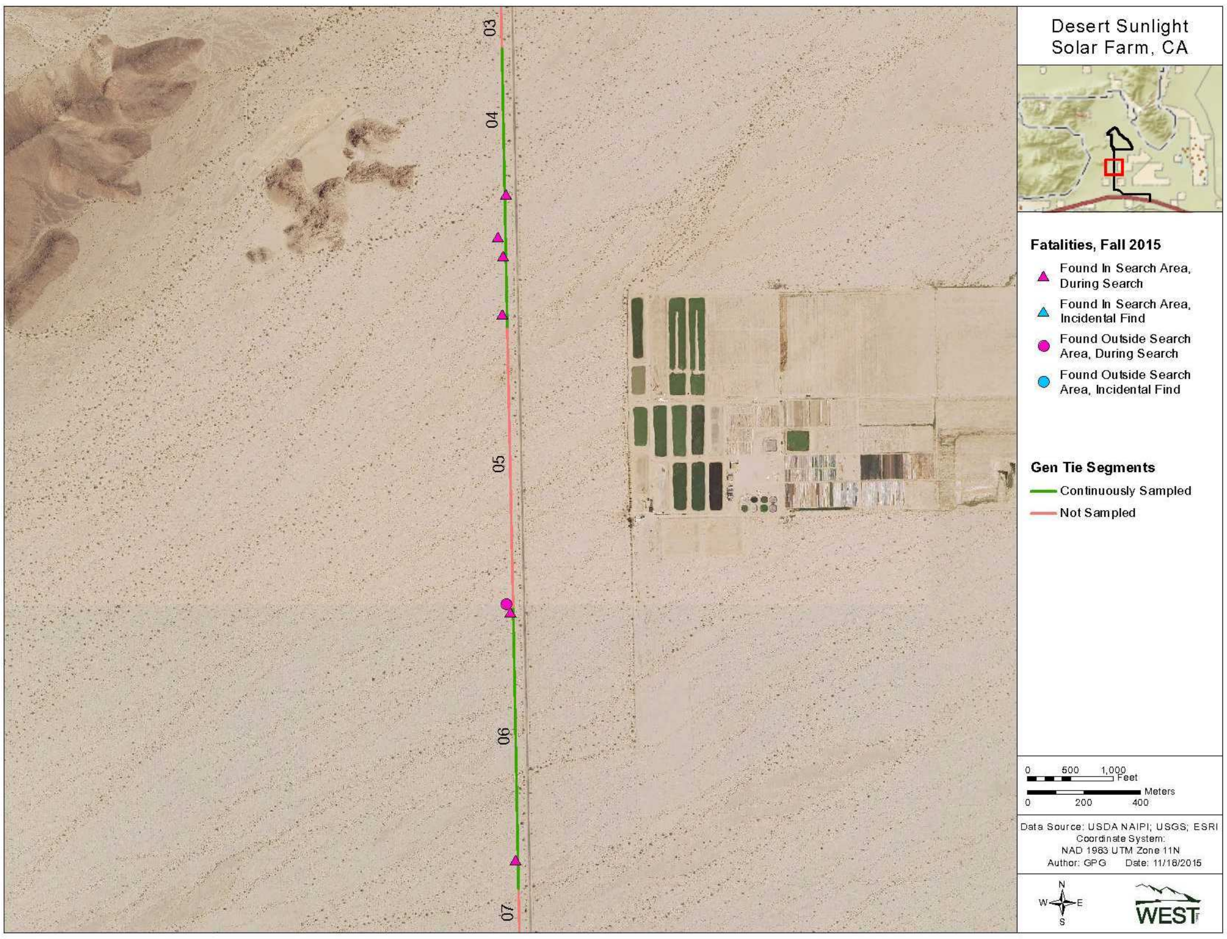


Figure A-1. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during fall (August 31 – Ocotber 31) 2015.

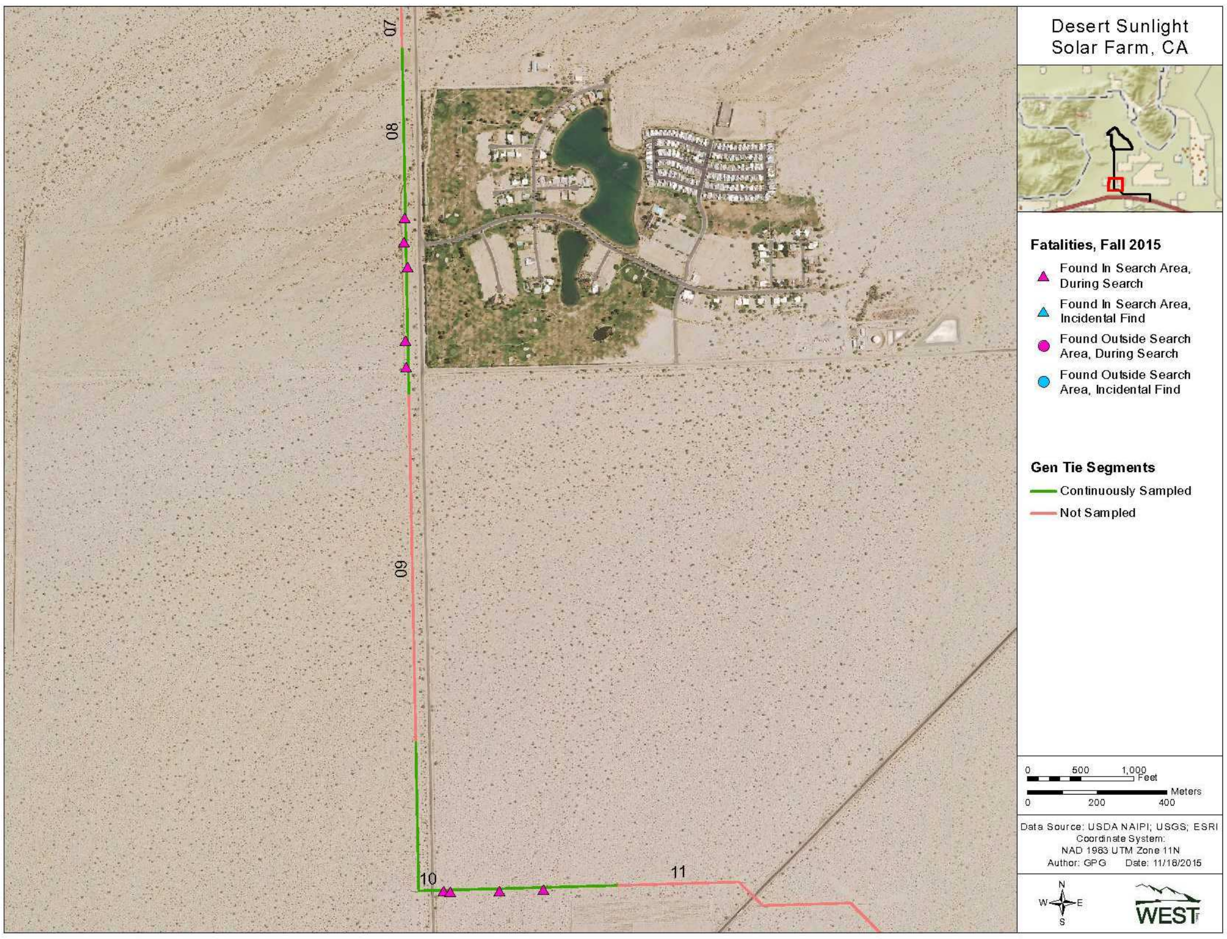


Figure A-2. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015.

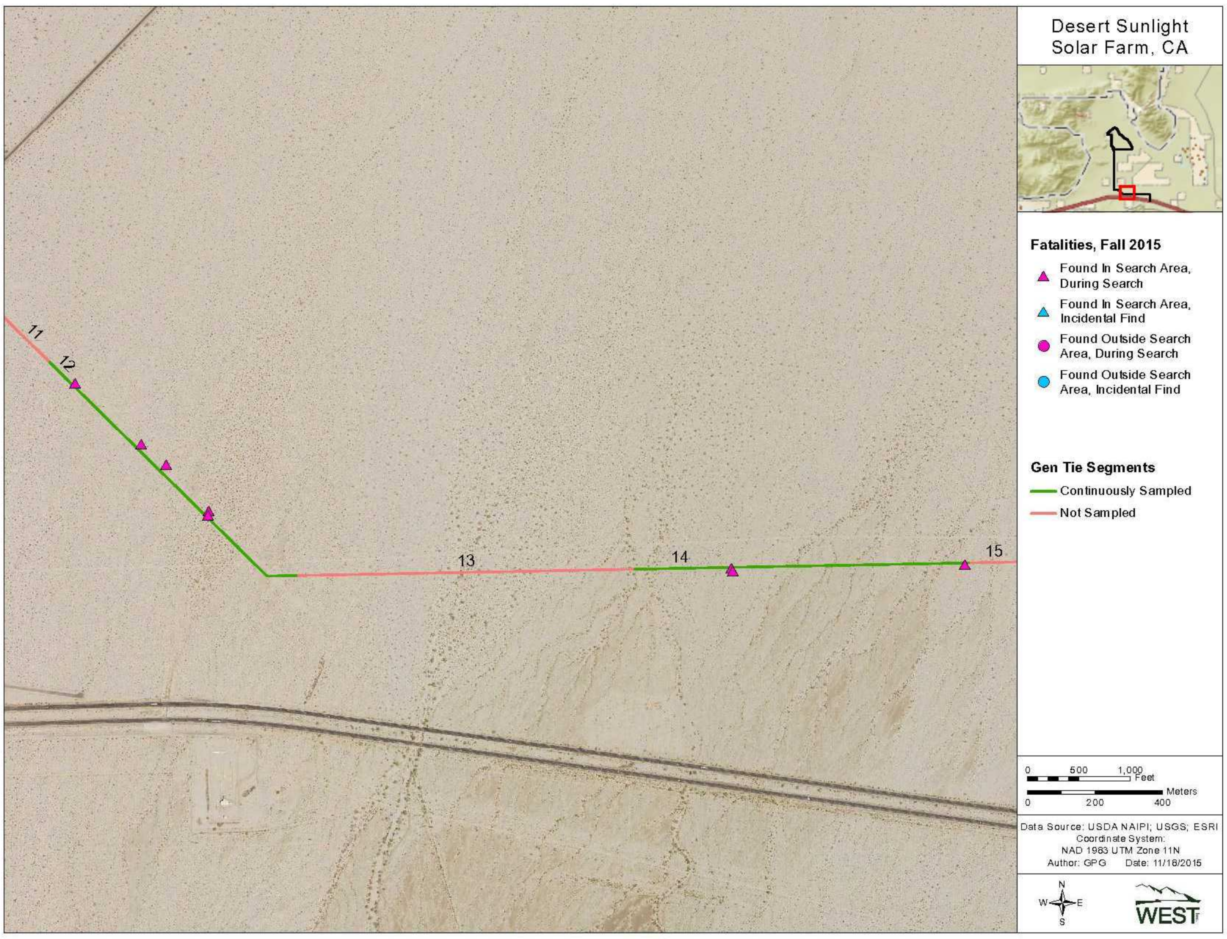


Figure A-3. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015.

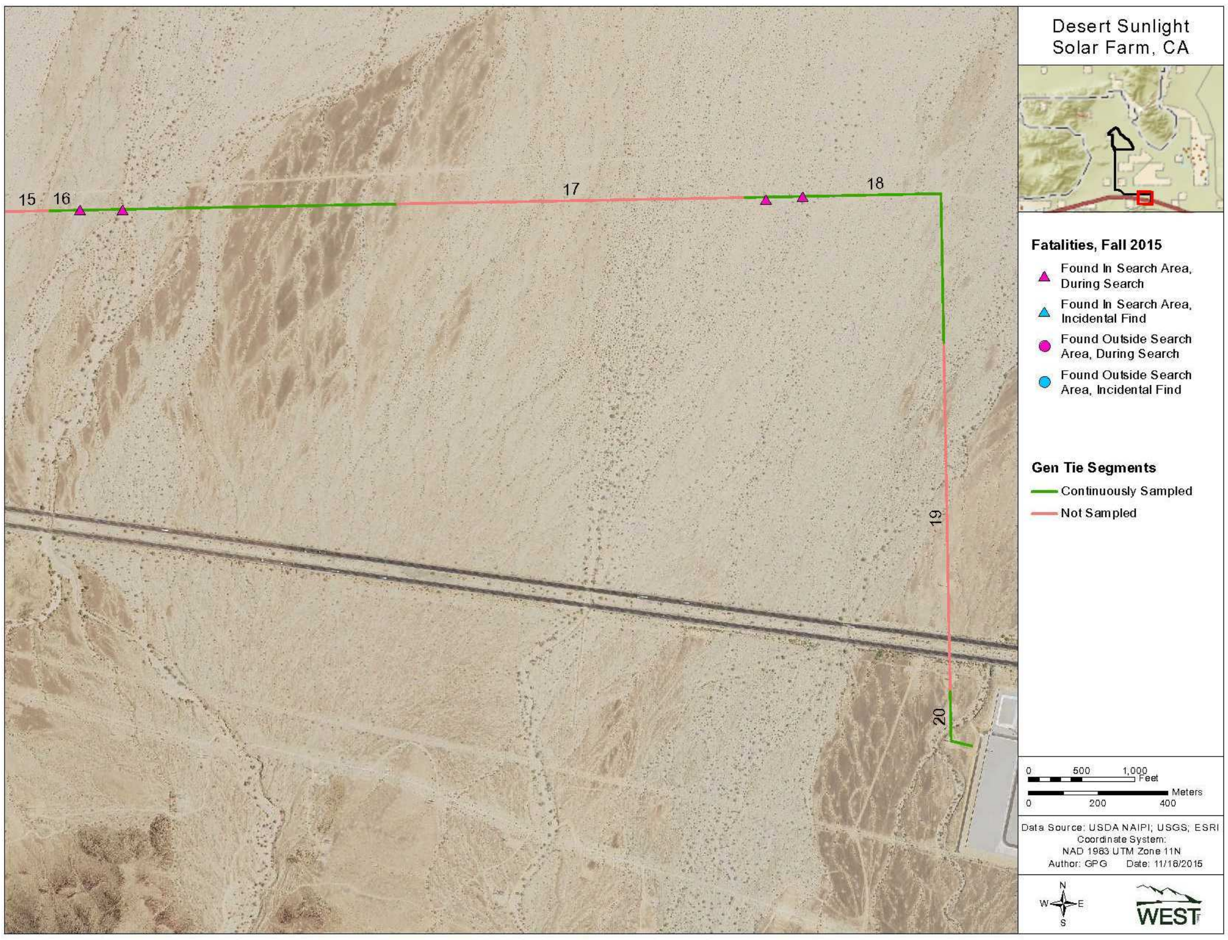


Figure A-4. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015.

Appendix B. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during Fall (August 31 – October 31) 2015

Table B-1. Weather conditions and body weights associated with detections estimated to be less than 24 hours old during fall (August 31 – October 31) 2015 at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hrs)	Species	Weight (g)[1]	Weather Summary for Preceding 24 hrs
091615-UNSP-GENTIE12-01	9/16/2015	0-8	black-throated sparrow	14	14 max wind. 8 average wind. SSE wind direction. Waxing crescent moon phase. No clouds. Very sunny and a very nice breeze ~95 degrees F.
092315-VIRA-11-15-MVOH-01	9/23/2015	0-8	Virginia rail	60	14 max wind speed. 3 average wind speed. NNE wind direction. Waxing gibbous moon phase. Max temp. 94. Clear until bird found.
100615-AMCO-GENTIE-8-01	10/6/2015	0-8	American coot	465	20 mph max wind speed. 9 mph avg wind speed. WSW wind direction. Last quarter moon phase.
100615-LISP-GENTIE-06-01	10/6/2015	0-8	Lincoln's sparrow	14	MAX WIND SPEED: 20. AVG WIND SPEED: 9. WIND DIRECTION: WSW. MOON PHASE: LAST QUARTER. MOSTLY CLOUDY
100815-EAGR-05-16-MAINROAD-02	10/8/2015	0-8	eared grebe	-	MAX WIND SPEED: 10. AVG WIND SPEED: 4. WIND DIRECTION: WSW. MOON PHASE: WANING CRESCENT. CLEAR.
101415-WEGR-07-15-A-34-01	10/14/2015	0-8	western grebe	670	MAX WIND SPEED: 13. AVG WIND SPEED: 5. WIND DIRECTION: NE. MOON PHASE: NEW MOON. CLEAR.
101515-RUDU-06-15-A-10E-02	10/15/2015	0-8	ruddy duck	-	MAX WIND SPEED: 6 MPH. AVG WIND SPEED: 3 MPH. WIND DIRECTION: ENE. MOON PHASE: WAXING CRESCENT. 10 MILE VISIBILITY
101515-RUDU-08-01-B-14-E-01	10/15/2015	0-8	ruddy duck	-	MAX WIND SPEED: 13 MPH. AVG WIND SPEED: 4 MPH. WIND DIRECTION: NW. MOON PHASE: WAXING CRESCENT. MOSTLY CLOUDY, LIGHT SPRINKLES, AVG TEMP 90 DEG F
102015-BHCO-GENTIE-10-01	10/20/2015	0-8	brown-headed cowbird	43	10-18NNW Wind, gusts to 25 MPH, waxing crescent moon, max temp 85, clear until 6pm then partly cloudy/overcast until midnight then clear until bird found
102315-COLO-04-05-A-02	10/23/2015	0-8	common loon	-	MAX WIND SPEED: 7. AVG WIND SPEED: 3. WIND DIRECTION: ENE. MOON PHASE: WAXING GIBBOUS. MAX TEMP ON 10/22 84 DEG F. CLEAR, VISIBILITY 10 MILES ON 10/22 AND 10/23
091015-BTYW-02-21-A-MVOH-04	9/9/2015	8-24	black-throated gray warbler	8	MAX WIND SPEED- 34. AVG WIND SPEED- 10. WIND DIRECTION- SSE. MOON PHASE- WANING CRESCENT. MAX TEMP 108. CLEAR UNTIL 2PM ON 09/08
090915-YWAR-18-11-A-MVOH-03	9/9/2015	8-24	yellow warbler	8	MAX WIND SPEED- 34 MPH. ANG WIND SPEED- 10. WIND DIRECTION- SSE. MOON PHASE- WANING CRESCENT. MAX TEMP- 108. CLEAR UNTIL 2PM ON

					9/08. HAZE/THUNDERSTORM UNTIL 5PM, THEN CLEAR.
092215-LISP-GENTIE-10-01	9/22/2015	8-24	Lincoln's sparrow	13	6-16mph SE wind, 9.21 max temp 91F, clear until 4pm, partly cloudy until 5pm, clear until 3am then clear/partly cloudy/overcast until bird found
092315-SAVS-GENTIE-12-03	9/23/2015	8-24	Savannah sparrow	18	3-14 mph NNE wind, waxing gibbous moon, max temp 94, clear
092515-RUDU-19-05-B-2W-01	9/25/2015	8-24	ruddy duck	-	4-14mph NE wind, waxing gibbous moon, clear until bird found
092815-WEGR-10-24-A-PCS-02	9/28/2015	8-24	western grebe	630	12 max wind speed. Gusts 16. 4 avg wind speed. ESE wind direction. Full moon phase. Max temp 105 F. Clear until bird found, according to Weather Underground. 40-55% clouds morning bird found as seen in field.
092815-YRWA-10-19-B-01W-03	9/28/2015	8-24	yellow-rumped warbler	10	12 max wind speed. Gusts 16. 4 avg wind speed. ESE wind direction. Full moon phase. Max temp 105 F. According to weather underground clear until bird found. However 40-55% clouds in field on morning of 09/28 until bird found.
100715-SAVS-GENTIE-12-01	10/7/2015	8-24	Savannah sparrow	16	MAX WIND SPEED: 13. AVG WIND SPEED: 6. WIND DIRECTION: NNW. GUSTS 17. MOON PHASE: WANING CRESCENT. HIGH TEMP 89F. CLEAR UNTIL 4 PM ON 10/06, THEN OVERCAST/ MOSTLY CLOUDY. CLEAR AGAIN FROM 7PM UNTIL BIRD FOUND ON 10/07.
100715-VESP-GENTIE-16-03	10/7/2015	8-24	vesper sparrow	23	MAX WIND SPEED: 13. ANG WIND SPEED: 6. WIND DIRECTION: NNW. MOON PHASE: WANING CRESCENT. HIGH TEMP 89 DEG F. CLEAR UNTIL 4 PM ON 10/06, THEN OVERCAST/ MOSTLY CLOUDY. CLEAR AGAIN FROM 7 PM UNTIL BIRD FOUND ON 10/07.
100715-HOWR-GENTIE-18-04	10/7/2015	8-24	house wren	9	MAX WIND SPEED: 13. AVG WIND SPEED: 6. WIND DIRECTION: NNW. GUSTS: 17. MOON PHASE: WANING CRESCENT. HIGH TEMP 89 DEF F. CLEAR UNTIL 4PM ON 10/06, THEN OVERCAST/MOSTLY CLOUDY. CLEAR AGAIN FROM 7PM UNTIL BIRD FOUND ON 10/07.
100715-WCSP-GENTIE-14-02	10/7/2015	8-24	white-crowned sparrow	24	MAX WIND SPEED: 13. AVG WIND SPEED: 6. WIND DIRECTION: NNW. MOON PHASE: WANING CRESCENT. HIGH TEMP 89 DEG F. CLEAR UNTIL 4 PM ON 10/06, THEN OVERCAST/ MOSTLY CLOUDY. CLEAR AGAIN FROM 7 PM UNTIL BIRD FOUND ON 10/07.
101315-WEME-GENTIE-10-01	10/13/2015	8-24	western meadowlark	72	MAX WIND SPEED: 9. AVG WIND SPEED: 5. WIND DIRECTION: SW. MOON PHASE: WANING CRESCENT. CLEAR.
101615-AMCO-20-08-A-7-E-01	10/16/2015	8-24	American coot		MAX WIND SPEED: 21 MPH. AVG WIND SPEED: 6 MPH. WIND DIRECTION: NNW.

					MOON PHASE: WAXING CRESCENT. HEAVY CLOUD COVER GREATER THAN 80%. T-STORM PREVIOUS NIGHT, ON 101515 (WITH RAIN AND LIGHTENING)
102115-WCSP-GENTIE-14-01	10/21/2015	8-24	white-crowned sparrow	27	8-33 MPH NNW wind, waxing crescent moon, rain, thunderstorm

[1] Weight recorded only for intact carcasses with no evidence of scavenging.

Appendix C. Correction Factors and Bird Fatality Rates at the Desert Sunlight Solar Farm Project during Fall (August 31 – October 31) 2015.

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during fall (August 31 – October 31) 2015. *Distribution of easy and difficult visibility on the gen-tie line was 50% and 50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Proportion of area searched by component								
Gen-tie line	0.479	-	0.479	-	0.479	-	0.479	-
Fence	0.744	-	0.744	-	0.744	-	0.744	-
Solar arrays	0.295	-	0.295	-	0.295	-	0.295	-
Searcher efficiency by component and visibility class								
Gen-tie line: Easy vis.*	0.447	0.274 - 0.624	0.625	0.455 - 0.8	0.810	0.6 - 1	0.447	0.274 - 0.624
Gen-tie line: Difficult vis.*	0.447	0.274 - 0.624	0.625	0.455 - 0.8	0.810	0.6 - 1	0.447	0.274 - 0.624
Gen-tie line	0.447	0.274 - 0.624	0.625	0.455 - 0.8	0.810	0.6 - 1	0.447	0.274 - 0.624
Fence	0.901	0.781 - 1	0.949	0.862 - 1	0.980	0.926 - 1	0.901	0.781 - 1
Solar arrays	0.557	0.439 - 0.665	0.821	0.714 - 0.91	0.828	0.648 - 0.953	0.557	0.439 - 0.665
Average probability of carcass persistence through the effective search interval								
Gen-tie line	0.080	0.027 - 0.141	0.299	0.169 - 0.425	0.719	0.582 - 0.866	0.080	0.027 - 0.141
Solar arrays & fence	0.463	0.295 - 0.632	0.802	0.640 - 0.924	0.977	0.948 - 0.995	0.463	0.295 - 0.632
Carcass counts by component								
Gen-tie line	13	5 - 22	9	3 - 15	0	-	1	0 - 3
Fence	0	-	0	-	0	-	0	-
Solar arrays	10	5 - 16	18	12 - 25	7	3 - 12	3	0 - 6
Average Probability of Carcass Availability and Detected (Searcher efficiency * average probability of carcass persistence)								
Gen-tie line	0.036	0.01 - 0.07	0.187	0.098 - 0.286	0.583	0.395 - 0.771	0.036	0.01 - 0.07
Fence	0.417	0.259 - 0.581	0.761	0.595 - 0.892	0.957	0.897 - 0.988	0.417	0.259 - 0.581
Solar arrays	0.258	0.157 - 0.364	0.658	0.508 - 0.783	0.810	0.631 - 0.939	0.258	0.157 - 0.364
Adjusted Fatality Estimates (Fatalities /Season; values in italics are considered unreliable due to low counts of carcasses: carcass count / (proportion of area searched * average probability of carcass availability and detected)**								
Gen-tie line	729	229 - 2636	109	32 - 223	0	-	*56*	(1) - 243
Fence	0	-	0	-	0	-	0	-
Solar arrays	131	59 - 262	94	58 - 140	30	11 - 54	*40*	(3) - 101
Facility	860	348 - 2830	203	112 – 331	30	11 - 54	*96*	16 - 294

Table C-2. Carcasses excluded from the fall 2015 fatality analysis at the Desert Sunlight Solar Farm.

Parameter	Small birds	Medium birds	Large birds	Unknown size	Bats
LA solar arrays	3	0	1	0	0
NLA solar arrays	1	8	2	1	0
Visitor Center	0	1	0	0	0
Gentie line	4	1	0	0	0

Post-Construction Monitoring at the Desert Sunlight Solar Project Riverside County, California

2015 Fall Quarterly Interim Report

Prepared for:

Desert Sunlight 250, LLC and
Desert Sunlight 300, LLC
700 Universe Blvd.,
Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.

415 West 17th Street, Suite 2000
Cheyenne, Wyoming

May 6, 2016 rev. 3

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from August 31 to October 31, 2015 (the fall reporting period) at Desert Sunlight Solar Farm Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the third seasonal report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS. This report and the other interim quarterly reports are considered preliminary summaries of data and information. Data and final information from all four quarterly monitoring periods will be included in a comprehensive final annual report.

Included in this report are data from standardized carcass searches conducted during the fall season at the Project, defined as August 31 to October 31, 2015. For logistical reasons, fall monitoring began on Monday, August 31, 2015. Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 29.5% sample of solar photovoltaic (PV) panels, 2) along inner portions of the fenceline, resulting in 74.4% of the length of the perimeter fence, and 3) along 47.9% of the total length of generation-tie (gen-tie) line from the Project fence to the Red Bluff Substation located south of Interstate 10 (I-10). Searches conducted within the fall season had intervals of approximately seven days.

All bird and bat fatalities and injuries that were discovered by observers, referred to as "detections" in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, there were 83 avian detections, and there were no detections of bats.

According to specifications of the BBCS, avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were applied to a fatality estimator model (Huso 2010) to provide a preliminary estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias. The estimate is considered preliminary because the annual report may pool information from bias trials and other data across seasons which could affect seasonal estimates.

During the reporting period, carcass persistence was influenced by carcass size and Project component. Small carcasses (0-100 g) in the arrays and along the fence (combined) had a 46% chance (90% confidence interval [CI]: 30 – 63%) of persisting through the effective search interval, medium carcasses (101 – 999 g) had a 80% (64 – 92%) chance, and large carcasses (1000+ g) had a 98% (95 – 100%) chance. Mean (median) removal time within the arrays for small, medium, and large carcasses was 2.2 (1.5), 17.4 (16), and 203.3 (>30) days, respectively. Along the gen-tie line, chances of persistence for small, medium, and large carcasses were 8% (3 – 14%), 30% (17 – 43%), and 72% (58 – 87%), respectively; mean

Comentado [FWS1]: Please include median removal times and n for each size class.

Comentado [WEST2]: added

(median) removal time for small, medium, and large carcasses was 0.1 (0.5), 0.8 (1.5), and 9.7 (3.5) days, respectively. Sample sizes for each stratum were contained to fall trials only and included 15, 10, and 5, small, medium and large bird carcasses respectively. Within the solar arrays, searcher efficiency was influenced by carcass size: 55.7% for small birds, 82.1% for medium birds, and 82.9% for large birds. The sample size included trials from fall and was composed of 45 small, 30 medium and 15 large birds. Along the interior of the fence, searcher efficiency ranged ~~was~~ from 90.1% (CI: 78.1 – 100%), 94.9% (CI: 86.2 – 100%), and 98.0% (CI: 92.6 – 100%) for small, medium, and large carcasses, respectively. Along the gen-tie line, searcher efficiency ranged from 44.7% (CI: 27.4 – 62.4%), 62.5% (CI: 45.5 – 80%), and 81.0% (CI: 60.0 – 100%) for small, medium, and large carcasses, respectively. Searcher efficiency estimates along the gen-tie were informed by a sample size of 30, 20, and 10 bird carcasses respectively, placed during the fall season.

Comentado [FWS3]: Add median removal times and n for each size class.

Comentado [WEST4]: added

Comentado [FWS5]: Please include n for each size class.

Comentado [WEST6]: added

Composition of detections during fall 2015 included 13 avian guilds. Waterbirds and waterfowl comprised the majority of detections (n = 21), followed by rails and coots (n = 13), grassland birds and sparrows (n = 12), and warblers (n = 10). All other guilds were represented by fewer than ten detections. No bats have been detected since monitoring began at the Project. Species that migrate nocturnally were detected most frequently during fall (n = 21 species).

During fall 2015, 296 carcasses (90% CI: 198 – 461) were estimated for the solar arrays. There were an estimated 0.115 carcasses per acre (within the solar field only; 296 estimated carcasses/2,585 acres) and an estimated 0.538 carcasses per nameplate MW (296 estimated carcasses/550 MW) within the solar field.

Estimates of fatalities along the gen-tie are heavily influenced by the high rates of scavenging observed during the limited trials at the gen-tie (ie. large correction factors) and are likely very unreliable. The estimate along the gen-tie was 894 carcasses (90% CI: 362 – 2,948). No carcasses were estimated for the perimeter fenceline because there were no detections made along the fence.

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Tracey Johnson	Research Biologist
Lacey Jeroue	Statistician
Sarah Nichols	Designated Biologist
Pam Bullard	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2016. Post-construction monitoring at the Desert Sunlight Solar Farm Project, Riverside County, California. 2015 Fall Quarterly Interim Report. 28 pp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Project Background

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC (collectively, Desert Sunlight) constructed and operates the Desert Sunlight Solar Farm Project (referred to in this report as "Project"), which consists of two main components: 1) a 550-megawatt (MW) photovoltaic (PV) generating facility; and 2) a 220-kilovolt (kV) generation interconnection (gen-tie) line. The Project comprises approximately 1,700 hectares (ha; 4,200 acres) of land administered by the Bureau of Land Management (BLM) six miles north of Desert Center in Riverside County, California (Figure 1).

1.2 Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (2014; “BBCS”) was prepared by the Project proponent in collaboration with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and BLM to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency approval of the BBCS occurred in December 2014. Amendments to the sampling protocol along some portions of the Project fenceline were made by Desert Sunlight and approved by the BLM on February 11, 2015.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Desert Sunlight in collaboration with the USFWS, CDFW, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the gen-tie line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
3. Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

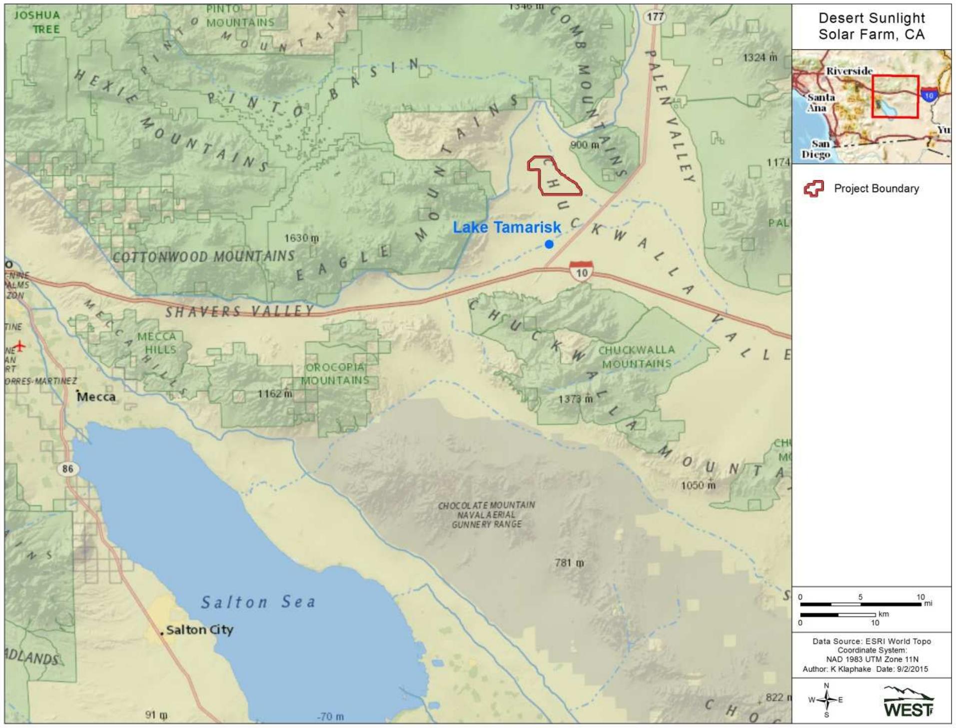


Figure 1. Desert Sunlight Solar Farm Project vicinity map, Riverside County, California.

1.3 Purpose of This Report

This report represents the third seasonal report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS. This and the other interim quarterly reports are considered preliminary summaries of data and information. Data and final information from all four quarterly monitoring periods will be included in a comprehensive final annual report.

This report covers the period August 31 to October 31, 2015, or the 2015 fall season. For logistical reasons, fall monitoring began on Monday, August 31, 2015. All carcasses and injuries that were discovered by observers are referred to as “detections” in this report. As stated in the approved BBCS, this seasonal report includes the observed detections for likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and suspected causes of death. Species composition of detections and the results of the bias trials are also reported. This report presents information related to the spatial distribution of detections, but no formal statistical analysis of the spatial distribution of carcasses will be conducted until the end of the monitoring year, given the limited data presently available.

2.0 METHODS

The BBCS describes the methods by which monitoring and certain analyses, including compilation of the overall fatality estimate, will occur. Below is an abridged description (see BBCS for detailed methods).

2.1 Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. Dead or injured birds and bats are called detections in this report to provide consistency in naming. This section also describes the methods for conducting carcass removal and searcher efficiency trials; how data were reported and analyzed; and the methods for producing fatality estimates for the Project.

2.1.1 *Areas Surveyed*

Standardized carcass searches were conducted at sampling units, which include the solar arrays (Table 1, 2; Figure 2); the "fenceline" defined as the perimeter fence for the Project (Table 1, Figure 2); and the gen-tie line (from the Project fence to the Red Bluff Substation on the south side of I-10; Table 1, Figure 3). Some overhead lines co-occur with solar arrays (medium voltage overhead lines [MVOH]). The MVOH were part of standardized carcass searches to the extent that they co-occured with solar arrays included in the sample (Table 2; Figure 2).

Table 1. Areas included in standardized carcass searches at the Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015.

Project Component	Total Size	Units	% of Component Searched
Solar arrays	1045.9	Hectares	29.5[1]
Fence	16.7	Kilometers	99.0[2]
Gen-tie line	19.2	Kilometers	47.9[3]

[1] Percent area that was searched in fall 2015. Slightly less than 30% total because of unequally-sized arrays.

[2] 74.4% of the fence is fully accessible and surveyed following the standard protocol, while approximately 25% of the fence is surveyed from a distance. Fatality rates estimated for sections of the fence that are sampled were extrapolated to sections of the fence where the standard monitoring protocol cannot be used, as described in section 4.2.6 of the approved Desert Sunlight BBCS. A very short segment near the gate is not sampled due to restoration activities.

[3] 52.1% of the gen-tie will be sampled in 2016.

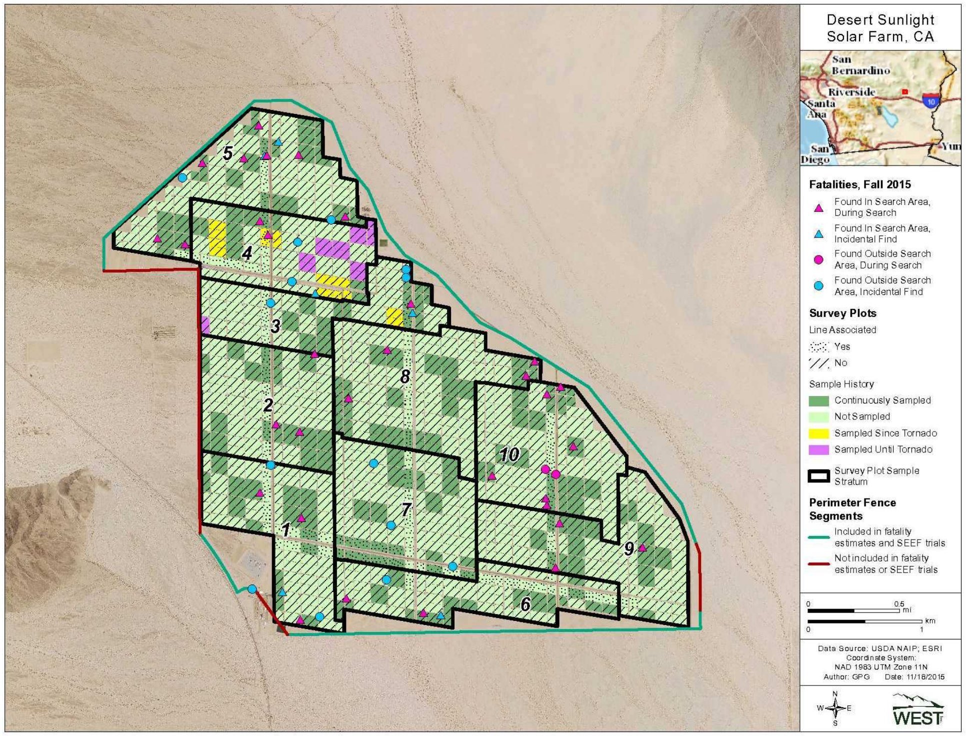


Figure 2. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at the solar field, visitor center, and overhead lines within the fence at Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015. No detections occurred along the fence during fall 2015. The detection that appears at the fence in the map was located at the visitor center.

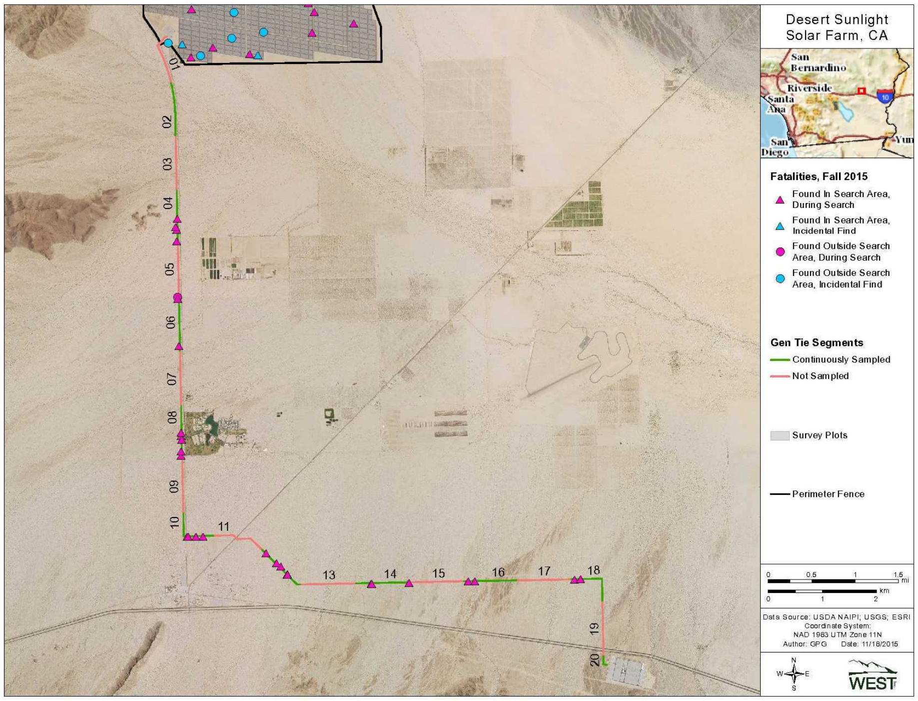


Figure 3. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance activities) along the generation tie line at the Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015. Detailed maps of detections along the line are presented in Appendix A.

To ensure a balanced distribution of sample units in the solar field (defined as the collection of all photovoltaic [PV] solar panels), the entire field was divided into ten strata, and individual sampling units were randomly selected within each stratum to compose an approximately 30% sample. This sampling design ensures that units included in the sample were not spatially clumped within the solar field. The solar field consists of arrays of solar panels (referred to as a solar array) that are either 70-m or 140-m wide. The sample includes 133 of each type of array. There are 2,580 70-m rows, and 3,900 140-m rows in the sample.

2.1.1 *Search Frequency and Timing*

Standardized searches occurred during the fall survey season, which includes the period from August 31 through October 31, 2015. All project components included in standardized searches were surveyed nine times during fall. All searches took place during daylight hours from 06:30 to 17:00.

As specified in the approved Desert Sunlight BBCS, the average search interval for all Project components included in standardized carcass searches during fall was 7.0 days (median 7.0 days). Slight variation in search interval was anticipated due to weather and logistical delays.

Table 2. Area and proportion of solar arrays that are and are not associated with overhead lines at the Desert Sunlight Solar Farm Project, Riverside County, CA.

	Line-associated[1]	Not line-associated	Proportion line-associated
Entire facility	89.4 ha	956.5 ha	0.09
Standardized searches	32.2 ha	291.0 ha	0.10

[1] Line-associated area was estimated as the area of any array that fell within the 30-m strip transect below the MVOH.

2.1.2 *Search Methods*

Standardized carcass searches were performed by BLM-approved biologists, in accordance with methods outlined in the BBCS.

Within the solar field, arrays of solar panels were surveyed by observers traveling on foot. A distance sampling approach was used, whereby biologists slowly walked a transect line along the ends of rows of solar panels in a direction perpendicular to the rows, searching ahead and to the side within the array for bird and bat detections. Biologists scanned out to a maximum perpendicular distance of approximately 70 m from the transect. Biologists carried binoculars to allow them to verify the presence of a detection versus rocks or vegetation. Once a detection was confirmed, the distance of the detection to the transect line was estimated using laser range finders. Each array included in the sample was searched by observers walking two transects – one on the west side and one on the east side of the array with observers looking toward the center of the array.

Once a carcass was detected, it was photographed, and data were recorded according to specifications outlined in section 7.2.5 of the approved Desert Sunlight BBCS. Carcasses were then retrieved from their location on the ground, labeled, and placed in a freezer on site.

Most (74.4%) of the length of fenceline (approximately 10 miles; Figure 2) was searched from a vehicle using the standard protocol. Biologists searched a 6-m wide strip transect centered on the fence from the inner perimeter. Travel speed was below five miles per hour (mph) while searching. Some sections along the fence cannot be driven close to the fence line. The fence line along the western edge of the Project is drivable but the road is approximately 15 m away from the fence and the road and fence are separated by a drainage ditch. The fence along this section is covered with a tan tarp and trees and shrubs have been planted to reduce visibility of the project from the west. Additions of vegetation and the tarp likely reduce potential for bird collision with the fence. This section of the fence was driven to document carcasses, but detections along this portion of the fence are not included in adjusted fatality estimates because detection rates are likely very low. As specified in section 4.2.6 in the approved Desert Sunlight

BBCS, we assume that fatality rates are similar between the portion of fence that was searched and the portion that was not. A separate section of the fence in the southeastern corner of the Project cannot be driven because the eastern edge of the berm that bounded construction ponds is too narrow for a vehicle. Along this portion of the fence, the observer stopped at both north and south ends of the berm and used binoculars to search for carcasses. Finally, the road along a portion of the southwest fence line near the entrance gate is approximately 30 to 50 m from the road and is separated from the fence by an area that has recently undergone vegetation restoration. This area was eliminated from sampling. Fatality rates estimated for sections of the fence that were sampled were adjusted to account for the proportion of fence not sampled with the standard monitoring protocol, as specified in section 4.2.6 of the approved Desert Sunlight BBCS. In other words, the fatality rates (# carcasses/m of fenceline sampled) was multiplied by the total fenceline in the facility to get the total fenceline carcass estimate for the facility.

Comentado [FWS7]: Is there a reason that this can't be done using an estimator based on the fraction that was searched?

Comentado [WEST8]: An area adjustment was applied using exactly the approach you outlined and the Huso estimator was applied. We added a sentence to clarify

The gen-tie line was searched using a 30-m wide strip transect (i.e., 15 m of ground on either side of the overhead line). Sample units along the gen-tie line were chosen by dividing the total length of line from the Project fence south to the Red Bluff Substation just south of I-10 into 1-km segments. Thus, a 47.9% sample of the total length of the line was searched (Figure 3). Biologists slowly walked every other 1-km segment of the line, meandering the width of the strip transect, scanning for dead or injured birds or bats within 15 m (49.2 ft) of the overhead line.

For each detection, a suspected cause of death or injury was assigned based on evidence available from the detection, evidence available on Project infrastructure, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as "unknown" because it cannot be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed. Detections assigned to the "unknown" category were included in fatality estimates if they were located within standardized carcass search areas, and all detections made during the fall season are reported here.

2.2 Carcass Persistence Trials

Carcass persistence trials were conducted throughout the fall period. Carcasses from three size classes (small [0-100 g], medium [101-999], and large [1000+ g]) were used for trials. The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), chukar (*Alectoris chukar*), and adult coturnix quail, and the large size class comprised hen mallard (*Anas platyrhynchos*) and hen ring-necked pheasant (*Phasianus colchicus*).

2.2.1 *Carcass Persistence Data Collection*

To quantify carcass persistence rates, 15 small, 10 medium, and 5 large carcasses were randomly placed and monitored along the gen-tie line during fall 2015. Within the solar arrays the same numbers of each size category were placed, for a total of 60 carcass persistence trials at Desert Sunlight during the fall season, as specified in the approved Desert Sunlight BBCS. By placing carcasses inside (within arrays and along inner perimeter of the fence) and outside (along the gen-tie) the project fence, the possibility that there are different carcass persistence rates inside and outside the project fence is accounted for. Fifteen carcasses within the Project fence (within solar arrays and along the fence) were monitored using motion-triggered digital trail cameras, while the remaining carcasses were visited on foot, for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality. No carcasses along the gen-tie line were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as "feeding stations", trail cameras were installed five days before specimens were placed, and two fake cameras without bias trial carcasses were also placed within the Project fence and periodically moved to new locations within the fence. Periodic ground-based checking of carcasses with trail cameras also occurred to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera's field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire Project, not just in areas subject to standard searches, and trials were initiated in smaller numbers on two different dates throughout the fall season.

2.2.2 *Estimating Carcass Persistence Times*

Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g. days a carcass is present before being removed) may not be known exactly, but is known to be within a finite range. For example, suppose a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass became unavailable at some point between 7 and 10 days. This carcass would be considered "interval censored". Similarly, if a carcass lasts the entire 30-day trial period, that carcass is "right censored"— it is known that the carcass lasted at least 30 days, but it may have persisted longer. Because carcass persistence data were censored, persistence was analyzed using methods that can accommodate censored data and still produce unbiased estimates of the probability of persistence (Therneau 2015, Therneau and Grambsch 2000). It is beyond the scope of this document to provide statistical foundations of censored-data survival models but functions identical to those provided with the USGS-developed fatality estimator software (Huso et al 2012) were used to fit survival models to the censored carcass persistence data, and some background is available in the documentation provided with that software.

USGS-developed fatality estimator software (Huso et al 2012) was used to fit survival models to the censored carcass persistence data. The USGS software used to estimate carcass

Comentado [FWS9]: By placing carcasses in unsearched areas, doesn't this introduce an unnecessary assumption that carcass persistence is the same in searched and unsearched areas? Have you tested that carcass persistence is the same in searched and unsearched areas?

Comentado [FWS10]: This isn't clear. Is it possible to only distribute carcasses on two dates and have small numbers? Is it possible to distribute the carcass on more dates, so there are fewer "arriving" at any one time?

Comentado [WEST11]: If we restrict trials to searched areas we risk scavenger swamping. If we use the entire facility we need to assume searched areas are similar to unsearched areas. Given that the searched sample was randomly drawn, it is unlikely to have an intrinsically higher removal rate, In addition, the habitats are similar for both the searched and unsearched areas.

With respect to two vs. more trial dates, the addition of 15 carcasses across 5 square miles of solar field (assuming we use unsearched areas) amounts to one carcass per 200 acres and probablynot enough to appreciably affect the scavenging pool. Placing carcasses on more dates becomes very labor intensive as well and can complicate check schedules.

persistence calculates the period over which there is less than a 1% chance for a carcass to persist. The 'effective search interval' is defined as the shorter of a) the length of time beyond which there is less than a 1% probability that a carcass persists, and b) the actual search interval (Huso 2010). The probability of persistence is given for the effective search interval, and the probability that a carcass persists through the actual search interval is equal to *p* (persist through effective search interval) * effective search interval / actual search interval.

There were four distributions implemented in survival models used to estimate the probability a carcass is unscavenged and available to be found at the end of the search interval (*r*): exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike's Information Criterion adjusted for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model with combinations of the covariates carcass size, Project component, season, and visibility, to observed carcass persistence data.

2.3 Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the fall period. Carcasses from three size classes (small, medium, and large) were used for trials. The small size class comprised house sparrows and 2-3 week old coturnix quail, the medium size class comprised rock pigeons, chukar, and older coturnix quail, and the large size class comprised hen mallards and hen ring-necked pheasants.

2.3.1 *Searcher Efficiency Data Collection*

Training of biologists on the Project-specific protocol and early assessments of habitat conditions within the solar arrays suggested that the amount of cobble present in the soil may be an important factor influencing searcher efficiency. To satisfy requirements regarding consideration of visibility class per the BBCS and address the influence of cobble cover on searcher efficiency, sample units in the solar arrays and along the gen-tie were stratified by cobble cover and assigned to one of two classes (<15% and >15% cobble cover). Classes were determined by making ocular estimates of cobble cover at each sample unit and then evaluating the frequency histogram of sample units across the range of estimated cobble cover (Figure 4). A natural break point was identified at 15% cobble cover, so the same value was chosen as the break point that defined the two cobble cover classes. Thus, in the solar arrays, two sets of searcher efficiency trials were conducted (one set in each cobble cover class; ~~total~~ *n* in low cobble = ~~45~~ 30 small birds, 21~~30~~ medium birds, and 9~~15~~ large birds; *n* in high cobble = 15 small birds, 9 medium birds and 6 large birds, most of which are in excess of that ~~as~~ agreed upon in section 7.4 of the approved Desert Sunlight BBCS). Along the gen-tie, visibility was expected to be related to vegetation and rock cover. Thus, searcher efficiency trials along the gen-tie occurred in two visibility classes (*n* for each class = 15 small birds, 10 medium birds, and 5 large birds (easy: ≥90% bare ground, vegetation <6" tall; and more difficult: <90% bare ground, vegetation ≥6" tall). Thirty searcher efficiency trials (*n* = 15 small birds, 10 medium birds, and 5 large birds) occurred along the fence in the only visibility class present on the fence (easy visibility). During fall, a total of 180 searcher efficiency trials occurred at the Project. Locations

Comentado [FWS12]: This isn't very clear. two sets of trials should be n= 30 (s); 20 (m); 10 (l). Trial carcasses of 45, 30, 15 sounds like a multiple of three. Please clarify.

Comentado [WEST13]: We clarified

Con formato: Fuente: Sin Cursiva

Con formato: Fuente: Cursiva

for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches.

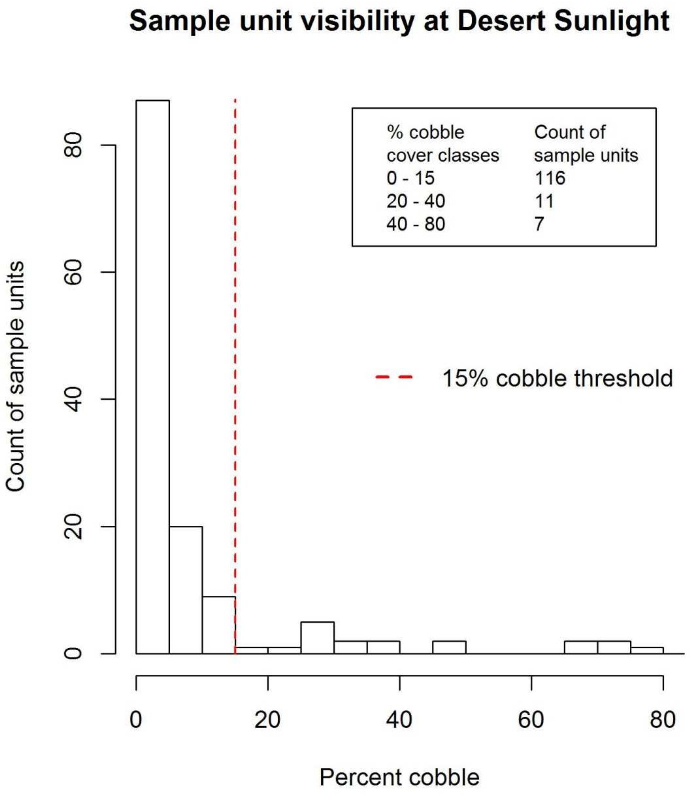


Figure 4. Frequency histogram of sample units (in the arrays only) at Desert Sunlight Solar Farm Project by estimates of cobble cover. Based on this distribution, each sample unit was assigned to one of two classes of cobble cover (<15%; >15%).

2.3.2 *Estimating Searcher Efficiency*

Searcher efficiency at Desert Sunlight was estimated separately for linear features (the project fence and the gen-tie line), and the solar arrays, reflecting the different search methods used on arrays and linear features. For linear features, logistic regression models were fit to searcher efficiency data and AICc was used to compare models. Models including effects of carcass size (three classes), visibility (two classes; gen-tie only), and season were compared to each other and the null model. Model selection indicated that the most supported model included main effects of Project component, carcass size, and season and an interaction between season and component. Once the analysis was focused on fall data only (because of the seasonal effect), the most supported model was reduced to main effects of Project component and carcass size. Once the most supported model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, *p*, was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from the fall 2015 season.

For the solar arrays, searcher efficiency was evaluated using a distance sampling approach (Buckland et al. 1993). Distance sampling assumes perfect detection on the transect line (at distance = 0), an assumption that is likely valid in the solar arrays given the relatively flat & vegetation-free nature of the soil surface. A curve is fitted to the observed carcass data that predicts probability of detection as a function of distance from the transect line. The mean value of this function over a specified distance, *w,* is equal to the average searcher efficiency for a transect of width *w*. The mean value of the detection curve is the integral of the detection function calculated between 0-m and the maximum survey distance (*w;* half the width of the solar array row), divided by the maximum survey distance:

$$p = \frac{\int_0^w f(x)dx}{w},$$

where f(x) is the detection function evaluated at distance, *x*.

One departure in the methods used here, relative to the methods presented in Buckland et al. (1993), was that for this study the detection function was estimated using trial carcasses, which meant that there were both presence (detected) and absence (not detected) data available to fit the detection function (Figure 5). The availability of both presence and absence data means that the detection function can be estimated using only trial carcasses whose distribution is known. Therefore the detection function, the average searcher efficiency among the arrays, and the final fatality estimate within the arrays are all insensitive to the spatial distribution of carcasses within individual arrays, and the overall searcher efficiency estimate is valid even if the distribution of carcasses among the arrays is not uniform.

Distances of trial carcasses (trials both found and missed) from the transect line were used to fit half-normal, exponential, and hazard rate distribution detection functions for searches among the arrays, which are all commonly used functions for distance sampling surveys (Buckland et al. 1993). The fit of detection functions were compared using AICc and each model was fit with covariates (season, carcass size, cobble cover class), and without. The most supported detection function had an exponential distribution and the most supported among these models included an interactive effect of carcass size and season.

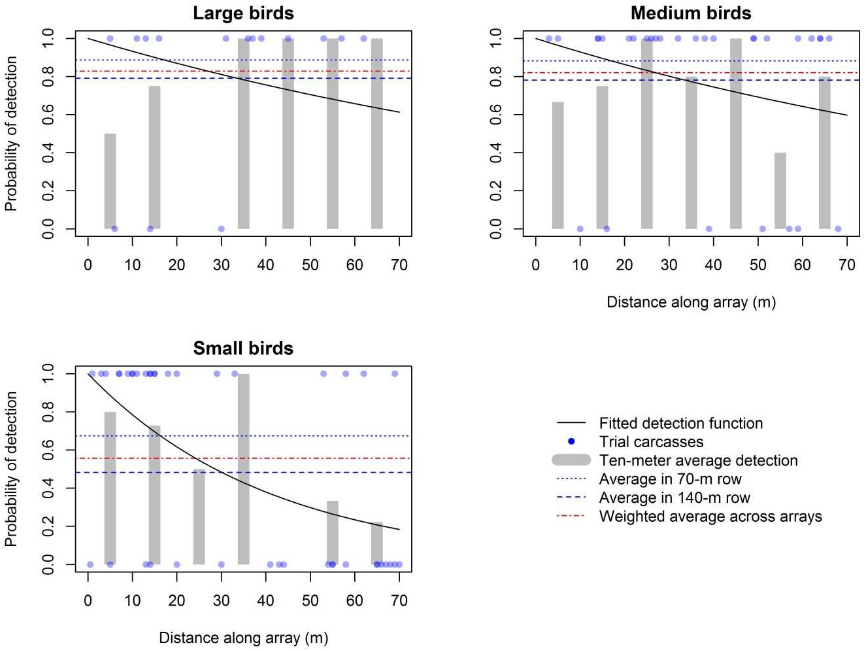


Figure 5. Estimated detection probabilities for bird carcasses by size class during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented. Estimates are informed by 45, 30 and 15 small, medium and large bird trials respectively.

Comentado [FWS14]: Please include n for each figure.

Comentado [WEST15]: We added n

Because the solar arrays were surveyed by searchers who walked down both sides of the rows of panels, the width of the search transect was specified as half the width of the rows of panels. For larger birds, there is almost certainly a non-zero detection probability beyond this distance but the bias that occurs by ignoring this non-zero detection probability is conservative (i.e. the searcher efficiency is underestimated). Some solar arrays have row widths of 70 m (search transect width of 35 m) and some have row widths of 140 m (search transect width of 70 m). The weighted average searcher efficiency is calculated based on the number of panel rows of each length in the survey sample:

$$p_{weighted\ average} = \frac{n_{70}}{n} \times \frac{\int_0^{35} f(x)dx}{35} + \frac{n_{140}}{n} \times \frac{\int_0^{70} f(x)dx}{70},$$

where n_{70} is the number of 70-m rows in the sample, n_{140} is the number of 140-m rows in the sample, and *n* is the total number of rows in the sample. Searcher efficiency was higher for the arrays with a width of 70 m, and overall searcher efficiency was estimated as a weighted average based on the proportions of 70-m arrays and 140-m arrays in the sample units.

2.4 Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots are also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie line versus cleared areas beneath solar panels). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where *F* is the total number of fatalities, *C* is the number fatalities detected and included in fatality estimation*, r* is the probability a carcass is unscavenged and available to be found at the end of the search interval, and *p* is the probability of detecting a carcass (Huso 2010). Huso (2010) describes the use of a binomial model to estimate the probability of carcass detection; in the present study, the binomial carcass detection model was used to calculate fatalities at project linear features (fence, overhead lines), and the weighted average probability of detection based on distance sampling (described above) was used to estimate probability of detection within the solar arrays.

.

All fatality estimates were calculated using the Huso estimator estimator (modified to accommodate the distance-sampling based estimate of searcher efficiency in the solar arrays), as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates was used for each variable including of searcher efficiency (*p*), probability of a carcass persisting to the next search ($\hat{r}$), adjusted search interval and observed fatalities. From these bootstrap samples, the probability of available and detected was calculated and applied to the bootstrapped observed fatalities. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

2.5 Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by WEST avian biologists and operational personnel and were considered “incidental” detections. When found by operational personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the Desert Sunlight SPUT Avian Injury and Mortality Report Forms August - October 2015. All detections made in search areas during the reporting period were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

3.0 MONITORING RESULTS

3.1 Summary of Avian Detections

During fall 2015, a total of 83 avian detections (including incidentals) of 38 identified species were recorded (Table 3). The most common identified species was American coot (*Fulica americana*) with 11 detections. Most detections (n = 54, or 65.1% of total detections) occurred in the solar arrays (Figures 2 and 3; Tables 4, 5, and 6). Sixty-two (74.7%) detections occurred during standardized carcass searches and 21 (25.3%) were documented as incidentals. No bats were detected during the fall season. For fresh carcasses, body weights and weather conditions the preceding nights are described in Appendix B.

Table 3. Number of individual bird detections, by species, found during scheduled searches and incidentally (August 31 – October 31, 2015) ~~2015~~ at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Comentado [FWS16]: Please specify that this includes carcasses found during searches and those found incidentally. Also, please include the size category for each species.

Comentado [WEST17]: Revised table

Common Name	Scientific Name	Migration Behavior*	Guild	Size	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Visitor Center	Total
common loon	*Gavia immer*	diurnal	Waterbirds/Waterfowl	LB	1	0	0	0	0	1
common raven	*Corvus corax*	resident	Corvids	LB	0	1	0	0	0	1
double-crested cormorant	*Phalacrocorax auritus*	diurnal	Waterbirds/Waterfowl	LB	0	1	0	0	0	1
mallard	*Anas platyrhynchos*	variable	Waterbirds/Waterfowl	LB	1	0	0	0	0	1
ring-necked pheasant	*Phasianus colchicus*	resident	Upland Game Birds	LB	0	2	0	0	0	2
western grebe	*Aechmophorus occidentalis*	nocturnal	Waterbirds/Waterfowl	LB	0	4	0	0	0	4
American coot	*Fulica americana*	nocturnal	Rails/Coots	MB	2	7	0	2	0	11
blue-winged teal	*Anas discors*	nocturnal	Waterbirds/Waterfowl	MB	0	1	0	0	0	1
cinnamon teal	*Anas cyanoptera*	nocturnal	Waterbirds/Waterfowl	MB	0	1	0	0	0	1
Cooper's hawk	*Accipiter cooperii*	diurnal	Accipiters	MB	0	1	0	0	0	1
eared grebe	*Podiceps nigricollis*	nocturnal	Waterbirds/Waterfowl	MB	0	2	0	0	0	2
Eurasian collared-dove	*Streptopelia decaocto*	resident	Doves/Pigeons	MB	0	0	0	3	0	3
Gambel's quail	*Callipepla gambelii*	resident	Upland Game Birds	MB	0	0	0	1	0	1
mourning dove	*Zenaida macroura*	variable	Doves/Pigeons	MB	0	2	0	1	1	4
northern pintail	*Anas acuta*	nocturnal	Waterbirds/Waterfowl	MB	0	1	0	0	0	1

Table 3. Number of individual bird detections, by species, found during scheduled searches and incidentally (August 31 – October 31, 2015) ~~2015~~ at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Comentado [FWS16]: Please specify that this includes carcasses found during searches and those found incidentally. Also, please include the size category for each species.

Comentado [WEST17]: Revised table

Common Name	Scientific Name	Migration Behavior*	Guild	Size	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Visitor Center	Total
northern shoveler	*Anas clypeata*	both	Waterbirds/Waterfowl	MB	0	1	0	0	0	1
ruddy duck	*Oxyura jamaicensis*	nocturnal	Waterbirds/Waterfowl	MB	1	2	0	1	0	4
unidentified bird (medium)	na	na	Unidentified Birds	MB	0	0	0	1	0	1
unidentified duck	na	na	Waterbirds/Waterfowl	MB	0	1	0	0	0	1
unidentified grebe	na	na	Waterbirds/Waterfowl	MB	0	1	0	0	0	1
unidentified teal	*Anas spp*	na	Waterbirds/Waterfowl	MB	0	2	0	0	0	2
western meadowlark	*Sturnella neglecta*	diurnal	Blackbirds/Orioles	MB	0	2	0	1	0	3
American pipit	*Anthus rubescens*	diurnal	Grassland/Sparrows	SB	0	1	0	0	0	1
black-throated gray warbler	*Setophaga nigrescens*	nocturnal	Warblers	SB	1	0	0	1	0	2
black-throated sparrow	*Amphispiza bilineata*	diurnal	Grassland/Sparrows	SB	0	0	0	1	0	1
Brewer's sparrow	*Spizella breweri*	nocturnal	Grassland/Sparrows	SB	1	0	0	0	0	1
brown-headed cowbird	*Molothrus ater*	diurnal	Blackbirds/Orioles	SB	0	0	0	1	0	1
common yellowthroat	*Geothlypis trichas*	nocturnal	Warblers	SB	0	0	0	1	0	1
house wren	*Troglodytes aedon*	nocturnal	Wrens	SB	0	0	0	1	0	1
least sandpiper	*Calidris minutilla*	both	Shorebirds	SB	0	1	0	0	0	1
lesser goldfinch	*Spinus psaltria*	resident	Finches/Crossbills	SB	0	2	0	0	0	2

Table 3. Number of individual bird detections, by species, found during scheduled searches and incidentally (August 31 – October 31, 2015) ~~2015~~ at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Comentado [FWS16]: Please specify that this includes carcasses found during searches and those found incidentally. Also, please include the size category for each species.

Comentado [WEST17]: Revised table

Common Name	Scientific Name	Migration Behavior*	Guild	Size	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Visitor Center	Total
Lincoln's sparrow	*Melospiza lincolnii*	nocturnal	Grassland/Sparrows	SB	0	0	0	2	0	2
northern mockingbird	*Mimus polyglottos*	resident	Mimids	SB	0	1	0	0	0	1
orange-crowned warbler	*Oreothlypis celata*	nocturnal	Warblers	SB	0	0	0	3	0	3
Savannah sparrow	*Passerculus sandwichensis*	nocturnal	Grassland/Sparrows	SB	0	1	0	2	0	3
sora	*Porzana carolina*	nocturnal	Rails/Coots	SB	0	1	0	0	0	1
unidentified bird (small)	na	na	Unidentified Birds	SB	0	0	0	1	0	1
unidentified sparrow	na	na	Grassland/Sparrows	SB	0	0	0	1	0	1
vesper sparrow	*Pooecetes gramineus*	nocturnal	Grassland/Sparrows	SB	0	0	0	1	0	1
Virginia rail	*Rallus limicola*	nocturnal	Rails/Coots	SB	1	0	0	0	0	1
white-crowned sparrow	*Zonotrichia leucophrys*	nocturnal	Grassland/Sparrows	SB	0	0	0	2	0	2
Wilson's warbler	*Cardellina pusilla*	nocturnal	Warblers	SB	0	1	0	0	0	1
yellow-rumped warbler	*Setophaga coronata*	nocturnal	Warblers	SB	0	2	0	0	0	2
yellow warbler	*Setophaga petechia*	nocturnal	Warblers	SB	1	0	0	0	0	1
unidentified bird	na	na	Unidentified Birds	Unk	0	3	0	1	0	4

Table 3. Number of individual bird detections, by species, found during scheduled searches and incidentally (August 31 – October 31, 2015) ~~2015~~ at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Common Name	Scientific Name	Migration Behavior*	Guild	Size	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Visitor Center	Total
(unknown size)										
Total					**9**	**45**	**0**	**28**	**1**	**83**

[1] Ring-necked pheasants are used for bias trials and these two detections were likely from trial carcasses; however, ring-necked pheasants have been reported in Riverside County, CA south of the Project area near the Salton Sea (eBird 2015). Thus, we cannot be certain that these detections were exclusively from trial carcasses.

[2] See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in Birds of North America (BNA) Online (http://bna.birds.cornell.edu/bna/); where information on migration behavior was lacking in BNA accounts, Newton (2008) or Murray (2004) were used.

Comentado [FWS16]: Please specify that this includes carcasses found during searches and those found incidentally. Also, please include the size category for each species.

Comentado [WEST17]: Revised table

Comentado [FWS18]: Can you mark trial carcasses so there is no confusion? You can tie a small inconspicuous but distinctive piece of string on one leg to identify trial carcasses.

Comentado [WEST19]: Seef carcasses are marked with black electrical tape on leg. Tampering with crt carcasses may effect scavenging.

Table 4. Total avian detections by Project component and detection category during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. Only carcasses found within search areas were included in fatality estimates.

	Inside carcass search area		Outside carcass search area	
Project Component	**Carcass search**	**Incidental**	**Carcass search**	**Incidental**
Fence	0	0	0	0
Visitor Center	0	0	0	1
Gen-tie line	23	0	5	0
Solar arrays				
Line-associated	4	1	1	3
Non-line associated	28	5	1	11
Total	**55**	**6**	**7**	**15**

Table 5. Total avian detections (including incidentals) by Project component and suspected cause of death during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

	Suspected Cause of Death*				
Project Component	**Collision**	**Predation**	**Other**	**Unknown**	**Percent of Total**
Fence	0	0	0	0	0.0
Visitor Center	0	0	0	1	1.2
Gen-tie line	9	1	0	18	33.7
Solar arrays					
Line-associated	2	0	0	7	10.8
Non-line associated	6	0	1	38	54.2
Percent of Total	**20.5**	**1.2**	**1.2**	**77.1**	**100.0**

* Suspected cause of death was assigned based on evidence available on the detection, evidence available on Project infrastructure, and proximity of detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as "unknown" because it can't be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, there is substantial uncertainy associated with cause of death assignments because no events were directly observed.

3.2 Temporal Patterns of Avian Detections

The number of detections recorded daily during the reporting period ranged from zero to six, and were more or less evenly distributed throughout the season (Figure 6). Daily detections peaked on September 22 and this event was reported to the agencies per Special Purpose Utilities Permit Condition H(c). The number of detections per day represents those discovered during standardized carcass searches and incidentally.

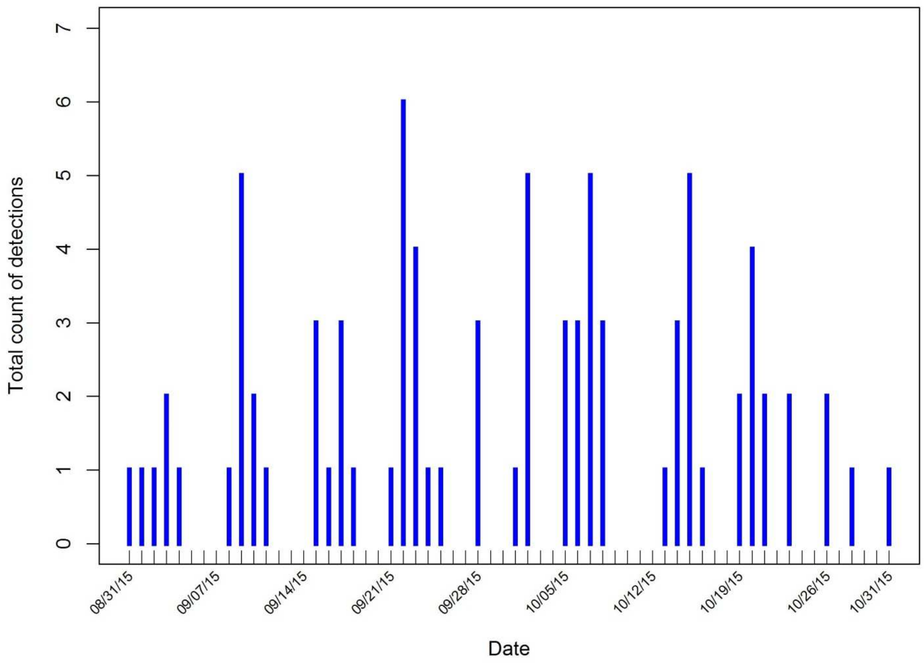


Figure 6. Total count of detections (including incidentals) by date during fall (August 31 – October 31) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.3 Spatial Distribution of Avian Detections

3.3.1 *Detections by Project Component*

During the reporting period, detections were documented from the solar arrays, the Visitor Center, and the gen-tie line; no detections occurred ~~at the Visitor center or~~ along the fence (Tables 3, 4, and 5). Of the 54 detections within the solar arrays, 16.7% (9) were associated either with overhead lines or arrays that co-occurred with overhead lines. Twenty-eight detections (33.7% of season total) were along the gen-tie line, and one detection (1.2% of season total) was at the Visitor Center.

3.3.2 *Feather Spot Detections*

Fourteen (16.9%) of the 83 detections made during fall consisted only of feather spots. Along the gen-tie, nine of 28 detections (32.1%) were feather spots. Five of 54 detections (9.3%) in the solar arrays were feather spots. There were no detections along the fence during fall.

3.4 Detections of Injured or Stranded Birds

There were six injured or stranded birds detected during fall 2015. Three injured birds were detected at line-associated (ruddy duck [*Oxyura jamaicensis*]) and non-line associated arrays (2; mourning dove [*Zenaida macroura*] and western grebe [*Aechmophorus occidentalis*]). Three stranded but uninjured birds were detected at line-associated (common loon [*Gavia immer*]) and non-line associated (ruddy duck and eared grebe [*Podiceps nigricollis*]) arrays. The injured mourning dove and ruddy duck were transported to wildlife rehabilitation facilities; the ruddy duck was released by the rehabilitator on the same day. The injured western grebe died before it got to a rehabilitation facility. The stranded ruddy duck, eared grebe, and common loon were evaluated for a short period for injuries and general stress and when none were observed, released at Lake Tamarisk. Three detections of injured or stranded birds were included in fall fatality estimates; three were excluded because they were found outside of a standardized carcass search area.

3.5 Summary of Bat Detections

No bats were detected during the fall 2015 season.

3.6 Carcass Persistence Trials

Data from carcass persistence trials were available from late winter, spring, summer, and fall at the solar field and gen-tie line (n = 215 total). Based on carcass persistence data from all seasons so far in 2015, survival models were compared for relative quality using the corrected AICc score, as suggested in Huso (2010). The AICc score provides a relative measure of model fit and parsimony among a selection of candidate models, and provides a framework for testing hypotheses regarding which factors contribute to carcass persistence rates. Carcass size was tested as a potentially important variable, as larger carcasses tend to persist longer and may be more likely to leave feather spots which persist for long durations, whereas smaller carcasses may be more likely to be completely removed. Project component (solar arrays, gen-tie line) was also included as a potentially important variable, as was season.

The model with lowest AICc score is typically chosen as the “most supported” model relative to other models tested; however, any model within two AICc points of the most supported model is considered competitive with the most supported model (Burnham and Anderson 2004). Preliminary modeling suggested a main effect of season, so further modeling efforts were restricted to data collected in fall only. The most supported model using only the fall data included main effects of carcass size and Project component, with a removal time that was lognormally-distributed (Appendix C). Estimates of carcass removal time and persistence probabilities from the most supported model are reported in Table 6, and estimates of proportion of carcasses remaining as a function of days since carcass placement are provided in Figure 7. Detailed estimates of carcass removal and associated confidence intervals are provided in Appendix C.

Table 6. Mean and median carcass removal time and probability of a carcass persisting through the effective search interval during the fall (August 31 – October 31) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass size	Project component	Mean removal time (days)	Median removal time (days)	Day when 50% carcasses were removed	Probability of persistence
Small	Arrays/fence	2.2	1.5	1 - 2	0.46
	Overhead		0.5	<1	
Small	lines	0.1			0.08
Medium	Arrays/fence	17.4	16	8	0.80
	Overhead		1.5	1 – 2	
Medium	lines	0.8			0.30
Large	Arrays/fence	203.3	>30	Na	0.98
	Overhead		3.5	3 - 4	
Large	lines	9.7			0.72

Comentado [FWS20]: Also include the Time until 50% of the carcasses have been removed.

Comentado [WEST21]: median removal time is the time until 50% of carcasses are removed.

Comentado [WEST22]: First day that 50% are gone is day 8, nothing changes the rest of the trial. The rest (5 out of 10) are censored.

Right censored events skew the median metric.

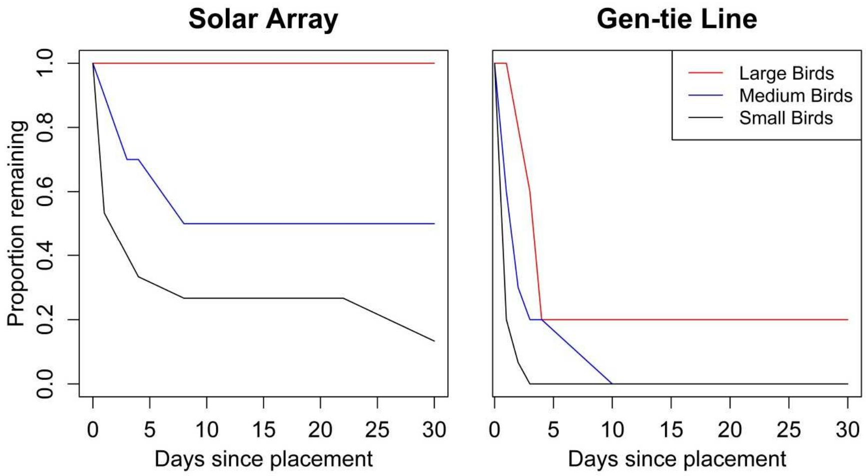


Figure 7. Proportion of trial carcasses remaining as a function of days since placement and carcass size class (n = 30, 20, and 10 for small, medium, and large size classes, respectively) during the fall (August 31 – October 31) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.7 Searcher Efficiency Trials

During the reporting period, a total of 180 searcher efficiency trials were placed at the Project. Most trials were available to be found, but some disappeared before or during the trial. Overall, 90 trials were placed in the solar arrays and 87 were available to be found; 30 trials were placed along the perimeter fence (inner perimeter only) and 29 were available to be found; and 60 trials were placed along the gen-tie line and 51 were available to be found. Three observers conducted searches at the Project during fall. Searcher efficiency trials were conducted on each observer in approximate proportion to the number of searches they conducted at the Project, as follows: Sarah Nichols (number of trials available to be found: 28), Darin Blood (62), and Wanda Bruhns (77). All trials were included in estimation of searcher efficiency.

In the solar arrays, the model that included an effect of carcass size was chosen as the most supported model to estimate searcher efficiency (Appendix C). Within the solar arrays, searcher efficiency was: 55.7% for small birds, 82.1% for medium birds, and 82.9% for large birds (Figure 5; Appendix C).

For linear Project components, the model that included an effect of carcass size, Project component, and season was chosen as the most supported model to estimate searcher efficiency. Along the fence, searcher efficiency was 90.1% (CI: 78.1 – 100%), 94.9% (CI: 86.2 – 100%), and 98.0% (CI: 92.6 – 100%) for small, medium, and large carcasses, respectively. Along the gen-tie, searcher efficiency was 44.7% (CI: 27.4 – 62.4%), 62.5% (CI: 45.5 – 80.0%), 81.0% (CI: 60.0 – 100%) for small, medium, and large carcasses, respectively. Detailed estimates of searcher efficiency estimates specific to each component and carcass size are reported in Appendix C.

3.8 Fatality Estimates

Fatality estimates were calculated separately for each component (solar arrays, fence, and overhead lines). Ultimately, 22 detections were excluded from the fatality analysis because they were found outside standardized search areas (Table ~~4~~7; Appendix C). All 83 detections that occurred~~made~~ during fall are reported in Table 3.

Table 7. Status of detections during the fall (August 31 – October 31) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California. All detections outside the search area were excluded from the fatality analysis, regardless of whether they occurred during a standardized carcass search or incidentally.

	Carcass search	Incidental detection	*Pushed to next season's fatality estimate	*Pulled from previous season's fatality estimate
Inside search area	55	6	0	0
Outside search area	7	15	0	0

* Incidental detections occurring after the last standardized carcass search in a season are considered for inclusion in the fatality analysis for the following season. This is consistent with the assumption we make throughout the monitoring seasons; that carcasses found incidentally would have been available to be found on the next scheduled search. This assumption may result in some carcasses found during one season but considered in the following season's fatality analysis. Once a carcass has been moved to a different season's analysis it is still subject to the same criteria for inclusion or exclusion based on location (in versus out of a searched area) and carcass age (greater than versus less than the search interval).

During fall 2015, 296 carcasses (90% CI: 198 – 461) were estimated for the solar arrays. There were an estimated 0.115 carcasses per acre (within the solar field only; 296 estimated carcasses/2,585 acres) and an estimated 0.538 carcasses per nameplate MW (296 estimated carcasses/550 MW) within the solar field.

Estimates of fatalities along the gen-tie are heavily influenced by the high rates of scavenging observed during the limited trials at the gen-tie (i.e., large correction factors) and are likely very unreliable. The estimate along the gen-tie was 894 carcasses (90% CI: 362 – 2,948). No carcasses were estimated for the perimeter fenceline because there were no detections made along the fence. A complete list of estimates for each Project component and carcass size class with confidence intervals is presented in Appendix C.

4.0 DISCUSSION

The 2015 fall season represented the third full season of standardized monitoring at Desert Sunlight per the BBCS. Searcher efficiency and carcass persistence trials were conducted concurrently at the solar arrays, fencelines, and along the gen-tie line. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. Although these estimates were produced from a statistically robust sample, only limited inference may be drawn from three seasons of data. These results should be considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. As more data are collected throughout the monitoring year (and additional quality assurance/quality control measures occur, for example characterizing feather spots to species or size class), data from all seasons may be pooled. At that time, data will be tested for seasonal differences retrospectively, but because seasonal estimates will be produced from the much larger annual data set, they may differ from what is reported here because they are based on a larger, more informative sample.

4.1 Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Thus, rates of carcass persistence reported here should be interpreted cautiously as they may change over the coming months.

Fatality estimates are influenced by the relationship between carcass removal dynamics and search intervals. In practical terms, longer search intervals reduce average probability that a carcass persists until the next search. In terms of the analysis, this can manifest as a lower probability of persistence through the effective search interval, or an effective search interval that is shorter than the nominal search interval. In either case, the adjustment to carcass counts due to carcass removal dynamics is calculated as

$$\frac{length\ of\ effective\ search\ interval}{length\ of\ nominal\ search\ interval * average\ probability\ of\ persistence\ through\ the\ effective\ search\ interval}$$

The adjustment to estimated fatality for carcass removal increases with longer search intervals, and the variance in the estimate may increase, also.

Carcass persistence at the Project is clearly influenced by whether a carcass is located in the solar field (inside the perimeter fence) or along the gen-tie (outside the perimeter fence), with higher removal rates occurring along the gen-tie. Although the same scavenger species may occur at both Project components, a difference in scavenger density or activity between the components could possibly be responsible for the different rates of carcass persistence. If there are differences in scavenging rates between the trial carcasses and naturally-occurring carcasses, it is possible that the high scavenging rates observed along the gen-tie have resulted in inflated fatality estimates. This hypothesis may be evaluated in the annual report by comparing persistence rates of trial carcasses to the age of carcasses detected by observers. Given the very high scavenging rates along the gen-tie line, fatality estimates for the gen-tie are unreliable.

Searcher efficiency was influenced by Project component, carcass size, and season. In the solar arrays, searcher efficiency was high (>0.5) for all carcass size classes and this is likely influenced by the limited vegetation cover beneath solar panels. Beneath the gen-tie line, vegetation cover is higher in some portions of the strip transects, but results reported here support the hypothesis that visibility class was not a factor in searcher efficiency along the gen-tie line during fall. Placement of trial carcasses in both difficult and easy visibility classes ensures that the adjustment due to searcher efficiency accounts for both visibility classes, even if there is a real difference in searcher efficiency that cannot be detected with the trial data.

4.2 Distribution of Fatalities and Fatality Estimates

Detections were distributed throughout the fall season, and there were no clear peaks in detections associated with a particular date or range of dates. Tapering of daily detections at the beginning and end of the fall season (Figure 6) suggests that the current dates that define the season likely capture the majority of fall migration at the Project.

Most (65.1%) of the 83 detections made during fall were in the solar field. Approximately 13% of the carcasses found in search plots had overhead lines associated with those plots and 10% of the plots searched had lines associated with them, suggesting overhead lines within the solar field may not influence mortality. The absence of any detections along the fence in fall coupled with the very low number of detections in previous seasons (spring: 2; summer: 1) and relatively high carcass persistence rates inside the fence suggest the perimeter fence at the Project may not be an important source of mortality.

Composition of detections during fall 2015 included 13 avian guilds. Waterbirds and waterfowl comprised the majority of detections (n = 21), followed by rails and coots (n = 13), grassland birds and sparrows (n = 12), and warblers (n = 10). All other guilds were represented by fewer than ten detections. No bats have been detected since monitoring began at the Project. Species that migrate nocturnally were detected most frequently during fall (n = 21 species). Ring-necked pheasants were included in the list of detected birds (Table 3), but these detections were most likely from trial carcasses. However, because ring-necked pheasant have been reported in

Riverside County, CA (eBird 2015) south of the Project area near the Salton Sea, we could not be certain that both detections were from trial carcasses.

Detections attributed to an unknown cause accounted for 77.1% of all detections during the reporting period, and most of those attributed to an unknown cause were found in the solar arrays. Of the 54 detections made in the solar arrays, 11.1% were feather spots. Determining a cause of mortality from a feather spot is challenging because there is rarely visible evidence available on which to determine a cause of death. Thus, feather spots with an unknown cause of mortality could be encountered anywhere birds occur, and an unknown cause of a sizeable proportion of the carcasses is not unique to the Project. Further, the relatively large proportion of feather spots (18.1%) among the detections for the Project as a whole may inflate the fatality estimate based on the potential for multiple feather spots resulting from one fatality, feather spots resulting from predation not associated with the facility, or other causes.

5.0 LITERATURE CITED

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in 2nd International Symposium on Information Theory (B. N. Petran and F. Csaki, Eds.). Akademiai Kiado, Budapest, Hungary.

Ammon, Elisabeth M. and William M. Gilbert. 1999. Wilson's warbler (*Cardellina pusilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/478

Boarman, William I. and Bernd Heinrich. 1999. Common raven (*Corvus corax*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/476 doi:10.2173/bna.476

Buckland, S, D.R. Anderson, K. P. Burnham, and J.L. Laake. 1993. Distance sampling: estimating abundance of biological populations. Chapman & Hall, London. 446 pp.

Burnham, K.P., and D.R. Anderson. 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociological Methods & Research 33: 261-304.

Evers, David C., James D. Paruk, Judith W. Mcintyre and Jack F. Barr. 2010. Common loon (*Gavia immer*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/313 doi:10.2173/bna.313

Hudon, Jocelyn. 1999. Western tanager (*Piranga ludoviciana*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/432 doi:10.2173/bna.432

Hughes, Janice M. 2011. Greater roadrunner (*Geococcyx californianus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/244 doi:10.2173/bna.244

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. doi: 10.1002/env.1052

Huso, Manuela, Som, Nicholas, and Ladd, Lew, 2012, Fatality estimator user’s guide: U.S. Geological Survey Data Series 729, 22 p.

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A new method to determine bird and bat fatality at wind energy turbines from carcass searches. Wildlife Biology 17: 350-363.

Lowther, Peter E. and Janet McI. Williams. 2011. Nashville warbler (*Oreothlypis ruficapilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/205 doi:10.2173/bna.205

Manly, B.F.J.1997. Randomization, bootstrap and Monte Carlo methods in biology. Second Edition. CRC Press, LLC, Boca Raton, Florida, 455 pp.

Melvin, Scott M. and James P. Gibbs. 2012. Sora (*Porzana carolina*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/250 doi:10.2173/bna.250

Muller, Martin J. and Robert W. Storer. 1999. Pied-billed grebe (*Podilymbus podiceps*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/410 doi:10.2173/bna.410

Murray, J. 2004. Nocturnal flight call analysis as a method for monitoring density and species composition of migratory songbirds (Order Passeriformes) across southern Vancouver Island, British Columbia in 2004. Rocky Point Bird Observatory, 16 pp.

Newton, I. 2008. The migration ecology of birds. Academic Press, London.

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine-cause avian fatality estimates. Journal of Wildlife Management 74(5): 1089-1096.

Smallwood, K. S. 2013. Comparing bird and bat ratality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37(1): 19-33.

Therneau, T. 2015. _A Package for Survival Analysis in S. version 2.38, <URL: http://CRAN.R-project.org/package=survival>.

Therneau, T.M. and P. M. Grambsch 2000. Modeling Survival Data: Extending the Cox Model. Springer, New York. ISBN 0-387-98784-3.

Western Ecosystems Technology (WEST), Inc. 2014. Bird and bat conservation strategy, Desert Sunlight Solar Farm Project, Riverside County, California. 57 pp.

Wheelwright, N. T. and J. D. Rising. 2008. Savannah sparrow (*Passerculus sandwichensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/045 doi:10.2173/bna.45

Appendix A. Detailed Areas of Carcass Locations along the Generation Tie Line of the Desert Sunlight Solar Farm Project during Fall (August 31 – October 31) 2015

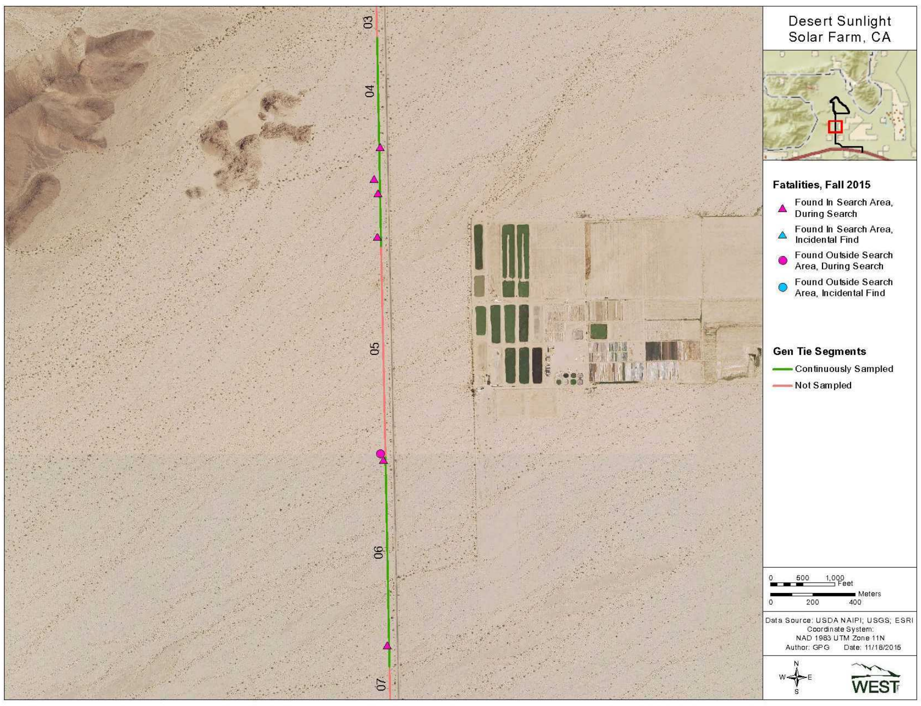


Figure A-1. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during fall (August 31 – Ocotber 31) 2015.

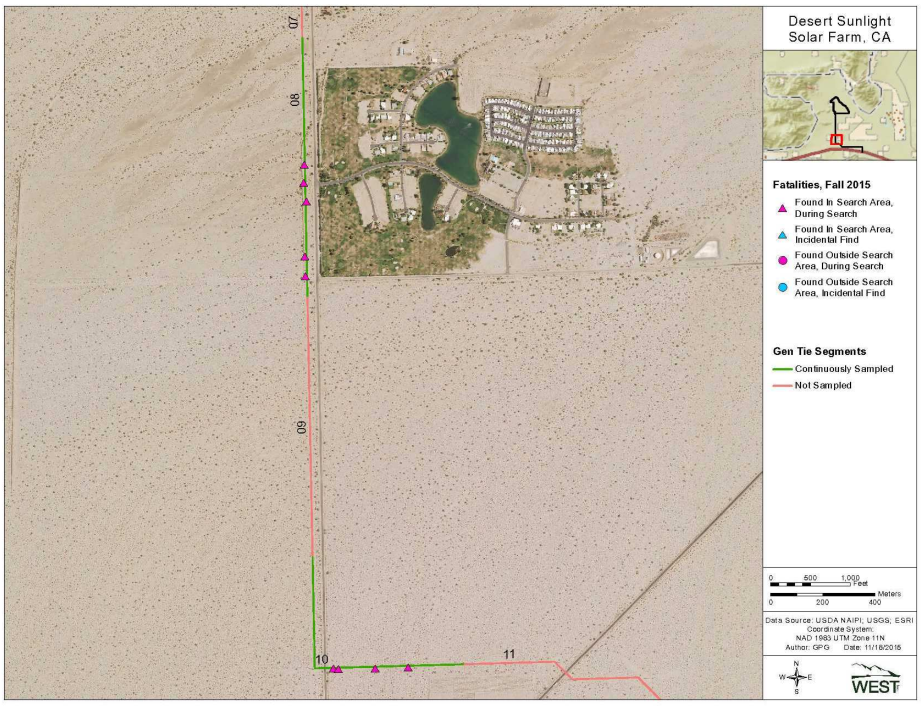


Figure A-2. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015.

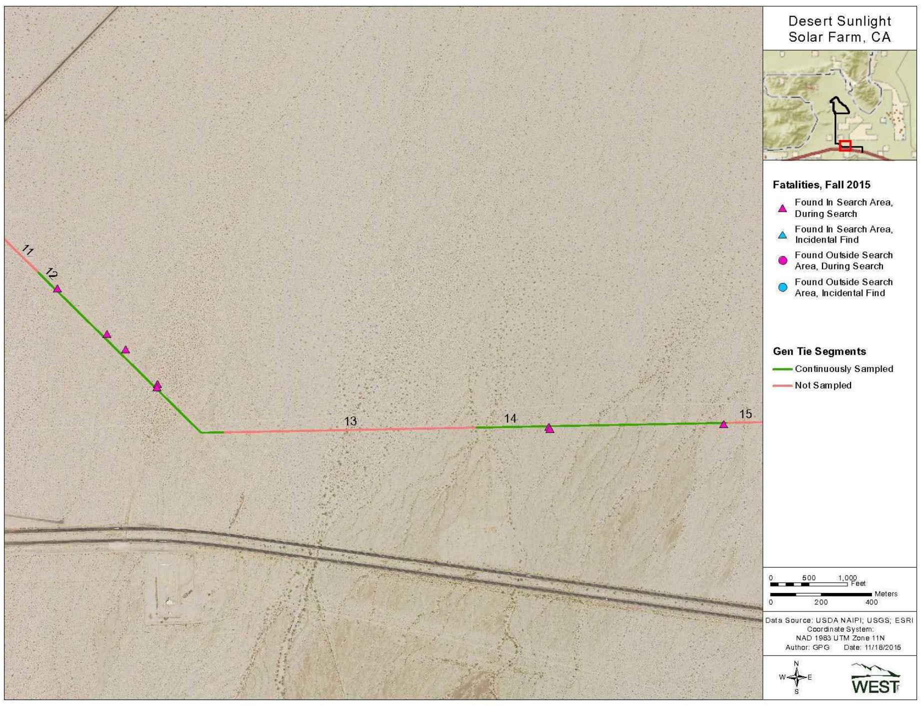


Figure A-3. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015.

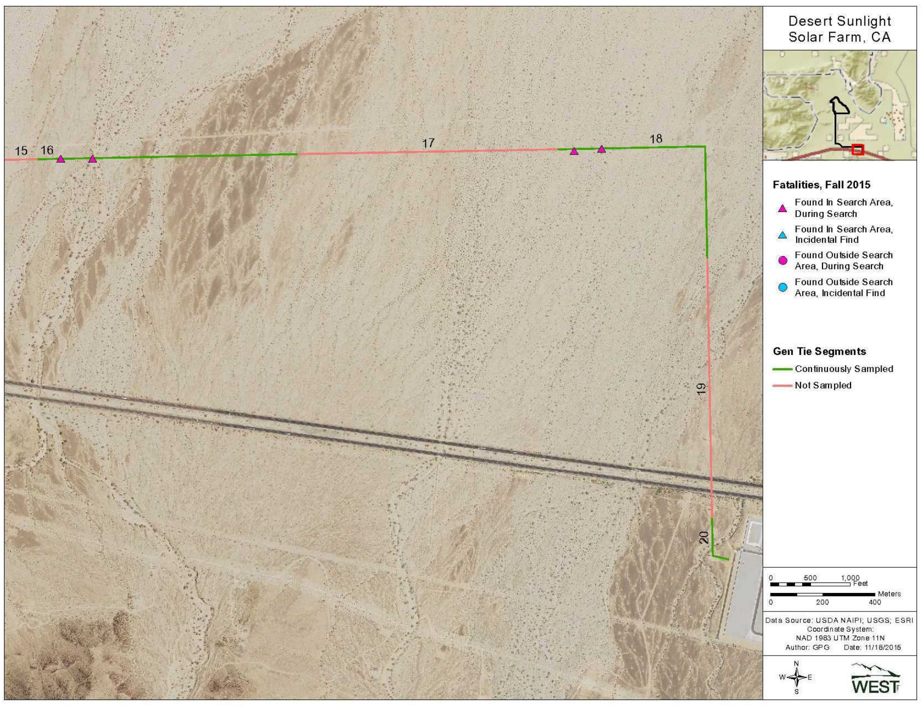


Figure A-4. Detailed map of carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during fall (August 31 – October 31) 2015.

Appendix B. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during Fall (August 31 – October 31) 2015

Table B-1. Weather conditions and body weights associated with detections estimated to be less than 24 hours old during fall (August 31 – October 31) 2015 at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hrs)	Species	Weight (g)[1]	Weather Summary for Preceding 24 hrs
091615-UNSP-GENTIE12-01	9/16/2015	0-8	black-throated sparrow	14	14 max wind. 8 average wind. SSE wind direction. Waxing crescent moon phase. No clouds. Very sunny and a very nice breeze ~95 degrees F.
092315-VIRA-11-15-MVOH-01	9/23/2015	0-8	Virginia rail	60	14 max wind speed. 3 average wind speed. NNE wind direction. Waxing gibbous moon phase. Max temp. 94. Clear until bird found.
100615-AMCO-GENTIE-8-01	10/6/2015	0-8	American coot	465	20 mph max wind speed. 9 mph avg wind speed. WSW wind direction. Last quarter moon phase.
100615-LISP-GENTIE-06-01	10/6/2015	0-8	Lincoln's sparrow	14	MAX WIND SPEED: 20. AVG WIND SPEED: 9. WIND DIRECTION: WSW. MOON PHASE: LAST QUARTER. MOSTLY CLOUDY
100815-EAGR-05-16-MAINROAD-02	10/8/2015	0-8	eared grebe	-	MAX WIND SPEED: 10. AVG WIND SPEED: 4. WIND DIRECTION: WSW. MOON PHASE: WANING CRESCENT. CLEAR.
101415-WEGR-07-15-A-34-01	10/14/2015	0-8	western grebe	670	MAX WIND SPEED: 13. AVG WIND SPEED: 5. WIND DIRECTION: NE. MOON PHASE: NEW MOON. CLEAR.
101515-RUDU-06-15-A-10E-02	10/15/2015	0-8	ruddy duck	-	MAX WIND SPEED: 6 MPH. AVG WIND SPEED: 3 MPH. WIND DIRECTION: ENE. MOON PHASE: WAXING CRESCENT. 10 MILE VISIBILITY
101515-RUDU-08-01-B-14-E-01	10/15/2015	0-8	ruddy duck	-	MAX WIND SPEED: 13 MPH. AVG WIND SPEED: 4 MPH. WIND DIRECTION: NW. MOON PHASE: WAXING CRESCENT. MOSTLY CLOUDY, LIGHT SPRINKLES, AVG TEMP 90 DEG F
102015-BHCO-GENTIE-10-01	10/20/2015	0-8	brown-headed cowbird	43	10-18NNW Wind, gusts to 25 MPH, waxing crescent moon, max temp 85, clear until 6pm then partly cloudy/overcast until midnight then clear until bird found
102315-COLO-04-05-A-02	10/23/2015	0-8	common loon	-	MAX WIND SPEED: 7. AVG WIND SPEED: 3. WIND DIRECTION: ENE. MOON PHASE: WAXING GIBBOUS. MAX TEMP ON 10/22 84 DEG F. CLEAR, VISIBILITY 10 MILES ON 10/22 AND 10/23
091015-BTYW-02-21-A-MVOH-04	9/9/2015	8-24	black-throated gray warbler	8	MAX WIND SPEED- 34. AVG WIND SPEED- 10. WIND DIRECTION- SSE. MOON PHASE- WANING CRESCENT. MAX TEMP 108. CLEAR UNTIL 2PM ON 09/08
090915-YWAR-18-11-A-MVOH-03	9/9/2015	8-24	yellow warbler	8	MAX WIND SPEED- 34 MPH. ANG WIND SPEED- 10. WIND DIRECTION- SSE. MOON PHASE- WANING CRESCENT. MAX TEMP- 108. CLEAR UNTIL 2PM ON

					9/08. HAZE/THUNDERSTORM UNTIL 5PM, THEN CLEAR.
092215-LISP-GENTIE-10-01	9/22/2015	8-24	Lincoln's sparrow	13	6-16mph SE wind, 9.21 max temp 91F, clear until 4pm, partly cloudy until 5pm, clear until 3am then clear/partly cloudy/overcast until bird found
092315-SAVS-GENTIE-12-03	9/23/2015	8-24	Savannah sparrow	18	3-14 mph NNE wind, waxing gibbous moon, max temp 94, clear
092515-RUDU-19-05-B-2W-01	9/25/2015	8-24	ruddy duck	-	4-14mph NE wind, waxing gibbous moon, clear until bird found
092815-WEGR-10-24-A-PCS-02	9/28/2015	8-24	western grebe	630	12 max wind speed. Gusts 16. 4 avg wind speed. ESE wind direction. Full moon phase. Max temp 105 F. Clear until bird found, according to Weather Underground. 40-55% clouds morning bird found as seen in field.
092815-YRWA-10-19-B-01W-03	9/28/2015	8-24	yellow-rumped warbler	10	12 max wind speed. Gusts 16. 4 avg wind speed. ESE wind direction. Full moon phase. Max temp 105 F. According to weather underground clear until bird found. However 40-55% clouds in field on morning of 09/28 until bird found.
100715-SAVS-GENTIE-12-01	10/7/2015	8-24	Savannah sparrow	16	MAX WIND SPEED: 13. AVG WIND SPEED: 6. WIND DIRECTION: NNW. GUSTS 17. MOON PHASE: WANING CRESCENT. HIGH TEMP 89F. CLEAR UNTIL 4 PM ON 10/06, THEN OVERCAST/ MOSTLY CLOUDY. CLEAR AGAIN FROM 7PM UNTIL BIRD FOUND ON 10/07.
100715-VESP-GENTIE-16-03	10/7/2015	8-24	vesper sparrow	23	MAX WIND SPEED: 13. ANG WIND SPEED: 6. WIND DIRECTION: NNW. MOON PHASE: WANING CRESCENT. HIGH TEMP 89 DEG F. CLEAR UNTIL 4 PM ON 10/06, THEN OVERCAST/ MOSTLY CLOUDY. CLEAR AGAIN FROM 7 PM UNTIL BIRD FOUND ON 10/07.
100715-HOWR-GENTIE-18-04	10/7/2015	8-24	house wren	9	MAX WIND SPEED: 13. AVG WIND SPEED: 6. WIND DIRECTION: NNW. GUSTS: 17. MOON PHASE: WANING CRESCENT. HIGH TEMP 89 DEF F. CLEAR UNTIL 4PM ON 10/06, THEN OVERCAST/MOSTLY CLOUDY. CLEAR AGAIN FROM 7PM UNTIL BIRD FOUND ON 10/07.
100715-WCSP-GENTIE-14-02	10/7/2015	8-24	white-crowned sparrow	24	MAX WIND SPEED: 13. AVG WIND SPEED: 6. WIND DIRECTION: NNW. MOON PHASE: WANING CRESCENT. HIGH TEMP 89 DEG F. CLEAR UNTIL 4 PM ON 10/06, THEN OVERCAST/ MOSTLY CLOUDY. CLEAR AGAIN FROM 7 PM UNTIL BIRD FOUND ON 10/07.
101315-WEME-GENTIE-10-01	10/13/2015	8-24	western meadowlark	72	MAX WIND SPEED: 9. AVG WIND SPEED: 5. WIND DIRECTION: SW. MOON PHASE: WANING CRESCENT. CLEAR.
101615-AMCO-20-08-A-7-E-01	10/16/2015	8-24	American coot		MAX WIND SPEED: 21 MPH. AVG WIND SPEED: 6 MPH. WIND DIRECTION: NNW.

102115-WCSP-GENTIE-14-01	10/21/2015	8-24	white-crowned sparrow	27	MOON PHASE: WAXING CRESCENT. HEAVY CLOUD COVER GREATER THAN 80%. T-STORM PREVIOUS NIGHT, ON 101515 (WITH RAIN AND LIGHTENING) 8-33 MPH NNW wind, waxing crescent moon, rain, thunderstorm

[1] Weight recorded only for intact carcasses with no evidence of scavenging.

Appendix C. Correction Factors and Bird Fatality Rates at the Desert Sunlight Solar Farm Project during Fall (August 31 – October 31) 2015.

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during fall (August 31 – October 31) 2015. *Distribution of easy and difficult visibility on the gen-tie line was 50% and 50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Proportion of area searched by component								
Gen-tie line	**0.479**	-	**0.479**	-	**0.479**	-	**0.479**	-
Fence	0.744	-	0.744	-	0.744	-	0.744	-
Solar arrays	0.295	-	0.295	-	0.295	-	0.295	-
Searcher efficiency by component and visibility class								
Gen-tie line: Easy vis.*	0.447	0.274 - 0.624	0.625	0.455 - 0.8	0.810	0.6 - 1	0.447	0.274 - 0.624
Gen-tie line: Difficult vis.*	0.447	0.274 - 0.624	0.625	0.455 - 0.8	0.810	0.6 - 1	0.447	0.274 - 0.624
Gen-tie line	0.447	0.274 - 0.624	0.625	0.455 - 0.8	0.810	0.6 - 1	0.447	0.274 - 0.624
Fence	0.901	0.781 - 1	0.949	0.862 - 1	0.980	0.926 - 1	0.901	0.781 - 1
Solar arrays	0.557	0.439 - 0.665	0.821	0.714 - 0.91	0.828	0.648 - 0.953	0.557	0.439 - 0.665
Average probability of carcass persistence through the effective search interval								
Gen-tie line	0.080	0.027 - 0.141	0.299	0.169 - 0.425	0.719	0.582 - 0.866	0.080	0.027 - 0.141
Solar arrays & fence	0.463	0.295 - 0.632	0.802	0.640 - 0.924	0.977	0.948 - 0.995	0.463	0.295 - 0.632
Carcass counts by component								
Gen-tie line	13	5 - 22	9	3 - 15	0	-	1	0 - 3
Fence	0	-	0	-	0	-	0	-
Solar arrays	10	5 - 16	18	12 - 25	7	3 - 12	3	0 - 6
Average Probability of Carcass Availability and Detected (Searcher efficiency * average probability of carcass persistence)								
Gen-tie line	0.036	0.01 - 0.07	0.187	0.098 - 0.286	0.583	0.395 - 0.771	0.036	0.01 - 0.07
Fence	0.417	0.259 - 0.581	0.761	0.595 - 0.892	0.957	0.897 - 0.988	0.417	0.259 - 0.581
Solar arrays	0.258	0.157 - 0.364	0.658	0.508 - 0.783	0.810	0.631 - 0.939	0.258	0.157 - 0.364
Adjusted Fatality Estimates (Fatalities /Season; values in italics are considered unreliable due to low counts of carcasses: carcass count / (proportion of area searched * average probability of carcass availability and detected)**								
Gen-tie line	729	229 - 2636	109	32 - 223	0	-	*56*	(1) - 243
Fence	0	-	0	-	0	-	0	-
Solar arrays	131	59 - 262	94	58 - 140	30	11 - 54	*40*	(3) - 101
Facility	860	348 - 2830	203	112 – 331	30	11 - 54	*96*	16 - 294

Comentado [FWS23]: These percentages are different than they were in the Summer report (75% and 30%). Please explain the difference.

Comentado [WEST24]: For the summer report we made an estimate of easy and difficult visibiltity based on our searchers' impression of the site. By the time we produced the fall report we had been able to put together a better estimate of proportion in each visibility class.

Con formato: Fuente: Negrita

Table C-2. Carcasses excluded from the fall 2015 fatality analysis at the Desert Sunlight Solar Farm due to 1) having been detected outside of a regular search area or 2) having an estimated carcass age that is greater than the actual search interval and hence violating assumptions of the Huso estimator.

Parameter	Small birds	Medium birds	Large birds	Unknown size	Bats
LA solar arrays	3	0	1	0	0
NLA solar arrays	1	8	2	1	0
Visitor Center	0	1	0	0	0
Gentie line	4	1	0	0	0

Comentado [FWS25]: Please provide more contect for this Table including the rationale for why carcasses are being excluded.

Comentado [WEST26]: Added content

Desert Sunlight Solar Project

Avian and Bat Monitoring

WEST Inc.

Environmental
& Statistical
Consultants

Technical Advisory Group Meeting

January 20, 2016

Monitoring Objectives

- Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the gen-tie line, perimeter fence and other features of the Project that may result in injury and fatality.
- Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
- Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.
- Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

Preliminary/Interim Results

- This is a quarterly report, and we consider the estimates preliminary; they may change because of the statistical methods used and potential adjustments.
  - Potential pooling of information across seasons to get better estimates
  - Additional QA/QC conducted in the annual report
  - TAG recommendations may alter definitions (e.g. unknown classifications, etc).

Reporting Period

August 31– October 31, 2015

1. Standardized carcass searches
   - 7-day intervals
2. Incidental carcass finds
3. Carcass persistence trials
4. Searcher efficiency trials
5. Preliminary fatality estimates

All surveys conducted by BLM-approved WEST biologists

Percent of Facility Searched

Project Component	Total Size	Units	Percent of Component Searched
Solar arrays	447	Solar arrays	29.5[1]
Fence	16.7	Kilometers	99.4[2]
Generation tie line	19.2	Kilometers	47.9[3]

[1] Percent area that was searched in summer 2015. Slightly less than 30% total because of unequally-sized arrays.

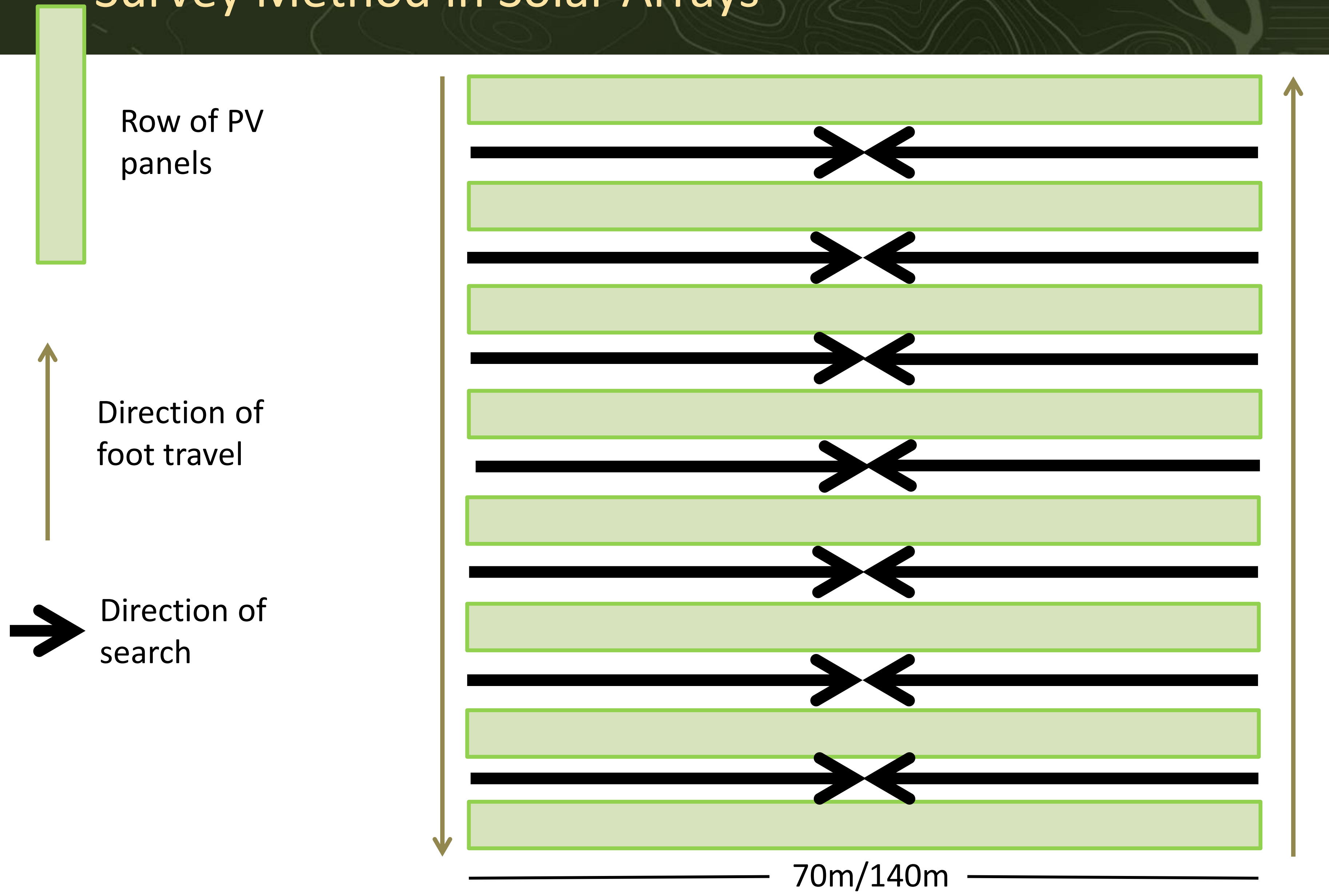
[2] 74.4% of the fence is fully accessible and surveyed following the standard protocol, while approximately 25% of the fence is surveyed from a distance. Fatality rates estimated for sections of the fence that are sampled were extrapolated to sections of the fence where the standard monitoring protocol cannot be used, as described in section 4.2.6 of the approved Desert Sunlight BBCS. A very short segment near the gate is not sampled due to restoration activities.

[3] 52.1% of gen-tie will be sampled in 2016.

Facility Examples

Solar arrays

Survey Method in Solar Arrays



🟩 Row of PV panels

↑ Direction of foot travel

→ Direction of search

Facility Examples

Fence

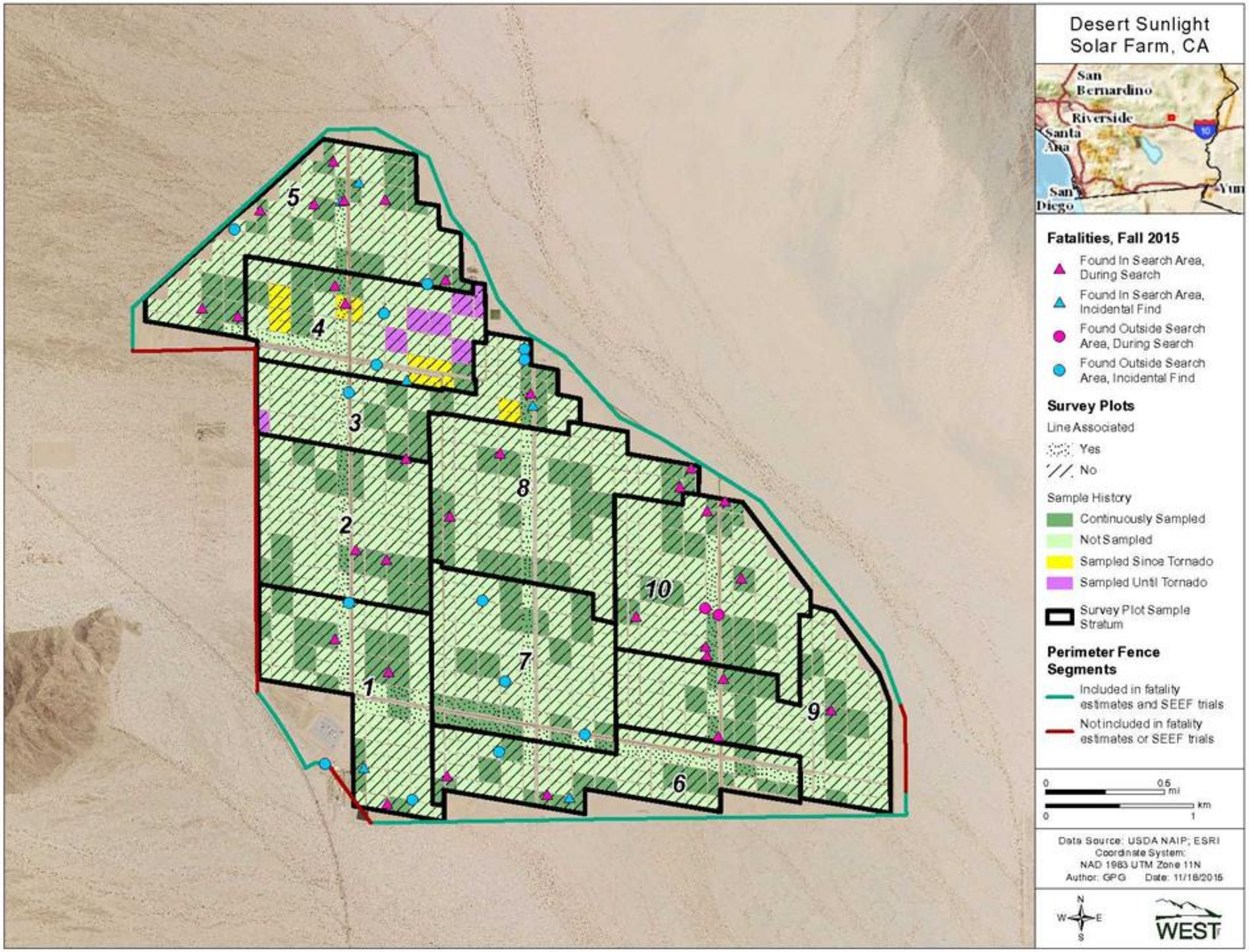
Facility Examples

Fence – searched with adjusted protocol

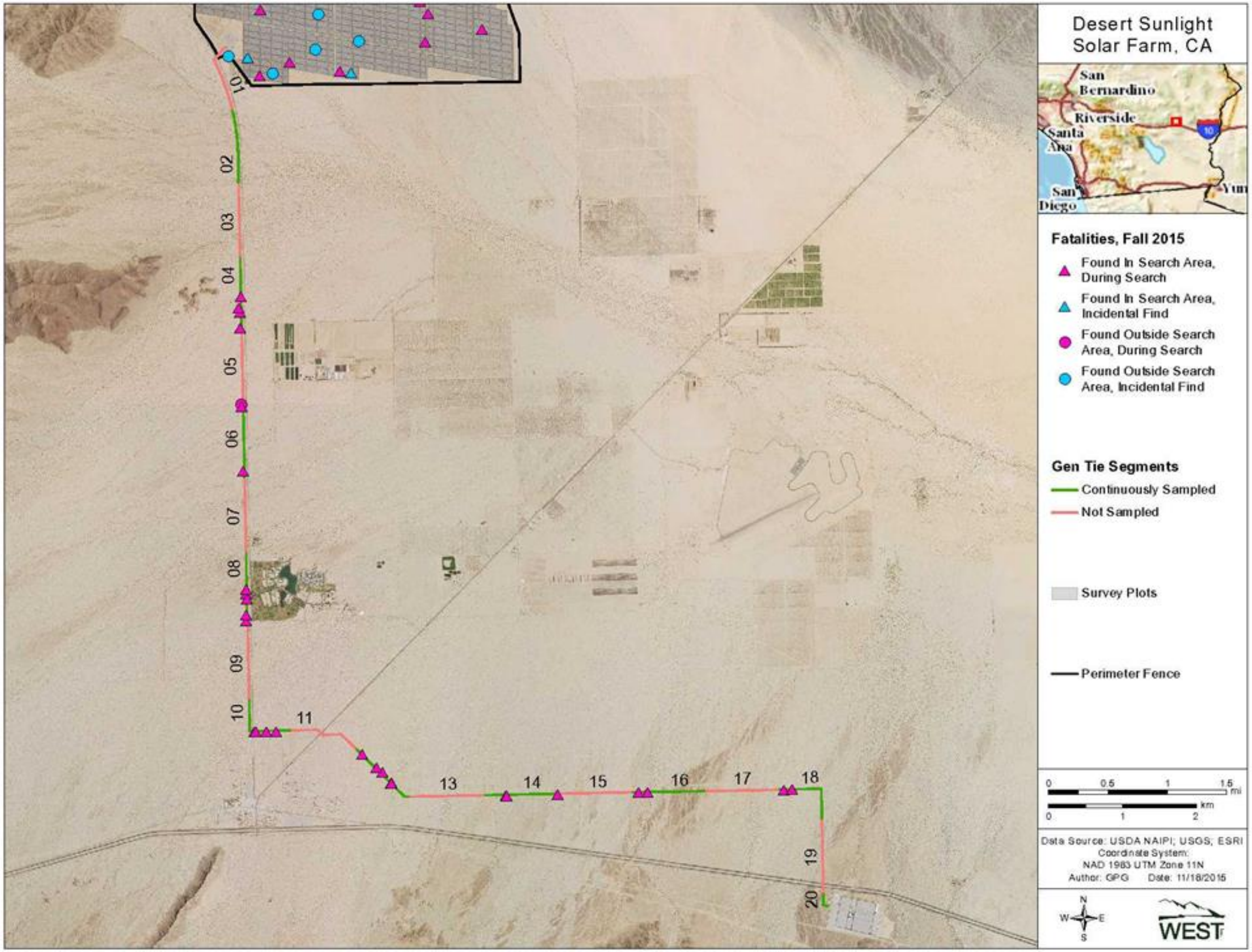
Facility Examples

Gen-tie line

Searched Areas and Locations of Detections Solar Arrays and Fence – Fall 2015



Searched Areas and Locations of Detections Gen-tie Line – Fall 2015



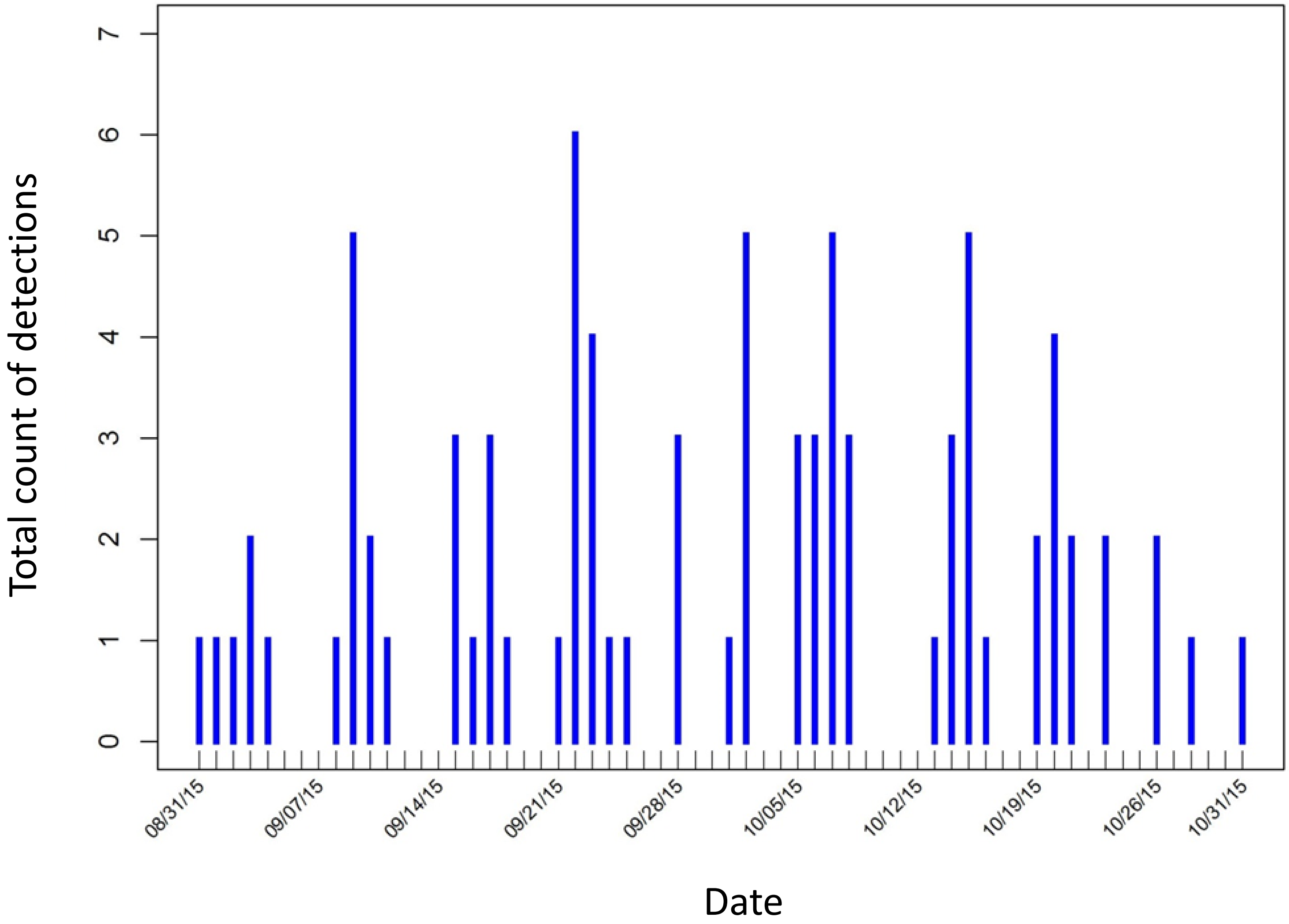
Avian Detections – Fall 2015

- No bats were detected
- Avian
  - 83 total detections (77 carcasses; 6 injured/stranded birds)

Project Component	In search area		Out of search area	
	Carcass search	Incidental	Carcass search	Incidental
Fence	0	0	0	0
Visitor Center	0	0	0	1
Gen-tie line	23	0	5	0
Non-line associated solar arrays	28	5	1	11
Line-associated solar arrays	4	1	1	3
Total	**55**	**6**	**7**	**15**

* 22 detections from this list were excluded from the fatality analysis because they were outside the search area.

Detections by Date – Fall 2015



Detections by Suspected Cause of Death/Injury – Fall 2015

	Suspected Cause *			
Project Component	Collision	Predation	Other/Unknown	% of Total
Fence	0	0	0	**0**
Visitor Center	0	0	1	**1.2**
Gen-tie Line	9	1	18	**33.7**
Solar arrays (line)	2	0	7	**10.8**
Solar arrays (no line)	6	0	39	**54.2**
% of Total	**20.5**	**1.2**	**78.3**	

A suspected cause of death or injury was assigned based on evidence available from the detection, evidence available on Project infrastructure, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it cannot be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed.

Species Composition – Fall 2015 3+ Detections

- 38 unique species
- American coot most common

Common Name	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Visitor Center	Total
American coot	2	7	0	2	0	11
mourning dove	0	2	0	1	1	4
western grebe	0	4	0	0	0	4
ruddy duck	1	2	0	1	0	4
western meadowlark	0	2	0	1	0	3
Eurasian collared-dove	0	0	0	3	0	3
Savannah sparrow	0	1	0	2	0	3
orange-crowned warbler	0	0	0	3	0	3

Feather Spots – Fall 2015

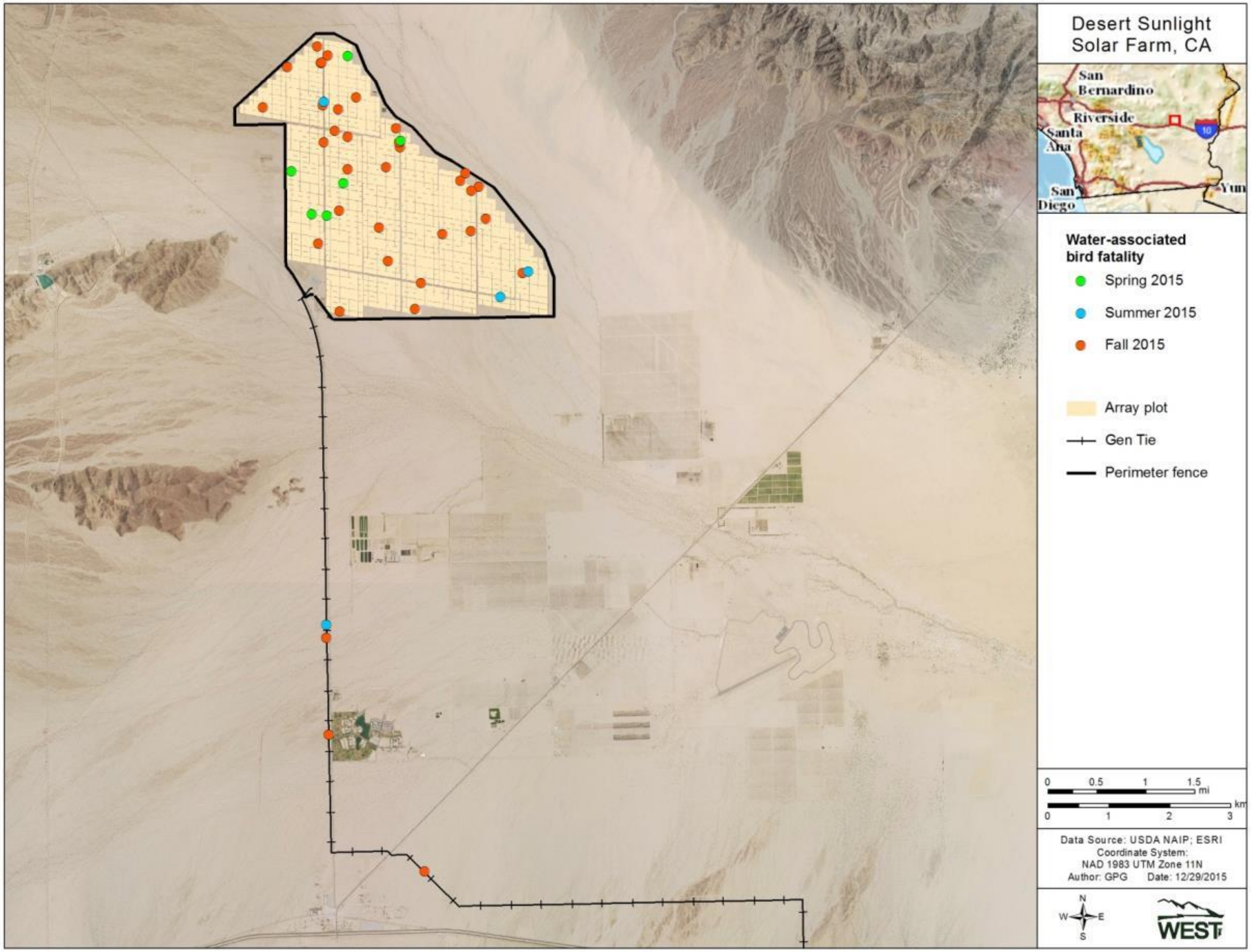
- 14 (17%) of the 83 detections consisted only of feather spots.
  - Gen-tie Line
    - 9 detections (11%)
  - Solar arrays
    - 5 detections (6%)

Fall Reporting Period Summary

- 83 detections
    - 38 species; 13 guilds
    - American coot was most common (11 detections)
        - Most common guilds (no. of detections):
            - Waterbirds/waterfowl (21)
            - Rails/coots (13)
            - Grassland birds/sparrows (12)
            - Warblers (10)
- Detection category
    - 75% were found during scheduled searches
    - 25% were found incidentally

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Detections of all water-associated birds – Spring, Summer, Fall 2015



Data Source: USDA NAIP; ESRI
Coordinate System:
NAD 1983 UTM Zone 11N
Author: GPG Date: 12/29/2015

Scavengers – Fall 2015

Kit Fox, *Vulpes macrotis*

Common Raven, *Corvus corax*

Scavengers – Fall 2015

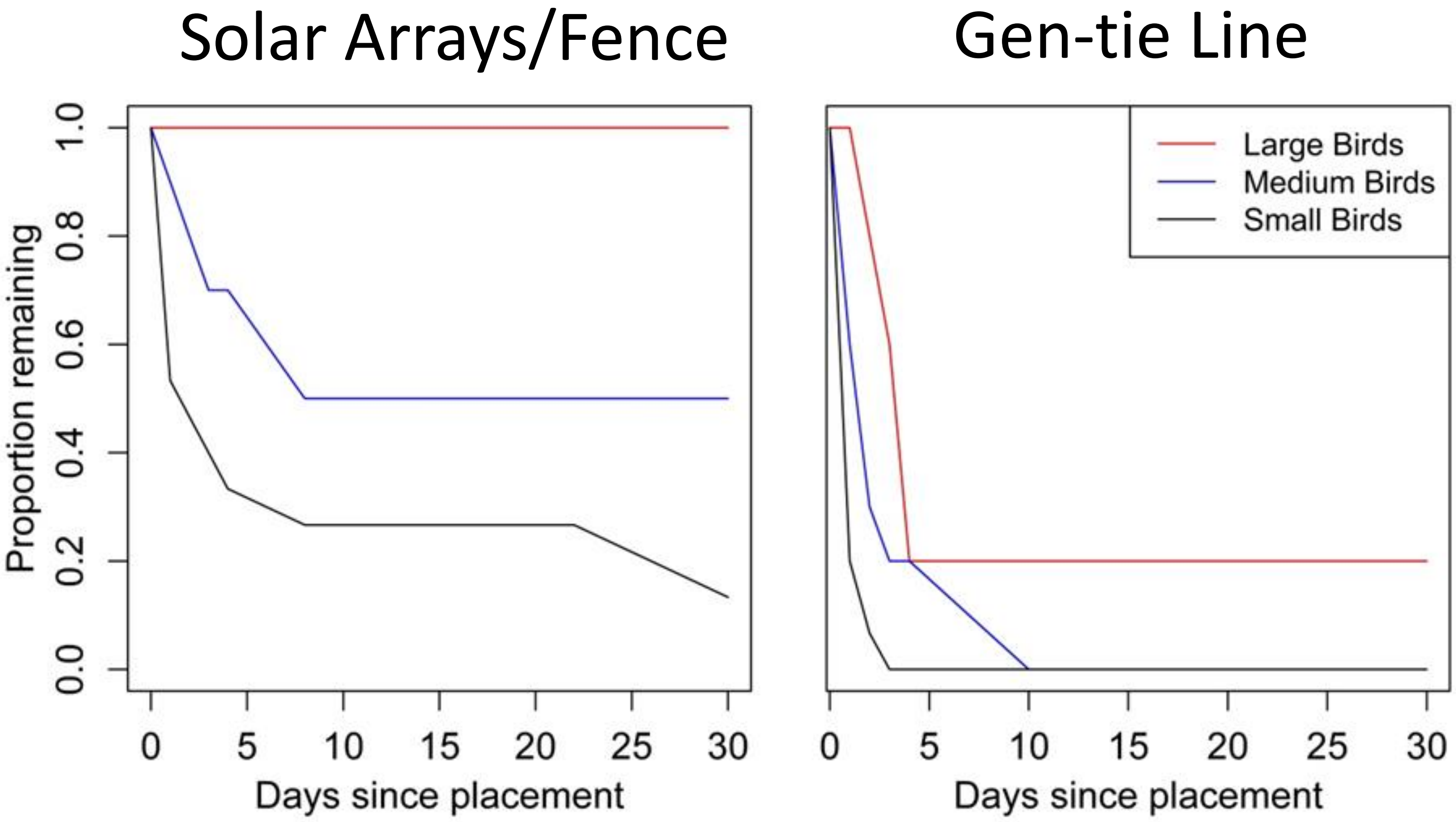
Coyote, *Canis latrans*

Turkey Vulture, *Cathartes aura*

Carcass Persistence Trials – Fall 2015

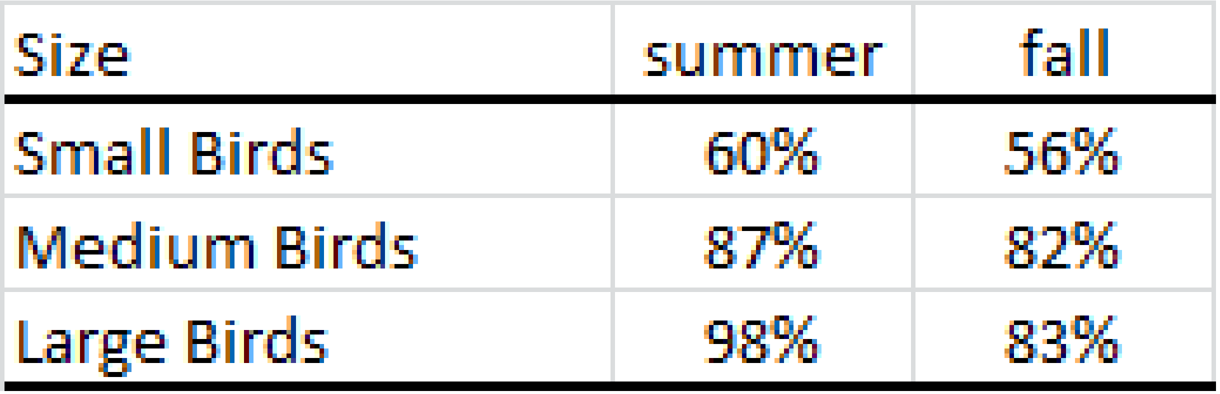
- Chance of persisting through the 7-day search interval
  - Arrays/fence
    - Small bird = 46%
    - Medium bird = 80%
    - Large bird = 98%
  - Gen-tie line
    - Small bird = 8%
    - Medium bird = 30%
    - Large bird = 72%

Carcasses remaining as a function of time since placement



*Fall data only (n = 30 per Project component)

Searcher Efficiency Trials – Detection Probability Estimates in Arrays using Distance Sampling Approach



Size	summer	fall
Small Birds	60%	56%
Medium Birds	87%	82%
Large Birds	98%	83%

Searcher Efficiency Trials – Fall 2015

- WEST preliminary searcher efficiency values
  - Fence
    - Small birds = 90%
    - Medium birds = 95%
    - Large = 98%
  - Gen-tie Line
    - Small birds = 45%
    - Medium birds = 63%
    - Large birds = 81%

Preliminary Avian Fatality Estimates – Fall 2015

		Area/Linear Metrics		**Energy Metrics**	
Facility Component	**Total (90% CI)**	value	unit	value	unit
Solar arrays	296 (198 – 461)	0.07	per acre	0.54	per MW
Fence	0	0.00	per km		
Gen-tie*	894 (362 – 2,948)	61.66	per km		
Total	1,190 (636 – 3,265)				

* Very low carcass persistence rates; point estimate and variance estimates are unreliable

Winter Update – Monitoring Effort

- Fourth carcass search occurs this week – two more remains for winter
- First round of carcass persistence trials completed – 2nd ends on Feb. 3
- Searcher efficiency trials completed so far:
  - 34 along gen-tie line
  - 34 in solar arrays
  - 20 along fence
- Continued high removal rates on gen-tie
- Preliminary searcher efficiency similar

Guild Composition – Winter Season – preliminary thru Jan 15

Group	Arrays	Fence	Gen-tie line	Total
Blackbirds/Orioles	0	0	2	2
Grassland/Sparrows	1	0	0	1
Shrikes	2	0	0	2
Unidentified Birds	2	0	0	2
Waterbirds/Waterfowl	9	0	0	9
Woodpeckers	1	0	0	1
Total	15	0	2	17

Species Composition – Winter Season – preliminary through Jan 15

Species	Count
unidentified grebe	6
loggerhead shrike	2
unidentified bird (small)	2
unidentified duck	2
Brewer's blackbird	1
eared grebe	1
northern flicker	1
unidentified sparrow	1
western meadowlark	1

1st Year Effort Summary

- Solar arrays
  - 32 searches X 134 arrays = 4,288 array searches
- Gen-tie line
  - 32 searches X 9, 1-km segments = 288 km of gen-tie searches
- Fence
  - 32 searches X 16.6 km = 534 km of fence searches

Cumulative Carcass Detections: Feb. 2015 – Jan. 15, 2016

Guild	Arrays w/o lines	Arrays w lines	Buildings	Fence	Gentie	Other	total
Diurnal Raptors	1	0	0	0	0	0	1
Large Corvids	4	0	0	1	0	0	5
Waterfowl	13	0	0	1	2	0	16
Waterbirds	1	0	0	0	0	0	1
Loons/Grebes	21	1	0	1	0	0	23
Rails/Coots	13	0	0	0	3	0	16
Shorebirds	1	0	0	0	0	0	1
Upland Game Birds	2	0	0	0	1	0	3
Cuckoos	0	0	0	0	1	0	1
Doves/Pigeons	4	1	1	1	6	0	13
Passerines	20	1	1	0	22	1	45
Swifts/Hummingbirds	1	0	0	0	0	0	1
Woodpeckers	1	0	0	0	0	0	1
Unidentified Birds	9	0	0	0	4	0	13
Total	91	3	2	4	39	1	140

Cumulative Carcass Detections: Feb. 2015 – Jan. 15, 2016

Species	Arrays w/o lines	Arrays w lines	Bldgs	Fence	Gentie	Other	total
American coot	9	0	0	0	2	0	11
unidentified grebe	9	0	0	0	0	0	9
mourning dove	4	0	1	0	1	0	6
common raven	4	0	0	1	0	0	5
common loon	4	0	0	1	0	0	5
western grebe	4	1	0	0	0	0	5
white-winged dove	0	1	0	1	2	0	4
Savannah sparrow	2	0	0	0	2	0	4
western meadowlark	2	0	0	0	2	0	4
ruddy duck	3	0	0	0	1	0	4
Eurasian collared-dove	0	0	0	0	3	0	3
eared grebe	3	0	0	0	0	0	3
orange-crowned warbler	0	0	0	0	3	0	3
sora	2	0	0	0	1	0	3
mallard	1	0	0	1	1	0	3
unidentified duck	3	0	0	0	0	0	3

WEST Inc.

west-inc.com

Corporate Headquarters

415 West 17th Street, Suite 200, Cheyenne, WY 82001
307.634.1756

Post-Construction Monitoring at the Desert Sunlight Solar Project Riverside County, California

2015 Spring Report

Prepared for:

Desert Sunlight 250, LLC and
Desert Sunlight 300, LLC
700 Universe Blvd.,
Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.
415 West 17th Street, Suite 2000
Cheyenne, Wyoming

July 17, 2015

Draft Pre-Decisional Document – Privileged and Confidential – Not For Distribution

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from February 10 to May 31, 2015 (the reporting period) at Desert Sunlight Solar Farm Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the first seasonal report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS.

The spring season at the Project is defined as March 01 to May 31. Included in this report are data from the spring season and data collected from February 10-28. Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 29.5% sample of solar photovoltaic (PV) panels, 2) along inner portions of the fenceline, resulting in 74.4% of the length of the perimeter fence, and 3) along 47.9% of the total length of generation-tie (gen-tie) line from the Project fence to the Red Bluff Substation located south of Interstate 10 (I-10). The two searches conducted during February had an interval of approximately 16 days, and searches conducted within the spring season had intervals of approximately seven days.

All bird and bat fatalities and injuries that were discovered by observers, referred to as “detections” in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, 25 avian detections (including 1 injured bird) were made, while there were no detections of bats.

According to specifications of the BBCS, avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were applied to a fatality estimator model (Huso 2010) to provide a preliminary estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias. The estimate is considered preliminary because the annual report may pool information from bias trials and other data across seasons which could affect seasonal estimates.

During the reporting period, carcass persistence was influenced by carcass size and Project component. Small carcasses (0-100 g) in the arrays and along the fence (combined) had a 0.54 probability (90% confidence interval [CI]: 0.47 – 0.61) of persisting through the 7-day search interval, medium carcasses (101 – 999 g) had a 0.82 (90% CI: 0.69 – 0.92) probability, and large carcasses (1000+ g) had a 0.94 (90% CI: 0.88 – 0.98) probability. Mean removal time within the arrays for small, medium, and large carcasses was 5.7, 29.8, and 126.8 days, respectively. Along overhead lines, probability of persistence for small, medium, and large carcasses were 0.29, 0.71, and 0.72, respectively; mean removal time for small, medium, and large carcasses was 2.0, 13.7, and 14.7 days, respectively. Within the solar arrays, searcher efficiency was influenced by carcass size: 60.0% for small birds, 87.2% for medium birds, and

97.3% for large birds. Along the fence, searcher efficiency ranged from 79.3% to 100% depending on carcass size class. Along overhead lines, searcher efficiency ranged from 53.9% to 87.8%.

Using the Huso (2010) fatality estimator model, during the spring period 2015, there were an estimated total 111 fatalities (90% CI: 58 - 193) at the Project. Of these, 49 fatalities (44.1%; 90% CI: 19 – 86) were estimated for the solar arrays, 2 fatalities (1.8%; 90% CI: 2 – 4) were estimated for the fence, and 60 fatalities (54.1%; 90% CI: 16 – 132) were estimated for the overhead lines (gen-tie and medium voltage overhead lines combined). During spring 2015, there were an estimated 0.02 carcasses per acre (49 estimated carcasses/2,585 acres) and an estimated 0.09 carcasses per nameplate MW (49 estimated carcasses/ 550 MW) within the solar field.

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Tracey Johnson	Research Biologist
Paul Rabie	Statistician
Andrea Polachek	Technical Editor
Tracey Johnson	Field Supervisor
Pamela Bullard	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2015. Post-construction monitoring at the Desert Sunlight Solar Farm Project, Riverside County, California. 2015 Spring Report. 43 pp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Project Background

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC (collectively, Desert Sunlight) constructed and operates the Desert Sunlight Solar Farm Project (referred to in this report as "Project"), which consists of two main components: 1) a 550-megawatt (MW) photovoltaic (PV) generating facility; and 2) a 220-kilovolt (kV) generation interconnection (gen-tie) line. The Project comprises approximately 1,700 hectares (ha; 4,200 acres) of land administered by the Bureau of Land Management (BLM) six miles north of Desert Center in Riverside County, California (Figure 1).

1.2 Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (2014; “BBCS”) was prepared by the Project proponent in collaboration with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), (BLM) to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency approval of the BBCS occurred in December 2014.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Desert Sunlight in collaboration with the USFWS, CDFW, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the gen-tie line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
3. Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

Figure 1. Desert Sunlight Solar Farm Project vicinity map, Riverside County, California.

1.3 Purpose of This Report

This report represents the first seasonal report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS. This report covers the period February 10 to February 28, 2015, as well as the 2015 spring season, which includes the period from March 01 to May 31, 2015. All bird and bat fatalities and injuries that were discovered by observers are referred to as "detections" in this report. As stated in the approved BBCS, this seasonal report includes the observed detections for likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and suspected causes of death. Species composition of detections and the results of the bias trials are also reported. This report presents information related to the spatial distribution of detections, but no formal statistical analysis of the spatial distribution of carcasses will be conducted until the end of the monitoring year, given the limited data presently available.

2.0 METHODS

The BBCS describes the methods by which monitoring and certain analyses, including compilation of the overall fatality estimate, will occur. Below is an abridged description (see BBCS for detailed methods).

2.1 Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. Dead or injured birds and bats are called detections in this report to provide consistency in naming. This section also describes the methods for conducting carcass removal and searcher efficiency trials; how data were reported and analyzed; and the methods for producing fatality estimates for the Project.

2.1.1 *Areas Surveyed*

Standardized carcass searches were conducted at sampling units, which include the solar arrays; the "fenceline" defined as the perimeter fence for the Project (Table 1, Figure 2); and the gen-tie line (from the Project fence to the Red Bluff Substation on the south side of I-10; Table 1, Figure 3). Some overhead lines co-occur with solar arrays (medium voltage overhead lines [MVOH]). The MVOH were part of standardized carcass searches to the extent that they co-occured with solar arrays included in the sample. Table 1 provides the total area of each component as well as the percent of each component that was searched.

Table 1. Areas included in standardized carcass searches at the Desert Sunlight Solar Farm Project during spring 2015 (including February).

Project Component	Total Size	Units	% of Component Searched
Solar arrays	1045.9	Hectares	28.2[1]
Solar arrays	1045.9	Hectares	1.3[2]
Solar arrays	1045.9	Hectares	1.3[3]
Fence	16.7	Kilometers	99%[4]
Gen-tie line	19.2	Kilometers	47.9[5]

[1] Percent area that was searched continuously since monitoring commenced in February 2015. Slightly less than 30% total (including areas affected by the tornado) because of unequal size arrays.

[2] Percent that was searched before the April 21, 2015 tornado but not after.

[3] Percent that was searched after the tornado but not before.

[4] 74.4% of the fence is fully accessible and surveyed following the standard protocol, while approximately 25% of the fence is surveyed from a distance. A very short segment near the gate is not sampled due to restoration activities

[5] 52.1% of gen-tie will be sampled in 2016.

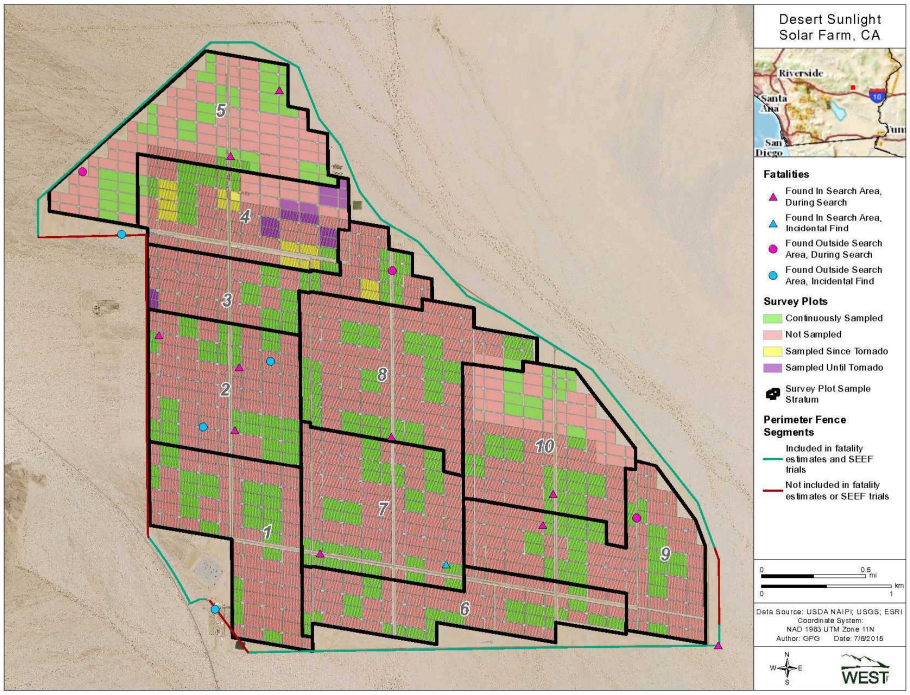


Figure 2. **Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at the solar field, fence, and overhead lines within the fence at Desert Sunlight Solar Farm Project during spring 2015 (including February). Because of the presence of medium voltage overhead lines within the solar arrays, some detections within the arrays were assigned to overhead lines.**

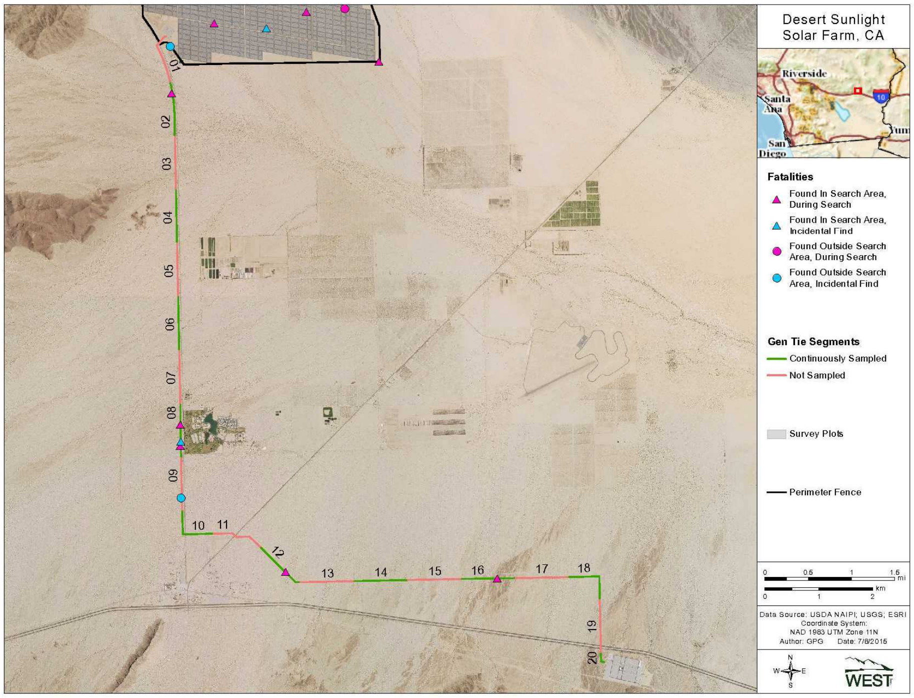


Figure 3. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance activities) along the generation tie line at the Desert Sunlight Solar Farm Project during spring 2015 (including February). Detailed maps of detections along the line are presented in Appendix A.

To ensure a balanced distribution of sample units in the solar field (defined as the collection of all photovoltaic [PV] solar panels), the entire field was divided into ten strata, and individual sampling units were randomly selected within each stratum to compose an approximately 30% sample. The solar field consists of arrays of solar panels (referred to as a solar array). This sampling design ensures that units included in the sample were not spatially clumped within the solar field.

2.1.1 *Search Frequency and Timing*

Standardized searches began February 10, 2015 (during the winter season outlined in the BBCS). The spring survey season includes the period from March 01 through May 31, 2015. All project components included in standardized searches were surveyed 14 times from February 10 to May 31, 2015 (twice in February and 12 times during spring).

The average search interval for all Project components included in standardized carcass searches during February was 16.1 days (median 15 days), and during spring was 7.1 days (median 7 days). Slight variation in search interval was anticipated due to weather and logistical delays. On April 21, 2015, the Project was struck by a tornado. The tornado damaged some of the sampling units, and resulted in limited access that ultimately lasted longer than initially expected. Thus, 142 sample units (128 arrays, fence, and gen-tie combined) were visited 14 times continuously and without interruption during the reporting period (two times in February and 12 times in spring). Six arrays were visited seven times before the tornado occurred; 3 weeks elapsed before the six damaged arrays were replaced with undamaged arrays. Five of the replacement arrays were visited twice and one was visited once.

2.1.2 *Search Methods*

Standardized carcass searches were performed by BLM-approved biologists, in accordance with methods outlined in the BBCS.

Within the solar field, arrays of solar panels were surveyed by observers traveling on foot. A distance sampling approach was used, whereby biologists slowly walked a transect line along the ends of rows of solar panels in a direction perpendicular to the rows, searching ahead and to the side within the array for bird and bat detections. Biologists scanned out to a maximum perpendicular distance of approximately 70 m from the transect. Biologists carried binoculars to allow them to verify the presence of a detection versus rocks or vegetation. Once a detection was confirmed, the distance of the detection to the transect line was estimated using laser range finders. Each array included in the sample was searched by observers walking two transects – one on the west side and one on the east side of the array.

Comentado [MR1]: 229 ft

Most (74.4%) of the length of fenceline (approximately 10 miles) was searched from a vehicle using the standard protocol (Figure 2). Biologists searched a 6-m wide strip transect centered on the fence from the inner perimeter. Travel speed was below five miles per hour (mph) while searching. Some sections along the fence cannot be driven close to the fence line. The fence line along the western edge of the Project is drivable but the road is approximately 15 m away from the fence and the road and fence are separated by a drainage ditch. The fence along this section is covered with a tan tarp to block and trees and shrubs have been planted to reduce visibility of the project from the west. Additions of vegetation and the tarp likely reduce potential for bird collision with the fence. This section of the fence was driven to document carcasses, but detections along this portion of the fence are not included in adjusted fatality estimates because detection rates are likely very low. A separate section of the fence in the southeastern corner of the Project cannot be driven because the eastern edge of the berm that bounded construction ponds is too narrow for a vehicle. Along this portion of the fence, the observer stopped at both north and south ends of the berm and used binoculars to search for carcasses. Finally, the road along a portion of the southwest fence line near the entrance gate is approximately 30 to 50 m from the road and is separated from the fence by an area that has recently undergone vegetation restoration. This area was eliminated from sampling. Fatality rates estimated for sections of the fence that were sampled were extrapolated to sections of the fence where the standard monitoring protocol was not used.

The gen-tie line was searched using a 30-m wide strip transect (i.e., 15 m of ground on either side of the overhead line). Sample units along the gen-tie line were chosen by dividing the total length of line from the Project fence south to the Red Bluff Substation just south of I-10 into 1-km segments. Thus, a 47.9% sample of the total length of the line was searched (Figure 3). Biologists slowly walked every other 1-km segment of the line, meandering the width of the strip transect, scanning for dead or injured birds or bats within 15 m (49.2 ft) of the overhead line.

For each detection, a suspected cause of death or injury was assigned based on available evidence and proximity of a detection to Project infrastructure. Detections that had evidence of scavenging were assigned as “unknown” because it cannot be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed.

2.2 Carcass Persistence Trials

Carcass persistence trials were conducted throughout the spring period. Carcasses from three size classes (small [0-100 g], medium [101-999], and large [1000+ g]) were used for trials. The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), and the large size class comprised hen mallard (*Anas platyrhynchos*) and hen ring-necked pheasant (*Phasianus colchicus*).

2.2.1 *Carcass Persistence Data Collection*

To quantify carcass persistence rates, 15 small, 10 medium, and 5 large carcasses were randomly placed and monitored along the gen-tie line during spring 2015. Within the solar arrays and along the perimeter fence, the same numbers of small and medium carcasses were placed, along with 10 large carcasses, for a total of 65 carcass persistence trials at Desert Sunlight during the spring season. Thirty-five carcasses within the Project fence (within solar arrays and along the fence) were monitored using motion-triggered digital trail cameras, while the remaining carcasses were visited on foot, for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality. No carcasses along the gen-tie line were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as “feeding stations”, trail cameras were installed five days before specimens were placed, and two fake cameras without bias trial carcasses were also placed within the Project fence and periodically moved to new locations within the fence. Periodic ground-based checking of carcasses with trail cameras also occured to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera’s field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire

Project, not just in areas subject to standard searches, and trials were initiated in small numbers on six different dates throughout the spring season.

In February, 15 (n = 7 small, 5 medium, and 3 large) carcass persistence trials were placed in the solar arrays and along the Project fence, and 15 trials (n = 8 small, 5 medium, and 2 large) were placed along the gen-tie line. Eight carcasses within the arrays and fence were monitored with trial cameras, and four fake cameras were placed within the arrays and along the fence. Carcass persistence trials were initiated on two different dates in February.

2.2.2 *Estimating Carcass Persistence Times*

Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g. days a carcass is present before being removed) may not be known exactly, but is known to be within a finite range. For example, suppose a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass was available to be found for between 7 and 10 days. This carcass would be considered “interval censored”. Similarly, if a carcass lasts the entire 30-day trial period, that carcass is “right censored”— it is known that the carcass lasted at least 30 days, but it may have persisted longer.

There were four distributions implemented in survival models used to estimate the probability a carcass is unscavenged and available to be found at the end of the search interval (r): exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike’s Information Criterion adjusted for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model with combinations of the covariates carcass size, location, and visibility, to observed carcass persistence data.

2.3 Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the spring period (including February). Carcasses from three size classes (small, medium, and large) were used for trials. The small size class comprised house sparrows and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons, and the large size class comprised hen mallards and hen ring-necked pheasants.

2.3.1 *Searcher Efficiency Data Collection*

Training of biologists on the Project-specific protocol and early assessments of habitat conditions at the Project site suggested that the amount of cobble present in the soil may be an important factor influencing searcher efficiency. To satisfy requirements regarding consideration of visibility class per the BBCS and address the influence of cobble cover on searcher efficiency, sample units in the solar arrays and along the gen-tie were stratified by cobble cover and assigned to one of two classes (<15% and >15% cobble cover). Classes were determined by making ocular estimates of cobble cover at each sample unit and then evaluating the frequency histogram of sample units across the range of estimated cobble cover (Figure 4). A natural break point was identified at 15% cobble cover, so the same value was chosen as the break point that defined the two strata. In the solar arrays, one set of searcher efficiency trials (*n* = 15 small birds, 10 medium birds, and 5 large birds) was conducted in each strata. Similarly, searcher efficiency trials along the gen-tie occurred in two visibility strata (easy: ≥90% bare ground, vegetation <6" tall; and more difficult: <90% bare ground, vegetation ≥6" tall). Thirty searcher efficiency trials (*n* = 15 small birds, 10 medium birds, and 5 large birds) occurred along the fence in the only stratum present on the fence (easy visibility). Thus, in February, a total of 150 searcher efficiency trials occurred at the Project, and the same methods and number occurred during the spring season. Locations for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches.

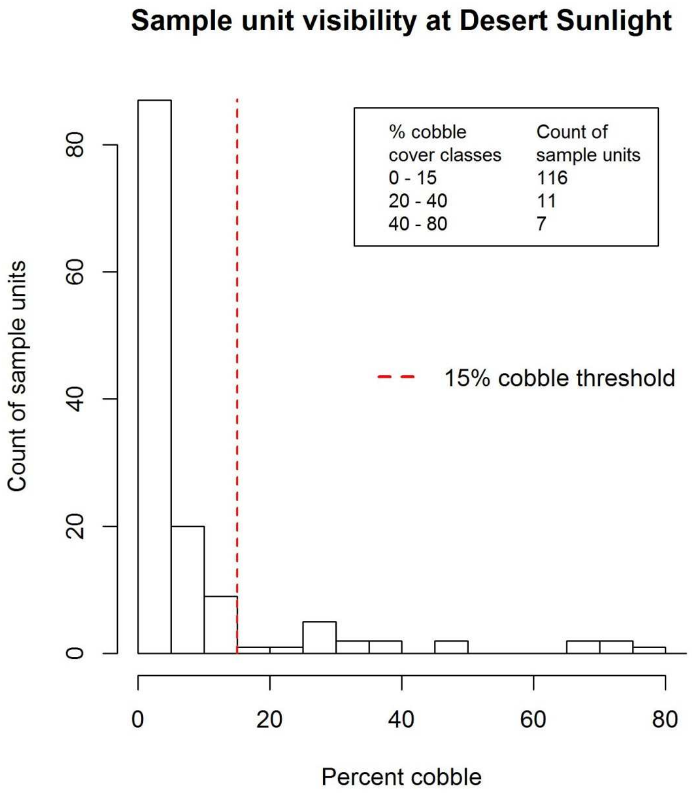


Figure 4. Frequency histogram of sample units (in the arrays only) at Desert Sunlight Solar Farm Project by estimates of cobble cover. Based on this distribution, each sample unit was assigned to one of two classes of cobble cover (<15%; >15%).

2.3.2 *Estimating Searcher Efficiency*

Searcher efficiency at Desert Sunlight was estimated separately for linear features (the project fence and the generation tie line), and the solar arrays, reflecting the different search methods used on arrays and linear features. For linear features, logistic regression models were fit to searcher efficiency data and AICc was used to compare models. Models including effects of carcass size (three classes) and visibility (two classes; gen-tie only), were compared to each other and the null model. Model selection indicated that best models accounted for component, carcass size, and on the gen-tie line, visibility. Once the best model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, *p*, was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from February and the spring 2015 season.

For the solar arrays, searcher efficiency was evaluated using a distance sampling approach (Buckland et al. 1993). Distance sampling assumes perfect detection on the transect line (at distance = 0), an assumption that is likely valid in the solar arrays given the relatively flat & vegetation-free nature of the soil surface. A curve is fitted to the observed carcass data that predicts probability of detection as a function of distance from the transect line. The mean value of this function over a specified distance, *w,* is equal to the average searcher efficiency for a transect of width *w*. One departure in the methods used here, relative to the methods presented in Buckland et al. (1993), was that for this study the detection function was estimated using trial carcasses, which meant that there were both presence (detected) and absence (not detected) data available to fit the detection function (Figure 5). The availability of both presence and absence data means that the detection function can be estimated using only trial carcasses whose distribution is known. Therefore the detection function, the average searcher efficiency among the arrays and the final fatality estimate within the arrays are all insensitive to the spatial distribution of carcasses within individual arrays, and the overall searcher efficiency estimate is valid even if the distribution of carcasses among the arrays is not uniform.

Distances of trial carcasses (trials both found and missed) from the transect line were used to fit a half-normal detection function for searches among the arrays (Figure 5). The half-normal detection function is a commonly used function for distance sampling surveys (Buckland et al. 1993). The detection function was fit with and without covariates (carcass size, visibility index, or no covariates) and AICc indicated that the best among these models included only carcass size as a covariate.

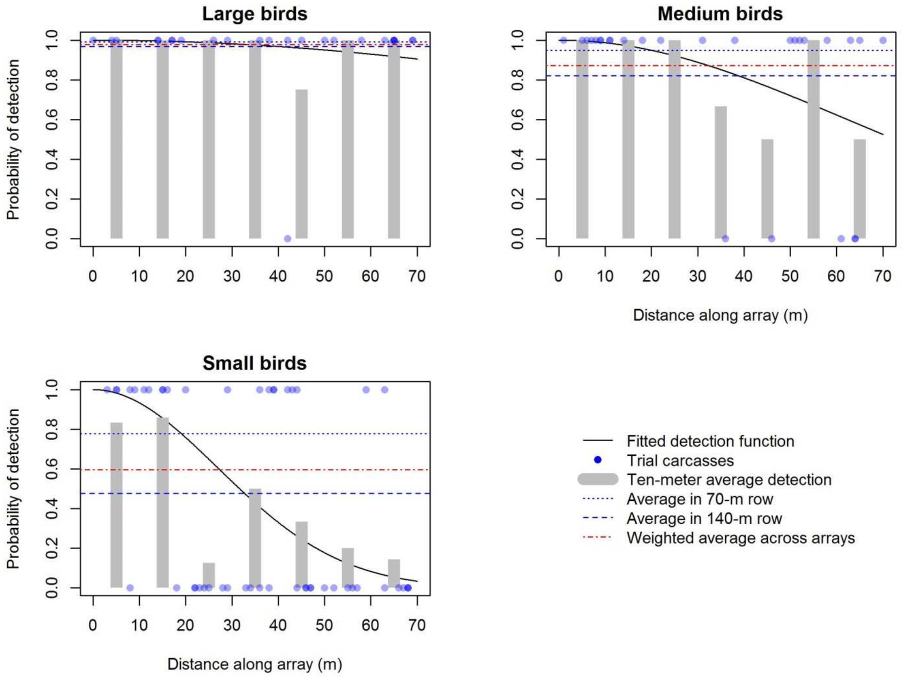


Figure 5. Estimated detection probabilities for bird carcasses by size class during spring 2015 (including February) at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m and 140-m panel rows in solar arrays are presented.

Because the solar arrays were surveyed by searchers who walked down both sides of the rows of panels, the width of the search transect was specified as half the width of the rows of panels. For larger birds, there is almost certainly a non-zero detection probability beyond this distance but the bias that occurs by ignoring this non-zero detection probability is conservative (i.e. the searcher efficiency is underestimated). Some solar arrays have row widths of 70 m (search transect width of 35 m) and some have row widths of 140 m (search transect width of 70 m). Searcher efficiency was higher for the arrays with a width of 70 m, and overall searcher efficiency was estimated as a weighted average based on the proportions of 70-m arrays and 140-m arrays in the sample units.

2.4 Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots are also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie line versus cleared areas beneath solar panels). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where F is the total number of fatalities, C is the number fatalities detected and included in fatality estimation, r is the probability a carcass is unscavenged and available to be found at the end of the search interval, and p is the probability of detecting a carcass (Huso 2010).

All fatality estimates were calculated using the Huso estimator, as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates were used. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

2.5 Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by WEST avian biologists and operational personnel and were considered “incidental” detections. When found by operational personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the Desert Sunlight SPUT Avian Injury and Mortality Report Forms February – May 2015. All detections made in search areas were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

3.0 MONITORING RESULTS

3.1 Summary of Avian Detections

During spring 2015 (including February), a total of 25 avian detections (including one injured bird and incidentals) of 13 identified species were recorded (Table 2). The most numerous detection of an identified species was common loon (*Gavia immer*), but with only four detections. Most detections (n = 12, or 48.0% of total detections) occurred in the solar arrays (Figures 2 and 3; Tables 2, 3, and 4). Eighteen (72%) detections were made during standardized carcass searches and seven (28.0%) were documented as incidentals. For fresh carcasses, body weights and weather conditions the preceding nights are described in Appendix B.

Table 2. Number of individual bird detections, by species, during spring 2015 (including February) at the Desert Sunlight Solar Farm Project, Riverside County, California. Overhead lines include the gen-tie line and medium voltage overhead lines that co-occur with the solar arrays.

Common Name	Scientific Name	Migration Behavior*	Guild	Count	Project Component
common loon	*Gavia immer*	diurnal	waterbirds/waterfowl	4	solar arrays
common raven	*Corvus corax*	resident	corvids	1	solar arrays
greater roadrunner	*Geococcyx californianus*	resident	cuckoos	1	overhead lines
mallard	*Anas platyrhynchos*	variable	waterbirds/waterfowl	1 1	fence overhead lines
Nashville warbler	*Oreothlypis ruficapilla*	nocturnal	warblers	1	overhead lines
pied-billed grebe	*Podilymbus podiceps*	nocturnal	waterbirds/waterfowl	1	solar arrays
Savannah sparrow	*Passerculus sandwichensis*	nocturnal	grassland/sparrows	1	solar arrays
sora	*Porzana carolina*	nocturnal	rails/coots	1	solar arrays
Townsend's warbler	*Setophaga townsendi*	unresolved	warblers	1	overhead lines
unidentified bird (small)	–	–	unidentified birds	1	solar arrays
unidentified bird (unknown size)	–	–	unidentified birds	1 2	solar arrays overhead lines
unidentified grebe	–	nocturnal	waterbirds/waterfowl	1	solar arrays
unidentified hummingbird	–	–	swifts/hummingbirds	1	solar arrays
western tanager	*Piranga ludoviciana*	nocturnal	tanagers	1	overhead lines
western wood-pewee	*Contopus sordidulus*	nocturnal	flycatchers	1	O&M building

Table 2. Number of individual bird detections, by species, during spring 2015 (including February) at the Desert Sunlight Solar Farm Project, Riverside County, California. Overhead lines include the gen-tie line and medium voltage overhead lines that co-occur with the solar arrays.

Common Name	Scientific Name	Migration Behavior*	Guild	Count	Project Component
white-winged dove	*Zenaida asiatica*	variable	doves/pigeons	1	fence
				2	overhead lines
Wilson's warbler	*Cardellina pusilla*	nocturnal	warblers	1	overhead lines
Total				**25**	

* See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in Birds of North America (BNA) Online (http://bna.birds.cornell.edu/bna/); where information on migration behavior was lacking in BNA accounts, Newton (2008) or Murray (2004) were used.

Table 3. Total avian detections by Project component and detection category during spring 2015 (including February) at the Desert Sunlight Solar Farm Project, Riverside County, California. Overhead lines includes the gen-tie and medium voltage overhead lines that co-occur with the solar arrays. Only carcasses found within search areas were included in fatality estimates.

	Inside carcass search area		Outside carcass search area	
Project Component	**Carcass search**	**Incidental**	**Carcass search**	**Incidental**
Fence	1	0	0	1
O&M Building	0	0	0	1
Overhead lines	7	1	0	1
Solar arrays	6	1	3	2

Table 4. Total avian detections (including incidentals) by Project component and suspected cause of death during spring 2015 (including February) at the Desert Sunlight Solar Farm Project, Riverside County, California. Overhead lines includes the gen-tie and medium voltage overhead lines that co-occur with the solar arrays.

	Suspected Cause of Death*				
Project Component	**Collision**	**Predation**	**Other**	**Unknown**	**Percent of Total**
Fence	1	0	0	1	8.0
O&M building	0	0	1	0	4.0
Overhead lines	7	1	1	1	40.0
Solar arrays	1	0	4	7	48.0
Percent of Total	**36.0**	**4.0**	**24.0**	**36.0**	**100.0**

* Suspected cause of death was assigned based on available evidence and proximity of detection to Project infrastructure. Detections that had evidence of scavenging were assigned as "unknown" because it can't be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed.

3.2 Temporal Patterns of Avian Detections

The number of detections recorded daily during the reporting period ranged from zero to two (Figure 6). The period from March 30 to May 27 was characterized by slightly higher numbers of detections with more days with two detections than the previous period. The number of detections per day represents those discovered during standardized carcass searches and incidentally.

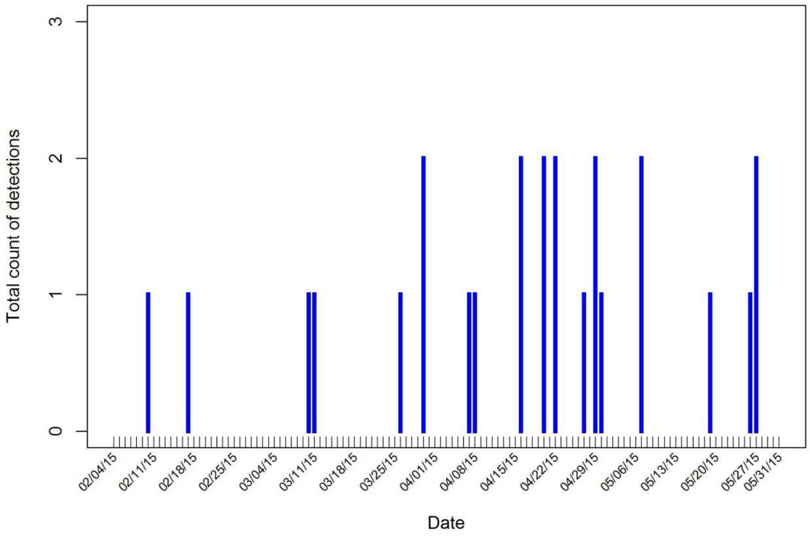


Figure 6. Total number of detections by date during spring 2015 (including February) at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.3 Spatial Distribution of Avian Detections

3.3.1 *Detections by Project Component*

During the reporting period, detections were documented from the solar arrays, perimeter fence, gen-tie line, MVOH lines within the solar field, and the O&M building (Tables 2, 3, and 4). Of the 12 detections within the solar arrays, most (7, or 58.3%) were assigned to the "unknown" category for suspected cause of death.

3.3.2 *Feather Spot Detections*

Eight (32.0%) of the 25 detections consisted only of feather spots. Along the fence, one detection (4.0%) was a feather spot. Three detections (12.0%) along the overhead lines were feather spots. Four detections (16.0%) in the solar arrays were feather spots.

3.4 Detections of Injured Birds

One bird was located during the reporting period that was injured. A mourning dove (*Zenaida macroura*) was discovered on April 22 along the northern section of the perimeter fence. The bird had an obvious injury to its breast. Because the bird was found the day after the tornado struck the Project, the injury may have been a result of the storm. The bird was taken to Coachella Valley Wild Bird Center and left with Linda York for rehabilitation. Numerous attempts to determine the final outcome for the dove were unsuccessful. The single injured bird detection was included in the fatality estimates.

3.5 Summary of Bat Detections

No bats were located during the spring 2015 season (including February).

3.6 Carcass Persistence Trials

Based on carcass persistence data from the spring 2015 season, 20 survival models were compared for relative quality using the corrected AICc score, as suggested in Huso (2010). The AICc score provides a relative measure of model fit and parsimony among a selection of candidate models. Carcass size is a potentially important variable, as larger carcasses tend to persist longer and may be more likely to leave feather spots which persist for long durations, whereas smaller carcasses may be more likely to be completely removed.

The model with lowest AICc score is typically chosen as the “best” model relative to other models tested; however, any model within two AICc points of the best model is considered competitive with the best model (Burnham and Anderson 2004). The top model had a ∆AICc value of 2.84 and included carcass size (small, medium or large), and location (solar arrays/fence or generation-tie line) with a Weibull-distributed removal time. Estimates of carcass removal time and persistence probabilities are provided in Table 5.

Table 5. Mean carcass removal time and probability of a carcass persisting through the 7-day search interval during the reporting period at the Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass size	Project component	Mean removal time (days)	Probability of persistence
Small	Arrays/fence	5.7	0.54
Small	Overhead lines	2.0	0.29
Medium	Arrays/fence	29.8	0.82
Medium	Overhead lines	13.7	0.71
Large	Arrays/fence	126.8	0.94
Large	Overhead lines	14.6	0.72

Comentado [MR2]: How do you get 126 days?

3.7 Searcher Efficiency Trials

During the reporting period, a total of 300 searcher efficiency trials were placed at the Project. Most trials were available to be found, but some disappeared before or during the trial. Overall, 120 trials were placed in the solar arrays and 102 were available to be found; 60 trials were placed along the perimeter fence (inner perimeter only) and 59 were available to be found; and 120 trials were placed along the gen-tie line and 105 were available to be found.

In the solar arrays, the model that included an effect of carcass size was chosen as the best model to estimate searcher efficiency. Within the solar arrays, searcher efficiency was influenced by carcass size: 60.0% for small birds, 87.2% for medium birds, and 97.3% for large birds. Along the fence, searcher efficiency ranged from 79.3% to 100% depending on carcass size class. Along overhead lines, searcher efficiency ranged from 53.9% to 87.8%. Detailed estimates of searcher efficiency estimates specific to each component and carcass size are reported in Appendix C.

3.8 Fatality Estimates

Fatality estimates were calculated separately for each component (solar arrays, fence, and overhead lines). Ultimately, nine detections were excluded from the fatality analysis: five were found outside standardized search areas; one was estimated to be older than the 7-day search interval (Huso 2010); and three were both outside standard search areas and estimated to be older than the 7-day search interval.

During spring 2015, there were an estimated total 111 fatalities (90% CI: 58 - 193) at the Project. Of these, 49 fatalities (44.1%; 90% CI: 19 – 86) were estimated for the solar arrays, 2 fatalities (1.8%; 90% CI: 2 – 4) were estimated for the fence, and 60 fatalities (54.1%; 90% CI: 16 – 132) were estimated for the overhead lines (gen-tie and medium voltage overhead lines combined). There were an estimated 0.02 fatalities per acre (within the solar field only) and an estimated 0.20 fatalities per nameplate MW at the Project. A complete list of estimates for each Project component and carcass size class with confidence intervals is presented in Appendix C.

4.0 DISCUSSION

The 2015 spring season represented the first full season of standardized monitoring at Desert Sunlight per the BBCS. Searcher efficiency trials and carcass removal trials were conducted concurrently at the solar arrays, fencelines, and along the gen-tie line. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. Although these estimates were produced from a statistically robust sample, only limited inference may be drawn from a single season of data. These results should be considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. As more data are collected throughout the monitoring year (and additional quality assurance/quality control measures occur, for example characterizing feather spots to species or size class), data from all seasons may be pooled. At that time, data will be tested for seasonal differences retrospectively, but because seasonal estimates will be produced from the much larger annual data set, they may differ from what is reported here because they are based on a larger, more informative sample.

4.1 Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Thus, rates of carcass persistence reported here should be interpreted cautiously as they may change over the coming months.

Searcher efficiency was influenced by Project component, carcass size, and visibility class (along the gen-tie only). In the solar arrays, searcher efficiency was high (> 0.5) for all carcass size classes and this is likely influenced by the limited vegetation cover beneath solar panels. Beneath the gen-tie line vegetation cover is higher in some portions of the strip transects, and results reported here support the hypothesis that visibility class is a factor in searcher efficiency along the lines.

For the current analysis, searcher efficiency in the solar arrays was assumed to be best predicted by a half-normal distribution. For future analyses, AICc will be used to compare and choose the best among multiple detection functions.

Searcher efficiency trials for this Project will be repeated seasonally. The desert landscape in which this Project is located generally changes little with the seasons, save for brief periods following winter and spring rains when floods may occur and blooming plants may flourish. A recent meta-analysis involving data from more than 70 wind-energy projects suggested that including habitat visibility class as a predictive variable generally eliminated any otherwise apparent seasonal effects on searcher efficiency (Smallwood 2013). Further, the possibility exists that searcher efficiency varies seasonally in some cover types but not others. Data from searcher efficiency trials conducted over the coming seasons will therefore continue to be tested for effects of habitat visibility class rather than effects of season.

4.2 Distribution of Fatalities and Fatality Estimates

The number of detections was more or less evenly distributed across the spring season, and there were no clear associations between number of detections and date. Given the small number of detections overall, it is premature to draw any conclusions about the spatial distribution of carcasses.

Detections attributed to an unknown cause accounted for 36.0% of all detections during the reporting period, and the distribution of the unknown cause detections varied by project component with 48.0% occurring in association with the solar arrays. Of the 12 detections made in the solar arrays, 16.0% were feather spots. Determining a cause of mortality from a feather spot is challenging because there is rarely visible evidence available on which to determine a cause of death. Thus, feather spots with an unknown cause of mortality could be encountered anywhere birds occur, and an unknown cause of a sizeable proportion of the carcasses is not unique to the Project. Further, the relatively large proportion of feather spots (32%) among the detections for the Project as a whole may inflate the fatality estimate when unknown cause detections are included based on the potential for multiple feather spots resulting from one fatality, feather spots resulting from predation not associated with the facility, or other causes.

5.0 LITERATURE CITED

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in 2nd International Symposium on Information Theory (B. N. Petran and F. Csaki, Eds.). Akademiai Kiado, Budapest, Hungary.

Ammon, Elisabeth M. and William M. Gilbert. 1999. Wilson's warbler (*Cardellina pusilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/478

Boarman, William I. and Bernd Heinrich. 1999. Common raven (*Corvus corax*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/476 doi:10.2173/bna.476

Buckland, S, D.R. Anderson, K. P. Burnham, and J.L. Laake. 1993. Distance sampling: estimating abundance of biological populations. Chapman & Hall, London. 446 pp.

Burnham, K.P., and D.R. Anderson. 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociological Methods & Research 33: 261-304.

Evers, David C., James D. Paruk, Judith W. Mcintyre and Jack F. Barr. 2010. Common loon (*Gavia immer*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/313 doi:10.2173/bna.313

Hudon, Jocelyn. 1999. Western tanager (*Piranga ludoviciana*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/432 doi:10.2173/bna.432

Hughes, Janice M. 2011. Greater roadrunner (*Geococcyx californianus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/244 doi:10.2173/bna.244

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. doi: 10.1002/env.1052

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A new method to determine bird and bat fatality at wind energy turbines from carcass searches. Wildlife Biology 17: 350-363.

Lowther, Peter E. and Janet McI. Williams. 2011. Nashville warbler (*Oreothlypis ruficapilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/205 doi:10.2173/bna.205

Manly, B.F.J.1997. Randomization, bootstrap and Monte Carlo methods in biology. Second Edition. CRC Press, LLC, Boca Raton, Florida, 455 pp.

Melvin, Scott M. and James P. Gibbs. 2012. Sora (*Porzana carolina*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/250 doi:10.2173/bna.250

Muller, Martin J. and Robert W. Storer. 1999. Pied-billed grebe (*Podilymbus podiceps*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/410 doi:10.2173/bna.410

Murray, J. 2004. Nocturnal flight call analysis as a method for monitoring density and species composition of migratory songbirds (Order Passeriformes) across southern Vancouver Island, British Columbia in 2004. Rocky Point Bird Observatory, 16 pp.

Newton, I. 2008. The migration ecology of birds. Academic Press, London.

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

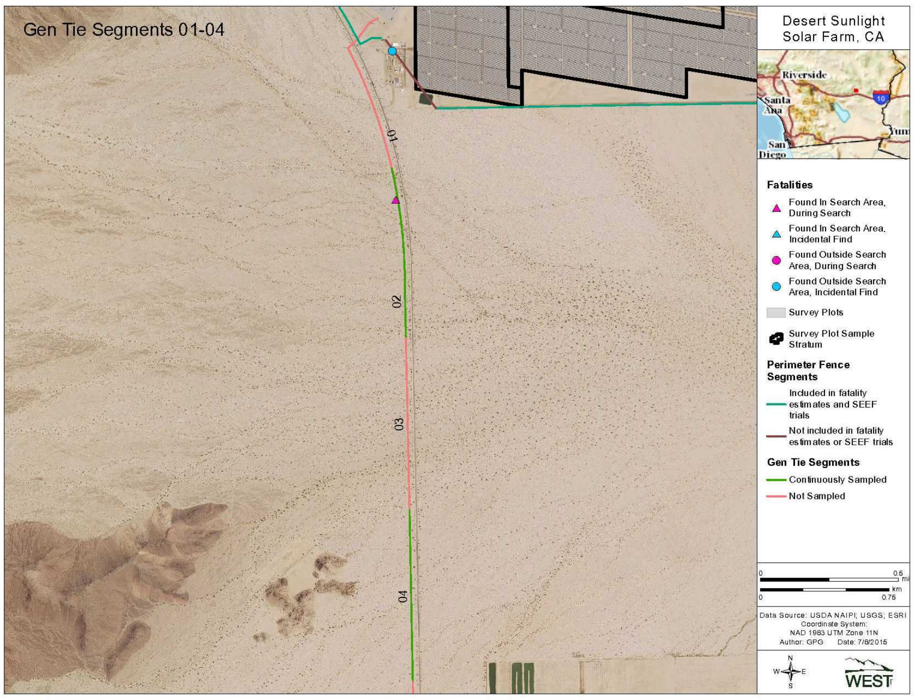
Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine-cause avian fatality estimates. Journal of Wildlife Management 74(5): 1089-1096.

Smallwood, K. S. 2013. Comparing bird and bat ratality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37(1): 19-33.

Western Ecosystems Technology (WEST), Inc. 2014. Bird and bat conservation strategy, Desert Sunlight Solar Farm Project, Riverside County, California. 57 pp.

Wheelwright, N. T. and J. D. Rising. 2008. Savannah sparrow (*Passerculus sandwichensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/045 doi:10.2173/bna.45

Appendix A. Detailed Areas of Standardized Searches and Carcass Locations along the Generation Tie Line of the Desert Sunlight Solar Farm Project during Spring 2015 (Including February)



Data Source: USDA NAIPI; USGS; ESRI
Coordinate System:
NAD 1983 UTM Zone 11N
Author: GPG Date: 7/8/2015

Figure A-1. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015 (including February).

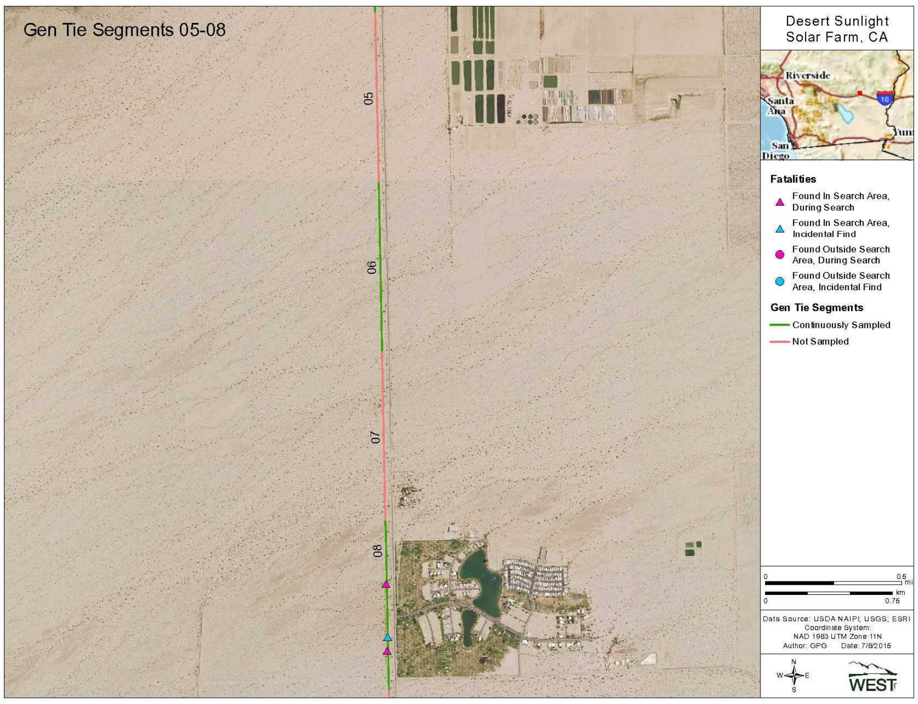


Figure A-2. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015 (including February).

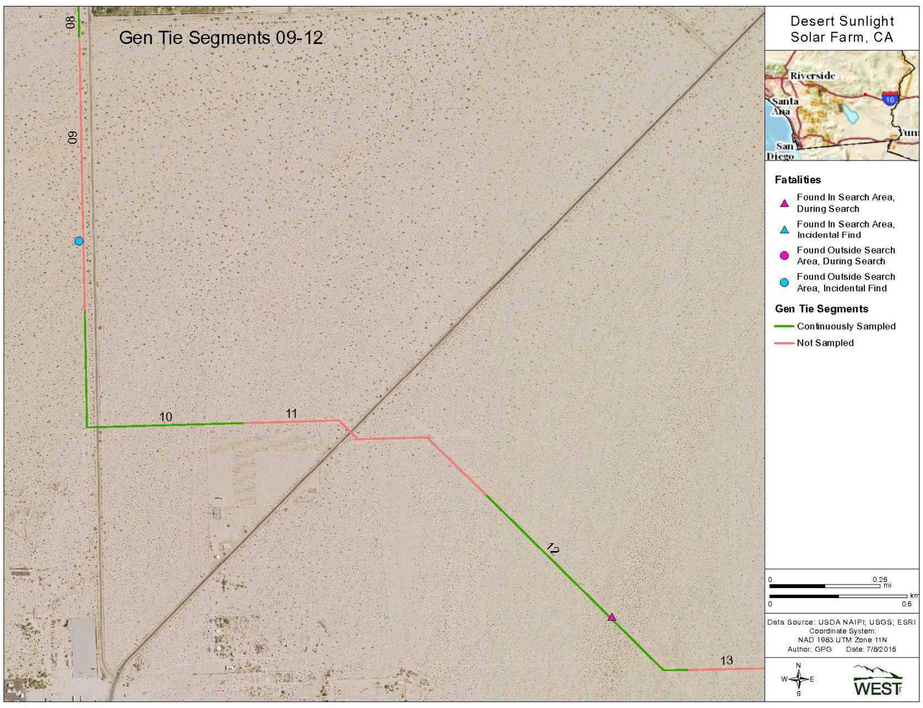


Figure A-3. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015 (including February).

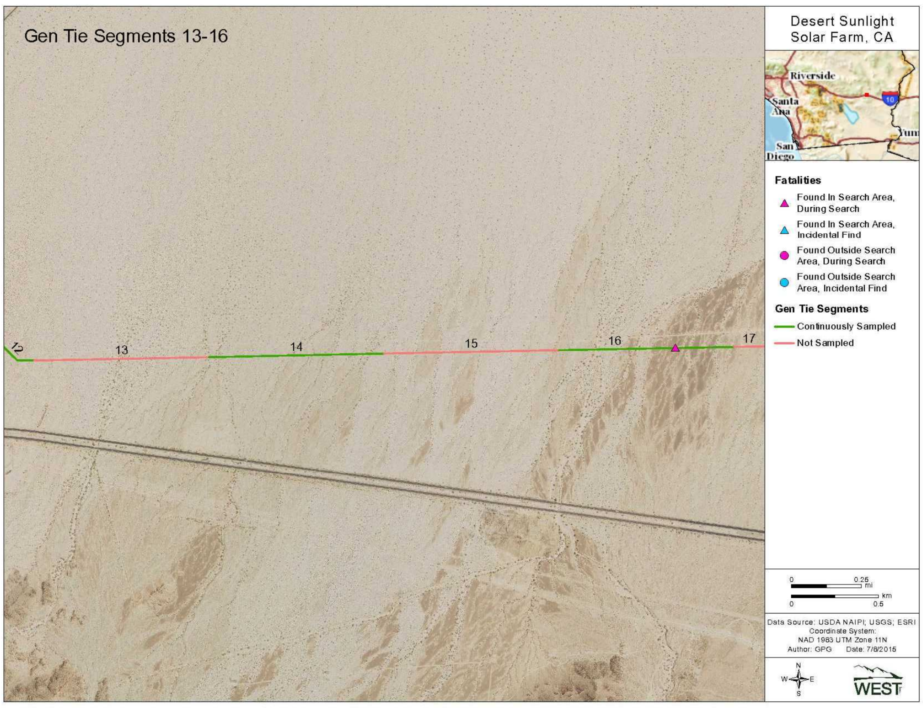


Figure A-4. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015 (including February).

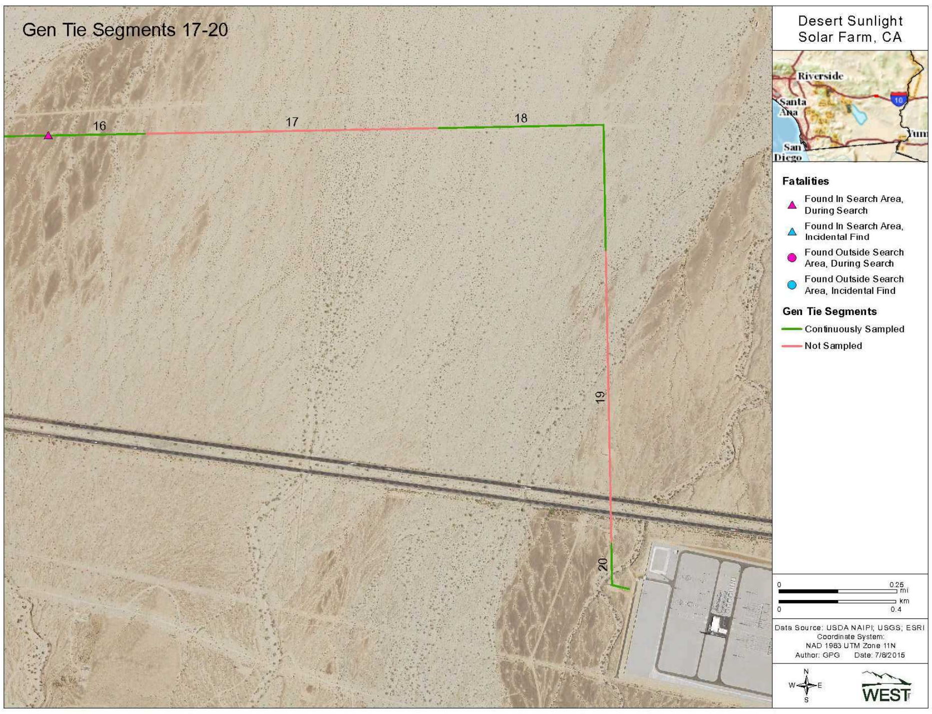


Figure A-5. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015 (including February).

Appendix B. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during Spring 2015

Table B-1. Weather conditions and body weights associated with avian detections estimated to be less than 24 hours old during spring 2015 at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hrs)	Species	Weight (g)	Weather Summary for Preceding 24 hrs
040715-TOWA-13-27A-MVOH-1	4/7/2015	8-24hrs	Townsend's warbler		
043015-WIWA-GENTIE-08-1	4/30/2015	8-24hrs	Wilson's warbler		TEMP HIGH 97 DEGREES, 2-5 PM OVERNIGHT LOW WAS 67 DEGREES, WINDS < 10 MPH
042215-WWDO-FENCE-NORTH-15-1	4/22/2015	8-24hrs	white-winged dove		TORNADO
042215-WWDO-18-19A-MVOH-1-1	4/22/2015	8-24hrs	white-winged dove		
050715-WETA-GENTIE-12-1	5/7/2015	8-24hrs	western tanager		
051915-WEWP-O&MBUILDING-1	5/19/2015	0-8hrs	western wood-pewee	7	CLEAR OVERNIGHT, RELATIVELY CALM WINDS, MAX 8MPH

Appendix C. Correction Factors and Bird Fatality Rates at the Desert Sunlight Solar Farm Project during Spring of 2015 (Including February).

Table B-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Farm Project during spring 2015. *Distribution of easy and difficult visibility on the generation-tie line was about 70% and 30%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero. ***Adjusted fatality estimates for spring are weighted to account for variable area adjustments during spring.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Search Area Adjustment								
Overhead lines	0.479	-	0.479	-	0.479	-	0.479	-
Fence	0.744	-	0.744	-	0.744	-	0.744	-
Solar arrays: Winter	0.295	-	0.295	-	0.295	-	0.295	-
Solar arrays: Spring weeks 1 - 7	0.295	-	0.295	-	0.295	-	0.295	-
Solar arrays: Spring weeks 8 - 10	0.282	-	0.282	-	0.282	-	0.282	-
Solar arrays: Spring weeks 11 - 12	0.295	-	0.295	-	0.295	-	0.295	-
Observer Detection Rate								
Overhead lines: Easy vis.*	0.583	0.417 - 0.750	0.952	0.857 - 1.000	0.8	0.600 - 1.000	0.583	0.417 - 0.750
Overhead lines: Difficult vis.*	0.435	0.261 - 0.609	0.706	0.529 - 0.882	0.6	0.300 - 0.800	0.435	0.261 - 0.609
Overhead lines: Weighted avg.*	0.539	0.419 - 0.665	0.878	0.794 - 0.947	0.74	0.570 - 0.880	0.539	0.419 - 0.665
Fence	0.793	0.690 - 0.897	1	1.000 - 1.000	0.9	0.700 - 1.000	0.793	0.690 - 0.897
Solar arrays	0.596	0.505 - 0.671	0.872	0.786 - 0.953	0.977	0.931 - 1.000	0.596	0.505 - 0.671
Average probability of carcass persistence to the next search								
Overhead lines: Winter	0.15	0.130 - 0.207	0.549	0.325 - 0.731	0.563	0.339 - 0.727	0.15	0.130 - 0.207
Overhead lines: Spring	0.29	0.192 - 0.387	0.714	0.520 - 0.852	0.724	0.529 - 0.849	0.29	0.192 - 0.387
Solar arrays & fence: Winter	0.343	0.284 - 0.403	0.705	0.511 - 0.848	0.885	0.794 - 0.956	0.343	0.284 - 0.403
Solar arrays & fence: Spring	0.536	0.470 - 0.610	0.824	0.678 - 0.917	0.935	0.881 - 0.978	0.536	0.470 - 0.610
Observed Fatality Rates (Fatalities /Season)								
Overhead lines: Winter	0	-	0	-	0	-	0	-
Overhead lines: Spring	3	1 - 5	2	0 - 4	0	-	1	0 - 3
Fence: Winter	0	-	0	-	0	-	0	-
Fence: Spring	0	-	1	0 - 2	0	-	0	-
Solar arrays: Winter	1	0 - 3	0	-	1	0 - 3	0	-
Solar arrays: Spring	2	0 - 4	2	0 - 5	2	0 - 5	1	0 - 3
Average Probability of Carcass Availability and Detected								
Overhead lines: Winter	0.081	0.062 - 0.122	0.482	0.280 - 0.652	0.416	0.240 - 0.578	0.081	0.062 - 0.122
Overhead lines: Spring	0.156	0.094 - 0.222	0.627	0.455 - 0.761	0.536	0.357 - 0.690	0.156	0.094 - 0.222
Fence: Winter	0.272	0.214 - 0.336	0.705	0.511 - 0.848	0.796	0.627 - 0.941	0.272	0.214 - 0.336
Fence: Spring	0.425	0.350 - 0.515	0.824	0.678 - 0.917	0.842	0.664 - 0.967	0.425	0.350 - 0.515
Solar arrays: Winter	0.204	0.159 - 0.247	0.615	0.442 - 0.765	0.865	0.767 - 0.948	0.204	0.159 - 0.247
Solar arrays Spring	0.319	0.259 - 0.378	0.719	0.585 - 0.835	0.914	0.847 - 0.970	0.319	0.259 - 0.378

Table B-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Farm Project during spring 2015. *Distribution of easy and difficult visibility on the generation-tie line was about 70% and 30%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero. ***Adjusted fatality estimates for spring are weighted to account for variable area adjustments during spring.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Adjusted Fatality Estimates (Fatalities /Season)**								
Overhead lines: Winter	0	-	0	-	0	-	0	-
Overhead lines: Spring	40.1	4.3 - 107.2	6.7	0.5 - 8.6	0	-	13.4	(1) - 22.1
Overhead lines: Total	40.1	4.3 - 107.2	6.7	0.5 - 8.6	0	-	13.4	(1) - 22.1
Fence: Winter	0	-	0	-	0	-	0	-
Fence: Spring	0	-	1.6	1.6 - 3.5	0	-	0	-
Fence: Total	0	-	1.6	1.6 - 3.5	0	-	0	-
Solar arrays: Winter	16.6	(1) - 26.3	0	-	3.9	(1) - 4.2	0	-
Solar arrays: Spring***	21.2	9.3 - 23.5	9.4	4.9 - 16.2	7.6	(2) - 26.7	10.6	(1) - 20.1
Solar arrays: Total	37.8	19.0 - 36.8	9.4	4.9 - 16.2	11.5	(3) - 30.7	10.6	(1) - 20.1
Facility: Winter	16.6	(1) - 26.3	0	-	3.9	(1) - 4.2	0	-
Facility: Spring	61.3	20.1 - 121.6	17.7	12.4 - 22.8	7.6	(2) - 26.7	24	(2) - 38.1
Facility: Total	77.9	25.5 - 135.7	17.7	12.4 - 22.8	11.5	(3) - 30.7	24	(2) - 38.1

Post-Construction Monitoring at the Desert Sunlight Solar Project Riverside County, California

---

2015 Spring Report

Prepared for:

Desert Sunlight 250, LLC and
Desert Sunlight 300, LLC
700 Universe Blvd.,
Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.

415 West 17th Street, Suite 2000
Cheyenne, Wyoming

December 9, 2015

Draft Pre-Decisional Document - Privileged and Confidential - Not For Distribution

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from February 10 to May 31, 2015 (the reporting period) at Desert Sunlight Solar Farm Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the first seasonal report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS.

Included in this report are data from standardized carcass searches conducted during the spring season at the Project, defined as March 01 to May 31, 2015. . Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 29.5% sample of solar photovoltaic (PV) panels, 2) along inner portions of the fenceline, resulting in 74.4% of the length of the perimeter fence, and 3) along 47.9% of the total length of generation-tie (gen-tie) line from the Project fence to the Red Bluff Substation located south of Interstate 10 (I-10). Searches conducted within the spring season had intervals of approximately seven days, and all searches were conducted during daylight hours.

All bird and bat fatalities and injuries that were discovered by observers, referred to as "detections" in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, 23 avian detections (including 1 injured bird) were made, and there were no detections of bats.

According to specifications of the BBCS, avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were applied to a fatality estimator model (Huso 2010) to provide a preliminary estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias. The estimate is considered preliminary because the annual report may pool information from bias trials and other data across seasons which could affect seasonal estimates.

During the reporting period, carcass persistence was influenced by carcass size and Project component. Small carcasses (0-100 g) in the arrays and along the fence (combined) had a 0.54 probability (90% confidence interval [CI]: 0.47 – 0.61) of persisting through the 7-day search interval, medium carcasses (101 – 999 g) had a 0.82 (0.69 – 0.92) probability, and large carcasses (1000+ g) had a 0.94 (0.88 – 0.98) probability. Mean removal time within the arrays for small, medium, and large carcasses was 5.7, 29.8, and 126.8 days, respectively. Along the generation tie-line, probability of persistence for small, medium, and large carcasses were 0.29 (0.19-0.39), 0.71 (0.52-0.85), and 0.72 (0.53-0.85), respectively; mean removal time for small, medium, and large carcasses was 2.0, 13.7, and 14.7 days, respectively. Within the solar arrays, searcher efficiency was influenced by carcass size: 60.0% for small birds, 87.2% for medium birds, and 97.3% for large birds. Along the fence, searcher efficiency ranged from 79.3% to 100% depending on carcass size class. Along the generation tie-line, searcher efficiency ranged from 53.9% to 87.8%.

Using the Huso (2010) fatality estimator model, during the spring period 2015, there were an estimated total 111 fatalities (90% CI: 58 - 193) at the Project. Of these, 49 fatalities (44.1%; 90% CI: 19 – 86) were estimated for the solar arrays, 2 fatalities (1.8%; 90% CI: 2 – 4) were estimated for the fence, and 60 fatalities (54.1%; 90% CI: 16 – 132) were estimated for the gen-tie line.There were an estimated 0.02 carcasses per acre (49 estimated carcasses/2,585 acres) and an estimated 0.09 carcasses per nameplate MW (49 estimated carcasses/ 550 MW) within the solar field. All of these estimates should be interpreted with caution because the variance estimates are in general unreliable when carcass counts are low (< 5 per category). Other projects (e.g. Ivanpah) are not reporting estimates when carcass counts are < 5 in a category, but the TAG has requested them for this project.

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Tracey Johnson	Research Biologist
Paul Rabie	Statistician
Andrea Polachek	Technical Editor
Tracey Johnson	Field Supervisor
Pamela Bullard	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2015. Post-construction monitoring at the Desert Sunlight Solar Farm Project, Riverside County, California. 2015 Spring Report. 27 pp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Project Background

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC (collectively, Desert Sunlight) constructed and operates the Desert Sunlight Solar Farm Project (referred to in this report as "Project"), which consists of two main components: 1) a 550-megawatt (MW) photovoltaic (PV) generating facility; and 2) a 220-kilovolt (kV) generation interconnection (gen-tie) line. The Project comprises approximately 1,700 hectares (ha; 4,200 acres) of land administered by the Bureau of Land Management (BLM) six miles north of Desert Center in Riverside County, California (Figure 1).

1.2 Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (2014; “BBCS”) was prepared by the Project proponent in collaboration with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), (BLM) to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency approval of the BBCS occurred in December 2014. Amendments to the sampling protocol along some portions of the Project fenceline were made by Desert Sunlight and approved by the BLM on February 11, 2015.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Desert Sunlight in collaboration with the USFWS, CDFW, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the gen-tie line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
3. Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

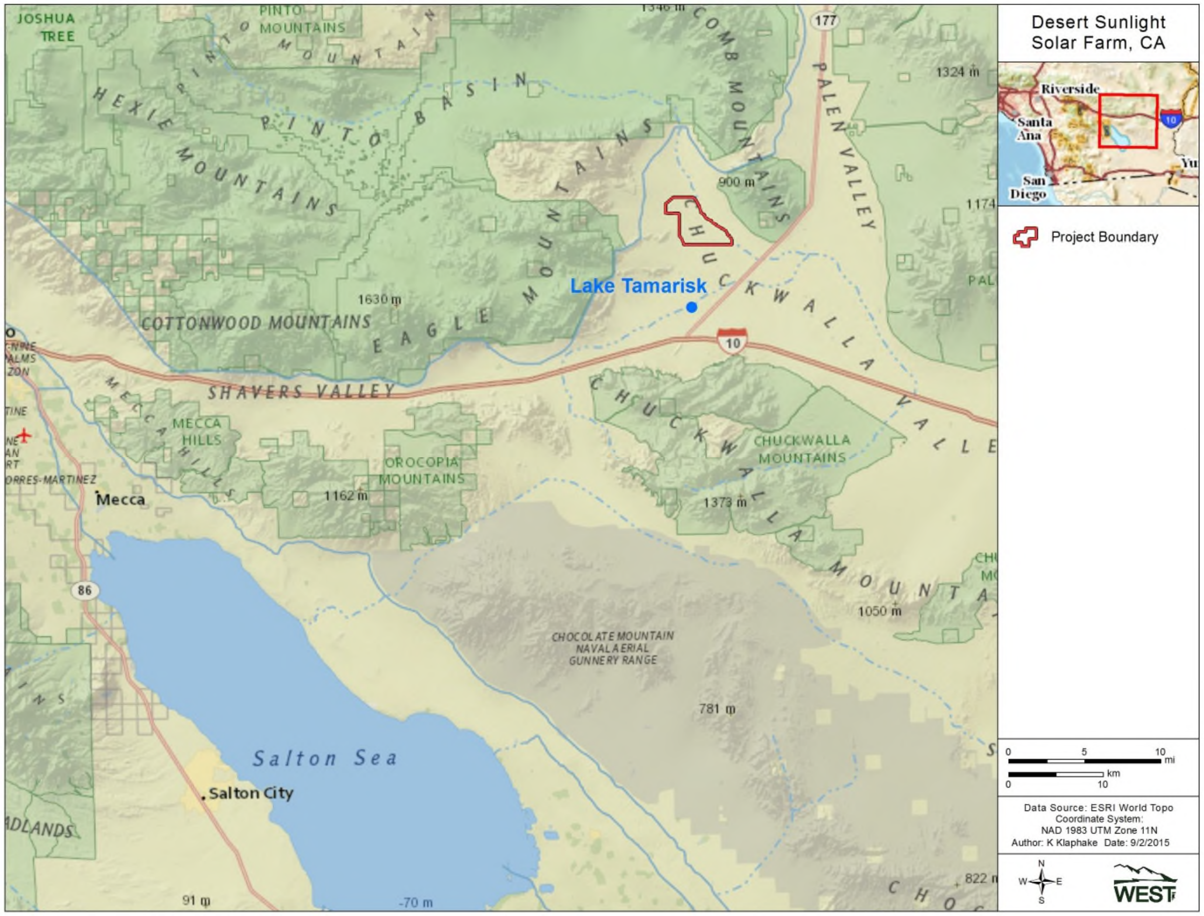


Figure 1. Desert Sunlight Solar Farm Project vicinity map, Riverside County, California.

1.3 Purpose of This Report

This report represents the first seasonal report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS. This report covers the period February 10 to February 28, 2015, as well as the 2015 spring season, which includes the period from March 01 to May 31, 2015. All bird and bat fatalities and injuries that were discovered by observers are referred to as “detections” in this report. Per USFWS comments on an earlier draft of this report (dated July 17, 2015), carcass search data collected before March 01 have been excluded and are not reported here. As stated in the approved BBCS, this seasonal report includes the observed detections for likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and suspected causes of death. Species composition of detections and the results of the bias trials are also reported. This report presents information related to the spatial distribution of detections, but no formal statistical analysis of the spatial distribution of carcasses will be conducted until the end of the monitoring year, given the limited data presently available.

2.0 METHODS

The BBCS describes the methods by which monitoring and certain analyses, including compilation of the overall fatality estimate, will occur. Below is an abridged description (see BBCS for detailed methods).

2.1 Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. Dead or injured birds and bats are called detections in this report to provide consistency in naming. This section also describes the methods for conducting carcass removal and searcher efficiency trials; how data were reported and analyzed; and the methods for producing fatality estimates for the Project.

2.1.1 *Areas Surveyed*

Standardized carcass searches were conducted at sampling units, which include the solar arrays (Table 1, 2; Figure 2); the “fenceline” defined as the perimeter fence for the Project (Table 1, Figure 2); and the gen-tie line (from the Project fence to the Red Bluff Substation on the south side of I-10; Table 1, Figure 3). Some overhead lines co-occur with solar arrays (medium voltage overhead lines [MVOH]). The MVOH were part of standardized carcass searches to the extent that they co-occured with solar arrays included in the sample (Table 3; Figure 2).

Table 1. Areas included in standardized carcass searches at the Desert Sunlight Solar Farm Project during spring 2015.

Project Component	Total Size	Units	% of Component Searched
Solar arrays	1045.9	Hectares	28.2[1]
Solar arrays	1045.9	Hectares	1.3[2]
Solar arrays	1045.9	Hectares	1.3[3]
Fence	16.7	Kilometers	99%[4]
Gen-tie line	19.2	Kilometers	47.9[5]

[1] Percent area that was searched continuously since monitoring commenced in February 2015. Slightly less than 30% total (including areas affected by the tornado) because of unequal size arrays.

[2] Percent that was searched before the April 21, 2015 tornado but not after.

[3] Percent that was searched after the tornado but not before.

[4] 74.4% of the fence is fully accessible and surveyed following the standard protocol, while approximately 25% of the fence is surveyed from a distance. Fatality rates estimated for sections of the fence that are sampled were extrapolated to sections of the fence where the standard monitoring protocol cannot be used, as described in section 4.2.6 of the approved Desert Sunlight BBCS. A very short segment near the gate is not sampled due to restoration activities.

[5] 52.1% of gen-tie will be sampled in 2016.

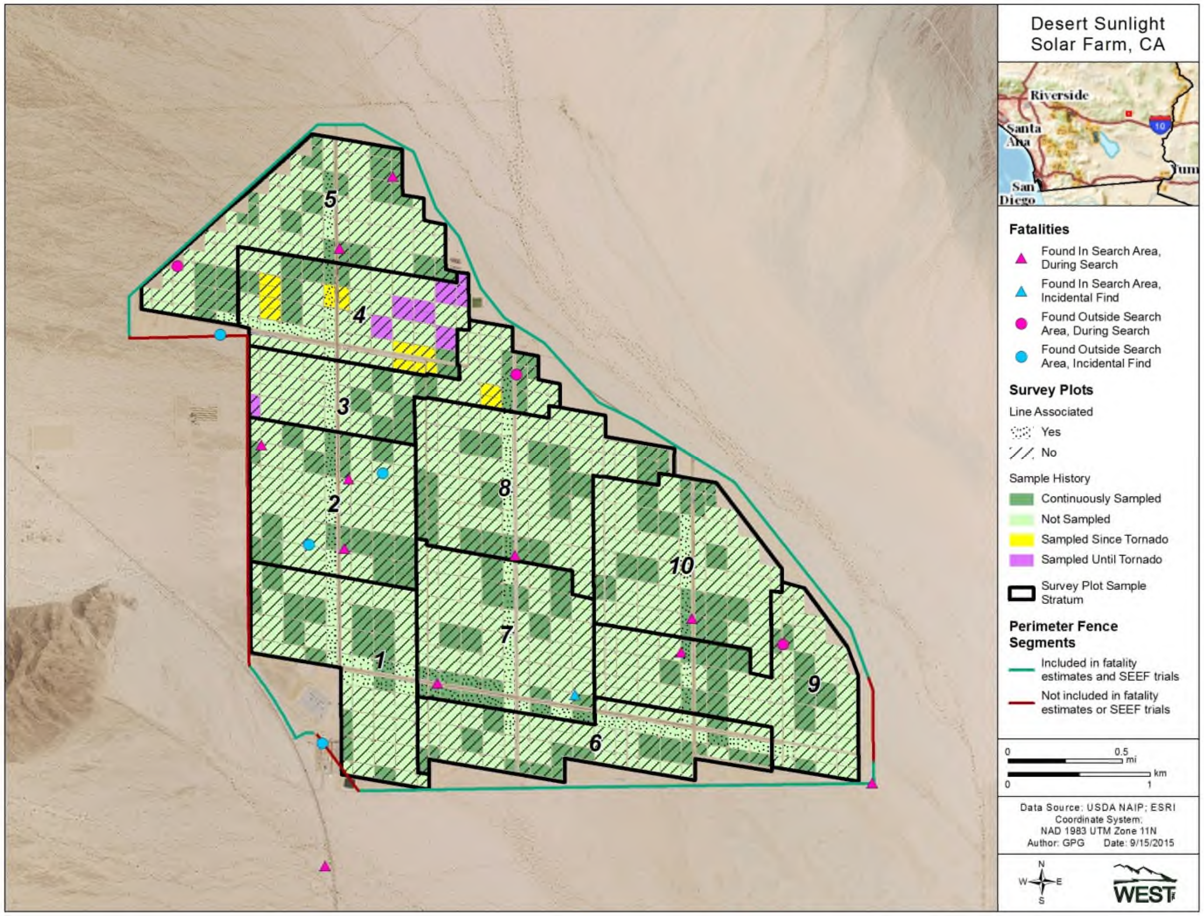


Figure 2. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at the solar field, fence, and overhead lines within the fence at Desert Sunlight Solar Farm Project during spring 2015.

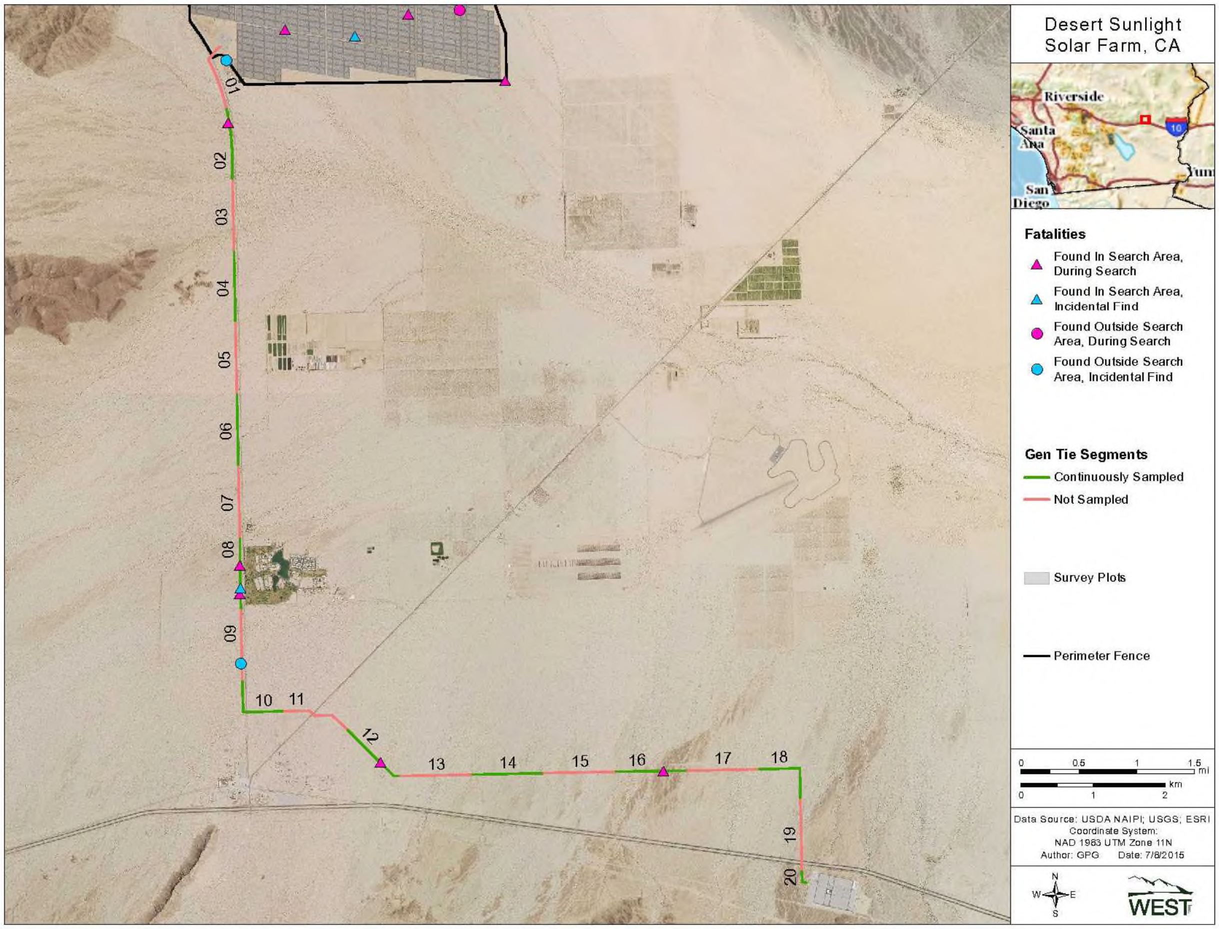


Figure 3. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance activities) along the generation tie line at the Desert Sunlight Solar Farm Project during spring 2015. Detailed maps of detections along the line are presented in Appendix A.

To ensure a balanced distribution of sample units in the solar field (defined as the collection of all photovoltaic [PV] solar panels), the entire field was divided into ten strata, and individual sampling units were randomly selected within each stratum to compose an approximately 30% sample. The solar field consists of arrays of solar panels (referred to as a solar array). This sampling design ensures that units included in the sample were not spatially clumped within the solar field.

2.1.2 *Search Frequency and Timing*

Standardized searches occurred during the spring survey season, which includes the period from March 01 through May 31, 2015. All project components included in standardized searches were surveyed 12 times during spring. All searches took place during daylight hours from 06:30 to 17:00.

Table 2. Sample sizes and number of rows for each 70-m and 140-m array type included in standardized carcass searches at the Desert Sunlight Solar Farm Project during spring 2015.

	Number of rows		Number of arrays	
Time period	**70 m**	**140 m**	**70 m**	**140 m**
Before tornado	2560	3920	133	133
3-week interim	2460	3720	127	127
After tornado	2580	3900	133	133

As specified in the approved Desert Sunlight BBCS, the average search interval for all Project components included in standardized carcass searches during spring was 7.1 days (median 7 days). Slight variation in search interval was anticipated due to weather and logistical delays. On April 21, 2015, the Project was struck by a tornado. The tornado damaged some of the sampling units, and resulted in limited access that ultimately lasted longer than initially expected. Thus, 142 sample units (128 arrays, fence, and gen-tie combined) were visited 12 times continuously and without interruption during the spring season. Six arrays were visited seven times from the beginning of the spring season until the tornado occurred on April 21, 2015; 3 weeks elapsed before the six damaged arrays were replaced with arrays in the solar field that were not affected by the tornado. During this 3-week period, Desert Sunlight LLC remained in contact with the BLM as details on access limitation developed. Once it was determined that access to damaged arrays would be limited for a longer time period, six replacement arrays were identified; five were visited twice and one was visited once. Replacement arrays were identified by choosing a random sample of non-damaged arrays within the same block that contained the original arrays that were damaged by the tornado.

Table 3. Area, proportion, and detections for solar arrays that are and are not associated with overhead lines at the Desert Sunlight Solar Farm Project.

	Line-associated[1]	**Not line-associated**	**Proportion line-associated**
Entire facility	89.4 ha	956.5 ha	0.09
Standardized searches	32.2 ha	291.0 ha	0.10
Detections	3[2]	10	0.23

[1] Line-associated area was estimated as the area of any array that fell within the 30-m strip transect below the MVOH.

[2] Includes detections where closest component was an MVOH or a line-associated array.

2.1.3 *Search Methods*

Standardized carcass searches were performed by BLM-approved biologists, in accordance with methods outlined in the BBCS.

Within the solar field, arrays of solar panels were surveyed by observers traveling on foot. A distance sampling approach was used, whereby biologists slowly walked a transect line along the ends of rows of solar panels in a direction perpendicular to the rows, searching ahead and to the side within the array for bird and bat detections. Biologists scanned out to a maximum perpendicular distance of approximately 70 m from the transect. Biologists carried binoculars to allow them to verify the presence of a detection versus rocks or vegetation. Once a detection was confirmed, the distance of the detection to the transect line was estimated using laser range finders. Each array included in the sample was searched by observers walking two transects – one on the west side and one on the east side of the array with observers looking toward the center of the array.

Once a carcass was detected, it was then photographed, and data were recorded according to specifications outlined in section 7.2.5 of the approved Desert Sunlight BBCS. Carcasses detected before amendment of the WEST California Scientific Collecting Permit (Permit # 3790) were covered and secured in place until permission was granted from California Department of Fish and Wildlife to handle carcasses on April 21, 2015. Since that date, all carcasses have been retrieved from their location on the ground, labeled, and placed in a freezer on site.

Most (74.4%) of the length of fenceline (approximately 10 miles) was searched from a vehicle using the standard protocol (Figure 2). Biologists searched a 6-m wide strip transect centered on the fence from the inner perimeter. Travel speed was below five miles per hour (mph) while searching. Some sections along the fence cannot be driven close to the fence line. The fence line along the western edge of the Project is drivable but the road is approximately 15 m away from the fence and the road and fence are separated by a drainage ditch. The fence along this section is covered with a tan tarp to block and trees and shrubs have been planted to reduce visibility of the project from the west. Additions of vegetation and the tarp likely reduce potential for bird collision with the fence. This section of the fence was driven to document carcasses, but detections along this portion of the fence are not included in adjusted fatality estimates because detection rates are likely very low. As specified in section 4.2.6 in the approved Desert Sunlight BBCS, we assume that fatality rates are similar between the portion of fence that was searched and the portion that was not. A separate section of the fence in the southeastern corner of the Project cannot be driven because the eastern edge of the berm that bounded construction ponds is too narrow for a vehicle. Along this portion of the fence, the observer stopped at both north and south ends of the berm and used binoculars to search for carcasses. Finally, the road along a portion of the southwest fence line near the entrance gate is approximately 30 to 50 m from the road and is separated from the fence by an area that has recently undergone vegetation restoration. This area was eliminated from sampling. Fatality rates estimated for sections of the fence that were sampled were adjusted to account for the proportion of fence not sampled with the standard monitoring protocol, as specified in section 4.2.6 of the approved Desert Sunlight BBCS.

The gen-tie line was searched using a 30-m wide strip transect (i.e., 15 m of ground on either side of the overhead line). Sample units along the gen-tie line were chosen by dividing the total length of line from the Project fence south to the Red Bluff Substation just south of I-10 into 1-km segments. Thus, a 47.9% sample of the total length of the line was searched (Figure 3). Biologists slowly walked every other 1-km segment of the line, meandering the width of the strip transect, scanning for dead or injured birds or bats within 15 m (49.2 ft) of the overhead line.

For each detection, a suspected cause of death or injury was assigned based on evidence available from the detection, evidence available on Project infrastructure, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it cannot be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed. Detections assigned to the “unknown” category were included in fatality estimates if they were located within standardized carcass search areas.

2.2 Carcass Persistence Trials

Carcass persistence trials were conducted during February and throughout the spring period. Carcasses from three size classes (small [0-100 g], medium [101-999], and large [1000+ g]) were used for trials. The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), and the large size class comprised hen mallard (*Anas platyrhynchos*) and hen ring-necked pheasant (*Phasianus colchicus*).

2.2.1 *Carcass Persistence Data Collection*

To quantify carcass persistence rates, 15 small, 10 medium, and 5 large carcasses (i.e., trials) were randomly placed and monitored along the gen-tie line during spring 2015. Within the solar arrays and along the perimeter fence, the same numbers of small and medium carcasses were placed, along with 10 large carcasses, for a total of 65 carcass persistence trials at Desert Sunlight during the spring season, as specified in the approved Desert Sunlight BBCS. By placing carcasses inside and outside the project fence, the possibility that there are different carcass persistence rates inside and outside the project fence is accounted for. As approved by BLM on March 18, 2015, carcass persistence trials within the Project fence were coordinated with trials implemented as part of the Raven Management Plan by Corvus Ecological Consulting, LLC. Thirty-five carcasses within the Project fence (within solar arrays and along the fence) were monitored using motion-triggered digital trail cameras, while the remaining carcasses were visited on foot, for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality. No carcasses along the gen-tie line were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as “feeding stations”, trail cameras were installed five days before specimens were placed, and two fake cameras without bias trial carcasses were also placed within the Project fence and periodically moved to new locations within the fence. Periodic ground-based checking of carcasses with trail cameras also occurred to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera’s field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire

Project, not just in areas subject to standard searches, and trials were initiated in small numbers on six different dates throughout the spring season.

In February, 15 (*n* = 7 small, 5 medium, and 3 large) carcass persistence trials were placed in the solar arrays and along the Project fence, and 15 trials (*n* = 8 small, 5 medium, and 2 large) were placed along the gen-tie line. Eight carcasses within the arrays and fence were monitored with trial cameras, and four fake cameras were placed within the arrays and along the fence. Carcass persistence trials within the solar arrays and fence were initiated two days earlier in February than trials along the gen-tie line.

2.2.2 *Estimating Carcass Persistence Times*

Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g. days a carcass is present before being removed) may not be known exactly, but is known to be within a finite range. For example, suppose a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass became unavailable at some point between 7 and 10 days. This carcass would be considered "interval censored". Similarly, if a carcass lasts the entire 30-day trial period, that carcass is "right censored"— it is known that the carcass lasted at least 30 days, but it may have persisted longer. Because carcass persistence data were censored, persistence was analyzed using methods that can accommodate censored data and still produce unbiased estimates of the probability of persistence (Therneau 2015, Therneau and Grambsch 2000).

USGS-developed fatality estimator software (Huso et al 2012) was used to fit survival models to the censored carcass persistence data. There were four distributions implemented in survival models used to estimate the probability a carcass is unscavenged and available to be found at the end of the search interval (*r*): exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike's Information Criterion adjusted for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model with combinations of the covariates carcass size, location, and visibility, to observed carcass persistence data.

2.3 Searcher Efficiency Trials

Searcher efficiency trials were conducted in February and throughout the spring period). Carcasses from three size classes (small, medium, and large) were used for trials. The small size class comprised house sparrows and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons, and the large size class comprised hen mallards and hen ring-necked pheasants.

2.3.1 *Searcher Efficiency Data Collection*

Training of biologists on the Project-specific protocol and early assessments of habitat conditions at the Project site suggested that the amount of cobble present in the soil may be an important factor influencing searcher efficiency. To satisfy requirements regarding consideration of visibility class per the BBCS and address the influence of cobble cover on searcher efficiency, sample units in the solar arrays and along the gen-tie were stratified by cobble cover and assigned to one of two classes (<15% and >15% cobble cover). Classes were determined by making ocular estimates of cobble cover at each sample unit and then evaluating the frequency histogram of sample units across the range of estimated cobble cover (Figure 4). A natural break point was identified at 15% cobble cover, so the same value was chosen as the break point that defined the two strata. In the solar arrays, one set of searcher efficiency trials (*n* = 15 small birds, 10 medium birds, and 5 large birds as agreed upon in section 7.4 of the approved Desert Sunlight BBCS) was conducted in each strata. Similarly, searcher efficiency trials along the gen-tie occurred in two visibility strata (easy: ≥90% bare ground, vegetation <6" tall; and more difficult: <90% bare ground, vegetation ≥6" tall). Thirty searcher efficiency trials (*n* = 15 small birds, 10 medium birds, and 5 large birds) occurred along the fence in the only stratum present on the fence (easy visibility). Thus, in February, a total of 150 searcher efficiency trials occurred at the Project, and the same methods and number occurred during the spring season. Locations for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches.

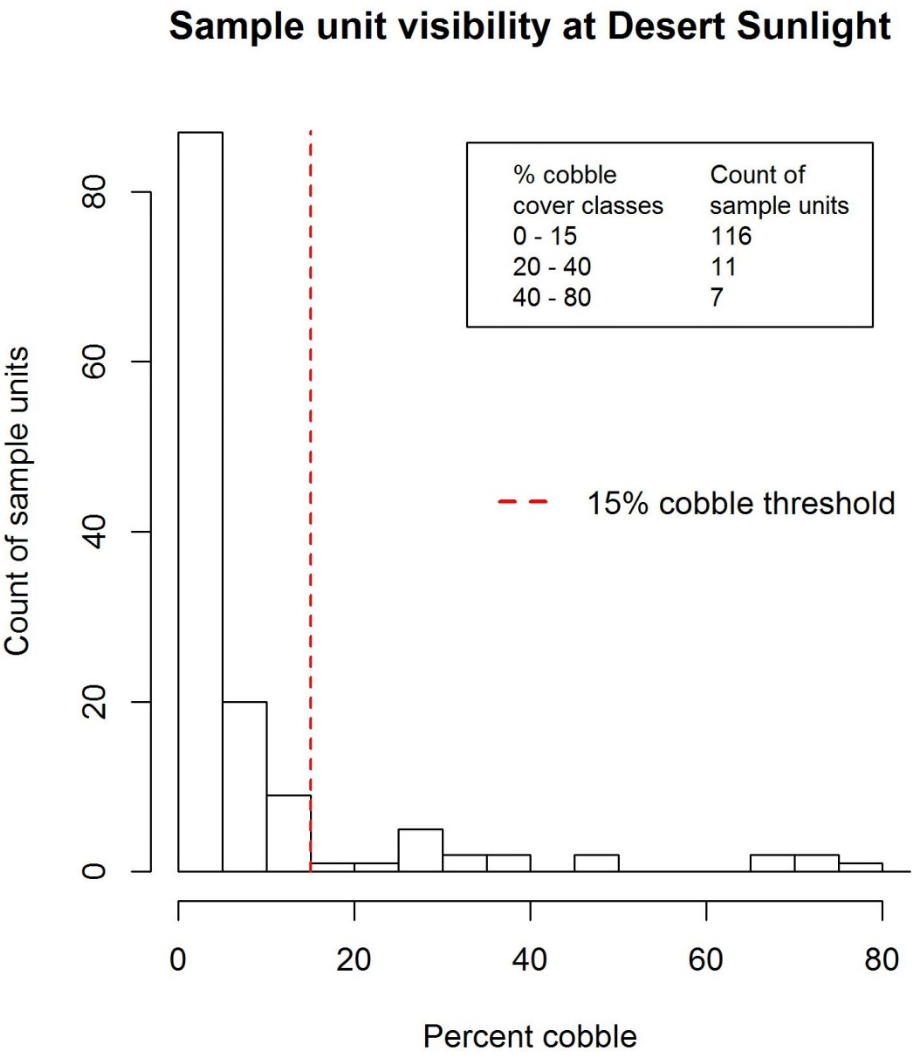


Figure 4. Frequency histogram of sample units (in the arrays only) at Desert Sunlight Solar Farm Project by estimates of cobble cover. Based on this distribution, each sample unit was assigned to one of two classes of cobble cover (<15%; >15%).

2.3.2 *Estimating Searcher Efficiency*

Searcher efficiency at Desert Sunlight was estimated separately for linear features (the project fence and the generation tie line), and the solar arrays, reflecting the different search methods used on arrays and linear features. For linear features, logistic regression models were fit to searcher efficiency data and AICc was used to compare models. Models including effects of carcass size (three classes) and visibility (two classes; gen-tie only), were compared to each other and the null model. Model selection indicated that best models accounted for component, carcass size, and on the gen-tie line, visibility. Once the best model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, p, was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from February and the spring 2015 season.

For the solar arrays, searcher efficiency was evaluated using a distance sampling approach (Buckland et al. 1993). Distance sampling assumes perfect detection on the transect line (at distance = 0), an assumption that is likely valid in the solar arrays given the relatively flat & vegetation-free nature of the soil surface. A curve is fitted to the observed carcass data that predicts probability of detection as a function of distance from the transect line. The mean value of this function over a specified distance, *w,* is equal to the average searcher efficiency for atransect of width *w*. The mean value of the detection curve is the integral of the detection function calculated between 0-m and the maximum survey distance (*w;* half the width of the solar array row), divided by the maximum survey distance:

$$p = \frac{\int_0^w f(x)dx}{w},$$

where f(x) is the detection function evaluated at distance, *x*.

One departure in the methods used here, relative to the methods presented in Buckland et al. (1993), was that for this study the detection function was estimated using trial carcasses, which meant that there were both presence (detected) and absence (not detected) data available to fit the detection function (Figure 5). The availability of both presence and absence data means that the detection function can be estimated using only trial carcasses whose distribution is known. Therefore the detection function, the average searcher efficiency among the arrays and the final fatality estimate within the arrays are all insensitive to the spatial distribution of carcasses within individual arrays, and the overall searcher efficiency estimate is valid even if the distribution of carcasses among the arrays is not uniform.

Distances of trial carcasses (trials both found and missed) from the transect line were used to fit a half-normal detection function for searches among the arrays (Figure 5). The half-normal detection function is a commonly used function for distance sampling surveys (Buckland et al. 1993). The detection function was fit with and without covariates (carcass size, visibility index, or no covariates) and AICc indicated that the best among these models included only carcass size as a covariate.

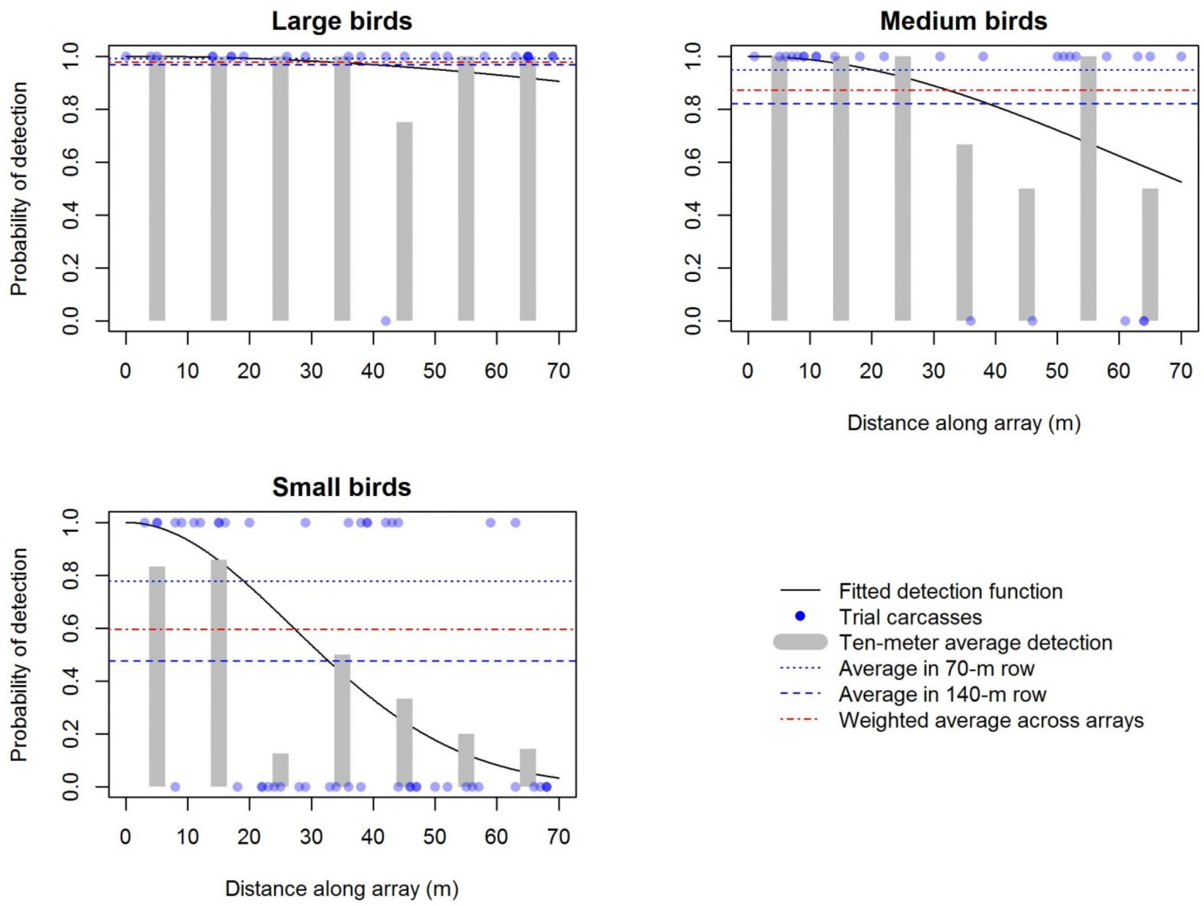


Figure 5. Estimated detection probabilities for bird carcasses by size class during spring 2015 (including February) at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented.

Because the solar arrays were surveyed by searchers who walked down both sides of the rows of panels, the width of the search transect was specified as half the width of the rows of panels. For larger birds, there is almost certainly a non-zero detection probability beyond this distance but the bias that occurs by ignoring this non-zero detection probability is conservative (i.e. the searcher efficiency is underestimated). Some solar arrays have row widths of 70 m (search transect width of 35 m) and some have row widths of 140 m (search transect width of 70 m). The weighted average searcher efficiency is calculated based on the number of panel rows of each length in the survey sample:

$$p_{weighted\ average} = \frac{n_{70}}{n} \times \int_0^{35} f(x)dx + \frac{n_{140}}{n} \times \int_0^{70} f(x)dx,$$

where n_{70} is the number of 70-m rows in the sample, n_{140} is the number of 140-m rows in the sample, and *n* is the total number of rows in the sample.

Searcher efficiency was higher for the arrays with a width of 70 m, and overall searcher efficiency was estimated as a weighted average based on the proportions of 70-m arrays and 140-m arrays in the sample units.

2.4 Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots are also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie line versus cleared areas beneath solar panels). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where F is the total number of fatalities, C is the number fatalities detected and included in fatality estimation, r is the probability a carcass is unscavenged and available to be found at the end of the search interval, and p is the probability of detecting a carcass (Huso 2010).

All fatality estimates were calculated using the Huso estimator, as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates were used. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

2.5 Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by WEST avian biologists and operational personnel and were considered “incidental” detections. When found by operational personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the Desert Sunlight SPUT Avian Injury and Mortality Report Forms March – May 2015. All detections made in search areas during the reporting period were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

3.0 MONITORING RESULTS

3.1 Summary of Avian Detections

During spring 2015, a total of 23 avian detections (including one injured bird and incidentals) of 12 identified species were recorded (Table 4). The most numerous detection of an identified species was common loon (*Gavia immer*) with four detections. Most detections (n = 10, or 43.5% of total detections) occurred in the solar arrays (Figures 2 and 3; Tables 4, 5, and 6). Seventeen (73.9%) detections were made during standardized carcass searches and six (26.1%) were documented as incidentals. For fresh carcasses, body weights and weather conditions the preceding nights are described in Appendix B.

Table 4. Number of individual bird detections, by species, during spring 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. NLA = non-line associated solar array; LA = line-associated solar array.

Common Name	Scientific Name	Migration Behavior*	Guild	Count	Project Component
common loon	*Gavia immer*	diurnal	waterbirds/waterfowl	4	NLA solar array
greater roadrunner	*Geococcyx californianus*	resident	cuckoos	1	NLA solar array
mallard	*Anas platyrhynchos*	variable	waterbirds/waterfowl	1 1	fence gen-tie line
Nashville warbler	*Oreothlypis ruficapilla*	nocturnal	warblers	1	gen-tie line
pied-billed grebe	*Podilymbus podiceps*	nocturnal	waterbirds/waterfowl	1	NLA solar array
Savannah sparrow	*Passerculus sandwichensis*	nocturnal	grassland/sparrows	1	NLA solar array
sora	*Porzana carolina*	nocturnal	rails/coots	1	NLA solar array
Townsend's warbler	*Setophaga townsendi*	unresolved	warblers	1	LA solar array
unidentified bird (unknown size)	–	–	unidentified birds	21	NLA solar array LA solar array
unidentified grebe	–	nocturnal	waterbirds/waterfowl	1	NLA solar array
unidentified hummingbird	–	–	swifts/hummingbirds	1	NLA solar array
western tanager	*Piranga ludoviciana*	nocturnal	tanagers	1	gen-tie line
western wood-pewee	*Contopus sordidulus*	nocturnal	flycatchers	1	O&M building
white-winged dove	*Zenaida asiatica*	variable	doves/pigeons	1	fence

Table 4. Number of individual bird detections, by species, during spring 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. NLA = non-line associated solar array; LA = line-associated solar array.

Common Name	Scientific Name	Migration Behavior*	Guild	Count	Project Component
				1	gen-tie line
				1	LA solar array
Wilson's warbler	*Cardellina pusilla*	nocturnal	warblers	1	gen-tie line
Total				**23**	

* See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in Birds of North America (BNA) Online (http://bna.birds.cornell.edu/bna/); where information on migration behavior was lacking in BNA accounts, Newton (2008) or Murray (2004) were used.

Table 5. Total avian detections by Project component and detection category during spring 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. Only carcasses found within search areas were included in fatality estimates.

	Inside carcass search area		Outside carcass search area	
Project Component	**Carcass search**	**Incidental**	**Carcass search**	**Incidental**
Fence	1	0	0	1
O&M Building	0	0	0	1
Gen-tie line	3	1	0	1
Solar arrays				
Line-associated	3	0	0	0
Non-line associated	7	0	3	2

Table 6. Total avian detections (including incidentals) by Project component and suspected cause of death during spring 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

	Suspected Cause of Death*				
Project Component	**Collision**	**Predation**	**Other**	**Unknown**	**Percent of Total**
Fence	1	0	0	1	8.7
O&M building	0	0	1	0	4.3
Gen-tie line	5	0	0	0	21.7
Solar arrays					
Line-associated	2	0	0	1	13.0
Non-line associated	1	1	5	5	52.2
Percent of Total	**39.1**	**4.3**	**26.1**	**30.4**	**100.0**

* Suspected cause of death was assigned based on evidence available on the detection, evidence available on Project infrastructure, and proximity of detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as "unknown" because it cannot be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However there is some uncertainy associated with cause of death assignments because no events were directly observed.

3.2 Temporal Patterns of Avian Detections

The number of detections recorded daily during the reporting period ranged from zero to two (Figure 6). The period from March 30 to May 27 was characterized by slightly higher numbers of detections with more days with two detections than the previous period. The number of detections per day represents those discovered during standardized carcass searches and incidentally.

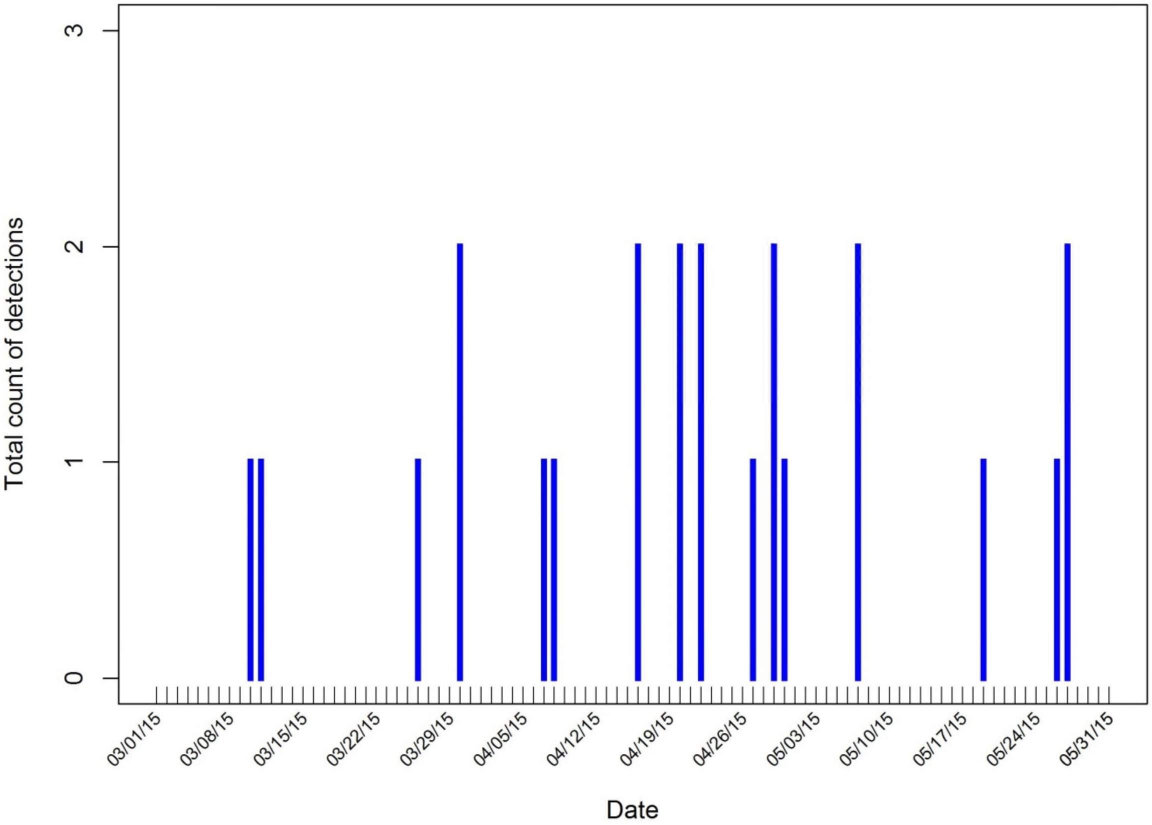


Figure 6. Total number of detections by date during spring 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.3 Spatial Distribution of Avian Detections

3.3.1 *Detections by Project Component*

During the reporting period, detections were documented from the solar arrays, perimeter fence, gen-tie line, MVOH lines within the solar field, and the O&M building (Tables 3, 4, 5 and 6). Of the 10 detections within the solar arrays, half (5) were assigned to the “unknown” category for suspected cause of death.

3.3.2 *Feather Spot Detections*

Seven (30.4.0%) of the 23 detections consisted only of feather spots. Along the fence, one detection (4.3%) was a feather spot. Two detections (8.7%) along the gen-tie line were feather spots. Four detections (17.4%) in the solar arrays were feather spots.

3.4 Detections of Injured Birds

One bird was located during the reporting period that was injured. A mourning dove (*Zenaida macroura*) was discovered on April 22 along the northern section of the perimeter fence. The bird had an obvious injury to its breast. Because the bird was found the day after the tornado struck the Project, the injury may have been a result of the storm. The bird was taken to Coachella Valley Wild Bird Center and left with Linda York for rehabilitation. Numerous attempts to determine the final outcome for the dove were unsuccessful. The single injured bird detection was included in the fatality estimates.

3.5 Summary of Bat Detections

No bats were located during the spring 2015 season.

3.6 Carcass Persistence Trials

Based on carcass persistence data from the spring 2015 season (and including February), 20 survival models were compared for relative quality using the corrected AICc score, as suggested in Huso (2010). The AICc score provides a relative measure of model fit and parsimony among a selection of candidate models, and provides a framework for testing hypotheses regarding which factors contribute to carcass persistence rates. Carcass size was tested as a potentially important variable, as larger carcasses tend to persist longer and may be more likely to leave feather spots which persist for long durations, whereas smaller carcasses may be more likely to be completely removed. Project component (solar arrays/fence, generation-tie line) was also included as a potentially important variable, as was season (February, or March-May).

The model with lowest AICc score is typically chosen as the “best” model relative to other models tested; however, any model within two AICc points of the best model is considered competitive with the best model (Burnham and Anderson 2004). The best model had a ΔAICc value of 0.77 and included effects of carcass size (small, medium or large), and location (solar arrays/fence or generation-tie line) with a Weibull-distributed removal time, but no effect of season. Estimates from the best model of carcass removal time and persistence probabilities are reported in Table 5 and Appendix C, and Figure 7 provides estimates of proportion of carcasses remaining as a function of days since carcass placement.

Table 7. Mean carcass removal time and probability of a carcass persisting through the 7-day search interval during the reporting period at the Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass size	Project component	Mean removal time (days)	Probability of persistence
Small	Arrays/fence	5.7	0.54
Small	Overhead lines	2.0	0.29
Medium	Arrays/fence	29.8	0.82
Medium	Overhead lines	13.7	0.71
Large	Arrays/fence	126.8	0.94
Large	Overhead lines	14.6	0.72

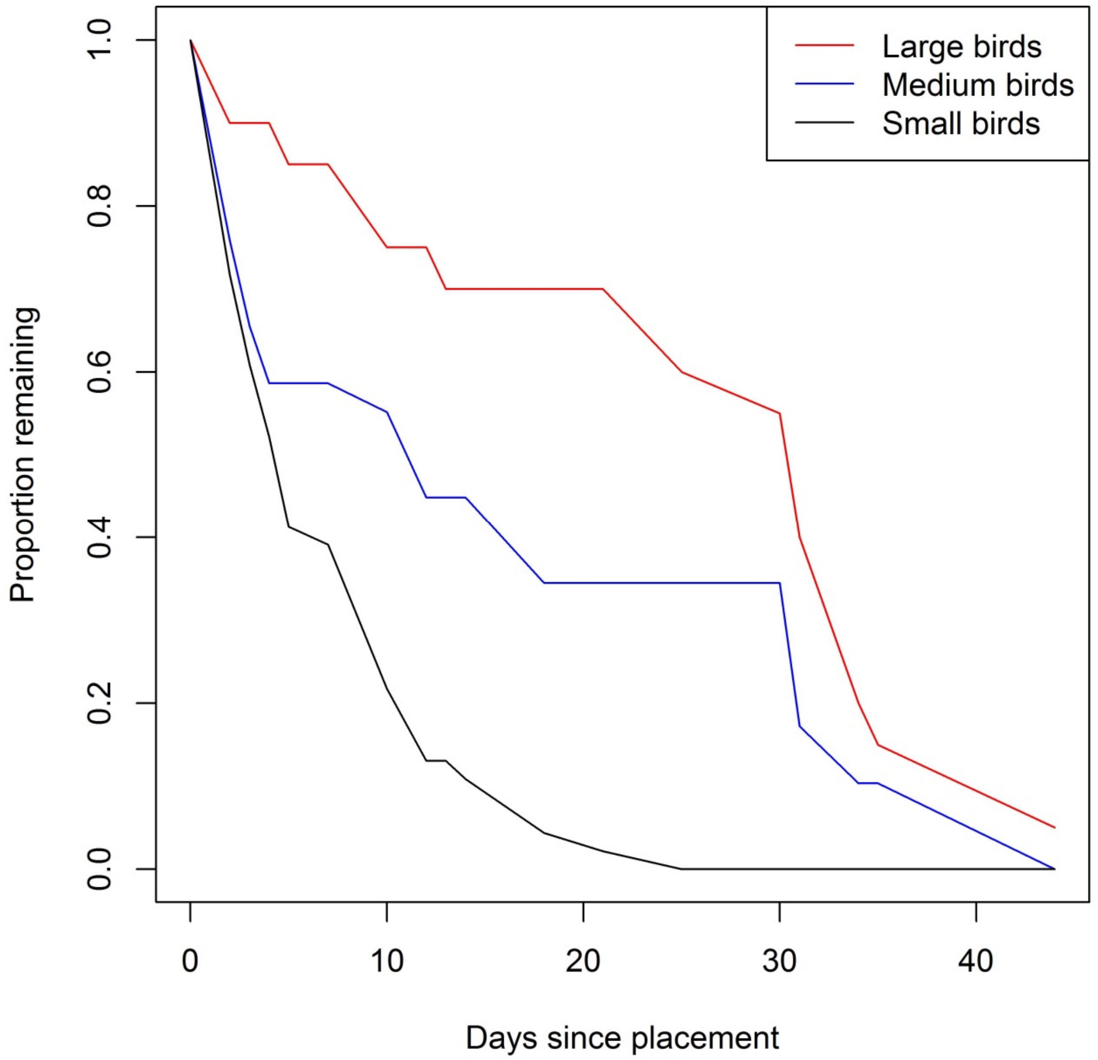


Figure 7. Proportion of trial carcasses remaining as a function of days since placement and carcass size class (n = 46, 29, and 20 for small, medium, and large size classes, respectively) February – May 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.7 Searcher Efficiency Trials

During the reporting period, a total of 300 searcher efficiency trials were placed at the Project. Most trials were available to be found, but some disappeared before or during the trial. Overall, 120 trials were placed in the solar arrays and 102 were available to be found; 60 trials were placed along the perimeter fence (inner perimeter only) and 59 were available to be found; and 120 trials were placed along the gen-tie line and 105 were available to be found. Five observers conducted searches at the Project during spring because of personnel turnover. Searcher efficiency trials were conducted on each observer in approximate proportion to the number of searches they conducted at the Project, as follows: Pam Bullard (number of trials available to be found: 8), Anika Mahoney (9), David Gallagher (21), Sarah Nichols (34), and Jennifer Johnson (91). All trials were included in estimation of searcher efficiency.

In the solar arrays, the model that included an effect of carcass size was chosen as the best model to estimate searcher efficiency (Appendix C). Within the solar arrays, searcher efficiency was influenced by carcass size: 60.0% for small birds, 87.2% for medium birds, and 97.3% for large birds (Appendix C). Along the fence, searcher efficiency ranged from 79.3% to 100% depending on carcass size class. Along overhead lines, searcher efficiency ranged from 53.9% to 87.8% (Appendix C). Detailed estimates of searcher efficiency estimates specific to each component and carcass size are reported in Appendix C.

3.8 Fatality Estimates

Fatality estimates were calculated separately for each component (solar arrays, fence, and overhead lines). Ultimately, nine detections were excluded from the fatality analysis: five were found outside standardized search areas; one was estimated to be older than the 7-day search interval (Huso 2010); and three were both outside standard search areas and estimated to be older than the 7-day search interval.

During spring 2015, there were an estimated total 111 fatalities (90% CI: 58 - 193) at the Project (Appendix C). Of these, 49 fatalities (44.1%; 90% CI: 19 – 86) were estimated for the solar arrays, 2 fatalities (1.8%; 90% CI: 2 – 4) were estimated for the fence, and 60 fatalities (54.1%; 90% CI: 16 – 132) were estimated for the gen-tie line (Appendix C). All of these estimates should be interpreted with caution because variance of the estimates are generally unreliable when carcass counts are low (< 5 per category).Other projects (e.g. Ivanpah) are not reporting estimates when carcass counts are low. However, the TAG has asked for both the estimates and confidence intervals for this project with the appropriate caveat added. There were an estimated 0.02 fatalities per acre (within the solar field only) and an estimated 0.20 fatalities per nameplate MW at the Project. A complete list of estimates for each Project component and carcass size class with confidence intervals is presented in Appendix C.

4.0 DISCUSSION

The 2015 spring season represented the first full season of standardized monitoring at Desert Sunlight per the BBCS. Searcher efficiency trials and carcass removal trials were conducted concurrently at the solar arrays, fencelines, and along the gen-tie line. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. Although these estimates were produced from a statistically robust sample, only limited inference may be drawn from a single season of data. These results should be considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. As more data are collected throughout the monitoring year (and additional quality assurance/quality control measures occur, for example characterizing feather spots to species or size class), data from all seasons may be pooled. At that time, data will be tested for seasonal differences retrospectively, but because seasonal estimates will be produced from the much larger annual data set, they may differ from what is reported here because they are based on a larger, more informative sample.

4.1 Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Thus, rates of carcass persistence reported here should be interpreted cautiously as they may change over the coming months.

Searcher efficiency was influenced by Project component, carcass size, and visibility class (along the gen-tie only). In the solar arrays, searcher efficiency was high (> 0.5) for all carcass size classes and this is likely influenced by the limited vegetation cover beneath solar panels. Beneath the gen-tie line vegetation cover is higher in some portions of the strip transects, and results reported here support the hypothesis that visibility class is a factor in searcher efficiency along the lines.

For the current analysis, searcher efficiency in the solar arrays was assumed to be best predicted by a half-normal distribution. For future analyses, AICc will be used to compare and choose the best among multiple detection functions.

.

4.2 Distribution of Fatalities and Fatality Estimates

The number of detections was more or less evenly distributed across the spring season, and there were no clear associations between number of detections and date. Given the small number of detections overall, it is premature to draw any conclusions about the spatial distribution of carcasses.

Detections attributed to an unknown cause accounted for 30.4% of all detections during the reporting period, and the distribution of the unknown cause detections varied by project component with 26.1% occurring in association with the solar arrays. Of the 15 detections made in the solar arrays, 26.7% were feather spots. Determining a cause of mortality from a feather spot is challenging because there is rarely visible evidence available on which to determine a cause of death. Thus, feather spots with an unknown cause of mortality could be encountered anywhere birds occur, and an unknown cause of a sizeable proportion of the carcasses is not unique to the Project. Further, the relatively large proportion of feather spots (30.4%) among the detections for the Project as a whole may inflate the fatality estimate when unknown cause detections are included based on the potential for multiple feather spots resulting from one fatality, feather spots resulting from predation not associated with the facility, or other causes.

5.0 LITERATURE CITED

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in 2nd International Symposium on Information Theory (B. N. Petran and F. Csaki, Eds.). Akademiai Kiado, Budapest, Hungary.

Ammon, Elisabeth M. and William M. Gilbert. 1999. Wilson's warbler (*Cardellina pusilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/478

Boarman, William I. and Bernd Heinrich. 1999. Common raven (*Corvus corax*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/476 doi:10.2173/bna.476

Buckland, S, D.R. Anderson, K. P. Burnham, and J.L. Laake. 1993. Distance sampling: estimating abundance of biological populations. Chapman & Hall, London. 446 pp.

Burnham, K.P., and D.R. Anderson. 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociological Methods & Research 33: 261-304.

Evers, David C., James D. Paruk, Judith W. Mcintyre and Jack F. Barr. 2010. Common loon (*Gavia immer*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/313 doi:10.2173/bna.313

Hudon, Jocelyn. 1999. Western tanager (*Piranga ludoviciana*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/432 doi:10.2173/bna.432

Hughes, Janice M. 2011. Greater roadrunner (*Geococcyx californianus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/244 doi:10.2173/bna.244

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. doi: 10.1002/env.1052

Huso, Manuela, Som, Nicholas, and Ladd, Lew. 2012. Fatality estimator user's guide: U.S. Geological Survey Data Series 729, 22 p.

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A new method to determine bird and bat fatality at wind energy turbines from carcass searches. Wildlife Biology 17: 350-363.

Lowther, Peter E. and Janet McI. Williams. 2011. Nashville warbler (*Oreothlypis ruficapilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/205 doi:10.2173/bna.205

Manly, B.F.J.1997. Randomization, bootstrap and Monte Carlo methods in biology. Second Edition. CRC Press, LLC, Boca Raton, Florida, 455 pp.

Melvin, Scott M. and James P. Gibbs. 2012. Sora (*Porzana carolina*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/250 doi:10.2173/bna.250

Muller, Martin J. and Robert W. Storer. 1999. Pied-billed grebe (*Podilymbus podiceps*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/410 doi:10.2173/bna.410

Murray, J. 2004. Nocturnal flight call analysis as a method for monitoring density and species composition of migratory songbirds (Order Passeriformes) across southern Vancouver Island, British Columbia in 2004. Rocky Point Bird Observatory, 16 pp.

Newton, I. 2008. The migration ecology of birds. Academic Press, London.

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine-cause avian fatality estimates. Journal of Wildlife Management 74(5): 1089-1096.

Smallwood, K. S. 2013. Comparing bird and bat ratality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37(1): 19-33.

Therneau, T. 2015. _A Package for Survival Analysis in S. version 2.38, <URL: http://CRAN.R-project.org/package=survival>.

Therneau, T.M. and P. M. Grambsch 2000. Modeling Survival Data: Extending the Cox Model. Springer, New York. ISBN 0-387-98784-3.

Western Ecosystems Technology (WEST), Inc. 2014. Bird and bat conservation strategy, Desert Sunlight Solar Farm Project, Riverside County, California. 57 pp.

Wheelwright, N. T. and J. D. Rising. 2008. Savannah sparrow (*Passerculus sandwichensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/045 doi:10.2173/bna.45

Appendix A. Detailed Areas of Standardized Searches and Carcass Locations along the Generation Tie Line of the Desert Sunlight Solar Farm Project during Spring 2015

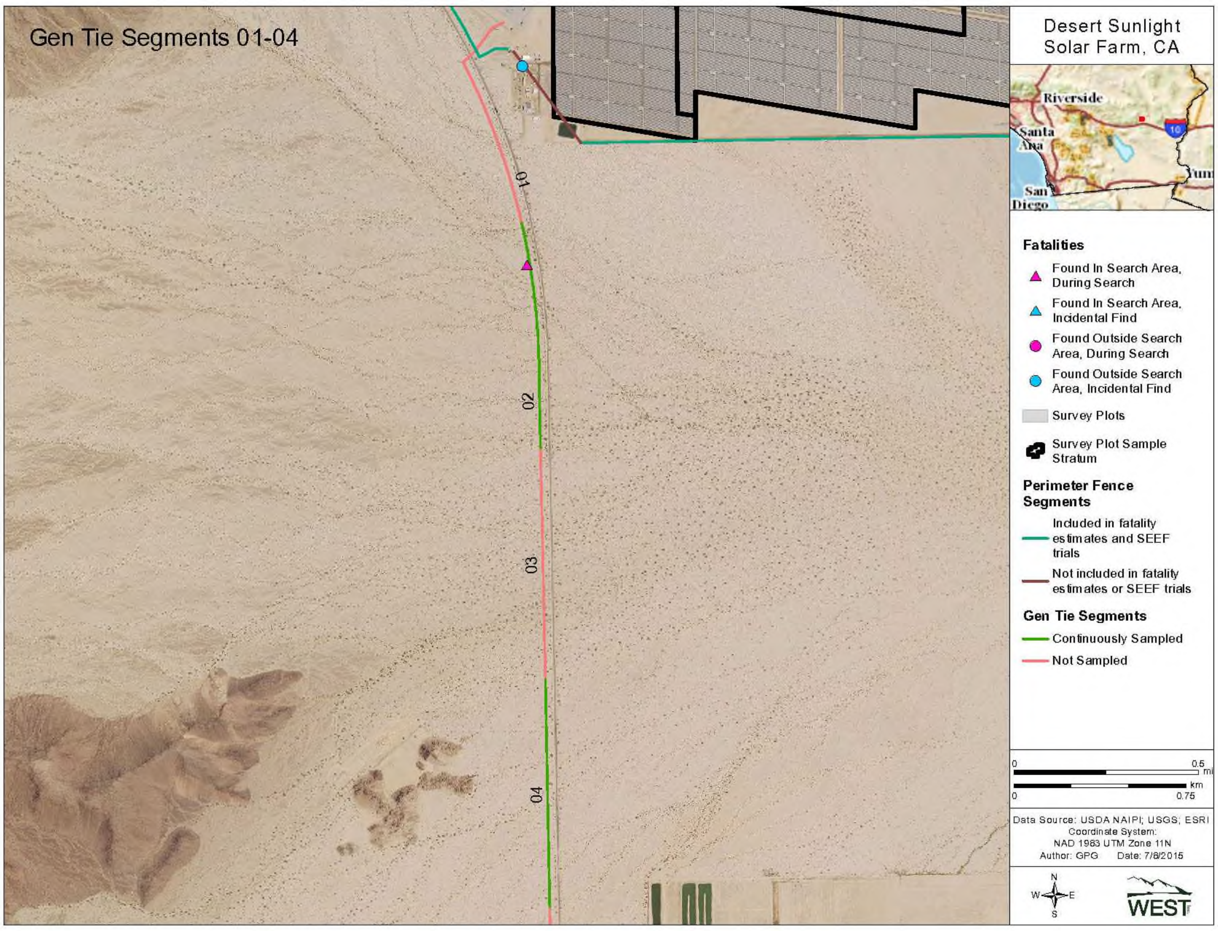


Figure A-1. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015.

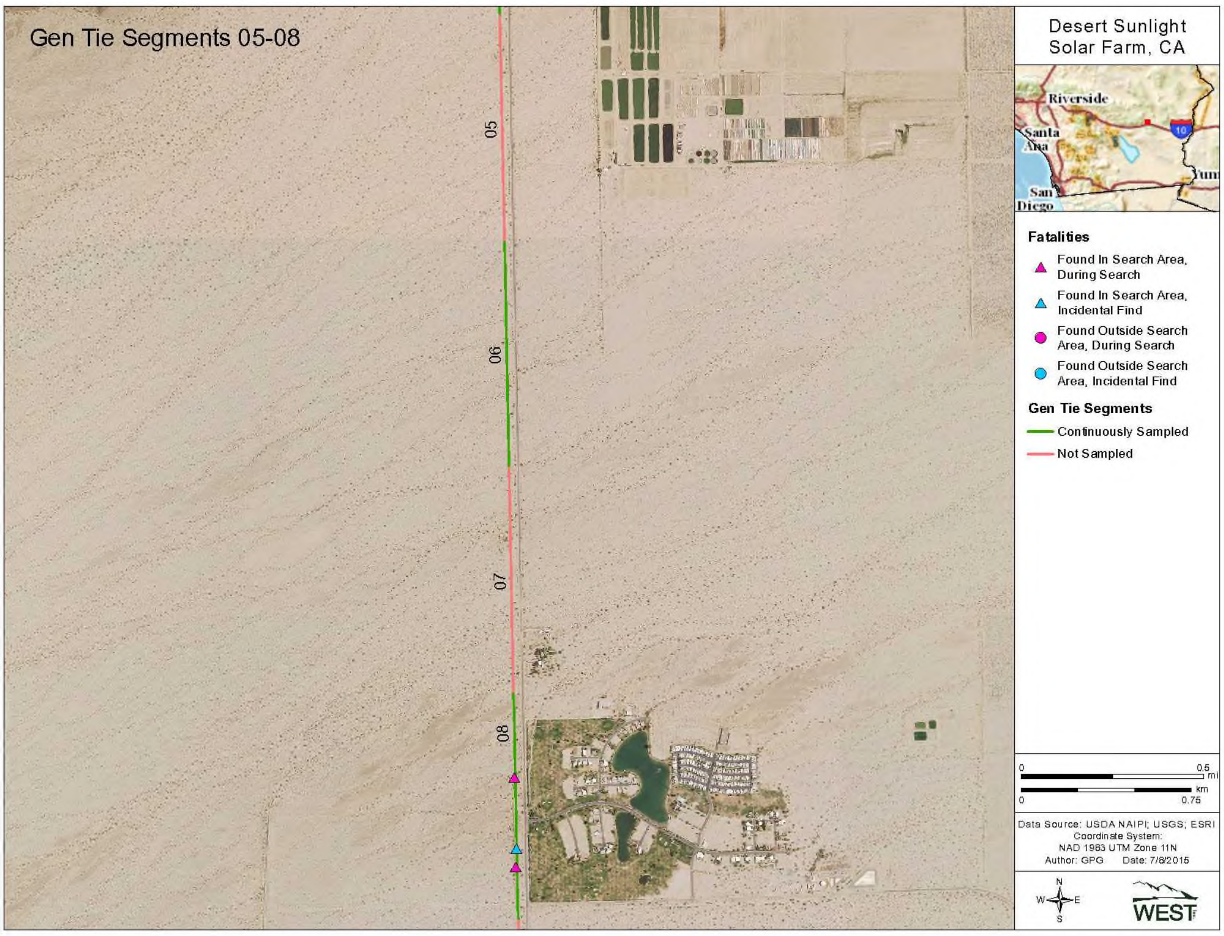


Figure A-2. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015.

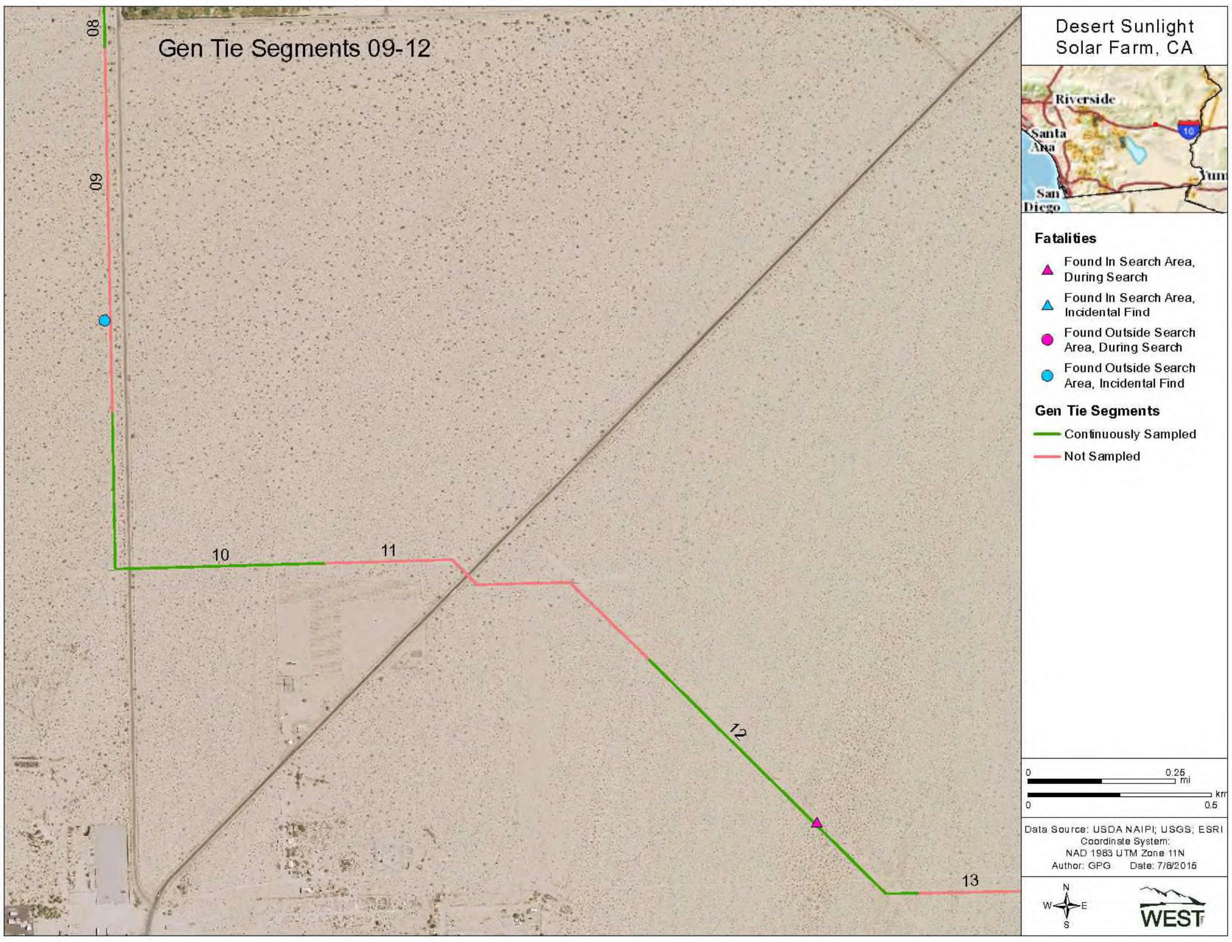


Figure A-3. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015.

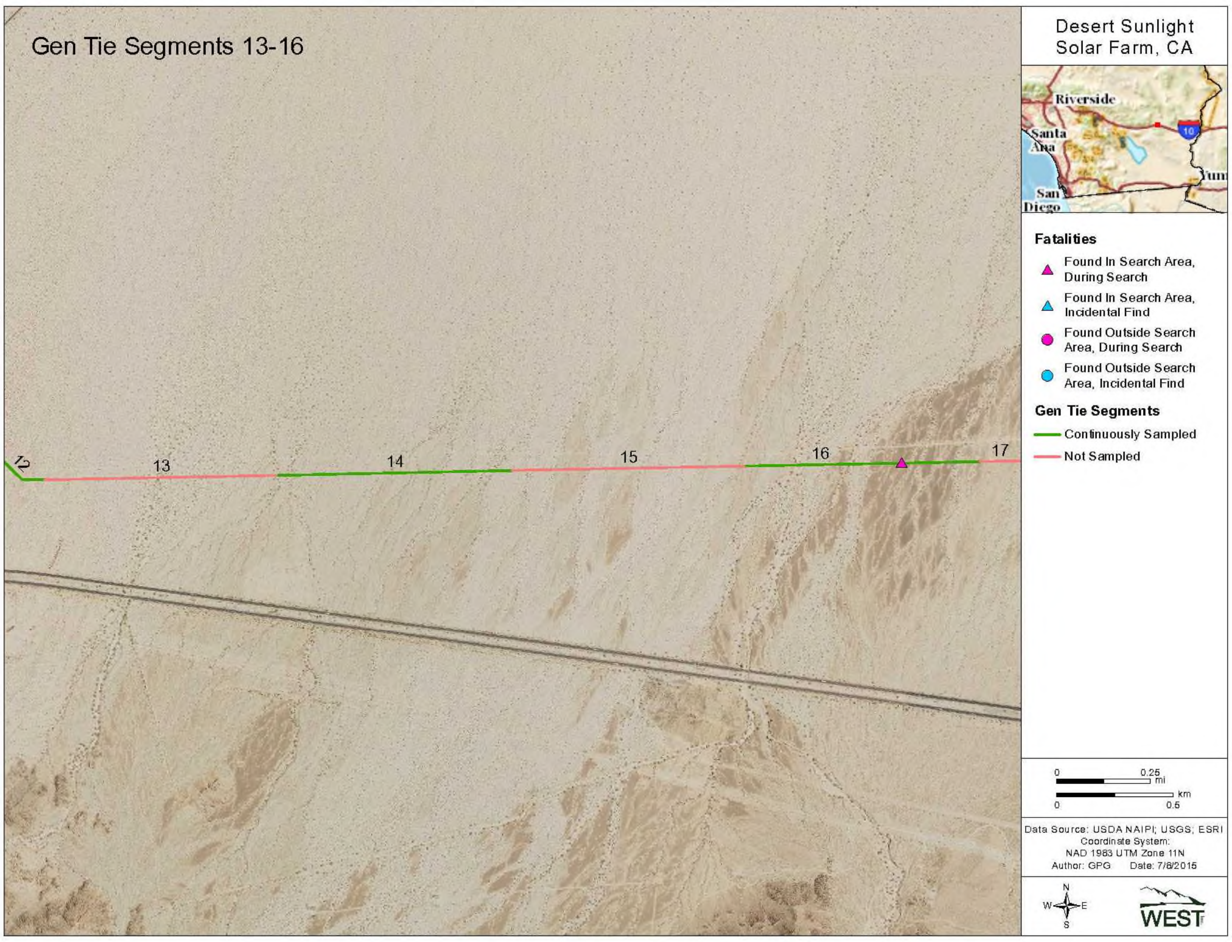


Figure A-4. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015.

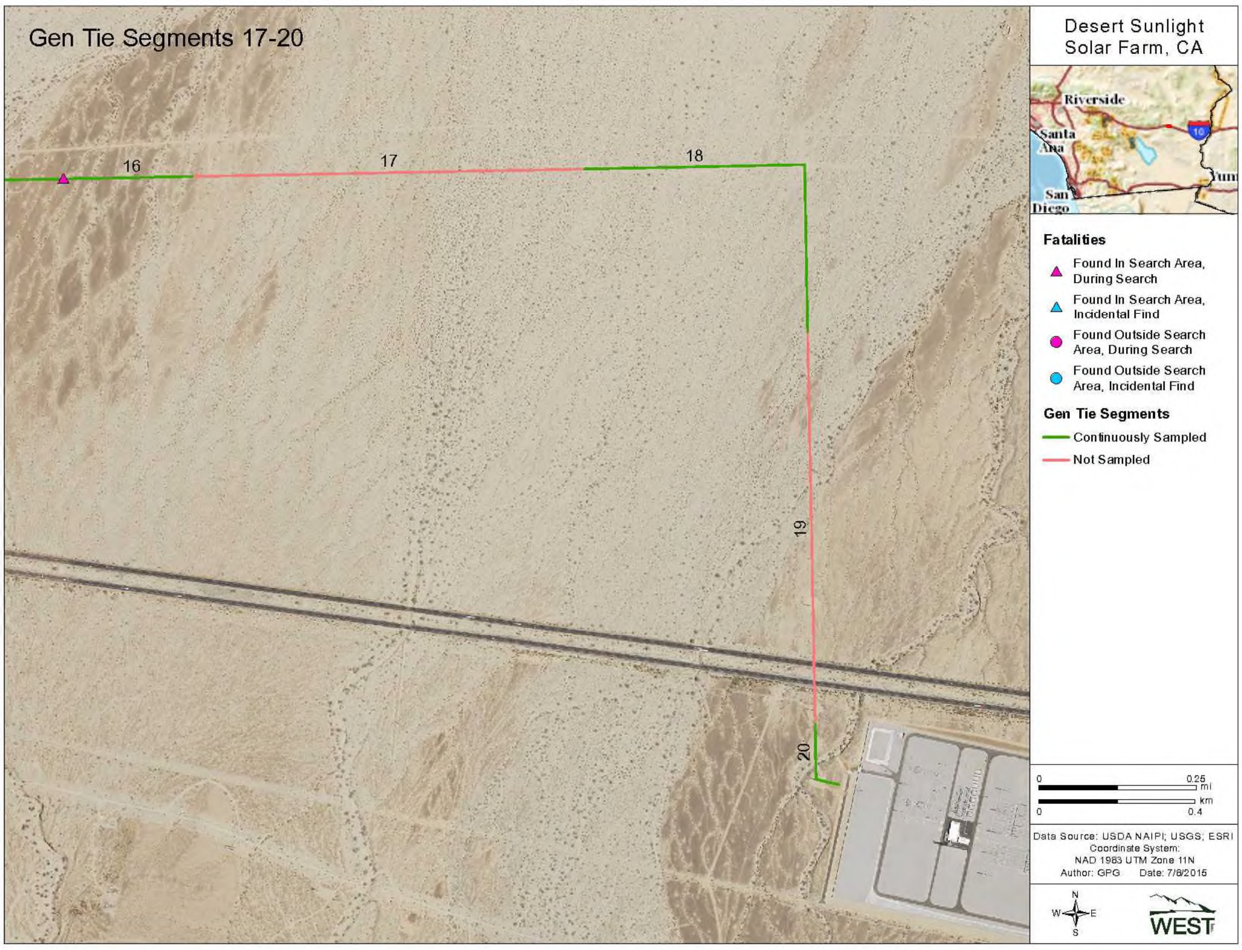


Figure A-5. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015 .

Appendix B. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during Spring 2015

Table B-1. Weather conditions and body weights associated with avian detections estimated to be less than 24 hours old during spring 2015 at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hrs)	Species	Weight (g)	Weather Summary for Preceding 24 hrs
040715-TOWA-13-27A-MVOH-1	4/7/2015	8-24hrs	Townsend's warbler		
043015-WIWA-GENTIE-08-1	4/30/2015	8-24hrs	Wilson's warbler		TEMP HIGH 97 DEGREES, 2-5 PM OVERNIGHT LOW WAS 67 DEGREES, WINDS < 10 MPH
042215-WWDO-FENCE-NORTH-15-1	4/22/2015	8-24hrs	white-winged dove		TORNADO
042215-WWDO-18-19A-MVOH-1-1	4/22/2015	8-24hrs	white-winged dove		
050715-WETA-GENTIE-12-1	5/7/2015	8-24hrs	western tanager		
051915-WEWP-O&MBUILDING-1	5/19/2015	0-8hrs	western wood-pewee	7	CLEAR OVERNIGHT, RELATIVELY CALM WINDS, MAX 8MPH

Appendix C. Correction Factors and Bird Fatality Rates at the Desert Sunlight Solar Farm Project during Spring of 2015.

Table C-1. Correction factors, observed carcass counts, and estimated bird fatality rates at the Desert Sunlight Solar Farm Project during spring (March – May) 2015. Note that fatality estimators of the type used here are unreliable when sample sizes are small, so the point estimates and confidence intervals presented for the adjusted fatality rates should be interpreted with extreme caution. *Distribution of easy and difficult visibility on the generation-tie line was about 70% and 30%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero. ***Adjusted fatality estimates are weighted to account for variable area adjustmentsdue to disruption of sample units by a tornado.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Proportion of area searched by component								
Gen-tie line	0.479	-	0.479	-	0.479	-	0.479	-
Fence	0.744	-	0.744	-	0.744	-	0.744	-
Solar arrays: weeks 1 - 7	0.295	-	0.295	-	0.295	-	0.295	-
Solar arrays: weeks 8 - 10	0.282	-	0.282	-	0.282	-	0.282	-
Solar arrays: weeks 11 - 12	0.295	-	0.295	-	0.295	-	0.295	-
Searcher efficiency by component and visibility class								
Gen-tie line: Easy vis.*	0.583	0.417 - 0.750	0.952	0.857 - 1.000	0.8	0.600 - 1.000	0.583	0.417 - 0.750
Gen-tie line: Difficult vis.*	0.435	0.261 - 0.609	0.706	0.529 - 0.882	0.6	0.300 - 0.800	0.435	0.261 - 0.609
Gen-tie line: Weighted avg.*	0.539	0.419 - 0.665	0.878	0.794 - 0.947	0.74	0.570 - 0.880	0.539	0.419 - 0.665
Fence	0.793	0.690 - 0.897	1	1.000 - 1.000	0.9	0.700 - 1.000	0.793	0.690 - 0.897
Solar arrays	0.596	0.505 - 0.671	0.872	0.786 - 0.953	0.977	0.931 - 1.000	0.596	0.505 - 0.671
Average probability of carcass persistence to the next search								
Gen-tie line	0.29	0.192 - 0.387	0.714	0.520 - 0.852	0.724	0.529 - 0.849	0.29	0.192 - 0.387
Solar arrays & fence	0.536	0.470 - 0.610	0.824	0.678 - 0.917	0.935	0.881 - 0.978	0.536	0.470 - 0.610
Carcass counts by component								
Gen-tie line	3	1 - 5	2	0 - 4	0	-	1	0 - 3
Fence	0	-	1	0 - 2	0	-	0	-
Solar arrays	2	0 - 4	2	0 - 5	2	0 - 5	1	0 - 3
Average Probability of Carcass Availability and Detected (Searcher efficiency * average probability of carcass persistence)								
Gen-tie line	0.156	0.094 - 0.222	0.627	0.455 - 0.761	0.536	0.357 - 0.690	0.156	0.094 - 0.222
Fence	0.425	0.350 - 0.515	0.824	0.678 - 0.917	0.842	0.664 - 0.967	0.425	0.350 - 0.515
Solar arrays	0.319	0.259 - 0.378	0.719	0.585 - 0.835	0.914	0.847 - 0.970	0.319	0.259 - 0.378
Adjusted Fatality Estimates (Fatalities /Season; values in italics are considered unreliable due to low counts of carcasses: carcass count / (proportion of area searched * Average								

Table C-1. Correction factors, observed carcass counts, and estimated bird fatality rates at the Desert Sunlight Solar Farm Project during spring (March – May) 2015. Note that fatality estimators of the type used here are unreliable when sample sizes are small, so the point estimates and confidence intervals presented for the adjusted fatality rates should be interpreted with extreme caution. *Distribution of easy and difficult visibility on the generation-tie line was about 70% and 30%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero. ***Adjusted fatality estimates are weighted to account for variable area adjustmentsdue to disruption of sample units by a tornado.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Probability of Carcass Availability and Detected)**								
Gen-tie line	*40.1*	*4.3 - 107.2*	*6.7*	*0.5 - 8.6*	0	-	*13.4*	*(1) - 22.1*
Fence	0	-	*1.6*	*1.6 - 3.5*	0	-	0	-
Solar arrays***	*21.2*	*9.3 - 23.5*	*9.4*	*4.9 - 16.2*	*7.6*	*(2) - 26.7*	*10.6*	*(1) - 20.1*
Facility	*61.3*	*20.1 - 121.6*	*17.7*	*12.4 - 22.8*	*7.6*	*(2) - 26.7*	*24*	*(2) - 38.1*

Post-Construction Monitoring at the Desert Sunlight Solar Project Riverside County, California

2015 Summer Quarterly Interim Report

Prepared for:

Desert Sunlight 250, LLC and
Desert Sunlight 300, LLC
700 Universe Blvd.,
Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.

415 West 17th Street, Suite 2000
Cheyenne, Wyoming

February 2, 2016 rev. 2

Draft Pre-Decisional Document – Business Confidential

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from June 01 to August 30, 2015 (the reporting period) at Desert Sunlight Solar Farm Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). For logistical reasons, fall monitoring began on Monday, August 31, 2015. Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the second seasonal report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS. This report and the other interim quarterly reports are considered preliminary summaries of data and information for the seasonal monitoring periods. Final information from all four quarterly monitoring periods will be included in a comprehensive final annual report.

Included in this report are data from standardized carcass searches conducted during the summer season at the Project, defined as June 01 to August 30, 2015. Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 29.5% sample of solar photovoltaic (PV) panels, 2) along inner portions of the fenceline, resulting in 74.4% of the length of the perimeter fence, and 3) along 47.9% of the total length of generation-tie (gen-tie) line from the Project fence to the Red Bluff Substation located south of Interstate 10 (I-10). Searches conducted within the summer season had intervals of approximately 21 days.

All bird and bat fatalities and injuries that were discovered by observers, referred to as "detections" in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, 15 avian detections were made, and there were no detections of bats.

According to specifications of the BBCS, avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were applied to a fatality estimator model (Huso 2010) to provide a preliminary estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias. The estimate is considered preliminary because the annual report may pool information from bias trials and other data across seasons which could affect seasonal estimates.

During the reporting period, carcass persistence was influenced by carcass size and Project component. Small carcasses (0-100 g) in the arrays and along the fence (combined) had a 63% chance (90% confidence interval [CI]: 48 – 76%) of persisting through the effective search interval, medium carcasses (101 – 999 g) had a 73% (55 – 86%) chance, and large carcasses (1000+ g) had a 100% chance because no removal was observed. Mean removal time within the arrays for small and medium carcasses was 15.5, and 19.2 days, respectively; median removal time for small and medium carcasses was 11.5, and 22.5 days, respectively; mean and median removal times were not estimated for large carcasses because no removal was observed. Along the generation tie-line, chances of persistence for small, medium, and large carcasses were 22% (14 – 26%), 60% (37 – 74%), and 22% (14 – 26%), respectively; mean removal time for small, medium, and large carcasses was, 1.4, 14.8, and 0.9 days, respectively; median removal time for small, medium, and large carcasses was, 0.5, 15.8, and 0.5 days respectively. The difference in carcass removal times between Project components is likely because scavengers occur in higher densities outside the perimeter fence.

Within the solar arrays, searcher efficiency averaged over all searchers and seasons (n = 180) was influenced by carcass size: 60.0% for small birds, 86.6% for medium birds, and 98.1% for large birds. Along the fence in summer (n = 30), searcher efficiency ranged from 87.5% to 100% depending on carcass size class. Along the generation tie-line in summer (n = 55), searcher efficiency ranged from 43.5% to 100%.

Composition of detections during summer 2015 included eight avian guilds. Corvids comprised the majority of detections (n = 3): there were two detections each within the doves/pigeons, rails/coots, and waterbirds/waterfowl guilds. No bats have been detected since monitoring began at the Project.

Using the Huso (2010) fatality estimator model, modified to accommodate a distance-sampling approach to the estimation of searcher efficiency, during summer 2015, there were an estimated total 148 carcasses (90% CI: 10 – 365) at the Project. Of these, 44 carcasses (27.5%; 90% CI: 8 – 64) were estimated for the solar arrays and 104 carcasses (66.9%; 90% CI: 2 – 339) were estimated for the gen-tie line. While we are required to report the gen-tie estimates per the approved BBCS, these estimates are not reliable due to the high rates of scavenging that were observed during the limited trials at the gen-tie and the low number of carcasses detected (n = 2 in the fatality analysis). No carcasses were estimated for the perimeter fenceline because there were no detections made along the fence. All of these estimates should be interpreted with caution because variance estimates are in general unreliable when carcass counts are low (< 5 per category). The TAG has asked for both the estimates and confidence intervals for this project with the appropriate caveat added. There were an estimated 0.017 fatalities per acre (within the solar field only; 44 estimated carcasses/2,585 acres) and an estimated 0.08 fatalities per nameplate MW (44 estimated carcasses/550 MW) within the solar field.

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Tracey Johnson	Research Biologist
Lacey Jeroue	Statistician
Paul Rabie	Statistician
Pamela Bullard	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2016. Post-construction monitoring at the Desert Sunlight Solar Farm Project, Riverside County, California. 2015 Summer Quarterly Interim Report. 25 pp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Project Background

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC (collectively, Desert Sunlight) constructed and operates the Desert Sunlight Solar Farm Project (referred to in this report as "Project"), which consists of two main components: 1) a 550-megawatt (MW) photovoltaic (PV) generating facility; and 2) a 220-kilovolt (kV) generation interconnection (gen-tie) line. The Project comprises approximately 1,700 hectares (ha; 4,200 acres) of land administered by the Bureau of Land Management (BLM) six miles north of Desert Center in Riverside County, California (Figure 1).

1.2 Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (2014; “BBCS”) was prepared by the Project proponent in collaboration with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and BLM to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency approval of the BBCS occurred in December 2014. Amendments to the sampling protocol along some portions of the Project fenceline were made by Desert Sunlight and approved by the BLM on February 11, 2015.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Desert Sunlight in collaboration with the USFWS, CDFW, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the gen-tie line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
3. Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

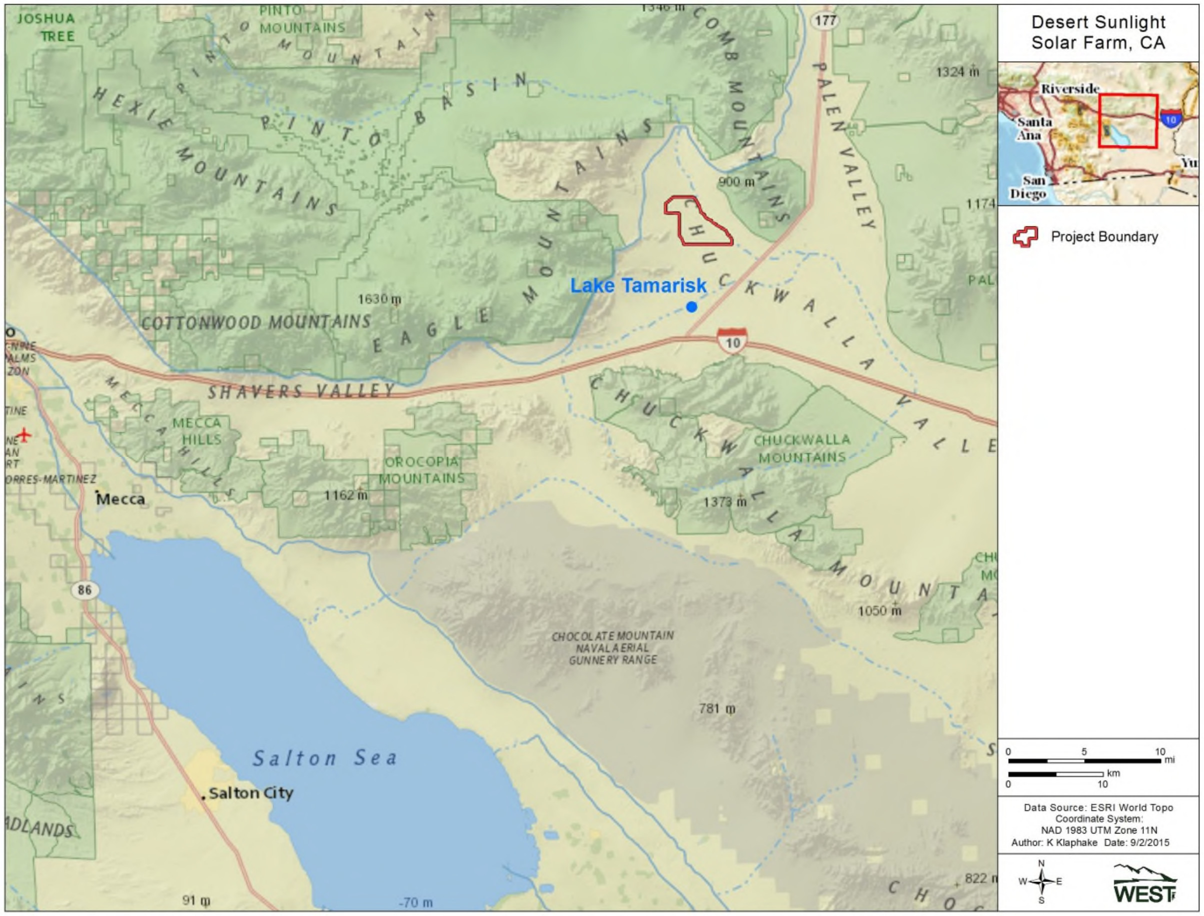


Figure 1. Desert Sunlight Solar Farm Project vicinity map, Riverside County, California.

1.3 Purpose of This Report

This report represents the second seasonal report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS. This report and the other interim quarterly reports are considered preliminary summaries of data and information for the seasonal monitoring periods. Final information from all four quarterly monitoring periods will be included in a comprehensive final annual report. This report covers the period June 01 to August 30, 2015, or the 2015 summer season. For logistical reasons, fall monitoring began on Monday, August 31, 2015. All carcasses and injuries that were discovered by observers are referred to as "detections" in this report. As stated in the approved BBCS, this seasonal report includes the observed detections for likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and suspected causes of death. Species composition of detections and the results of the bias trials are also reported. This report presents information related to the spatial distribution of detections, but no formal statistical analysis of the spatial distribution of carcasses will be conducted until the end of the monitoring year, given the limited data presently available.

2.0 METHODS

The BBCS describes the methods by which monitoring and certain analyses, including compilation of the overall fatality estimate, will occur. Below is an abridged description (see BBCS for detailed methods).

2.1 Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. Dead or injured birds and bats are called detections in this report to provide consistency in naming. This section also describes the methods for conducting carcass removal and searcher efficiency trials; how data were reported and analyzed; and the methods for producing fatality estimates for the Project.

2.1.1 *Areas Surveyed*

Standardized carcass searches were conducted at sampling units, which include the solar arrays (Table 1, 2; Figure 2); the “fenceline” defined as the perimeter fence for the Project (Table 1, Figure 2); and the gen-tie line (from the Project fence to the Red Bluff Substation on the south side of I-10; Table 1, Figure 3). Some overhead lines co-occur with solar arrays (medium voltage overhead lines [MVOH]). The MVOH were part of standardized carcass searches to the extent that they co-occured with solar arrays included in the sample (Table 2; Figure 2).

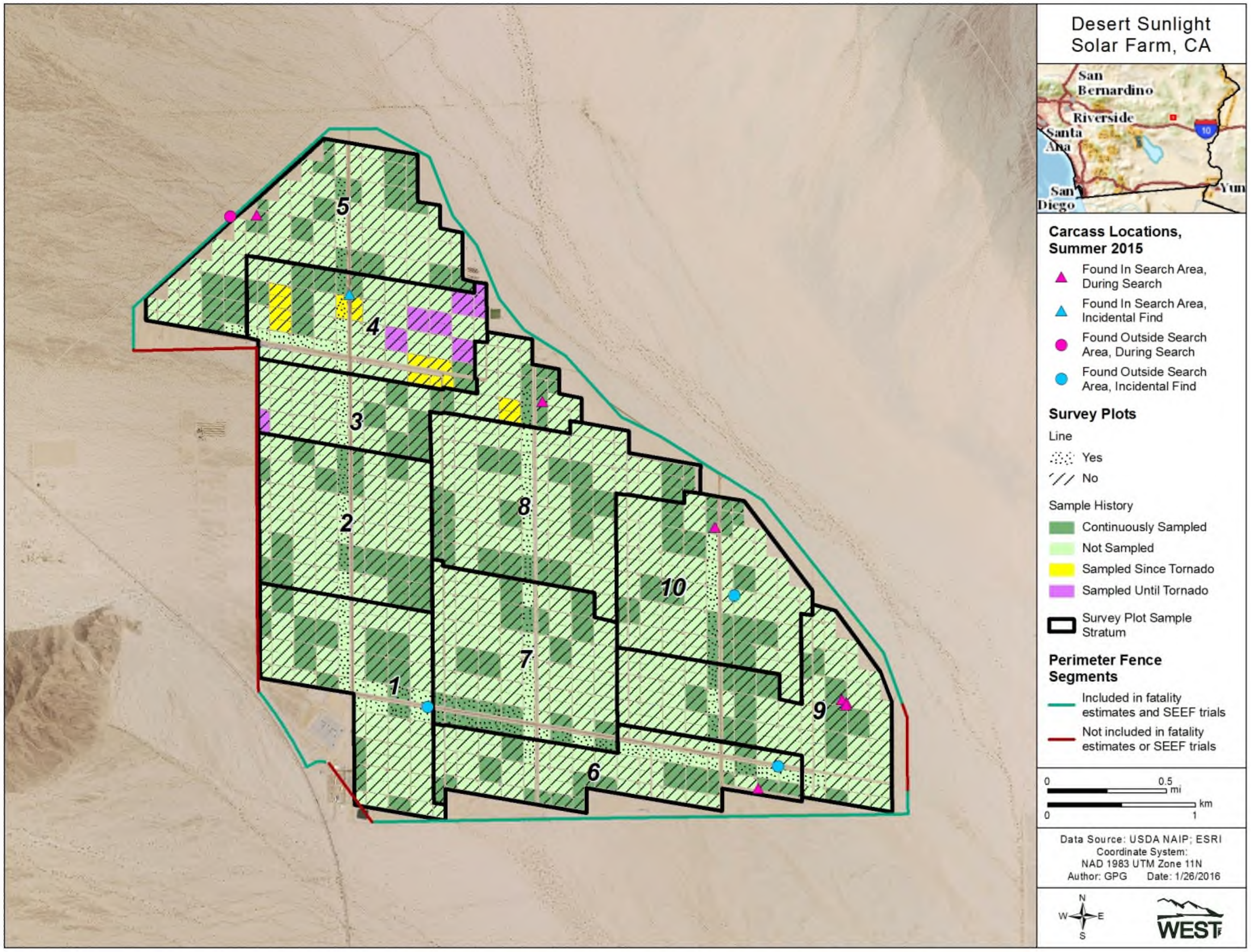
Table 1. Areas included in standardized carcass searches at the Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

Project Component	Total Size	Units	% of Component Searched
Solar arrays	1045.9	Hectares	29.5[1]
Fence	16.7	Kilometers	99.0[2]
Gen-tie line	19.2	Kilometers	47.9[3]

[1] Percent area that was searched in summer 2015. Slightly less than 30% total because of unequally-sized arrays.

[2] 74.4% of the fence is fully accessible and surveyed following the standard protocol, while approximately 25% of the fence is surveyed from a distance. Fatality rates estimated for sections of the fence that are sampled were extrapolated to sections of the fence where the standard monitoring protocol cannot be used, as described in section 4.2.6 of the approved Desert Sunlight BBCS. A very short segment near the gate is not sampled due to restoration activities.

[3] 52.1% of the gen-tie will be sampled in 2016.



Data Source: USDA NAIP; ESRI
Coordinate System:
NAD 1983 UTM Zone 11N
Author: GPG Date: 1/26/2016

Figure 2. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at the solar field, fence, and overhead lines within the fence at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

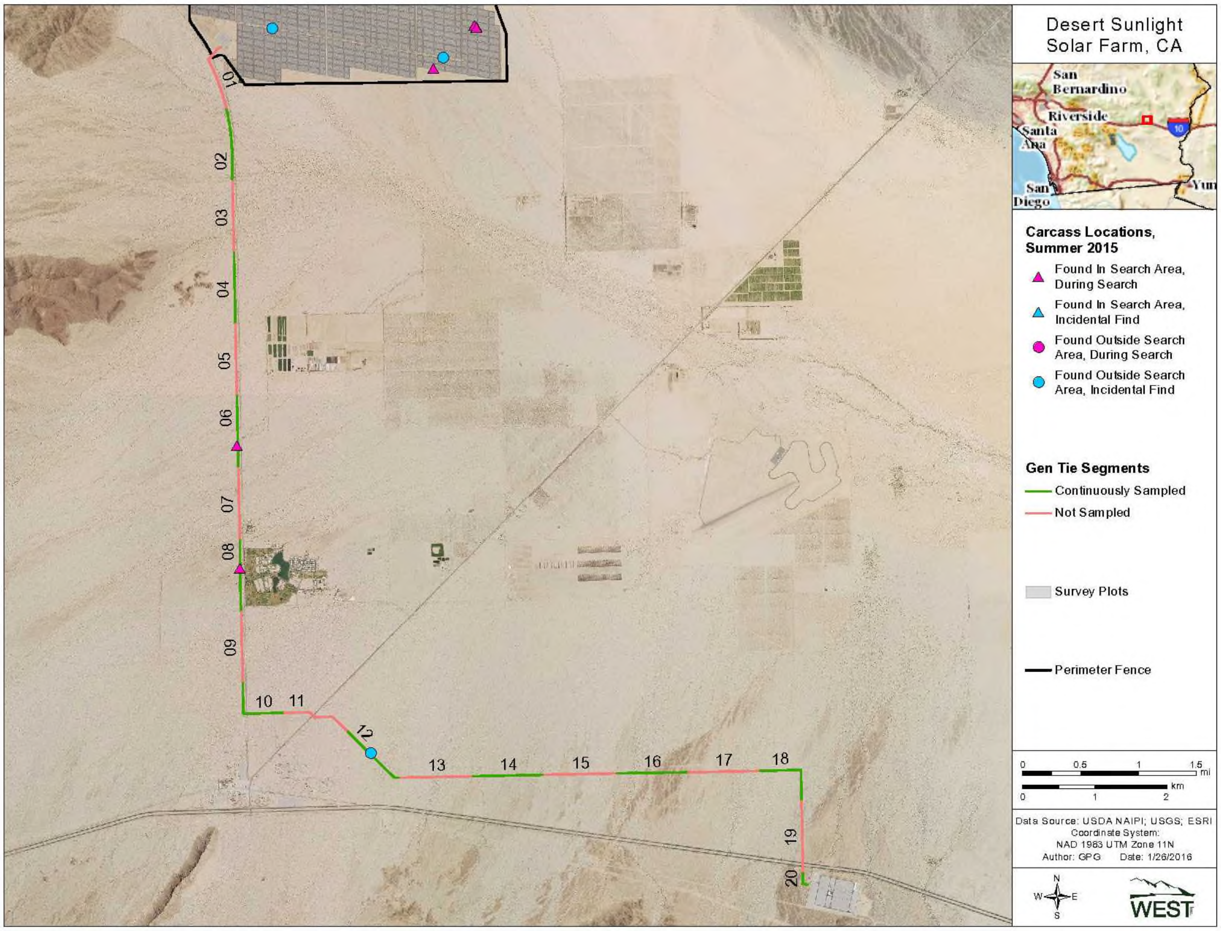


Figure 3. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance activities) along the generation tie line at the Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015. Detailed maps of detections along the line are presented in Appendix A.

To ensure a balanced distribution of sample units in the solar field (defined as the collection of all photovoltaic [PV] solar panels), the entire field was divided into ten strata, and individual sampling units were randomly selected within each stratum to compose an approximately 30% sample. This sampling design ensures that units included in the sample were not spatially clumped within the solar field. The solar field consists of arrays of solar panels (referred to as a solar array) that are either 70-m or 140-m wide. The sample includes 133 of each type of array. There are 2,580 70-m rows, and 3,900 140-m rows in the sample.

2.1.1 *Search Frequency and Timing*

Standardized searches occurred during the summer survey season, which includes the period from June 01 through August 30, 2015. All project components included in standardized searches were surveyed four times during summer. All searches took place during daylight hours from 05:40 to 14:08.

As specified in the approved Desert Sunlight BBCS, the average search interval for all Project components included in standardized carcass searches during summer was 21.0 days (median 21.0 days). Slight variation in search interval was anticipated due to weather and logistical delays.

Table 2. Area and proportion of solar arrays that are and are not associated with overhead lines at the Desert Sunlight Solar Farm Project, Riverside County, CA.

	Line-associated[1]	Not line-associated	Proportion line-associated
Entire facility	89.4 ha	956.5 ha	0.09
Standardized searches	32.2 ha	291.0 ha	0.10

[1] Line-associated area was estimated as the area of any array that fell within the 30-m strip transect below the MVOH.

2.1.2 *Search Methods*

Standardized carcass searches were performed by BLM-approved biologists, in accordance with methods outlined in the BBCS.

Within the solar field, arrays of solar panels were surveyed by observers traveling on foot. A distance sampling approach was used, whereby biologists slowly walked a transect line along the ends of rows of solar panels in a direction perpendicular to the rows, searching ahead and to the side within the array for bird and bat detections. Biologists scanned out to a maximum perpendicular distance of approximately 70 m from the transect. Biologists carried binoculars to allow them to verify the presence of a detection versus rocks or vegetation. Once a detection was confirmed, the distance of the detection to the transect line was estimated using laser range finders. Each array included in the sample was searched by observers walking two transects – one on the west side and one on the east side of the array with observers looking toward the center of the array.

As soon as a carcass was detected, it was photographed, and data were recorded according to specifications outlined in section 7.2.5 of the approved Desert Sunlight BBCS. Carcasses were then immediately retrieved from their location on the ground, labeled, and placed in a freezer on site.

Most (74.4%) of the length of fenceline (approximately 10 miles) was searched from a vehicle using the standard protocol (Figure 2). Biologists searched a 6-m wide strip transect centered on the fence from the inner perimeter. Travel speed was below five miles per hour (mph) while searching. Some sections along the fence cannot be driven close to the fence line. The fence line along the western edge of the Project is drivable but the road is approximately 15 m away from the fence and the road and fence are separated by a drainage ditch. The fence along this section is covered with a tan tarp and trees and shrubs have been planted to reduce visibility of the project from the west. Additions of vegetation and the tarp likely reduce potential for bird collision with the fence. This section of the fence was driven to document carcasses, but detections along this portion of the fence are not included in adjusted fatality estimates because detection rates are likely very low. As specified in section 4.2.6 in the approved Desert Sunlight BBCS, we assume that fatality rates are similar between the portion of fence that was searched and the portion that was not. A separate section of the fence in the southeastern corner of the Project cannot be driven because the eastern edge of the berm that bounded construction ponds is too narrow for a vehicle. Along this portion of the fence, the observer stopped at both north and south ends of the berm and used binoculars to search for carcasses. Finally, the road along a portion of the southwest fence line near the entrance gate is approximately 30 to 50 m from the road and is separated from the fence by an area that has recently undergone vegetation restoration. This area was eliminated from sampling. Fatality rates estimated for sections of the fence that were sampled were adjusted to account for the proportion of fence not sampled with the standard monitoring protocol, as specified in section 4.2.6 of the approved Desert Sunlight BBCS.

The gen-tie line was searched using a 30-m wide strip transect (i.e., 15 m of ground on either side of the overhead line). Sample units along the gen-tie line were chosen by dividing the total length of line from the Project fence south to the Red Bluff Substation just south of I-10 into 1-km segments. Thus, a 47.9% sample of the total length of the line was searched (Figure 3). Biologists slowly walked every other 1-km segment of the line, meandering the width of the strip transect, scanning for dead or injured birds or bats within 15 m (49.2 ft) of the overhead line.

For each detection, a suspected cause of death or injury was assigned based on evidence available from the detection, evidence available on Project infrastructure, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it cannot be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed. Detections assigned to the “unknown” category were included in fatality estimates if they were located within standardized carcass search areas, and all detections made during the summer season are reported here.

2.2 Carcass Persistence Trials

Carcass persistence trials were conducted throughout the summer period. Carcasses from three size classes (small [0-100 g], medium [101-999], and large [1000+ g]) were used for trials. The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), chukar (*Alectoris chukar*), and older coturnix quail, and the large size class comprised hen mallard (*Anas platyrhynchos*) and hen ring-necked pheasant (*Phasianus colchicus*).

2.2.1 *Carcass Persistence Data Collection*

To quantify carcass persistence rates, 15 small, 10 medium, and 5 large carcasses were randomly placed and monitored along the gen-tie line during summer 2015. Within the solar arrays and along the perimeter fence, the same numbers of each size category were placed, for a total of 60 carcass persistence trials at Desert Sunlight during the summer season, as specified in the approved Desert Sunlight BBCS. By placing carcasses inside (within arrays and along inner perimeter of the fence) and outside (along the gen-tie) the project fence, the possibility that there are different carcass persistence rates inside and outside the project fence is accounted for. Fifteen carcasses within the Project fence (within solar arrays and along the fence) were monitored using motion-triggered digital trail cameras, while the remaining carcasses were visited on foot, for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality. No carcasses along the gen-tie line were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as “feeding stations”, trail cameras were installed five days before specimens were placed, and two fake cameras without bias trial carcasses were also placed within the Project fence and periodically moved to new locations within the fence. Periodic ground-based checking of carcasses with trail cameras also occurred to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera’s field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire Project, not just in areas subject to standard searches, and trials were initiated in smaller numbers on three different dates throughout the summer season.

2.2.2 *Estimating Carcass Persistence Times*

Carcass persistence trials were checked daily during the first four days and then every three to five days until the 30-day trial length was reached. Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g. days a carcass is present before being removed) may not be known exactly, but is known to be within a finite range. For example, suppose a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass became unavailable at some point between 7 and 10 days. This carcass would be considered “interval censored”. Similarly, if a carcass lasts the entire 30-day trial period, that carcass is “right censored”— it is known that the carcass lasted at least 30 days, but it may have persisted longer. Because carcass persistence data were censored, persistence was analyzed using methods that can accommodate censored data and still produce unbiased estimates of the probability of persistence (Therneau 2015, Therneau and Grambsch 2000). It is beyond the scope of this document to provide statistical foundations of censored-data survival models but functions identical to those provided with the USGS-developed fatality estimator software (Huso et al 2012) were used to fit survival models to the censored carcass persistence data, and some background is available in the documentation provided with that software.

The USGS software used to estimate carcass persistence calculates the period over which there is less than a 1% chance for a carcass to persist. The 'effective search interval' is defined as the shorter of the period during which there is less than a 1% probability that a carcass persists, and the actual search interval (Huso 2010). The probability of persistence is given for the effective search interval, and the probability that a carcass persists through the actual search interval is equal to p (persist through effective search interval) * effective search interval / actual search interval.

There were four distributions implemented in survival models used to estimate the probability a carcass is unscavenged and available to be found at the end of the search interval (*r)*: exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike's Information Criterion adjusted for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model with combinations of the covariates carcass size, Project component, season, and visibility, to observed carcass persistence data.

2.3 Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the summer period. Carcasses from three size classes (small, medium, and large) were used for trials. The small size class comprised house sparrows and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons, chukar, and older coturnix quail, and the large size class comprised hen mallards and hen ring-necked pheasants.

2.3.1 *Searcher Efficiency Data Collection*

Training of biologists on the Project-specific protocol and early assessments of habitat conditions within the solar arrays suggested that the amount of cobble present in the soil may be an important factor influencing searcher efficiency. To satisfy requirements regarding consideration of visibility class per the BBCS and address the influence of cobble cover on searcher efficiency, sample units in the solar arrays and along the gen-tie were stratified by cobble cover and assigned to one of two classes (<15% and >15% cobble cover). Classes were determined by making ocular estimates of cobble cover at each sample unit and then evaluating the frequency histogram of sample units across the range of estimated cobble cover (Figure 4). A natural break point was identified at 15% cobble cover, so the same value was chosen as the break point that defined the two cobble cover classes. For most seasons, In the solar arrays, two sets of searcher efficiency trials will be conducted (one set in each cobble cover class; *n* for each class= 15 small birds, 10 medium birds, and 5 large birds as agreed upon in section 7.4 of the approved Desert Sunlight BBCS). During summer 2015, all searcher efficiency trial carcasses were inadvertently placed in the low cobble cover class, precluding any tests of the effect of cobble cover class on searcher efficiency in the solar arrays. Additional trials will be conducted in the winter period in cobble to address this oversight and small sample size. Along the gen-tie, visibility was expected to be related to vegetation and rock cover. Thus, searcher efficiency trials along the gen-tie occurred in two visibility classes (*n* for each class = 15 small birds, 10 medium birds, and 5 large birds (easy: ≥90% bare ground, vegetation <6" tall; and more difficult: <90% bare ground, vegetation ≥6" tall). Inadvertently, one large carcass was not placed and one extra small carcass was placed during summer, so total sample size for large carcasses along the gen-tie was nine, and for small carcasses was 31. Thirty searcher efficiency trial carcasses (*n* = 15 small birds, 10 medium birds, and 5 large birds) were placed along the fence in the only visibility class present on the fence (easy visibility). Thus, during summer, a total of 150 searcher efficiency trials occurred at the Project. Locations for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches.

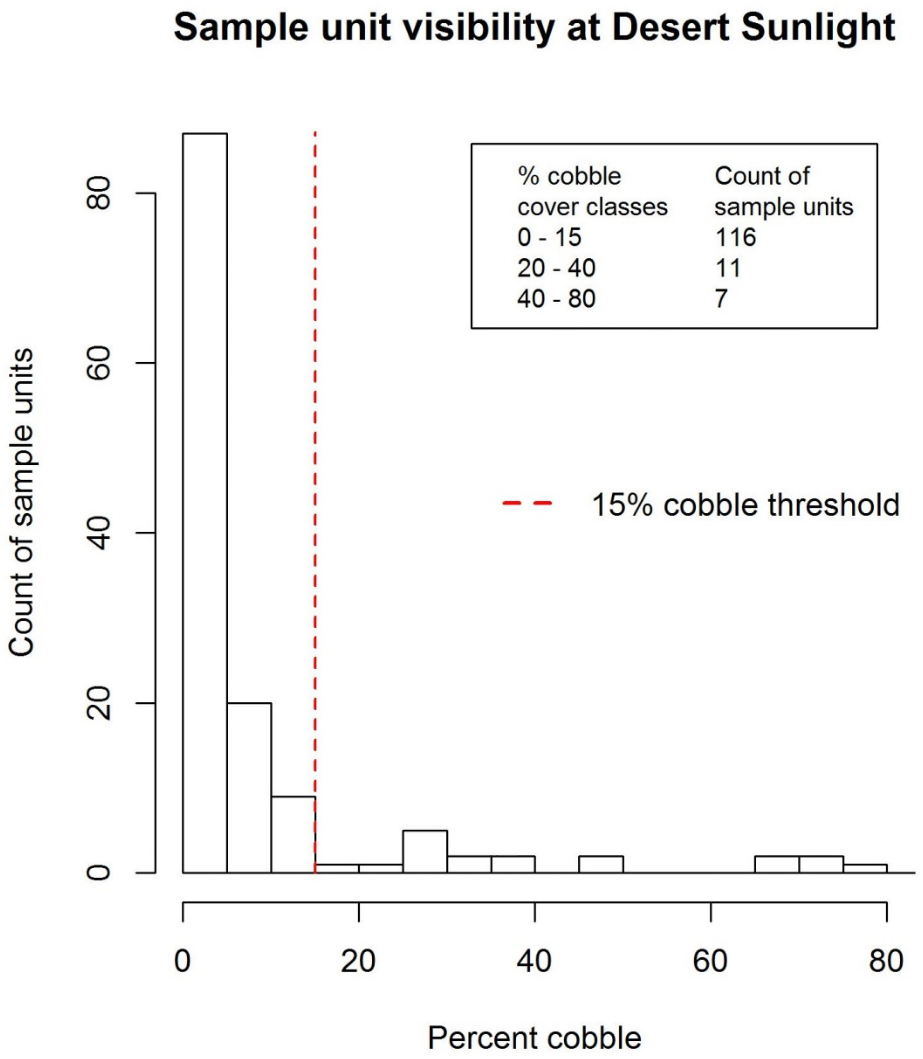


Figure 4. Frequency histogram of sample units (in the arrays only) at Desert Sunlight Solar Farm Project by estimates of cobble cover. Based on this distribution, each sample unit was assigned to one of two classes of cobble cover (<15%; >15%).

2.3.2 *Estimating Searcher Efficiency*

Searcher efficiency at Desert Sunlight was estimated separately for linear features (the project fence and the generation tie line), and the solar arrays, reflecting the different search methods used on arrays and linear features. For linear features, logistic regression models were fit to searcher efficiency data and AICc was used to compare models. Models including effects of carcass size (three classes), visibility (two classes; gen-tie only), and season were compared to each other and the null model. Model selection indicated that the most supported model included main effects of Project component, carcass size, and season. Once the most supported model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, *p*, was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from the summer 2015 season.

For the solar arrays, searcher efficiency was evaluated using a distance sampling approach (Buckland et al. 1993). Distance sampling assumes perfect detection on the transect line (at distance = 0), an assumption that is likely valid in the solar arrays given the relatively flat & vegetation-free nature of the soil surface. A curve is fitted to the observed carcass data that predicts probability of detection as a function of distance from the transect line. The mean value of this function over a specified distance, *w,* is equal to the average searcher efficiency for a transect of width *w*. The mean value of the detection curve is the integral of the detection function calculated between 0-m and the maximum survey distance (*w;* half the width of the solar array row), divided by the maximum survey distance:

$$p = \frac{\int_0^w f(x)dx}{w},$$

where f(x) is the detection function evaluated at distance, *x*.

One departure in the methods used here, relative to the methods presented in Buckland et al. (1993), was that for this study the detection function was estimated using trial carcasses, which meant that there were both presence (detected) and absence (not detected) data available to fit the detection function (Figure 5). The availability of both presence and absence data means that the detection function can be estimated using only trial carcasses whose distribution is known. Therefore the detection function, the average searcher efficiency among the arrays and the final fatality estimate within the arrays are all insensitive to the spatial distribution of carcasses within individual arrays, and the overall searcher efficiency estimate is valid even if the distribution of carcasses among the arrays is not uniform.

Distances of trial carcasses (trials both found and missed) from the transect line were used to fit a half-normal detection function for searches among the arrays (Figure 5). The half-normal detection function is a commonly used function for distance sampling surveys (Buckland et al. 1993). The detection function was fit with and without covariates (carcass size, season, or no covariates) and AICc indicated that the most supported among these models included only carcass size as a covariate.

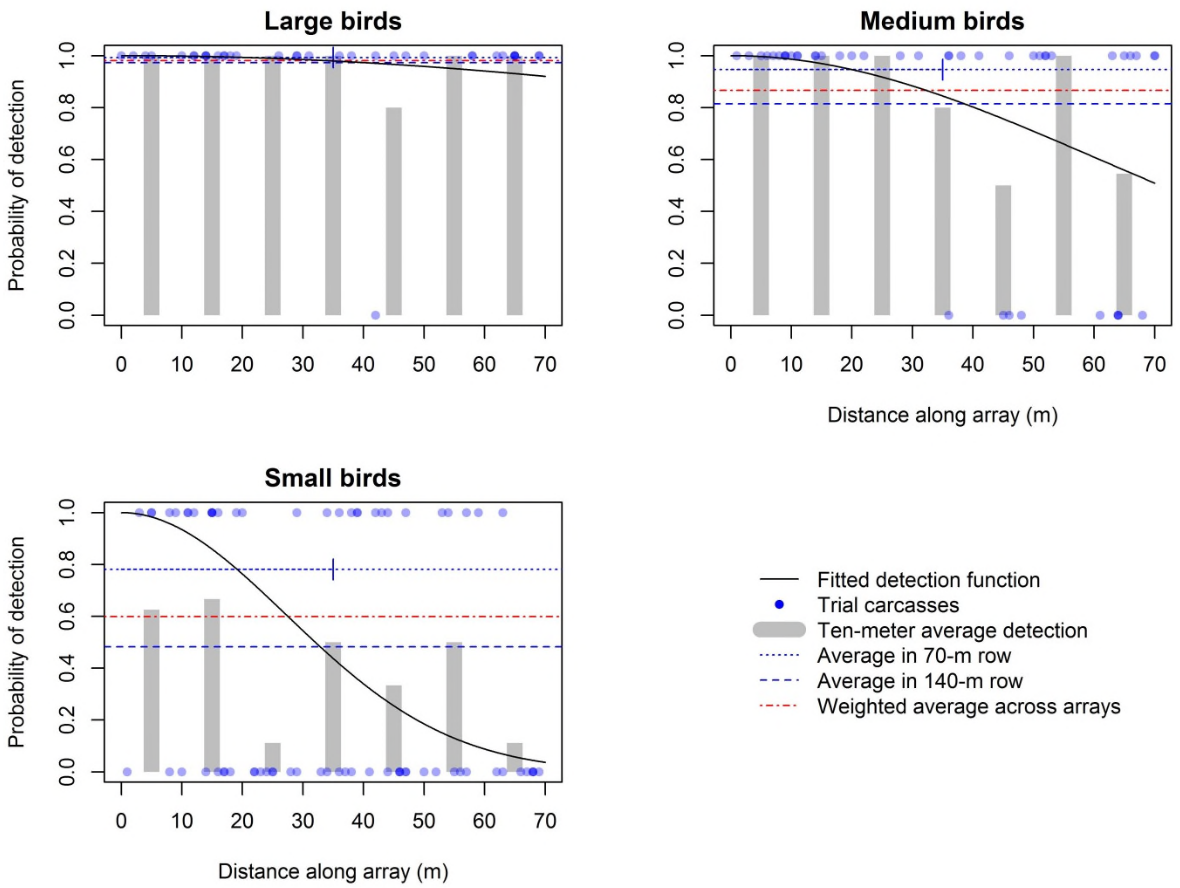


Figure 5. Estimated detection probabilities for bird carcasses by size class across all available seasons used for summer (June 01 – August 30) 2015 fatality estimates at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented.

Because the solar arrays were surveyed by searchers who walked down both sides of the rows of panels, the width of the search transect was specified as half the width of the rows of panels. For larger birds, there is almost certainly a non-zero detection probability beyond this distance but the bias that occurs by ignoring this non-zero detection probability is conservative (i.e. the searcher efficiency is underestimated). Some solar arrays have row widths of 70 m (search transect width of 35 m) and some have row widths of 140 m (search transect width of 70 m). The weighted average searcher efficiency is calculated based on the number of panel rows of each length in the survey sample:

$$p_{weighted\ average} = \frac{n_{70}}{n} \times \frac{\int_0^{35} f(x)dx}{35} + \frac{n_{140}}{n} \times \frac{\int_0^{70} f(x)dx}{70},$$

where $n_{70} = 2580$ is the number of 70-m rows in the sample, $n_{140} = 4020$ is the number of 140-m rows in the sample, and *n* is the total number of rows in the sample. Searcher efficiency was higher for the arrays with a width of 70 m, and overall searcher efficiency was estimated as a weighted average based on the proportions of 70-m arrays and 140-m arrays in the sample units.

2.4 Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots are also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie line versus cleared areas beneath solar panels). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where *F* is the total number of fatalities, *C* is the number fatalities detected and included in fatality estimation*, r* is the probability a carcass is not scavenged and available to be found at the end of the search interval, and *p* is the probability of detecting a carcass (Huso 2010). Huso (2010) describes the use of a binomial model to estimate the probability of carcass detection; in the present study, the binomial carcass detection model was used to calculate fatalities at project linear features (fence, overhead lines), and the weighted average probability of detection based on distance sampling (described above) was used to estimate probability of detection within the solar arrays.

All fatality estimates were calculated using the Huso estimator (modified to accommodate the distance-sampling based estimate of searcher efficiency in the solar arrays), as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates was used for each of the variables, including searcher efficiency (*p*), probability of a carcass persisting to the next search ($\hat{r}$), adjusted search interval and observed fatalities. From these bootstrap samples, the probability of available and detected was calculated and applied to the bootstrapped observed fatalities. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

2.5 Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by WEST avian biologists and operational personnel and were considered "incidental" detections. When found by operational personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the Desert Sunlight SPUT Avian Injury and Mortality Report Forms June – August 2015. All detections made in search areas during the reporting period were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

3.0 MONITORING RESULTS

3.1 Summary of Avian Detections

During summer 2015, a total of 15 avian detections (including incidentals) of 11 identified species were recorded (Table 3). The most common identified species was common raven (*Corvus corax*) with three detections. Most detections (n = 11, or 73.3% of total detections) occurred in the solar arrays (Figures 2 and 3; Tables 4, 5, and 6). Ten (66.7%) detections were made during standardized carcass searches and five (33.3%) were documented as incidentals. No bats were detected during the summer season. For fresh carcasses, body weights and weather conditions the preceding nights are described in Appendix B.

Table 3. Number of individual bird detections, by species, during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Common Name	Scientific Name	Migration Behavior*	Guild	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Total
common raven	*Corvus corax*	resident	Corvids	-	2	1	-	3
white-winged dove	*Zenaida asiatica*	variable	Doves/Pigeons	-	-	-	1	1
black-throated sparrow	*Amphispiza bilineata*	diurnal	Grassland/ Sparrows	-	-	-	1	1
sora	*Porzana carolina*	nocturnal	Rails/Coots	-	-	-	1	1
Virginia rail	*Rallus limicola*	nocturnal	Rails/Coots	1	-	-	-	1
house wren	*Troglodytes aedon*	nocturnal	Wrens	1	-	-	-	1
mourning dove	*Zenaida macroura*	variable	Doves/Pigeons	-	1	-	-	1
Say's phoebe	*Sayornis saya*	diurnal	Flycatchers	-	1	-	-	1
northern rough-winged swallow	*Stelgidopteryx serripennis*	diurnal	Swallows	-	1	-	-	1
unidentified bird (small)	-	-	Unidentified Birds	-	1	-	-	1
unidentified bird (unknown size)	-	-	Unidentified Birds	-	1	-	-	1
unidentified grebe	*Aechmophorus sp.*	-	Waterbirds/ Waterfowl	-	1	-	-	1
western grebe	*Aechmophorus occidentalis*	nocturnal	Waterbirds/ Waterfowl	-	1	-	-	1
Total				**2**	**9**	**1**	**3**	**15**

* See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in Birds of North America (BNA) Online (http://bna.birds.cornell.edu/bna/); where information on migration behavior was lacking in BNA accounts, Newton (2008) or Murray (2004) were used.

Table 4. Total avian detections by Project component and detection category during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. Only carcasses found within search areas were included in fatality estimates.

	Inside carcass search area		Outside carcass search area	
Project Component	**Carcass search**	**Incidental**	**Carcass search**	**Incidental**
Fence	0	0	1	0
O&M Building	0	0	0	0
Gen-tie line	2	0	0	1
Solar arrays				
Line-associated	0	0	0	2
Non-line associated	7	1	0	1

Table 5. Total avian detections (including incidentals) by Project component and suspected cause of death during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

	Suspected Cause of Death*				
Project Component	**Collision**	**Predation**	**Other**	**Unknown**	**Percent of Total**
Fence	0	0	1	0	6.7
O&M building	0	0	0	0	0
Gen-tie line	2	0	1	0	20
Solar arrays					
Line-associated	1	0	1	0	13.3
Non-line associated	1	0	5	3	60
Percent of Total	**26.7**	**0**	**53.3**	**20.0**	**100.0**

* Suspected cause of death was assigned based on evidence available on the detection, evidence available on Project infrastructure, and proximity of detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it can’t be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, in the absence of a completed necropsy, there is some uncertainy associated with cause of death assignments because no events were directly observed.

3.2 Temporal Patterns of Avian Detections

The number of detections recorded daily during the reporting period ranged from zero to three (Figure 6). One detection was found per day with the exception of June 24 when three detections occurred. The number of detections per day represents those discovered during standardized carcass searches and incidentally.

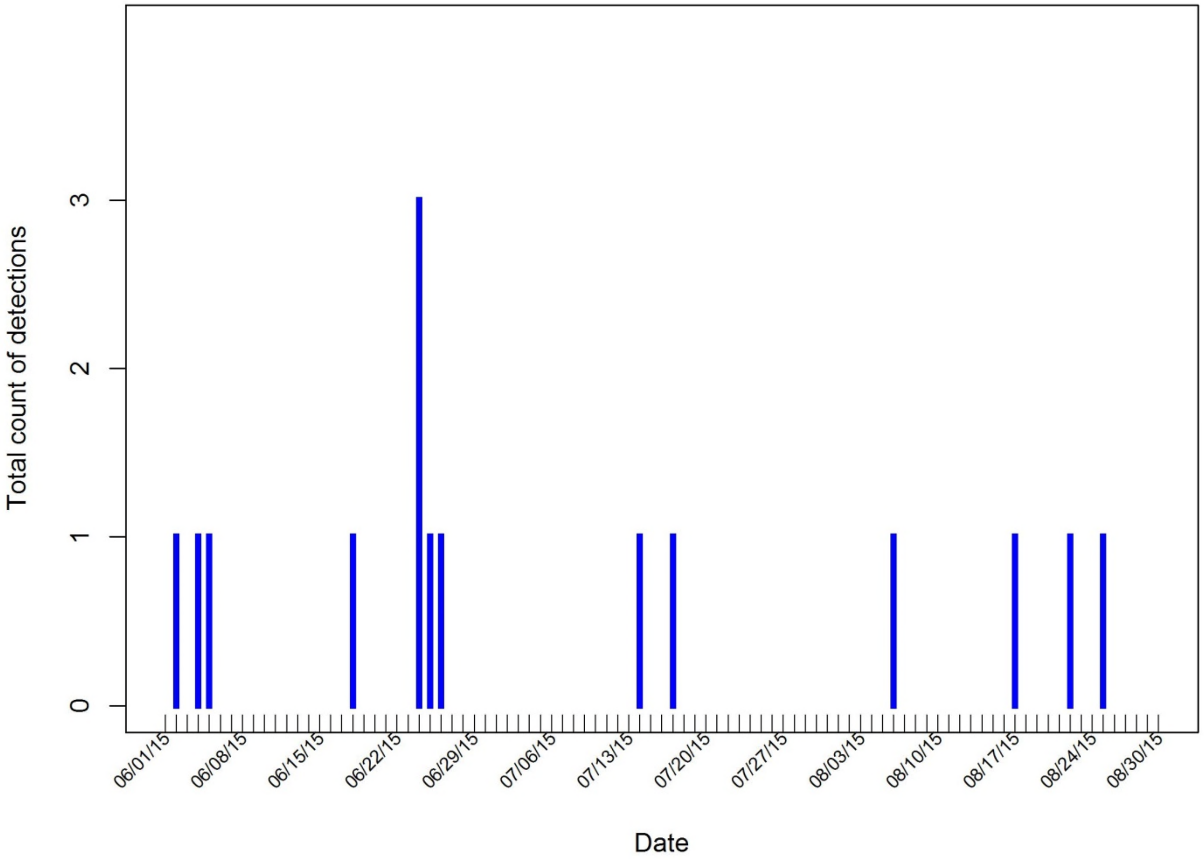


Figure 6. Total number of detections by date during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.3 Spatial Distribution of Avian Detections

3.3.1 *Detections by Project Component*

During the reporting period, detections were documented from the solar arrays, the northern section of the perimeter fence, and the gen-tie line; no detections occurred at the O&M building (Tables 3, 4, and 5). Of the 11 detections within the solar arrays, 18.2% (2) were associated either with overhead lines or arrays that co-occurred with overhead lines.

3.3.2 *Feather Spot Detections*

Five (33.3%) of the 15 detections consisted only of feather spots. Along the gen-tie, one of three detections (33.3%) was a feather spot. No detections along the fence were a feather spot. Four of 11 detections (36.4%) in the solar arrays were feather spots.

3.4 Detections of Injured Birds

No injured birds were detected during the summer 2015 season.

3.5 Summary of Bat Detections

No bats were detected during the summer 2015 season.

3.6 Carcass Persistence Trials

Data from carcass persistence trials were available from late winter, spring, and summer at the solar field and gen-tie line (n = 154 total). Based on carcass persistence data from late winter, spring, and summer 2015, survival models were compared for relative quality using the corrected AICc score, as suggested in Huso (2010). The AICc score provides a relative measure of model fit and parsimony among a selection of candidate models, and provides a framework for testing hypotheses regarding which factors contribute to carcass persistence rates. Carcass size was tested as a potentially important variable, as larger carcasses tend to persist longer than smaller carcasses. Project component (solar arrays/fence, generation-tie line) was also included as a potentially important variable, as was season.

The model with lowest AICc score is typically chosen as the model with the most empirical support relative to other models tested; however, any model within two AICc points of the model with the lowest score is considered competitive (Burnham and Anderson 2004). The most supported model included main effects of season, carcass size, Project component, and interactions of Project component × season and Project component × size with a Weibull-distributed removal time. Given the main effect of season, further modeling efforts were restricted to data collected in summer only. The most supported model using only the summer data suggested an interaction between carcass size and Project component. Estimates of carcass removal time and persistence probabilities are reported in Table 6 from the most supported model, and estimates of proportion of carcasses remaining as a function of days since carcass placement are provided in Figure 7. The difference in carcass removal times between Project components is because scavengers likely occur in higher densities outside the perimeter fence.

Table 6. Mean carcass removal time and probability of a carcass persisting through the effective search interval (5.8 days) during the summer season (June 01 – August 30) at the Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass size	Project component	Mean removal time (days)	Median removal time (days)	Probability of persistence
Small	Arrays/fence	15.5	11.5	0.63
Small	Gen-tie lines	1.37	0.5	0.22
Medium	Arrays/fence	19.2	22.5	0.73
Medium	Gen-tie lines	14.8	15.5	0.60
Large	Arrays/fence	-*	-*	1.00
Large	Gen-tie lines	0.9	0.5	0.22

* Mean and median removal time was not estimated because no removal was observed for large carcasses within the solar field.

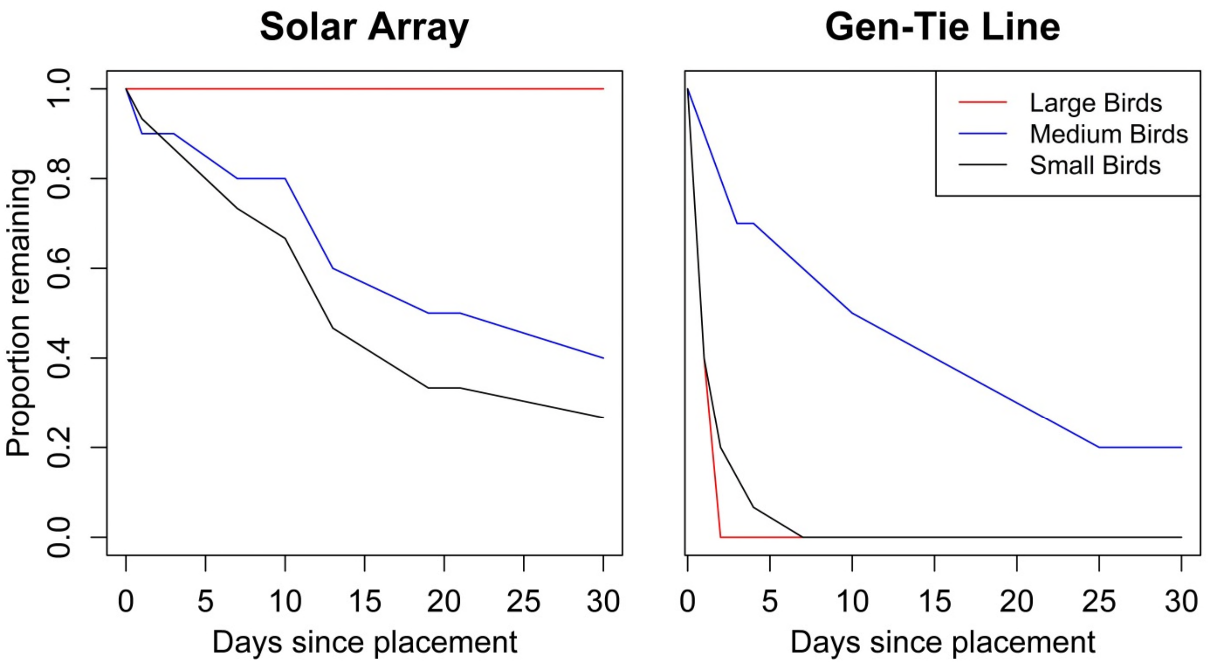


Figure 7. Proportion of trial carcasses remaining as a function of days since placement and carcass size class (n = 30, 20, and 10 for small, medium, and large size classes, respectively) during the summer (June 01 – August 30) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.7 Searcher Efficiency Trials

During the reporting period, a total of 150 searcher efficiency trials were placed at the Project. Most trials were available to be found, but some disappeared before or during the trial. Overall, 60 trials were placed in the solar arrays and 44 were available to be found; 30 trials were placed along the perimeter fence (inner perimeter only) and 30 were available to be found; and 60 trials were placed along the gen-tie line and 55 were available to be found. Searcher efficiency trials were conducted on each observer in approximate proportion to the number of searches they conducted at the Project, as follows: Sarah Nichols (number of trials available to be found: 84); Jennifer Johnson (67), and Pam Bullard (5).

In the solar arrays, the model that included an effect of carcass size was chosen as the most supported model to estimate searcher efficiency. Thus, the data used to produce the following estimates of searcher efficiency include trials available to be found during February, spring, and summer (n = 180). Within the solar arrays, searcher efficiency was: 60.0% for small birds, 86.6% for medium birds, and 98.1% for large birds (Figure 5).

For linear Project components, the model that included an effect of carcass size, Project component, and season was chosen as the most supported model to estimate searcher efficiency. Thus, the data used to produce the following estimates of searcher efficiency include trials available to be found during summer only along the fence (n = 30) and the overhead lines (n = 55). Along the fence, searcher efficiency ranged from 87.5% to 100% depending on carcass size class. Along overhead lines, searcher efficiency ranged from 43.5% to 100%. Detailed estimates of searcher efficiency estimates specific to each component and carcass size are reported in Appendix C.

3.8 Fatality Estimates

Fatality estimates were calculated separately for each component (solar arrays, fence, and overhead lines). Ultimately, five detections were excluded from the fatality analysis because they were found outside standardized search areas. All 15 detections made during summer are reported in Table 3. Detections used in the analysis, bias corrections, summer fatality estimates, and 90% confidence intervals for summer fatality estimates are detailed in Appendix C.

Table 7. Status of detections during the summer (June 01 – August 30) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California. All detections outside the search area were excluded from the fatality analysis, regardless of whether they occurred during a standardized carcass search or incidentally.

	Carcass search	Incidental detection	*Pushed to next season's fatality estimate	*Pulled from previous season's fatality estimate
Inside search area	9	1	0	0
Outside search area	1	4	0	0

* Incidental detections occurring after the last standardized carcass search in a season are considered for inclusion in the fatality analysis for the following season. This is consistent with the assumption we make throughout the monitoring seasons; that carcasses found incidentally would have been available to be found on the next scheduled search. This assumption may result in some carcasses found during one season but considered in the following season's fatality analysis. Once a carcass has been moved to a different season's analysis it is still subject to the same criteria for inclusion or exclusion based on location (in versus out of a searched area) and carcass age (greater than versus less than the search interval).

During summer 2015, there were an estimated total 148 carcasses (90% CI: 10 – 365) at the Project. Of these, 44 carcasses (27.5%; 90% CI: 8 – 64) were estimated for the solar arrays and 104 carcasses (66.9%; 90% CI: 2 – 339) were estimated for the gen-tie line. While we are required to report the gen-tie estimates per the approved BBCS, these estimates are not reliable due to the high rates of scavenging that were observed during the limited trials at the gen-tie and the low number of carcasses detected (n = 2 in the fatality analysis). No carcasses were estimated for the perimeter fenceline because there were no detections made along the fence. All of these estimates should be interpreted with caution because variance estimates are in general unreliable when carcass counts are low (< 5 per category). The TAG has asked for both the estimates and confidence intervals for this project with the appropriate caveat added. There were an estimated 17 fatalities per 1000 acres (within the solar field only; 44 estimated carcasses/2,585 acres) and an estimated 0.08 fatalities per nameplate MW (44 estimated carcasses/550 MW) within the solar field. A complete list of estimates for each Project component and carcass size class with confidence intervals is presented in Appendix C.

4.0 DISCUSSION

The 2015 summer season represented the second full season of standardized monitoring at Desert Sunlight per the BBCS. Searcher efficiency trials and carcass removal trials were conducted concurrently at the solar arrays, fencelines, and along the gen-tie line. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. Although these estimates were produced from a statistically robust sample, only limited inference may be drawn from two seasons of data. These results should be considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. As more data are collected throughout the monitoring year (and additional quality assurance/quality control measures occur, for example characterizing feather spots to species or size class), data from all seasons may be pooled. At that time, data will be tested for seasonal differences retrospectively, but because seasonal estimates will be produced from the much larger annual data set, they may differ from what is reported here because they are based on a larger, more informative sample.

4.1 Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Thus, rates of carcass persistence reported here should be interpreted cautiously as they may change over the coming months.

Fatality estimates are influenced by the relationship between carcass removal dynamics and search intervals. In practical terms, longer search intervals reduce average probability that a carcass persists until the next search. In terms of the analysis, this can manifest as a lower probability of persistence through the effective search interval, or an effective search interval that is shorter than the nominal search interval. In either case, the adjustment to carcass counts due to carcass removal dynamics is calculated as

$$\frac{length\ of\ effective\ search\ interval}{\begin{array}{c}length\ of\ nominal\ search\ interval * average\ probability\ of\ persistence\\ through\ the\ effective\ search\ interval\end{array}}$$

The adjustment to estimated fatality for carcass removal increases with longer search intervals, and the variance in the estimate may increase, also.

Searcher efficiency was influenced by Project component, carcass size, and season. In the solar arrays, searcher efficiency was high (> 0.5) for all carcass size classes and this is likely influenced by the limited vegetation cover beneath solar panels. Beneath the gen-tie line, vegetation cover is higher in some portions of the strip transects, but results reported here support the hypothesis that visibility class is not a factor in searcher efficiency along the lines during summer. Placement of trial carcasses in both difficult and easy visibility classes ensures that the adjustment due to searcher efficiency accounts for both visibility classes, even if there is a real difference in searcher efficiency that cannot be detected with the trial data.

For the current analysis, searcher efficiency in the solar arrays was assumed to be predicted by a half-normal distribution. For future analyses, AICc will be used to compare and choose the most supported among multiple detection functions.

4.2 Distribution of Fatalities and Fatality Estimates

The number of detections was more or less evenly distributed across the summer season, and there were no clear associations between number of detections and date. Given the small number of detections overall, it is premature to draw any conclusions about the spatial distribution of carcasses.

Composition of detections during summer 2015 included eight avian guilds. Corvids comprised the majority of detections (n = 3): there were two detections each within the doves/pigeons, rails/coots, and waterbirds/waterfowl guilds. No bats have been detected since monitoring began at the Project.

Detections attributed to an unknown cause accounted for 20.0% of all detections (68% of which were feather spots) during the reporting period, and all those attributed to an unknown cause were found in the solar arrays. Of the 11 detections made in the solar arrays, 36.4% were feather spots. Determining a cause of mortality from a feather spot is challenging because there is rarely visible evidence available on which to determine a cause of death. Thus, feather spots with an unknown cause of mortality could be encountered anywhere birds occur, and an unknown cause of a sizeable proportion of the carcasses is not unique to the Project. Further, game cameras trained on carcasses for carcass persistence trials at the Project have documented multiple feather spots originating from a single trial carcass. Ravens and turkey vultures, and possibly roadrunners, dislodge feathers from their attachment to the skin of carcasses during the scavenging process. There are a very large number of potential feather spots present on a single bird carcass (because a feather spot is defined as at least two or more primary flight feathers, at least five or more tail feathers, or two primaries within five m (16.4 ft) or less of each other, or a total of 10 or more feathers of any type concentrated together in an area of three square m). The relatively large proportion of feather spots (33.3%) among the detections for the Project as a whole may inflate the fatality estimate when unknown cause detections are included based on the potential for multiple feather spots resulting from one fatality, feather spots resulting from predation not associated with the facility, or other causes. However, feather spots are included in the analysis here to provide a more conservative estimate of fatality.

5.0 LITERATURE CITED

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in 2nd International Symposium on Information Theory (B. N. Petran and F. Csaki, Eds.). Akademiai Kiado, Budapest, Hungary.

Ammon, Elisabeth M. and William M. Gilbert. 1999. Wilson's warbler (*Cardellina pusilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/478

Boarman, William I. and Bernd Heinrich. 1999. Common raven (*Corvus corax*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/476 doi:10.2173/bna.476

Buckland, S, D.R. Anderson, K. P. Burnham, and J.L. Laake. 1993. Distance sampling: estimating abundance of biological populations. Chapman & Hall, London. 446 pp.

Burnham, K.P., and D.R. Anderson. 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociological Methods & Research 33: 261-304.

Evers, David C., James D. Paruk, Judith W. Mcintyre and Jack F. Barr. 2010. Common loon (*Gavia immer*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/313 doi:10.2173/bna.313

Hudon, Jocelyn. 1999. Western tanager (*Piranga ludoviciana*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/432 doi:10.2173/bna.432

Hughes, Janice M. 2011. Greater roadrunner (*Geococcyx californianus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/244 doi:10.2173/bna.244

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. doi: 10.1002/env.1052

Huso, Manuela, Som, Nicholas, and Ladd, Lew, 2012, Fatality estimator user’s guide: U.S. Geological Survey Data Series 729, 22 p.

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A new method to determine bird and bat fatality at wind energy turbines from carcass searches. Wildlife Biology 17: 350-363.

Lowther, Peter E. and Janet McI. Williams. 2011. Nashville warbler (*Oreothlypis ruficapilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/205 doi:10.2173/bna.205

Manly, B.F.J.1997. Randomization, bootstrap and Monte Carlo methods in biology. Second Edition. CRC Press, LLC, Boca Raton, Florida, 455 pp.

Melvin, Scott M. and James P. Gibbs. 2012. Sora (*Porzana carolina*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/250 doi:10.2173/bna.250

Muller, Martin J. and Robert W. Storer. 1999. Pied-billed grebe (*Podilymbus podiceps*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/410 doi:10.2173/bna.410

Murray, J. 2004. Nocturnal flight call analysis as a method for monitoring density and species composition of migratory songbirds (Order Passeriformes) across southern Vancouver Island, British Columbia in 2004. Rocky Point Bird Observatory, 16 pp.

Newton, I. 2008. The migration ecology of birds. Academic Press, London.

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine-cause avian fatality estimates. Journal of Wildlife Management 74(5): 1089-1096.

Smallwood, K. S. 2013. Comparing bird and bat ratality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37(1): 19-33.

Therneau, T. 2015. _A Package for Survival Analysis in S. version 2.38, <URL: http://CRAN.R-project.org/package=survival>.

Therneau, T.M. and P. M. Grambsch 2000. Modeling Survival Data: Extending the Cox Model. Springer, New York. ISBN 0-387-98784-3.

Western Ecosystems Technology (WEST), Inc. 2014. Bird and bat conservation strategy, Desert Sunlight Solar Farm Project, Riverside County, California. 57 pp.

Wheelwright, N. T. and J. D. Rising. 2008. Savannah sparrow (*Passerculus sandwichensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/045 doi:10.2173/bna.45

Appendix A. Detailed Areas of Carcass Locations along the Generation Tie Line of the Desert Sunlight Solar Farm Project during Summer (June 01 – August 30) 2015

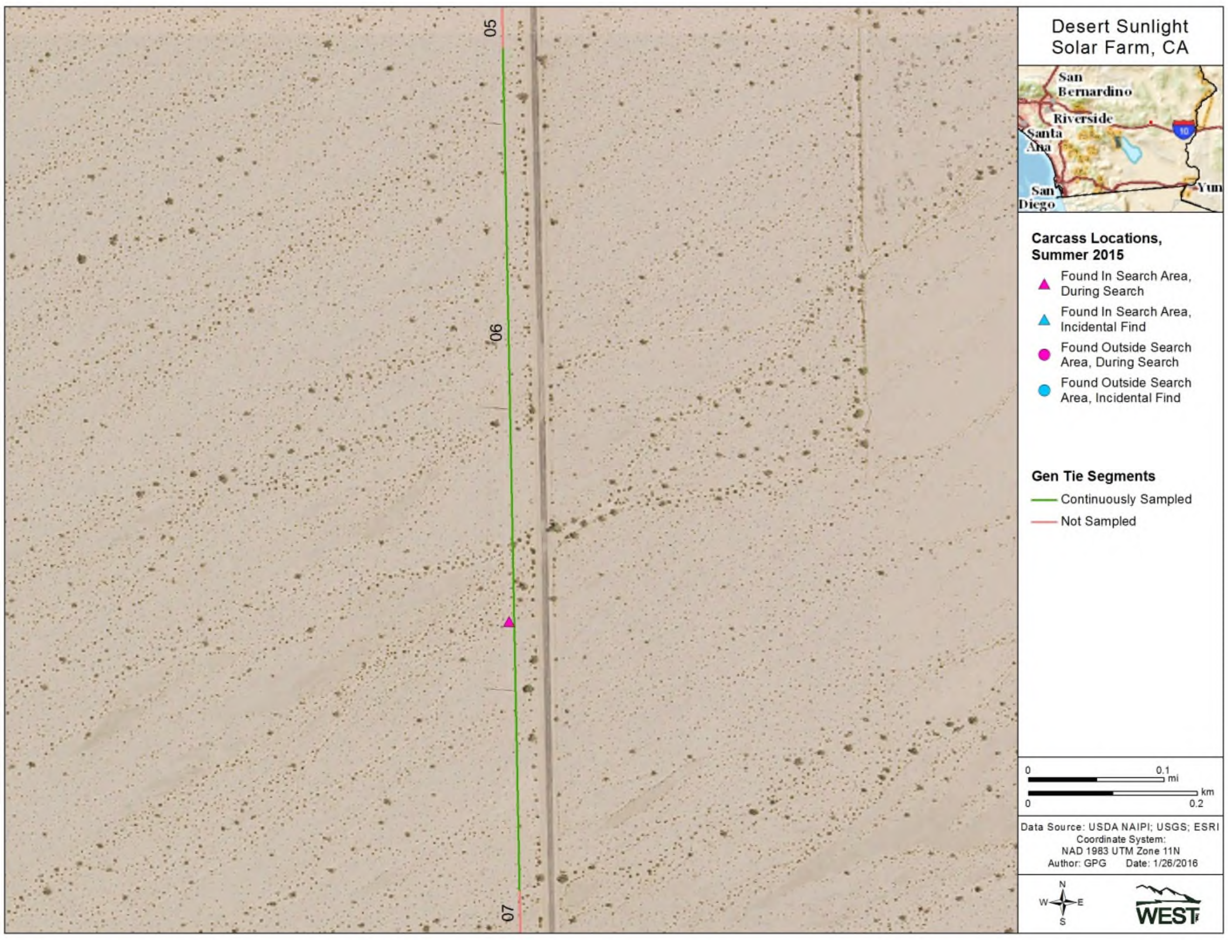


Figure A-1. Detailed map of a carcass location along the generation tie line at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

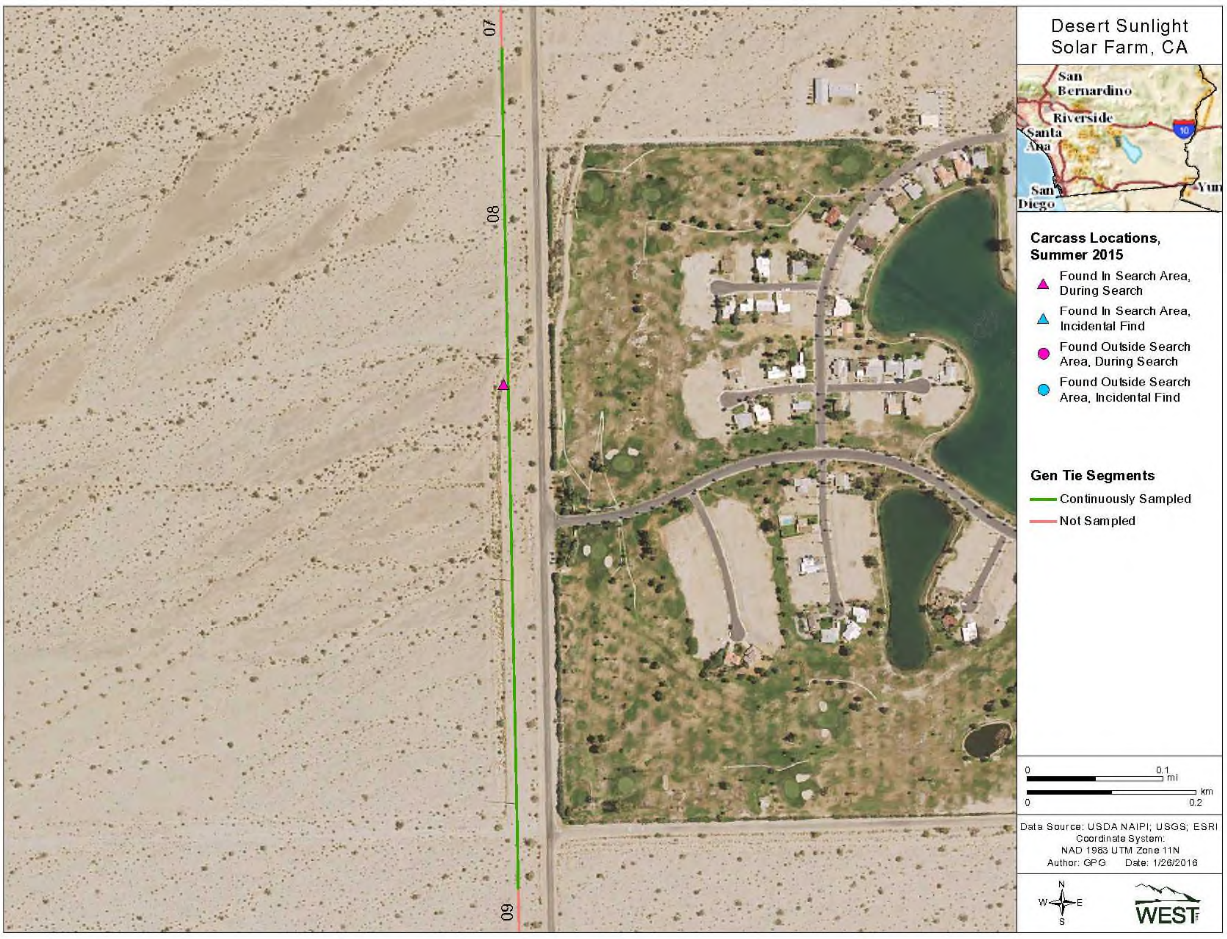


Figure A-2. Detailed map of a carcass location along the generation tie line at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

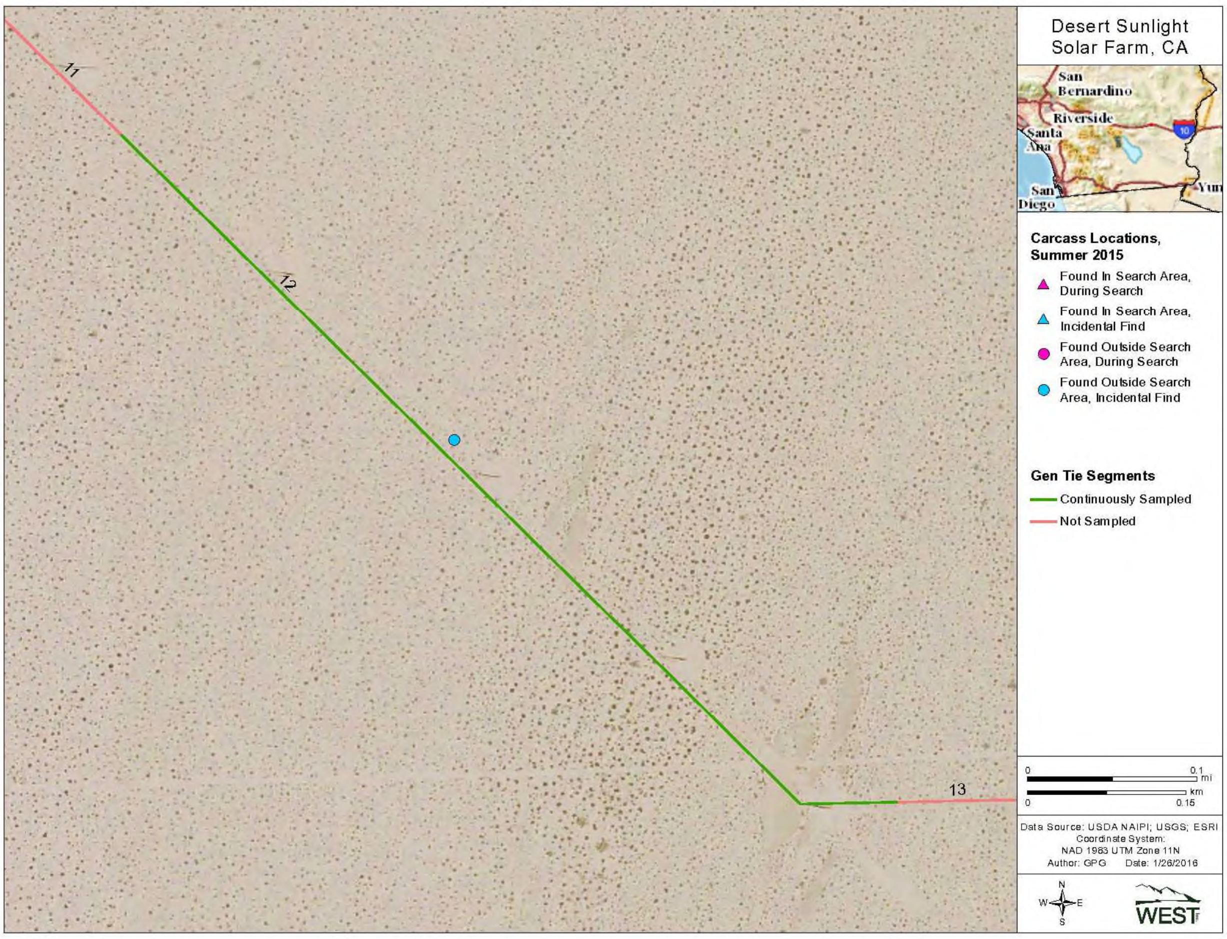


Figure A-3. Detailed map of a carcass location along the generation tie line at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015. This carcass was > 15 m from the gen-tie line, and was therefore excluded from the fatality estimate based on location.

Appendix B. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during Summer (June 01 – August 30) 2015

Table B-1. Weather conditions and body weights associated with avian detections estimated to be less than 24 hours old during summer (June 01 – August 30) 2015 at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hrs)	Species	Weight (g)	Weather Summary for Preceding 24 hrs
071715-SORA-GENTIE-06-01	7/17/2015	0-8hrs	sora	63	AVERAGE WIND SPEED OF 9MPH TO THE SOUTH, CLEAR 10 MILE VISIBILITY, MAX TEMPERATURE IS 107 DEGREES, MINIMUM IS 79 DEGREES, NEW MOON 1% ILLUMINATED
062415-HOWR-01-16MVOH-02	6/24/2015	8-24hrs	house wren	7	JUN 23, MAX TEMP 114, AVG WIND SPEED 10MPH-SSW, MAX WIND SPEED 16MPH. MAX GUST 21MPH. VIS 10 MILES, CLEAR UNTIL 3PM THEN PARTLY CLOUDY UNTIL 7PM, THEN CLEAR THROUGH NOGHT. MOON PHASE: WAXING CRESENT. CLEAR ALL DAY 6/24. TEMP 99 DEG F WHEN BIRD FOUND

Appendix C. Correction Factors and Bird Fatality Rates at the Desert Sunlight Solar Farm Project during Summer (June 01 – August 30) 2015.

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during summer (June 01 – August 30) 2015. *Distribution of easy and difficult visibility on the gen-tie line was about 50% and 50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Proportion of area searched by component								
Gen-tie line	0.479	-	0.479	-	0.479	-	0.479	-
Fence	0.744	-	0.744	-	0.744	-	0.744	-
Solar arrays	0.295	-	0.295	-	0.295	-	0.295	-
Searcher efficiency by component from all available data across seasons								
Gen-tie line*	0.662	0.519 - 0.815	0.954	0.869 - 1.000	0.999	1.000 - 1.000	0.662	0.519 - 0.815
Fence	0.875	0.733 - 1.000	0.987	0.943 - 1.000	1.000	1.000 - 1.000	0.875	0.733 - 1.000
Solar arrays	0.599	0.524 - 0.669	0.866	0.794 - 0.927	0.981	0.945 - 1.000	0.599	0.524 - 0.669
Average probability of carcass persistence through the effective search interval (estimates from summer data only)								
Gen-tie line	0.215	0.138 - 0.260	0.596	0.372 - 0.735	0.215	0.138 - 0.260	0.215	0.138 - 0.260
Solar arrays & fence:	0.633	0.478 - 0.757	0.733	0.548 - 0.863	1.000	1.000 - 1.000	0.633	0.478 - 0.757
Adjustment for effective search interval (proportion of nominal search interval)								
Gen-tie line: Summer effective search interval	0.278	0.202 – 0.355	1.00	-	0.175	0.122 – 0.223	0.278	0.202 – 0.355
Solar arrays & fence: Summer effective search interval	1.00	-	1.00	-	1.00	-	1.00	-
Carcass counts by component								
Gen-tie line	1	0 - 3	0	-	1	0 - 3	0	-
Fence	0	-	0	-	0	-	0	-
Solar arrays	2	0 - 4	0	-	5	1 - 10	1	0 - 3
Average Probability of Carcass Availability and Detected (Searcher efficiency * average probability of carcass persistence)								
Gen-tie line	0.040	0.020 - 0.054	0.569	0.357 - 0.713	0.038	0.020 - 0.050	0.040	0.020 - 0.054
Fence	0.554	0.406 - 0.683	0.723	0.527 - 0.851	1.000	1.000 - 1.000	0.554	0.406 - 0.683
Solar arrays	0.379	0.278 - 0.462	0.379	0.472 - 0.757	0.981	0.945 - 0.999	0.379	0.278 - 0.462
Adjusted Fatality Estimates (Fatalities /Season; values in italics are considered unreliable due to low counts of carcasses: carcass count / (proportion of area searched * average probability of carcass availability and detected)**								
Gen-tie line	*50.8*	*(1) - 200.2*	*0*	-	*53.5*	*(1) - 223.8*	*0*	-
Fence	*0*	-	*0*	-	*0*	-	*0*	-

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during summer (June 01 – August 30) 2015. *Distribution of easy and difficult visibility on the gen-tie line was about 50% and 50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Solar arrays	*17.9*	*(2) - 41.5*	*0*	*-*	*17.3*	*(5) - 34.5*	*8.9*	*(1) - 27.8*
Facility	*68.7*	*(3) - 212.1*	*0*	*-*	*70.8*	*(6) - 238.4*	*8.9*	*(1) - 27.8*

Table C-2. Carcasses excluded from the summer 2015 fatality analysis at the Desert Sunlight Solar Farm.

Parameter	**Small birds**	**Medium birds**	**Large birds**	**Unknown size**	**Bats**
LA solar arrays	2	0	0	0	0
NLA solar arrays	1	0	0	0	0
Fence	0	0	1	0	0
Gentie line	1	0	0	0	0

Post-Construction Monitoring at the Desert Sunlight Solar Project Riverside County, California

---

2015 Summer Quarterly Interim Report

Prepared for:

Desert Sunlight 250, LLC and
Desert Sunlight 300, LLC
700 Universe Blvd.,
Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.

415 West 17th Street, Suite 2000
Cheyenne, Wyoming

February 2, 2016 rev. 2

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from June 01 to August 30, 2015 (the reporting period) at Desert Sunlight Solar Farm Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). For logistical reasons, fall monitoring began on Monday, August 31, 2015. Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the second seasonal report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS. This report and the other interim quarterly reports are considered preliminary summaries of data and information for the seasonal monitoring periods. Final information from all four quarterly monitoring periods will be included in a comprehensive final annual report.

Included in this report are data from standardized carcass searches conducted during the summer season at the Project, defined as June 01 to August 30, 2015. Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 29.5% sample of solar photovoltaic (PV) panels, 2) along inner portions of the fenceline, resulting in 74.4% of the length of the perimeter fence, and 3) along 47.9% of the total length of generation-tie (gen-tie) line from the Project fence to the Red Bluff Substation located south of Interstate 10 (I-10). Searches conducted within the summer season had intervals of approximately 21 days.

All bird and bat fatalities and injuries that were discovered by observers, referred to as "detections" in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, 15 avian detections were made, and there were no detections of bats.

According to specifications of the BBCS, avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were applied to a fatality estimator model (Huso 2010) to provide a preliminary estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias. The estimate is considered preliminary because the annual report may pool information from bias trials and other data across seasons which could affect seasonal estimates.

During the reporting period, carcass persistence was influenced by carcass size and Project component. Small carcasses (0-100 g) in the arrays and along the fence (combined) had a 63% chance (90% confidence interval [CI]: 48 – 76%) of persisting through the effective search interval, medium carcasses (101 – 999 g) had a 73% (55 – 86%) chance, and large carcasses (1000+ g) had a 100% chance because no removal was observed. Mean removal time within the arrays for small and medium carcasses was 15.5, and 19.2 days, respectively; median removal time for small and medium carcasses was 11.5, and 22.5 days, respectively; mean and median removal times ~~was~~ were not estimated for large carcasses because no removal was

Comentado [FWS1]: Please explain why carcass persistence is influenced by project component.

Comentado [FWS2]: Please report median removal times and a figure showing the curve of # remaining over time.

observed. Along the generation tie-line, chances of persistence for small, medium, and large carcasses were 22% (14 – 26%), 60% (37 – 74%), and 22% (14 – 26%), respectively; mean removal time for small, medium, and large carcasses was, 1.4, 14.8, and 0.9 days, respectively; median removal time for small, medium, and large carcasses was, 0.5, 15.8, and 0.5 days respectively. The difference in carcass removal times between Project components is likely because scavengers occur in higher densities outside the perimeter fence.

Within the solar arrays, searcher efficiency averaged over all searchers and seasons (n = 180) was influenced by carcass size: 60.0% for small birds, 86.6% for medium birds, and 98.1% for large birds. Along the fence in summer (n = 30), searcher efficiency ranged from 87.5% to 100% depending on carcass size class. Along the generation tie-line in summer (n = 55), searcher efficiency ranged from 43.5% to 100%.

Comentado [FWS3]: Is this the searcher efficiency averaged for all observers? What is n?

Composition of detections during summer 2015 included eight avian guilds. Corvids comprised the majority of detections (n = 3): there were two detections each within the doves/pigeons, rails/coots, and waterbirds/waterfowl guilds. No bats have been detected since monitoring began at the Project.

Using the Huso (2010) fatality estimator model, modified to accommodate a distance-sampling approach to the estimation of searcher efficiency, during summer 2015, there were an estimated total 148 carcasses (90% CI: 10 – 365) at the Project. Of these, 44 carcasses (27.5%; 90% CI: 8 – 64) were estimated for the solar arrays and 104 carcasses (66.9%; 90% CI: 2 – 339) were estimated for the gen-tie line. While we are required to report the gen-tie estimates per the approved BBCS, these estimates are not reliable due to the high rates of scavenging that were observed during the limited trials at the gen-tie and the low number of carcasses detected (n = 2 in the fatality analysis). No carcasses were estimated for the perimeter fenceline because there were no detections made along the fence. All of these estimates should be interpreted with caution because variance estimates are in general unreliable when carcass counts are low (< 5 per category). ~~Other projects (e.g. Ivanpah) are not reporting estimates when carcass counts are less than or equal to five. However, t~~The TAG has asked for both the estimates and confidence intervals for this project with the appropriate caveat added. There were an estimated 0.017 fatalities per acre (within the solar field only; 44 estimated carcasses/2,585 acres) and an estimated 0.08 fatalities per nameplate MW (44 estimated carcasses/550 MW) within the solar field.

Comentado [FWS4]: IMPORTANT: WEST has said that it modified the Huso estimator, and despite several requests, those modifications have not been shared with the agencies. Until we understand what changes to the code were made, we are reserving judgment on these results.

Comentado [FWS5]: This supports increased frequency for this component.

Comentado [FWS6]: Is this relevant? Please delete.

All projects are reporting all mortalities via SPUT reporting regardless of how many.

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Tracey Johnson	Research Biologist
~~Paul Rabie~~Lacey Jeroue	Statistician
Paul Rabie	Statistician
Pamela Bullard	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2016~~5~~. Post-construction monitoring at the Desert Sunlight Solar Farm Project, Riverside County, California. 2015 Summer Quarterly Interim Report. 25 pp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Project Background

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC (collectively, Desert Sunlight) constructed and operates the Desert Sunlight Solar Farm Project (referred to in this report as "Project"), which consists of two main components: 1) a 550-megawatt (MW) photovoltaic (PV) generating facility; and 2) a 220-kilovolt (kV) generation interconnection (gen-tie) line. The Project comprises approximately 1,700 hectares (ha; 4,200 acres) of land administered by the Bureau of Land Management (BLM) six miles north of Desert Center in Riverside County, California (Figure 1).

1.2 Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (2014; “BBCS”) was prepared by the Project proponent in collaboration with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and BLM to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency approval of the BBCS occurred in December 2014. Amendments to the sampling protocol along some portions of the Project fenceline were made by Desert Sunlight and approved by the BLM on February 11, 2015.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Desert Sunlight in collaboration with the USFWS, CDFW, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the gen-tie line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
3. Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

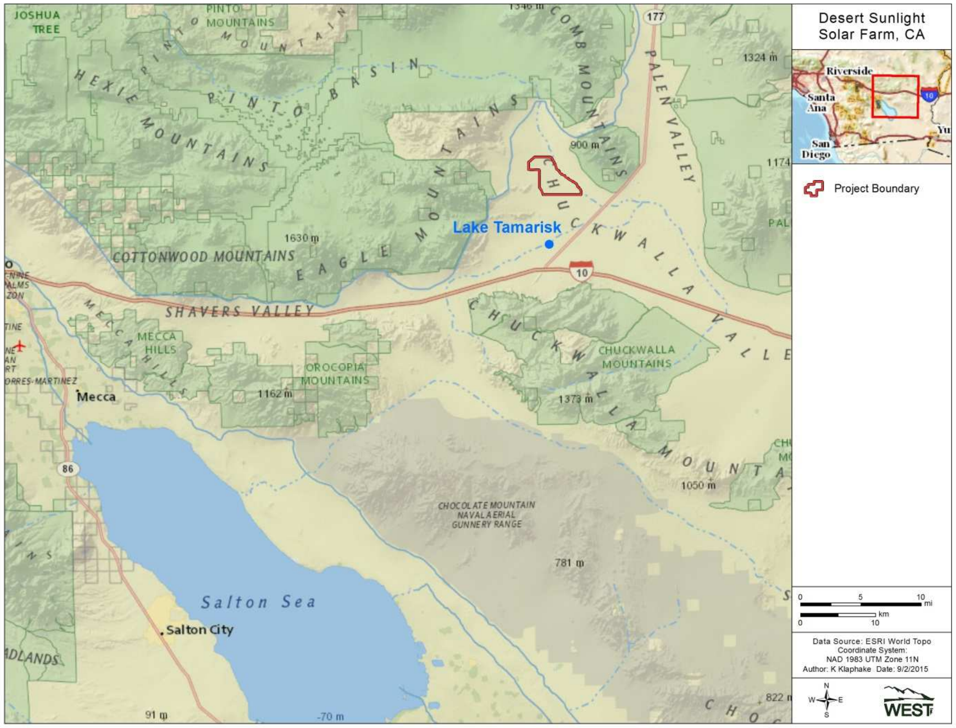


Figure 1. Desert Sunlight Solar Farm Project vicinity map, Riverside County, California.

1.3 Purpose of This Report

This report represents the second seasonal report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS. This report and the other interim quarterly reports are considered preliminary summaries of data and information for the seasonal monitoring periods. Final information from all four quarterly monitoring periods will be included in a comprehensive final annual report. This report covers the period June 01 to August 30, 2015, or the 2015 summer season. For logistical reasons, fall monitoring began on Monday, August 31, 2015. All carcasses and injuries that were discovered by observers are referred to as "detections" in this report. As stated in the approved BBCS, this seasonal report includes the observed detections for likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and suspected causes of death. Species composition of detections and the results of the bias trials are also reported. This report presents information related to the spatial distribution of detections, but no formal statistical analysis of the spatial distribution of carcasses will be conducted until the end of the monitoring year, given the limited data presently available.

2.0 METHODS

The BBCS describes the methods by which monitoring and certain analyses, including compilation of the overall fatality estimate, will occur. Below is an abridged description (see BBCS for detailed methods).

2.1 Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. Dead or injured birds and bats are called detections in this report to provide consistency in naming. This section also describes the methods for conducting carcass removal and searcher efficiency trials; how data were reported and analyzed; and the methods for producing fatality estimates for the Project.

2.1.1 *Areas Surveyed*

Standardized carcass searches were conducted at sampling units, which include the solar arrays (Table 1, 2; Figure 2); the "fenceline" defined as the perimeter fence for the Project (Table 1, Figure 2); and the gen-tie line (from the Project fence to the Red Bluff Substation on the south side of I-10; Table 1, Figure 3). Some overhead lines co-occur with solar arrays (medium voltage overhead lines [MVOH]). The MVOH were part of standardized carcass searches to the extent that they co-occured with solar arrays included in the sample (Table 2; Figure 2).

Table 1. Areas included in standardized carcass searches at the Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

Project Component	Total Size	Units	% of Component Searched
Solar arrays	1045.9	Hectares	29.5[1]
Fence	16.7	Kilometers	99.0[2]
Gen-tie line	19.2	Kilometers	47.9[3]

[1] Percent area that was searched in summer 2015. Slightly less than 30% total because of unequally-sized arrays.

[2] 74.4% of the fence is fully accessible and surveyed following the standard protocol, while approximately 25% of the fence is surveyed from a distance. Fatality rates estimated for sections of the fence that are sampled were extrapolated to sections of the fence where the standard monitoring protocol cannot be used, as described in section 4.2.6 of the approved Desert Sunlight BBCS. A very short segment near the gate is not sampled due to restoration activities.

[3] 52.1% of the gen-tie will be sampled in 2016.

Comentado [FWS7]: Please describe how detectability is being handled for the 25% being surveyed from a distance.

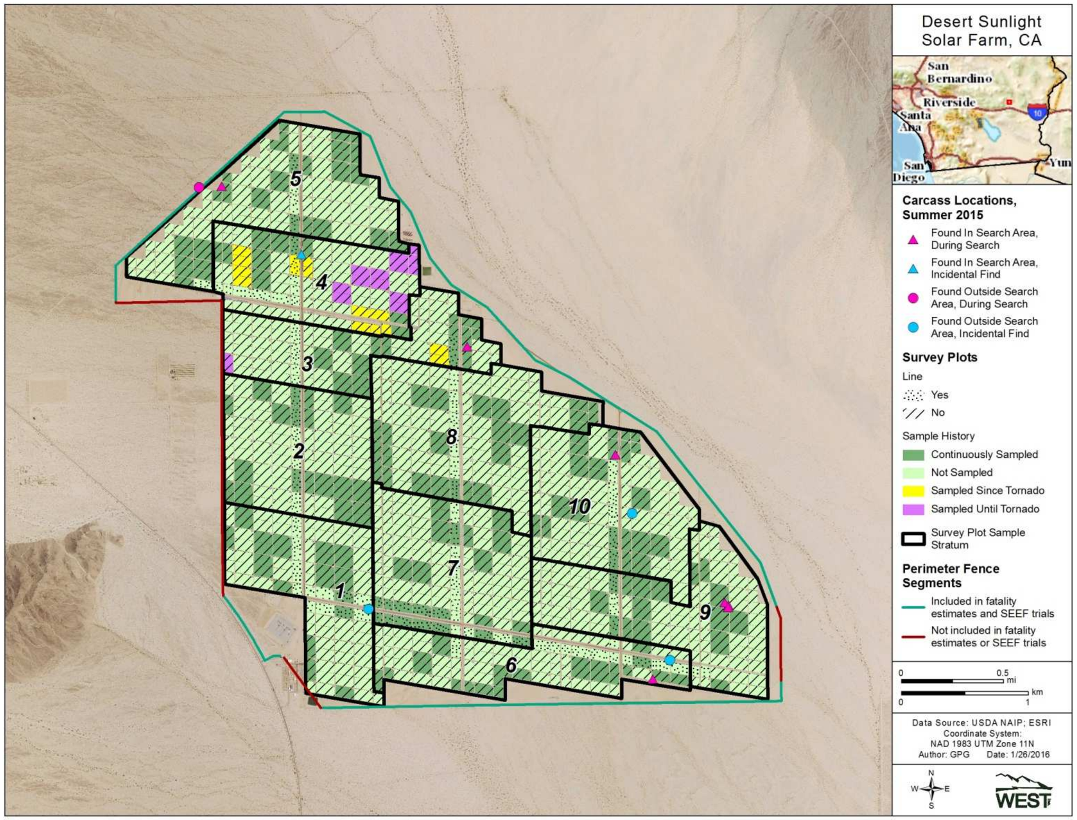


Figure 2. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at the solar field, fence, and overhead lines within the fence at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

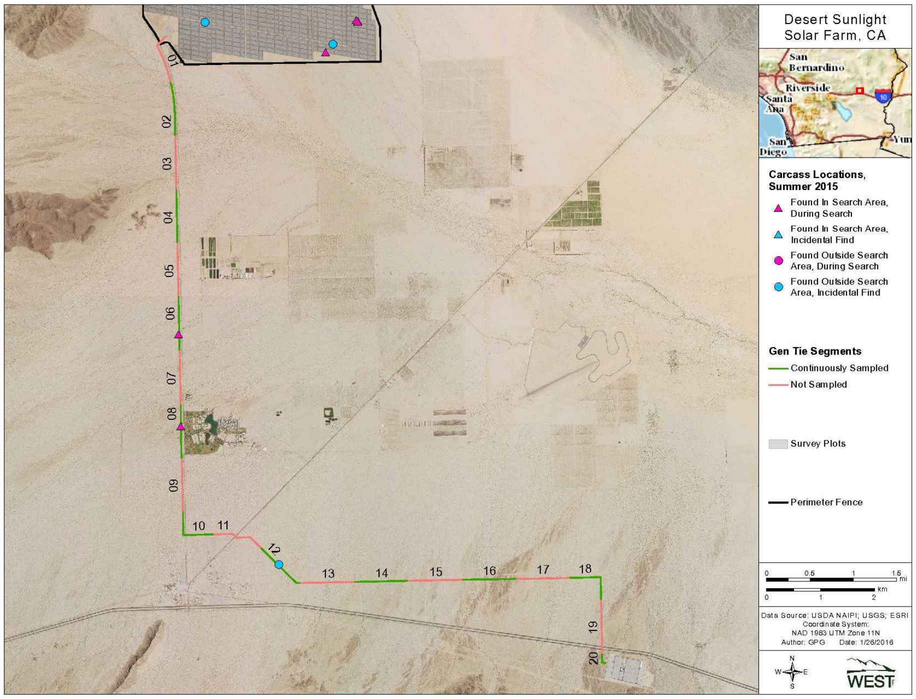


Figure 3. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance activities) along the generation tie line at the Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015. Detailed maps of detections along the line are presented in Appendix A.

To ensure a balanced distribution of sample units in the solar field (defined as the collection of all photovoltaic [PV] solar panels), the entire field was divided into ten strata, and individual sampling units were randomly selected within each stratum to compose an approximately 30% sample. This sampling design ensures that units included in the sample were not spatially clumped within the solar field. The solar field consists of arrays of solar panels (referred to as a solar array) that are either 70-m or 140-m wide. The sample includes 133 of each type of array. There are 2,580 70-m rows, and 3,900 140-m rows in the sample.

2.1.1 *Search Frequency and Timing*

Standardized searches occurred during the summer survey season, which includes the period from June 01 through August 30, 2015. All project components included in standardized searches were surveyed four times during summer. All searches took place during daylight hours from ~~06:30~~ 05:40 to ~~17:00~~14:08.

Comentado [FWS8]: Please record and report data on the time of the surveys. This will help determine if the surveys can be used to predict nocturnal vs. diurnal mig behavior.

Raw data sheets and GIS files should be submitted with each report.

As specified in the approved Desert Sunlight BBCS, the average search interval for all Project components included in standardized carcass searches during summer was 21.0 days (median 21.0 days). Slight variation in search interval was anticipated due to weather and logistical delays.

Comentado [FWS9]: Please discuss the effect of the long search interval in relation to the carcass persistence trial data.

Table 2. Area and proportion of solar arrays that are and are not associated with overhead lines at the Desert Sunlight Solar Farm Project, Riverside County, CA.

	Line-associated[1]	Not line-associated	Proportion line-associated
Entire facility	89.4 ha	956.5 ha	0.09
Standardized searches	32.2 ha	291.0 ha	0.10

[1] Line-associated area was estimated as the area of any array that fell within the 30-m strip transect below the MVOH.

2.1.2 *Search Methods*

Standardized carcass searches were performed by BLM-approved biologists, in accordance with methods outlined in the BBCS.

Within the solar field, arrays of solar panels were surveyed by observers traveling on foot. A distance sampling approach was used, whereby biologists slowly walked a transect line along the ends of rows of solar panels in a direction perpendicular to the rows, searching ahead and to the side within the array for bird and bat detections. Biologists scanned out to a maximum perpendicular distance of approximately 70 m from the transect. Biologists carried binoculars to allow them to verify the presence of a detection versus rocks or vegetation. Once a detection was confirmed, the distance of the detection to the transect line was estimated using laser range finders. Each array included in the sample was searched by observers walking two transects – one on the west side and one on the east side of the array with observers looking toward the center of the array.

~~Once~~ As soon as a carcass was detected, it was photographed, and data were recorded according to specifications outlined in section 7.2.5 of the approved Desert Sunlight BBCS. Carcasses were then immediately retrieved from their location on the ground, labeled, and placed in a freezer on site.

Comentado [FWS10]: Please explain details about how/when the processing occurred in relation to when carcasses were detected.

Most (74.4%) of the length of fenceline (approximately 10 miles) was searched from a vehicle using the standard protocol (Figure 2). Biologists searched a 6-m wide strip transect centered on the fence from the inner perimeter. Travel speed was below five miles per hour (mph) while searching. Some sections along the fence cannot be driven close to the fence line. The fence line along the western edge of the Project is drivable but the road is approximately 15 m away from the fence and the road and fence are separated by a drainage ditch. The fence along this section is covered with a tan tarp and trees and shrubs have been planted to reduce visibility of the project from the west. Additions of vegetation and the tarp likely reduce potential for bird collision with the fence. This section of the fence was driven to document carcasses, but detections along this portion of the fence are not included in adjusted fatality estimates because detection rates are likely very low. As specified in section 4.2.6 in the approved Desert Sunlight BBCS, we assume that fatality rates are similar between the portion of fence that was searched and the portion that was not. A separate section of the fence in the southeastern corner of the Project cannot be driven because the eastern edge of the berm that bounded construction ponds is too narrow for a vehicle. Along this portion of the fence, the observer stopped at both north and south ends of the berm and used binoculars to search for carcasses. Finally, the road along a portion of the southwest fence line near the entrance gate is approximately 30 to 50 m from the road and is separated from the fence by an area that has recently undergone vegetation restoration. This area was eliminated from sampling. Fatality rates estimated for sections of the fence that were sampled were adjusted to account for the proportion of fence not sampled with the standard monitoring protocol, as specified in section 4.2.6 of the approved Desert Sunlight BBCS.

Comentado [FWS11]: The Service is still concerned that this section of the fence is not being adequately sampled. Mortality rates may be different along this section of the fence.

The gen-tie line was searched using a 30-m wide strip transect (i.e., 15 m of ground on either side of the overhead line). Sample units along the gen-tie line were chosen by dividing the total length of line from the Project fence south to the Red Bluff Substation just south of I-10 into 1-km segments. Thus, a 47.9% sample of the total length of the line was searched (Figure 3). Biologists slowly walked every other 1-km segment of the line, meandering the width of the strip transect, scanning for dead or injured birds or bats within 15 m (49.2 ft) of the overhead line.

For each detection, a suspected cause of death or injury was assigned based on evidence available from the detection, evidence available on Project infrastructure, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it cannot be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed. Detections assigned to the “unknown” category were included in fatality estimates if they were located within standardized carcass search areas, and all detections made during the summer season are reported here.

Comentado [FWS12]: The Servicde disagrees with this assumption. If it’s under the line, the better assumption is that it was caused by the line and a scavenger subsequently discovered the carcass.

2.2 Carcass Persistence Trials

Carcass persistence trials were conducted throughout the summer period. Carcasses from three size classes (small [0-100 g], medium [101-999], and large [1000+ g]) were used for trials. The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), chukar (*Alectoris chukar*), and older coturnix quail, and the large size class comprised hen mallard (*Anas platyrhynchos*) and hen ring-necked pheasant (*Phasianus colchicus*).

2.2.1 *Carcass Persistence Data Collection*

To quantify carcass persistence rates, 15 small, 10 medium, and 5 large carcasses were randomly placed and monitored along the gen-tie line during summer 2015. Within the solar arrays and along the perimeter fence, the same numbers of each size category were placed, for a total of 60 carcass persistence trials at Desert Sunlight during the summer season, as specified in the approved Desert Sunlight BBCS. By placing carcasses inside (within arrays and along inner perimeter of the fence) and outside (along the gen-tie) the project fence, the possibility that there are different carcass persistence rates inside and outside the project fence is accounted for. Fifteen carcasses within the Project fence (within solar arrays and along the fence) were monitored using motion-triggered digital trail cameras, while the remaining carcasses were visited on foot, for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality. No carcasses along the gen-tie line were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as “feeding stations”, trail cameras were installed five days before specimens were placed, and two fake cameras without bias trial carcasses were also placed within the Project fence and periodically moved to new locations within the fence. Periodic ground-based checking of carcasses with trail cameras also occurred to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera’s field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire Project, not just in areas subject to standard searches, and trials were initiated in smaller numbers on three different dates throughout the summer season.

Comentado [FWS13]: This number of carcasses is extremely low. The Service recommends increasing the number of trial carcasses to help reduce the confidence intervals on estimates.

Comentado [FWS14]: With such a low number of carcasses this is unlikely to be a problem.

2.2.2 *Estimating Carcass Persistence Times*

Carcass persistence trials were checked daily during the first ~~4~~four days and then every ~~3~~three to ~~5~~five days until the 30-day trial length was reached. Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g. days a carcass is present before being removed) may not be known exactly, but is known to be within a finite range. For example, suppose a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass became unavailable at some point between 7 and 10 days. This carcass would be considered “interval censored”. Similarly, if a carcass lasts the entire 30-day trial period, that carcass is “right censored”— it is known that the carcass lasted at least 30 days, but it may have persisted longer. Because carcass persistence data were censored, persistence was analyzed using methods that can accommodate censored data and still produce unbiased estimates of the probability of persistence (Therneau 2015, Therneau and Grambsch 2000). It is beyond the scope of this document to provide statistical foundations of censored-data survival models but functions identical to those provided with the

Comentado [FWS15]: Please describe the interval that carcasses were checked. Is there a reason that they are not checked daily, particularly during the first week?

Comentado [FWS16]: Please clarify how censored data were analyzed and how the analytical methods affected the results. The referenced book is not available to the reader; please provide citation to the agencies. How does the method affect the effective search interval?

USGS-developed fatality estimator software (Huso et al 2012) ~~was~~ were used to fit survival models to the censored carcass persistence data, and some background is available in the documentation provided with that software.

The USGS software used to estimate carcass persistence calculates the period over which there is less than a 1% chance for a carcass to persist. The 'effective search interval' is defined as the shorter of the period during which there is less than a 1% probability that a carcass persists, and the actual search interval (Huso 2010). The probability of persistence is given for the effective search interval, and the probability that a carcass persists through the actual search interval is equal to p (persist through effective search interval) * effective search interval / actual search interval.

There were four distributions implemented in survival models used to estimate the probability a carcass is unscavenged and available to be found at the end of the search interval (*r*): exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike's Information Criterion adjusted for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model with combinations of the covariates carcass size, Project component, season, and visibility, to observed carcass persistence data.

2.3 Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the summer period. Carcasses from three size classes (small, medium, and large) were used for trials. The small size class comprised house sparrows and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons, chukar, and older coturnix quail, and the large size class comprised hen mallards and hen ring-necked pheasants.

2.3.1 *Searcher Efficiency Data Collection*

Training of biologists on the Project-specific protocol and early assessments of habitat conditions within the solar arrays suggested that the amount of cobble present in the soil may be an important factor influencing searcher efficiency. To satisfy requirements regarding consideration of visibility class per the BBCS and address the influence of cobble cover on searcher efficiency, sample units in the solar arrays and along the gen-tie were stratified by cobble cover and assigned to one of two classes (<15% and >15% cobble cover). Classes were determined by making ocular estimates of cobble cover at each sample unit and then evaluating the frequency histogram of sample units across the range of estimated cobble cover (Figure 4). A natural break point was identified at 15% cobble cover, so the same value was chosen as the break point that defined the two cobble cover classes. ~~Thus,~~ For most seasons, i~~I~~n the solar arrays, two sets of searcher efficiency trials ~~were~~ will be conducted (one set in each cobble cover class; *n* for each class~~trial~~ = 15 small birds, 10 medium birds, and 5 large birds as agreed upon in section 7.4 of the approved Desert Sunlight BBCS). During summer 2015, all searcher efficiency trial carcasses were inadvertently placed in the low cobble cover class, precluding any tests of the effect of cobble cover class on searcher efficiency in the solar arrays. Additional trials will be conducted in the winter period in cobble to address this oversight and small sample

Comentado [FWS17]: The Service proposed larger sample sizes for carcass persistence and searcher efficiency trials. Hence, has this been evaluated as adequate to determine searcher efficiency for a single strata? Please provide justification for small sample size.

size. Along the gen-tie, visibility was expected to be related to vegetation and rock cover. Thus, searcher efficiency trials along the gen-tie occurred in two visibility classes (*n* for each class = 15 small birds, 10 medium birds, and 5 large birds (easy: ≥90% bare ground, vegetation <6” tall; and more difficult: <90% bare ground, vegetation ≥6” tall). Inadvertently, one large carcass was not placed and one extra small carcass was placed during summer, so total sample size for large carcasses along the gen-tie was nine, and for small carcasses was 31. Thirty searcher efficiency trial carcasses~~s~~ (*n* = 15 small birds, 10 medium birds, and 5 large birds) ~~occurred~~ were placed along the fence in the only visibility class present on the fence (easy visibility). Thus, during summer, a total of 150 searcher efficiency trials occurred at the Project. Locations for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches.

Comentado [FWS18]: The terminology here is inconsistent with above. Each carcass counts as a trial or a trial consist of n carcasses?

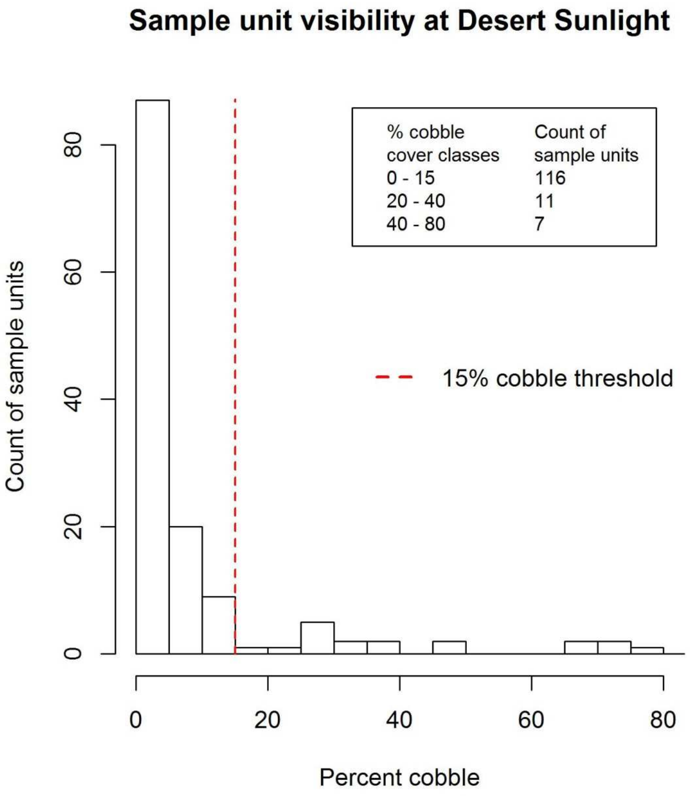


Figure 4. Frequency histogram of sample units (in the arrays only) at Desert Sunlight Solar Farm Project by estimates of cobble cover. Based on this distribution, each sample unit was assigned to one of two classes of cobble cover (<15%; >15%).

2.3.2 *Estimating Searcher Efficiency*

Comentado [FWS19]: Is searcher efficiency tested for each observer? Please provide these results along with an indication of variation in searcher efficiency across observers.

Searcher efficiency at Desert Sunlight was estimated separately for linear features (the project fence and the generation tie line), and the solar arrays, reflecting the different search methods used on arrays and linear features. For linear features, logistic regression models were fit to searcher efficiency data and AICc was used to compare models. Models including effects of carcass size (three classes), visibility (two classes; gen-tie only), and season were compared to each other and the null model. Model selection indicated that the ~~best~~ most supported model included main effects of Project component, carcass size, and season. Once the ~~best~~ most supported model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, *p*, was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from the summer 2015 season.

For the solar arrays, searcher efficiency was evaluated using a distance sampling approach (Buckland et al. 1993). Distance sampling assumes perfect detection on the transect line (at distance = 0), an assumption that is likely valid in the solar arrays given the relatively flat & vegetation-free nature of the soil surface. A curve is fitted to the observed carcass data that predicts probability of detection as a function of distance from the transect line. The mean value of this function over a specified distance, *w,* is equal to the average searcher efficiency for a transect of width *w*. The mean value of the detection curve is the integral of the detection function calculated between 0-m and the maximum survey distance (*w;* half the width of the solar array row), divided by the maximum survey distance:

$$p = \frac{\int_0^w f(x)dx}{w},$$

Con formato: Resaltar

where f(x) is the detection function evaluated at distance, *x*.

One departure in the methods used here, relative to the methods presented in Buckland et al. (1993), was that for this study the detection function was estimated using trial carcasses, which meant that there were both presence (detected) and absence (not detected) data available to fit the detection function (Figure 5). The availability of both presence and absence data means that the detection function can be estimated using only trial carcasses whose distribution is known. Therefore the detection function, the average searcher efficiency among the arrays and the final fatality estimate within the arrays are all insensitive to the spatial distribution of carcasses within individual arrays, and the overall searcher efficiency estimate is valid even if the distribution of carcasses among the arrays is not uniform.

Distances of trial carcasses (trials both found and missed) from the transect line were used to fit a half-normal detection function for searches among the arrays (Figure 5). The half-normal detection function is a commonly used function for distance sampling surveys (Buckland et al. 1993). The detection function was fit with and without covariates (carcass size, season, ~~visibility index,~~ or no covariates) and AICc indicated that the ~~best~~ most supported among these models included only carcass size as a covariate.

Comentado [FWS20]: Please provide an analysis that the sample size is adequate to detect a difference between visibility categories. This result seems to be an artifact of the low sample size.

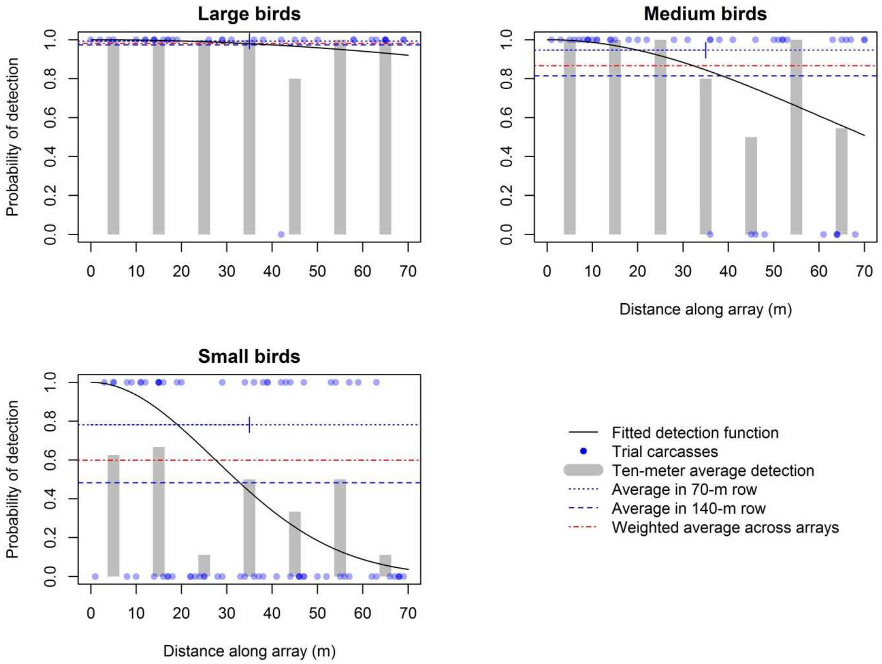


Figure 5. Estimated detection probabilities for bird carcasses by size class across all available seasons used for ~~during~~ summer (June 01 – August 30) 2015 fatality estimates at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented.

Comentado [FWS21]: Please explain the dots in the figure. The number of dots is greater than the number of trial carcasses.

Because the solar arrays were surveyed by searchers who walked down both sides of the rows of panels, the width of the search transect was specified as half the width of the rows of panels. For larger birds, there is almost certainly a non-zero detection probability beyond this distance but the bias that occurs by ignoring this non-zero detection probability is conservative (i.e. the searcher efficiency is underestimated). Some solar arrays have row widths of 70 m (search transect width of 35 m) and some have row widths of 140 m (search transect width of 70 m). The weighted average searcher efficiency is calculated based on the number of panel rows of each length in the survey sample:

$$p_{weighted\ average} = \frac{n_{70}}{n} \times \frac{\int_0^{35} f(x)dx}{35} \cancel{\int_0^{35} f(x)dx} + \frac{n_{140}}{n} \times \frac{\int_0^{70} f(x)dx}{70} \cancel{\int_0^{70} f(x)dx},$$

Comentado [FWS22]: The denominator (w) from the equation for p (from page 12 equation) is missing from this equation. Is this a typo or was the equation modified for a reason? If so, please explain.

where $n_{70} = 2580$ is the number of 70-m rows in the sample, $n_{140} = 4020$ is the number of 140-m rows in the sample, and *n* is the total number of rows in the sample. Searcher efficiency was higher for the arrays with a width of 70 m, and overall searcher efficiency was estimated as a weighted average based on the proportions of 70-m arrays and 140-m arrays in the sample units.

Comentado [FWS23]: Please provide the values for n_{70} and n_{140}.

2.4 Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots are also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie line versus cleared areas beneath solar panels). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where *F* is the total number of fatalities, *C* is the number fatalities detected and included in fatality estimation, *r* is the probability a carcass is ~~unscavenged~~ not scavenged and available to be found at the end of the search interval, and *p* is the probability of detecting a carcass (Huso 2010)–.– Huso (2010) describes the use of a binomial model to estimate the probability of carcass detection; in the present study, the binomial carcass detection model was used to calculate fatalities at project linear features (fence, overhead lines), and the weighted average probability of detection based on distance sampling (described above) was used to estimate probability of detection within the solar arrays.~~where the probability of detecting a carcass at solar arrays is the weighted average from above.~~

Comentado [FWS24]: Is this the weighted average probability from above?

All fatality estimates were calculated using the Huso estimator (modified to accommodate the distance-sampling based estimate of searcher efficiency in the solar arrays), as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates ~~were~~ was used for each of searcher efficiency (*p*), probability of a carcass persisting to the next search ($\hat{r}$), adjusted search interval and observed fatalities. From these bootstrap samples, the probability of available and detected was calculated and applied to the bootstrapped observed fata~~t~~lities. The lower 5th and upper 95th

Comentado [FWS25]: Please describe what was bootstrapped and how. The table in the appendix is difficult to understand without a better understanding of the bootstrapping methods.

percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

2.5 Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by WEST avian biologists and operational personnel and were considered “incidental” detections. When found by operational personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the Desert Sunlight SPUT Avian Injury and Mortality Report Forms June – August 2015. All detections made in search areas during the reporting period were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

3.0 MONITORING RESULTS

3.1 Summary of Avian Detections

During summer 2015, a total of 15 avian detections (including incidentals) of 11 identified species were recorded (Table 3). The most common identified species was common raven (*Corvus corax*) with three detections. Most detections (n = 11, or 73.3% of total detections) occurred in the solar arrays (Figures 2 and 3; Tables 4, 5, and 6). Ten (66.7%) detections were made during standardized carcass searches and five (33.3%) were documented as incidentals. No bats were detected during the summer season. For fresh carcasses, body weights and weather conditions the preceding nights are described in Appendix B.

Table 3. Number of individual bird detections, by species, during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Common Name	Scientific Name	Migration Behavior*	Guild	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Total
common raven	*Corvus corax*	resident	Corvids	-	2	1	-	3
white-winged dove	*Zenaida asiatica*	variable	Doves/Pigeons	-	-	-	1	1
black-throated sparrow	*Amphispiza bilineata*	diurnal	Grassland/ Sparrows	-	-	-	1	1
sora	*Porzana carolina*	nocturnal	Rails/Coots	-	-	-	1	1
Virginia rail	*Rallus limicola*	nocturnal	Rails/Coots	1	-	-	-	1
house wren	*Troglodytes aedon*	nocturnal	Wrens	1	-	-	-	1
mourning dove	*Zenaida macroura*	variable	Doves/Pigeons	-	1	-	-	1
Say's phoebe	*Sayornis saya*	diurnal	Flycatchers	-	1	-	-	1
northern rough-winged swallow	*Stelgidopteryx serripennis*	diurnal	Swallows	-	1	-	-	1
unidentified bird (small)	-	-	Unidentified Birds	-	1	-	-	1
unidentified bird (unknown size)	-	-	Unidentified Birds	-	1	-	-	1
unidentified grebe	-*Aechmophorus sp.*	-	Waterbirds/ Waterfowl	-	1	-	-	1
western grebe	*Aechmophorus occidentalis*	nocturnal	Waterbirds/ Waterfowl	-	1	-	-	1
Total				**2**	**9**	**1**	**3**	**15**

* See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in Birds of North America (BNA) Online (http://bna.birds.cornell.edu/bna/); where information on migration behavior was lacking in BNA accounts, Newton (2008) or Murray (2004) were used.

Comentado [FWS26]: Aechmophorus species or a different genus?

Table 4. Total avian detections by Project component and detection category during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. Only carcasses found within search areas were included in fatality estimates.

	Inside carcass search area		Outside carcass search area	
Project Component	**Carcass search**	**Incidental**	**Carcass search**	**Incidental**
Fence	0	0	1	0
O&M Building	0	0	0	0
Gen-tie line	2	0	0	1
Solar arrays				
Line-associated	0	0	0	2
Non-line associated	7	1	0	1

Table 5. Total avian detections (including incidentals) by Project component and suspected cause of death during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

	Suspected Cause of Death*				
Project Component	**Collision**	**Predation**	**Other**	**Unknown**	**Percent of Total**
Fence	0	0	1	0	6.7
O&M building	0	0	0	0	0
Gen-tie line	2	0	1	0	20
Solar arrays					
Line-associated	1	0	1	0	13.3
Non-line associated	1	0	5	3	60
Percent of Total	**26.7**	**0**	**53.3**	**20.0**	**100.0**

* Suspected cause of death was assigned based on evidence available on the detection, evidence available on Project infrastructure, and proximity of detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as "unknown" because it can't be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, in the absence of a completed necropsy, there is ~~substantial~~ some uncertainty associated with cause of death assignments because no events were directly observed.

Comentado [FWS27]: Was proximity to project features evaluated? Please describe how this information was utilized. Proximity distances may provide insights into which features may pose the greatest risks.

Comentado [FWS28]: Since scavenger rates are so high, this definition too easily categorizes carcasses as unknown. Low levels of scavenging should not exclude birds from a more thoughtful evaluation of the cause of the mortality. Other criteria should be considered, including patterns of disturbed dust on solar panels, proximity to a feature with collision risk. Such a blanket categorization, probably masks useful information.

3.2 Temporal Patterns of Avian Detections

The number of detections recorded daily during the reporting period ranged from zero to three (Figure 6). One detection was found per day with the exception of June 24 when three detections occurred. The number of detections per day represents those discovered during standardized carcass searches and incidentally.

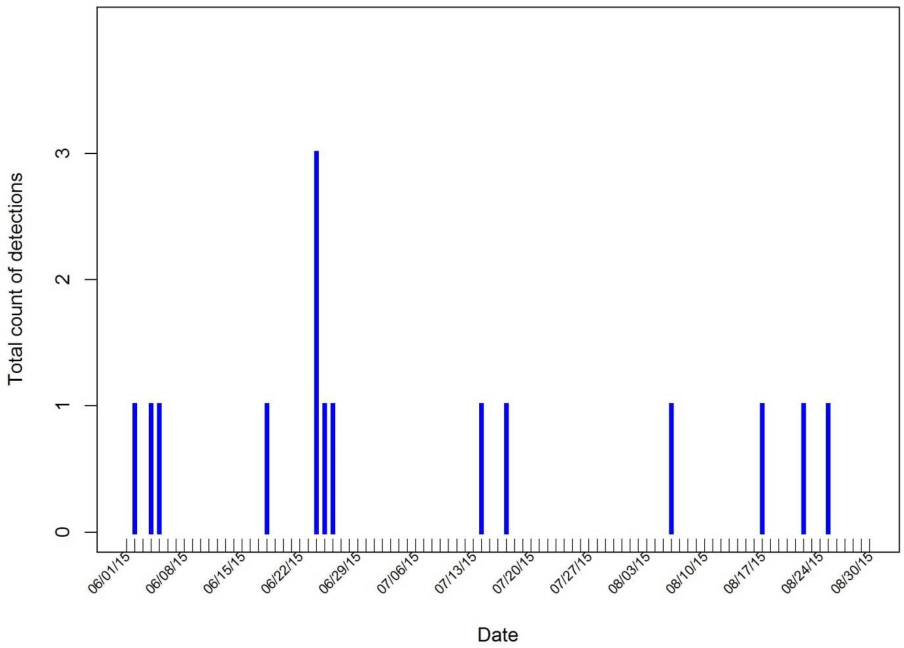


Figure 6. Total number of detections by date during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.3 Spatial Distribution of Avian Detections

Comentado [FWS29]: Spatial distribution of different taxonomic groups should be discussed, particularly as more data come in.

3.3.1 *Detections by Project Component*

During the reporting period, detections were documented from the solar arrays, the northern section of the perimeter fence, and the gen-tie line; no detections occurred at the O&M building (Tables 3, 4, and 5). Of the 11 detections within the solar arrays, 18.2% (2) were associated either with overhead lines or arrays that co-occurred with overhead lines.

3.3.2 *Feather Spot Detections*

Five (33.3%) of the 15 detections consisted only of feather spots. Along the gen-tie, one of three detections (33.3%) was a feather spot. No detections along the fence were a feather spot. Four of 11 detections (36.4%) in the solar arrays were feather spots.

3.4 Detections of Injured Birds

No injured birds were detected during the summer 2015 season.

3.5 Summary of Bat Detections

No bats were detected during the summer 2015 season.

3.6 Carcass Persistence Trials

Data from carcass persistence trials were available from late winter, spring, and summer at the solar field and gen-tie line (n = 154 total). Based on carcass persistence data from late winter, spring, and summer 2015, survival models were compared for relative quality using the corrected AICc score, as suggested in Huso (2010). The AICc score provides a relative measure of model fit and parsimony among a selection of candidate models, and provides a framework for testing hypotheses regarding which factors contribute to carcass persistence rates. Carcass size was tested as a potentially important variable, as larger carcasses tend to persist longer ~~and~~ than ~~may be more likely to leave feather spots which persist for long durations~~, ~~whereas~~ smaller carcasses ~~may be more likely to be completely removed~~. Project component (solar arrays/fence, generation-tie line) was also included as a potentially important variable, as was season.

The model with lowest AICc score is typically chosen as the ~~"best"~~ model with the most empirical support relative to other models tested; however, any model within two AICc points of the ~~best~~ model with the lowest score is considered competitive ~~with the best model~~ (Burnham and Anderson 2004). The ~~best~~ most supported model included main effects of season, carcass size, Project component, and interactions of Project component × season and Project component × size with a Weibull-distributed removal time. Given the main effect of season, further modeling efforts were restricted to data collected in summer only. The ~~best~~ most supported model using only the summer data suggested an interaction between carcass size and Project component. Estimates of carcass removal time and persistence probabilities are reported in Table 6 from the ~~best~~ most supported model, and estimates of proportion of carcasses remaining as a function of days since carcass placement are provided in Figure 7. The difference in carcass removal times between Project components is because scavengers likely occur in higher densities outside the perimeter fence.

Table 6. Mean carcass removal time and probability of a carcass persisting through the effective search interval (5.8 days) during the summer season (June 01 – August 30) at the Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass size	Project component	Mean removal time (days)	Median removal time (days)	Probability of persistence
Small	Arrays/fence	15.5~~3~~	11.5	0.63
Small	~~Overhead~~ Gen-t~~T~~ie lines	1.37	0.5	0.22
Medium	Arrays/fence	19.2	22.5	0.73
Medium	~~Overhead~~ Gen-t~~T~~ie lines	14.8~~75~~	15.5	0.60
Large	Arrays/fence	-*	-*	1.00
Large	~~Overhead~~ Gen-t~~T~~ie lines	0.9	0.5	0.22

Comentado [FWS30]: This is not clear. Are you suggesting that feather spots from large carcasses last longer than feather spots from small carcasses? Or are you suggesting that large carcasses are more likely to produce feather spots than small carcasses and feather spots in general (large or small) persist for long durations? Please clarify and provide a rationale for the assertion and describe how it might affect the analysis.

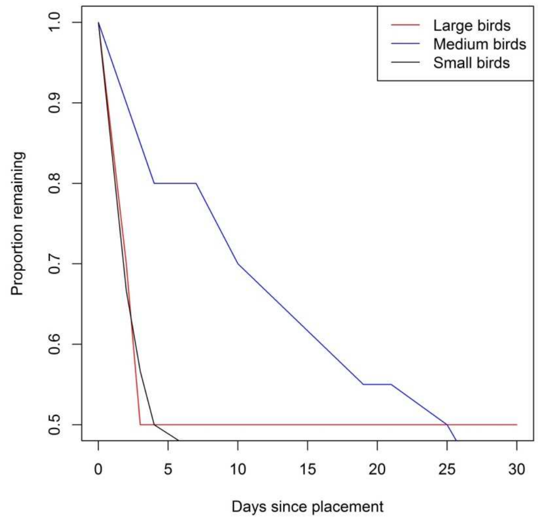
Comentado [FWS31]: Is there enough data to do a good analysis?

Comentado [FWS32]: Please include the timeframe for the persistence trails for ease of reference (30 days?).

Comentado [FWS33]: This looks like there may be an effect on persistence time from being outside the fence. This may be due to differences in the scavenger community. Was this tested?

Comentado [FWS34]: This is the Gen-Tie, right? Better to refer to this as the Gen-Tie to distinguish it from the internal overhaed lines above the panels.

* Mean and median removal time was not estimated because no removal was observed for large carcasses within the solar field.


Large birds
Medium birds
Small birds
Proportion remaining
1.0
0.9
0.8
0.7
0.6
0.5
0
5
10
15
20
25
30
Days since placement

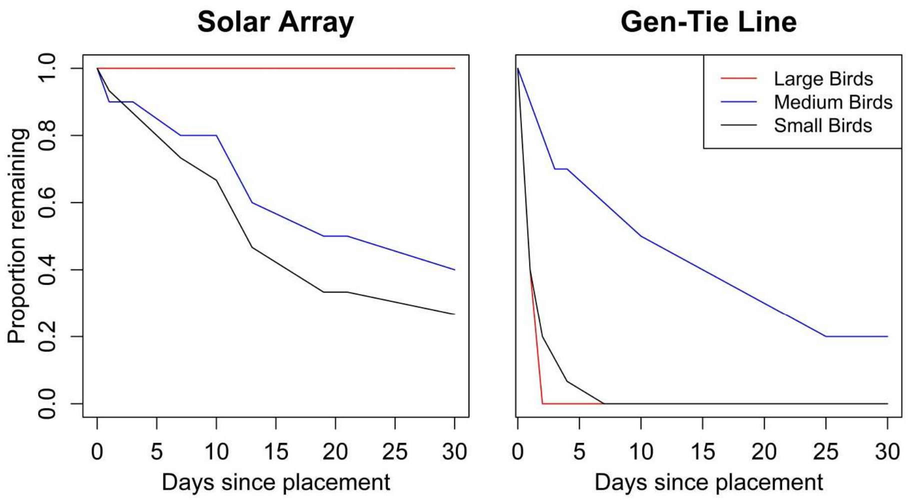

Solar Array
Gen-Tie Line
Large Birds
Medium Birds
Small Birds
Proportion remaining
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
Days since placement
0
5
10
15
20
25
30
Days since placement

Figure 7. Proportion of trial carcasses remaining as a function of days since placement and carcass size class (n = 30, 20, and 10 for small, medium, and large size classes, respectively) during the summer (June 01 – August 30) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California.

Comentado [FWS35]: The y-axis is cut off at 0.5. This obscures data for small and med bird size categories. Please provide the Figure with a y-axis range from 0.0-1.0.

3.7 Searcher Efficiency Trials

During the reporting period, a total of 150 searcher efficiency trials were placed at the Project. Most trials were available to be found, but some disappeared before or during the trial. Overall, 60 trials were placed in the solar arrays and 44 were available to be found; 30 trials were placed along the perimeter fence (inner perimeter only) and 30 were available to be found; and 60 trials were placed along the gen-tie line and 55 were available to be found. Searcher efficiency trials were conducted on each observer in approximate proportion to the number of searches they conducted at the Project, as follows: Sarah Nichols (number of trials available to be found: 84); Jennifer Johnson (67), and Pam Bullard (5).

Comentado [FWS36]: How was this broken down by visibility categories and size classes? See Appendix C?

In the solar arrays, the model that included an effect of carcass size was chosen as the ~~best~~ most supported model to estimate searcher efficiency. Thus, the data used to produce the following estimates of searcher efficiency include trials available to be found during February, spring, and summer (n = 180). Within the solar arrays, searcher efficiency was: 60.0% for small birds, 86.6% for medium birds, and 98.1% for large birds (Figure 5).

For linear Project components, the model that included an effect of carcass size, Project component, and season was chosen as the ~~best~~ most supported model to estimate searcher efficiency. Thus, the data used to produce the following estimates of searcher efficiency include trials available to be found during summer only along the fence (n = 30) and the overhead lines (n = 55). Along the fence, searcher efficiency ranged from 87.5% to 100% depending on carcass size class. Along overhead lines, searcher efficiency ranged from 43.5% to 100%. Detailed estimates of searcher efficiency estimates specific to each component and carcass size are reported in Appendix C.

3.8 Fatality Estimates

Fatality estimates were calculated separately for each component (solar arrays, fence, and overhead lines). Ultimately, five detections were excluded from the fatality analysis because they were found outside standardized search areas. All 15 detections made during summer are reported in Table 3. Detections used in the analysis, ~~and~~ bias corrections, summer fatality estimates, and 90% confidence intervals for summer fatality estimates are detailed in Appendix C.

Comentado [FWS37]: Please provide an additional summary tables with the following information for each component and for the entire facility: carcasses detected, estimated fatalities; 90% CI. An additional table with the same information for each size category is also requested.

Table 7. Status of detections during the summer (June 01 – August 30) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California. All detections outside the search area were excluded from the fatality analysis, regardless of whether they occurred during a standardized carcass search or incidentally.

	Carcass search	**Incidental detection**	***Pushed to next season's fatality estimate**	***Pulled from previous season's fatality estimate**
Inside search area	9	1	0	0
Outside search area	1	4	0	0

* Incidental detections occurring after the last standardized carcass search in a season are considered for inclusion in the fatality analysis for the following season. This is consistent with the assumption we make throughout the monitoring seasons; that carcasses found incidentally would have been available to be found on the next scheduled search. This assumption may result in some carcasses found during one season but considered in the following season's fatality analysis. Once a carcass has been moved to a different season's analysis it is still subject to the same criteria for inclusion or exclusion based on location (in versus out of a searched area) and carcass age (greater than versus less than the search interval).

During summer 2015, there were an estimated total 148 carcasses (90% CI: 10 – 365) at the Project. Of these, 44 carcasses (27.5%; 90% CI: 8 – 64) were estimated for the solar arrays and 104 carcasses (66.9%; 90% CI: 2 – 339) were estimated for the gen-tie line. While we are required to report the gen-tie estimates per the approved BBCS, these estimates are not reliable due to the high rates of scavenging that were observed during the limited trials at the gen-tie and the low number of carcasses detected (n = 2 in the fatality analysis). No carcasses were estimated for the perimeter fenceline because there were no detections made along the fence. All of these estimates should be interpreted with caution because variance estimates are in general unreliable when carcass counts are low (< 5 per category). ~~Other projects (e.g. Ivanpah) are not reporting estimates when carcass counts are less than or equal to five. However, t~~The TAG has asked for both the estimates and confidence intervals for this project with the appropriate caveat added. There were an estimated ~~0.0~~17 fatalities per 1000 acres (within the solar field only; 44 estimated carcasses/2,585 acres) and an estimated 0.08 fatalities per nameplate MW (44 estimated carcasses/550 MW) within the solar field. A complete list of estimates for each Project component and carcass size class with confidence intervals is presented in Appendix C.

Comentado [FWS38]: The Service continues to recommend 95% CI, but even at 90% the CI is still too wide to be useful.

Comentado [FWS39]: Given the size of utility scale projects "per 1000 acres seems more appropriate.

4.0 DISCUSSION

The 2015 summer season represented the second full season of standardized monitoring at Desert Sunlight per the BBCS. Searcher efficiency trials and carcass removal trials were conducted concurrently at the solar arrays, fencelines, and along the gen-tie line. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. Although these estimates were produced from a statistically robust sample, only limited inference may be drawn from two seasons of data. These results should be considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. As more data are collected throughout the monitoring year (and additional quality assurance/quality control measures occur, for example characterizing feather spots to species or size class), data from all seasons may be pooled. At that time, data will be tested for seasonal differences retrospectively, but because seasonal estimates will be produced from the much larger annual data set, they may differ from what is reported here because they are based on a larger, more informative sample.

4.1 Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Thus, rates of carcass persistence reported here should be interpreted cautiously as they may change over the coming months.

Fatality estimates are influenced by the relationship between carcass removal dynamics and search intervals. In practical terms, longer search intervals reduce average probability that a carcass persists until the next search. In terms of the analysis, this can manifest as a lower probability of persistence through the effective search interval, or an effective search interval that is shorter than the nominal search interval. In either case, the adjustment to carcass counts due to carcass removal dynamics is calculated as

$$\frac{length\ of\ effective\ search\ interval}{\begin{array}{c}length\ of\ nominal\ search\ interval * average\ probability\ of\ persistence\\ \text{-}through\ the\ effective\ search\ interval\end{array}}$$

The adjustment to estimated fatality for carcass removal increases with longer search intervals, and the variance in the estimate may increase, also.

Searcher efficiency was influenced by Project component, carcass size, and season. In the solar arrays, searcher efficiency was high (> 0.5) for all carcass size classes and this is likely influenced by the limited vegetation cover beneath solar panels. Beneath the gen-tie line, vegetation cover is higher in some portions of the strip transects, but results reported here support the hypothesis that visibility class is not a factor in searcher efficiency along the lines during summer. Placement of trial carcasses in both difficult and easy visibility classes ensures that the adjustment due to searcher efficiency accounts for both visibility classes, even if there is a real difference in searcher efficiency that cannot be detected with the trial data.

Comentado [FWS40]: Given the low number of trial carcasses, you can detect a difference between visibility classes.

For the current analysis, searcher efficiency in the solar arrays was assumed to be ~~best~~ predicted by a half-normal distribution. For future analyses, AICc will be used to compare and choose the ~~best~~ most supported among multiple detection functions.

4.2 Distribution of Fatalities and Fatality Estimates

The number of detections was more or less evenly distributed across the summer season, and there were no clear associations between number of detections and date. Given the small number of detections overall, it is premature to draw any conclusions about the spatial distribution of carcasses.

Composition of detections during summer 2015 included eight avian guilds. Corvids comprised the majority of detections (n = 3): there were two detections each within the doves/pigeons, rails/coots, and waterbirds/waterfowl guilds. No bats have been detected since monitoring began at the Project.

Detections attributed to an unknown cause accounted for 20.0% of all detections (68% of which were feather spots) during the reporting period, and all those attributed to an unknown cause were found in the solar arrays. Of the 11 detections made in the solar arrays, 36.4% were feather spots. Determining a cause of mortality from a feather spot is challenging because there is rarely visible evidence available on which to determine a cause of death. Thus, feather spots with an unknown cause of mortality could be encountered anywhere birds occur, and an unknown cause of a sizeable proportion of the carcasses is not unique to the Project. Further, game cameras trained on carcasses for carcass persistence trials at the Project have documented multiple feather spots originating from a single trial carcass. Ravens and turkey vultures, and possibly roadrunners, dislodge feathers from their attachment to the skin of carcasses during the scavenging process. There are a very large number of potential feather spots present on a single bird carcass (because a feather spot is defined as at least two or more primary flight feathers, at least five or more tail feathers, or two primaries within five m (16.4 ft) or less of each other, or a total of 10 or more feathers of any type concentrated together in an area of three square m). T~~t~~he relatively large proportion of feather spots (33.3%) among the detections for the Project as a whole may inflate the fatality estimate when unknown cause detections are included based on the potential for multiple feather spots resulting from one

Comentado [FWS41]: What fraction of these unknown detections are feather spots?

Comentado [FWS42]: We don't agree with this statement. This is unknown. Feather spots may be more mobile, but as far as I know there have been no studies on whether they "multiply" and cause bias. If there has, please provide a reference. It is possible that feather spots could accumulate along fences, but in general, they are just as likely to migrate into a survey area as they are to leave. If this is a significant problem, then I recommend shorter search intervals and more complete coverage of the project site.

fatality, feather spots resulting from predation not associated with the facility, or other causes. However, feather spots are included in the analysis here to provide a more conservative estimate of fatality.

5.0 LITERATURE CITED

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in 2nd International Symposium on Information Theory (B. N. Petran and F. Csaki, Eds.). Akademiai Kiado, Budapest, Hungary.

Ammon, Elisabeth M. and William M. Gilbert. 1999. Wilson's warbler (*Cardellina pusilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/478

Boarman, William I. and Bernd Heinrich. 1999. Common raven (*Corvus corax*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/476 doi:10.2173/bna.476

Buckland, S, D.R. Anderson, K. P. Burnham, and J.L. Laake. 1993. Distance sampling: estimating abundance of biological populations. Chapman & Hall, London. 446 pp.

Burnham, K.P., and D.R. Anderson. 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociological Methods & Research 33: 261-304.

Evers, David C., James D. Paruk, Judith W. Mcintyre and Jack F. Barr. 2010. Common loon (*Gavia immer*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/313 doi:10.2173/bna.313

Hudon, Jocelyn. 1999. Western tanager (*Piranga ludoviciana*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/432 doi:10.2173/bna.432

Hughes, Janice M. 2011. Greater roadrunner (*Geococcyx californianus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/244 doi:10.2173/bna.244

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. doi: 10.1002/env.1052

Huso, Manuela, Som, Nicholas, and Ladd, Lew, 2012, Fatality estimator user’s guide: U.S. Geological Survey Data Series 729, 22 p.

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A new method to determine bird and bat fatality at wind energy turbines from carcass searches. Wildlife Biology 17: 350-363.

Lowther, Peter E. and Janet McI. Williams. 2011. Nashville warbler (*Oreothlypis ruficapilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/205 doi:10.2173/bna.205

Manly, B.F.J.1997. Randomization, bootstrap and Monte Carlo methods in biology. Second Edition. CRC Press, LLC, Boca Raton, Florida, 455 pp.

Melvin, Scott M. and James P. Gibbs. 2012. Sora (*Porzana carolina*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/250 doi:10.2173/bna.250

Muller, Martin J. and Robert W. Storer. 1999. Pied-billed grebe (*Podilymbus podiceps*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/410 doi:10.2173/bna.410

Murray, J. 2004. Nocturnal flight call analysis as a method for monitoring density and species composition of migratory songbirds (Order Passeriformes) across southern Vancouver Island, British Columbia in 2004. Rocky Point Bird Observatory, 16 pp.

Newton, I. 2008. The migration ecology of birds. Academic Press, London.

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine-cause avian fatality estimates. Journal of Wildlife Management 74(5): 1089-1096.

Smallwood, K. S. 2013. Comparing bird and bat ratality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37(1): 19-33.

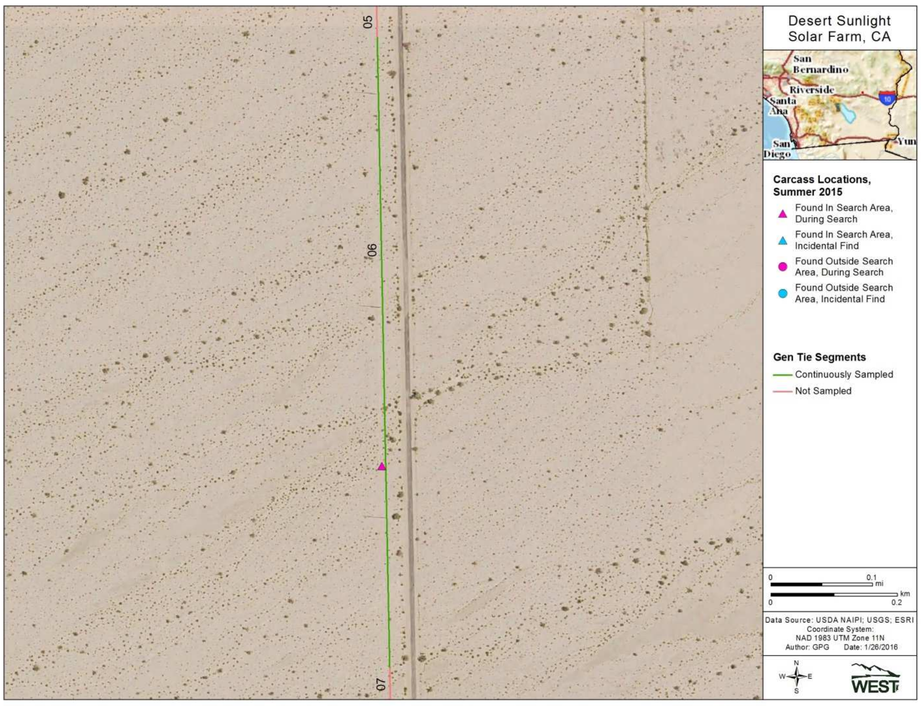
Therneau, T. 2015. _A Package for Survival Analysis in S. version 2.38, <URL: http://CRAN.R-project.org/package=survival>.

Therneau, T.M. and P. M. Grambsch 2000. Modeling Survival Data: Extending the Cox Model. Springer, New York. ISBN 0-387-98784-3.

Western Ecosystems Technology (WEST), Inc. 2014. Bird and bat conservation strategy, Desert Sunlight Solar Farm Project, Riverside County, California. 57 pp.

Wheelwright, N. T. and J. D. Rising. 2008. Savannah sparrow (*Passerculus sandwichensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/045 doi:10.2173/bna.45

Appendix A. Detailed Areas of Carcass Locations along the Generation Tie Line of the Desert Sunlight Solar Farm Project during Summer (June 01 – August 30) 2015



Data Source: USDA NAIPI; USGS; ESRI
Coordinate System:
NAD 1983 UTM Zone 11N
Author: GPG Date: 1/26/2016

Figure A-1. Detailed map of a carcass location along the generation tie line at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

Figure A-2. Detailed map of a carcass location along the generation tie line at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

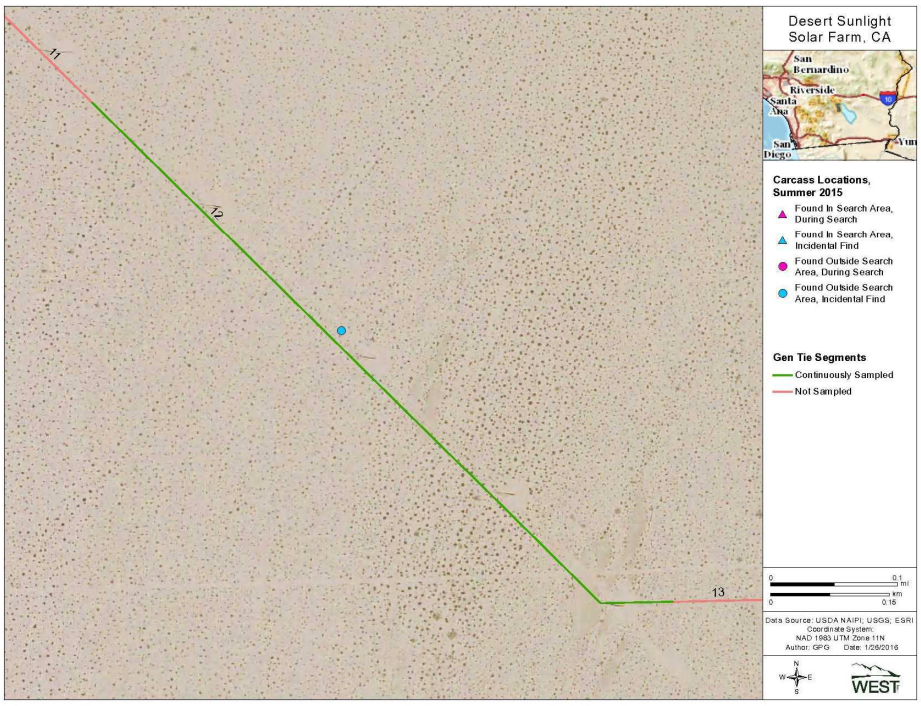


Figure A-3. Detailed map of a carcass location along the generation tie line at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015. This carcass was > 15 m from the gen-tie line, and was therefore excluded from the fatality estimate based on location.

Appendix B. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during Summer (June 01 – August 30) 2015

Table B-1. Weather conditions and body weights associated with avian detections estimated to be less than 24 hours old during summer (June 01 – August 30) 2015 at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hrs)	Species	Weight (g)	Weather Summary for Preceding 24 hrs
071715-SORA-GENTIE-06-01	7/17/2015	0-8hrs	sora	63	AVERAGE WIND SPEED OF 9MPH TO THE SOUTH, CLEAR 10 MILE VISIBILITY, MAX TEMPERATURE IS 107 DEGREES, MINIMUM IS 79 DEGREES, NEW MOON 1% ILLUMINATED
062415-HOWR-01-16MVOH-02	6/24/2015	8-24hrs	house wren	7	JUN 23, MAX TEMP 114, AVG WIND SPEED 10MPH-SSW, MAX WIND SPEED 16MPH. MAX GUST 21MPH. VIS 10 MILES, CLEAR UNTIL 3PM THEN PARTLY CLOUDY UNTIL 7PM, THEN CLEAR THROUGH NOGHT. MOON PHASE: WAXING CRESENT. CLEAR ALL DAY 6/24. TEMP 99 DEG F WHEN BIRD FOUND

Appendix C. Correction Factors and Bird Fatality Rates at the Desert Sunlight Solar Farm Project during Summer (June 01 – August 30) 2015.

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during summer (June 01 – August 30) 2015. *Distribution of easy and difficult visibility on the gen-tie line was about ~~70~~50% and ~~30~~50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	Mean	CI	Mean	90% CI	Mean	90% CI	Mean	90% CI
Proportion of area searched by component								
Gen-tie line	0.479	-	0.479	-	0.479	-	0.479	-
Fence	0.744	-	0.744	-	0.744	-	0.744	-
Solar arrays	0.295	-	0.295	-	0.295	-	0.295	-
Searcher efficiency by component ~~and visibility class~~ from all available data across seasons								
~~Gen-tie line: Easy vis.*~~	~~0.583~~	~~0.417 - 0.750~~	~~0.952~~	~~0.857 - 1.000~~	~~0.8~~	~~0.600 - 1.000~~	~~0.583~~	~~0.417 - 0.750~~
~~Gen-tie line: Difficult vis.*~~	~~0.435~~	~~0.261 - 0.609~~	~~0.706~~	~~0.529 - 0.882~~	~~0.6~~	~~0.300 - 0.800~~	~~0.435~~	~~0.261 - 0.609~~
~~Gen-tie line: Weighted avg.*~~	~~0.539~~	~~0.419 - 0.665~~	~~0.878~~	~~0.794 - 0.947~~	~~0.74~~	~~0.570 - 0.880~~	~~0.539~~	~~0.419 - 0.665~~
Gen-tie line*	0.662	0.519 - 0.815	0.954	0.869 - 1.000	0.999	1.000 - 1.000	0.662	0.519 - 0.815
Fence	0.875	0.733 - 1.000	0.987	0.943 - 1.000	1.000	1.000 - 1.000	0.875	0.733 - 1.000
Solar arrays	0.599	0.524 - 0.669	0.866	0.794 - 0.927	0.981	0.945 - 1.000	0.599	0.524 - 0.669
Average probability of carcass persistence through the effective search interval (estimates from summer data only)								
Gen-tie line	0.215	0.138 - 0.260	0.596	0.372 - 0.735	0.215	0.138 - 0.260	0.215	0.138 - 0.260
Solar arrays & fence:	0.633	0.478 - 0.757	0.733	0.548 - 0.863	1.000	1.000 - 1.000	0.633	0.478 - 0.757
Adjustment for effective search interval (proportion of nominal search interval)								
Gen-tie line: Summer effective search interval	0.278	0.202 – 0.355	1.00	-	0.175	0.122 – 0.223	0.278	0.202 – 0.355
Solar arrays & fence: Summer effective search interval	1.00	-	1.00	-	1.00	-	1.00	-
Carcass counts by component								
Gen-tie line	1	0 - 3	0	-	1	0 - 3	0	-
Fence	0	-	0	-	0	-	0	-
Solar arrays	2	0 - 4	0	-	5	1 - 10	1	0 - 3
Average Probability of Carcass Availability and Detected (Searcher efficiency * average probability of carcass persistence)								
Gen-tie line	0.040	0.020 - 0.054	0.569	0.357 - 0.713	0.038	0.020 - 0.050	0.040	0.020 - 0.054
Fence	0.554	0.406 - 0.683	0.723	0.527 - 0.851	1.000	1.000 - 1.000	0.554	0.406 - 0.683
Solar arrays	0.379	0.278 - 0.462	0.379	0.472 - 0.757	0.981	0.945 - 0.999	0.379	0.278 - 0.462
Adjusted Fatality Estimates (Fatalities /Season; values in italics are considered unreliable due to low counts of carcasses: carcass count / (proportion of area searched * average probability of carcass availability and detected)**								
Gen-tie line	*50.8*	*(1) - 200.2*	*0*	-	*53.5*	*(1) - 223.8*	*0*	-
Fence	*0*	-	*0*	-	*0*	-	*0*	-

Comentado [FWS43]: This table/appendix requires more explanation.

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during summer (June 01 – August 30) 2015. *Distribution of easy and difficult visibility on the gen-tie line was about ~~70~~50% and ~~30~~50%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

Comentado [FWS43]: This table/appendix requires more explanation.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Solar arrays	*17.9*	*(2) - 41.5*	*0*	*-*	*17.3*	*(5) - 34.5*	*8.9*	*(1) - 27.8*
Facility	*68.7*	*(3) - 212.1*	*0*	*-*	*70.8*	*(6) - 238.4*	*8.9*	*(1) - 27.8*

Table C-2. Carcasses excluded from the summer 2015 fatality analysis at the Desert Sunlight Solar Farm.

Parameter	**Small birds**	**Medium birds**	**Large birds**	**Unknown size**	**Bats**
LA solar arrays	2	0	0	0	0
NLA solar arrays	1	0	0	0	0
Fence	0	0	1	0	0
Gentie line	1	0	0	0	0

Tabla con formato

Additional Documentation Attachment to Comment 2-F1
Attachment I-3

Carcass Removal Assessment; Desert Sunlight Solar Farm

Proposed Methodology

PREPARED BY:

***Corvus* Ecological Consulting, LLC**

7810 Highway 89
Suite 270
Flagstaff AZ 86004

(928) 527-7549 (Office)
(858) 922-3264 (Cell)

PREPARED FOR:

Desert Sunlight Solar Farm

FIRST SOLAR

525 Market Street, 15 Floor

San Francisco, CA 94105

Contents

List of Figures

List of Tables

OVERVIEW

A draft *Bird and Bat Fatality Monitoring Plan for the Desert Sunlight Solar Farm* ("Plan") was prepared by H.T. Harvey and Associates and presented to the Renewable Energy Action Team (REAT), including representatives from the Bureau of Land Management (BLM), United States Fish and Wildlife Service (USFWS) and the California Department of Fish and Wildlife (CDFW); in December 2013. While the details of this plan are still being discussed and a final version has yet to be accepted, the following goals remain consistent:

1. Calculate bird and bat fatality rates for the project and for individual species of concern.
2. What is the composition of fatalities in relation to breeding, migrating, wintering and fully resident species?
3. Do estimated fatality rates vary within the project site in relation to site characteristics, weather patterns, seasonally, or among years?
4. How do the calculated rates compare to those documented for existing projects in similar landscapes with similar species composition and use?

Specific objectives have been outlined to meet the goals of this Plan:

1. Conduct fatality searches throughout the year according to a spatial and temporal sampling plan that provides representative and statistically sound coverage of the solar arrays and associated interrelated and interdependent features.
2. Conduct statistically sound assessments to quantify and evaluate searcher efficiency and support calculations of adjusted fatality rates that account for variation in searcher efficiency.
3. Conduct statistically sound assessments to quantify and evaluate carcass removal rates (i.e. removal/ destruction of carcasses by scavengers, decay or other abiotic factors) and support calculations of adjusted fatality rates that account for relevant spatial and temporal variation in carcass removal rates and variation in removal rates related to carcass size classes.
4. Use current scientifically validated and accepted methods for calculating fatality rates adjusted for searcher-efficiency, carcass removal rates and spatial and temporal sampling intensity.

This document outlines a planned methodology to address objective 3 above, Carcass Removal Assessment

METHODOLOGY

Thirty non-native bird species of three different size classes (ten of each) will be randomly distributed within the survey area. A remote trail camera will accompany each placement and be used to determine: cause of removal (scavenger species or abiotic factor), date of removal and time of removal. Cautionary measures (described below) will be taken to minimize scavenger bias and avoid scavenger swamping. Trial monitoring will consist of a 30-day period for each carcass placement and upon conclusion of the monitoring period, each trial specimen will be classified into one of the following categories based its physical persistence and detectability:

Intact: Whole and unscavenged other than by insects

Scavenged/ depredated: Carcass present but incomplete, dismembered or flesh removed

Feather Spot: Carcass scavenged and removed, but ten or more feathers remain to qualify as a detectable fatality

Removed: Not enough remains to be considered a detectable fatality

Game Cameras

Thirty game cameras will be placed at randomized carcass locations within the Sample Area at least five-days in advance of the trial period in an effort to reduce the possibility that potential scavengers will form an association between cameras and a food subsidy. Cameras will remain in place, even after carcasses have been removed, until the end of the trial period. *Wildgame Innovations LO8* (eight megapixel) cameras will be powered by external battery packs to help ensure trouble-free operations over the monitoring period.

Carcass Placements

The placement of trial carcasses will be randomized within the Sample Area. The Sample Area will consist of primary project components that will be the focus of fatality surveys including: solar arrays, perimeter fence and overhead power lines. Other project areas, such as: retention basins, onsite sub-station and temporary water storage ponds, are not included as part of the Sample Area since focused fatality surveys will not take place within these project features. Areas of active construction, including main access roads, are not included in the Sample Area due to the presence of uncontrolled variables that will not exist once the project enters into a fully-operational phase.

Randomizing Carcass Placements

The methodology described for Avian Carcass Surveys by the draft *Bird and Bat Fatality Monitoring Plan for the Desert Sunlight Solar Farm* is based on the assumption that avian fatalities are random within the Sample Area. The placement of trial specimens for carcass removal assessments is based on the same assumptions used for carcass surveys. Trial specimens were randomly placed using a spatially balanced sampling routine. Areas of primary project components, including solar modules and perimeter fence, were identified in a GIS and an inclusion probability for each was created based on the relative area of each primary project component within the Sample Area. In the case of the linear perimeter fence, an interior buffer distance of 35 meters was applied. Using this approach, thirty carcasses, ten of each size class, will be randomly placed within the Sample Area

Figure 1 depicts randomized trial specimen locations within the Sample Area (energized zones).

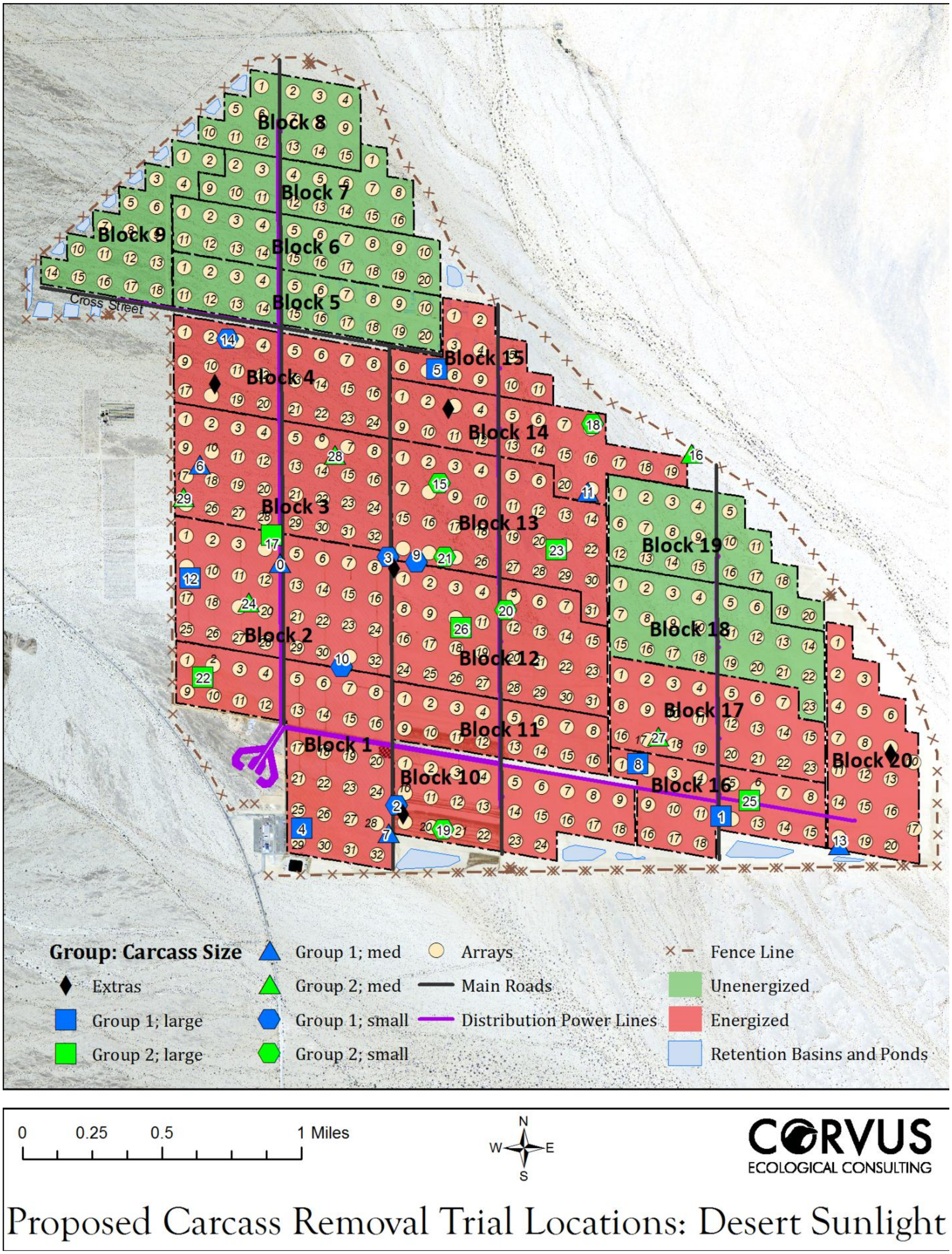


Figure 1 Randomized and Spatially-Balanced Trial Specimen Locations Within the Sample Area.

Timing of Carcass Placements

To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010) trial specimens will be placed over a fifteen-day period. Five days after the installation of thirty game cameras, fifteen trial specimens (five small, five medium and five large) will be placed at random locations within the Study Area. A game camera will be setup within 40-feet of each trial specimen. The initial placement of trial specimens will mark the beginning of the trial period. Fifteen days after the beginning of the trial period, fifteen additional trial specimens (five small, five medium and five large) will be placed at pre-determined random and spatially-balanced locations within the Sample Area. The placement of trial specimens will not be duplicated at any single camera placement and all cameras will remain in place and fully operational throughout the trial period. Trial specimens will be collected (if applicable) thirty days after their placement. The Carcass Removal Assessment will be complete thirty days after the placement of the second group of trial specimens, forty-five days after the beginning of the trial period.

Trial Specimens

Trial specimens will consist of the following size classes/ species:

- Small/ House Sparrow (*Passer domesticus*)
- Medium/ Eurasion Collared-Dove (*Streptopelia decaocto*)
- Large/ Ring-necked Pheasant (*Phasianus colchicus*)

Trial specimens will include only intact, fresh (i.e., estimated to be no more than 1–2 days old and not noticeably desiccated) bird carcasses that were frozen immediately following death.

All carcasses will be handled with latex gloves and handling time will be minimized. All trial specimens will be inconspicuously marked by clipping a toe to distinguish them from unmarked fatalities and other trial specimens.

Periodic Ground-based Monitoring

Biologists will periodically check the placement of each trial specimen to guard against misleading indicators of carcass removal, such as wind blowing the trial specimen out of the camera's field of view. To minimize the potential for scavenger bias caused by the activity pattern of biologists, every camera will be checked (not just those with trial specimens) following a standard schedule. The placement of trial specimens may be checked from a distance, using spotting scopes or binoculars, to avoid close approach. At least once every week, cameras will be checked for proper functioning at the same time that ground-based monitoring is performed.

The following table provides a standard schedule which outlines the periodic ground-based monitoring of trial specimens:

Table 1 Carcass Removal Assessment – Standard Schedule

TRIAL PERIOD - DAYS	TRIAL SPECIMEN GROUP 1 DISPOSITION	TRIAL SPECIMEN GROUP 2 DISPOSITION	GROUND-BASED MONITORING	CAMERA DISPOSITION/ CHECK
-5	NONE	NONE	NONE	PLACEMENT
1	PLACEMENT	NONE	NONE	X
4	X	NONE	X	NONE
7	X	NONE	X	X
15	X	PLACEMENT	X	X
18	X	X	X	NONE
21	X	X	X	X
30	REMOVE	X	X	X
37	NONE	X	X	X
45	NONE	REMOVE	X	REMOVE

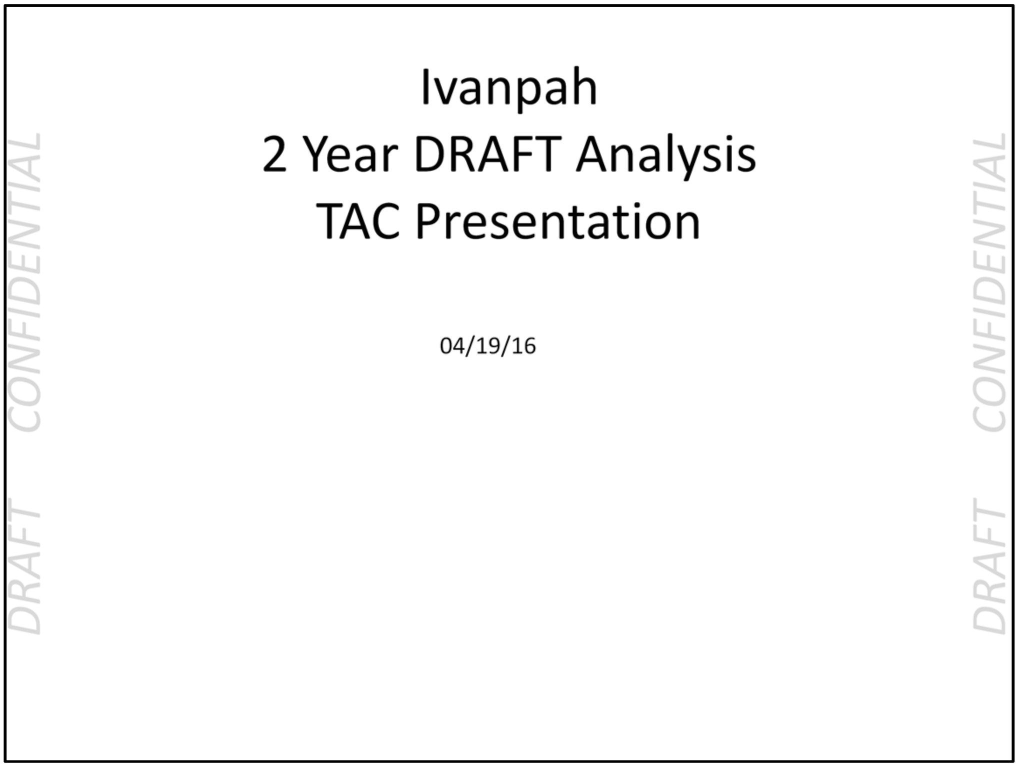
SUMMARY

Carcass removal assessment are a critical component to the overall sampling design aimed at calculating fatality estimates. The fatality estimate will be adjusted for variation in carcass persistence by applying seasonal correlation factors to data for each carcass size class. These data will also be used to inform the search interval for avian carcass surveys.

LITERATURE CITED

Smallwood, K. S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71:2781–2791.

Smallwood, K. S., D. A. Bell, S. A. Snyder, and J. E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine–caused avian fatality estimates. Journal of Wildlife Management 74:1089–1097.



Ivanpah
2 Year DRAFT Analysis
TAC Presentation

04/19/16

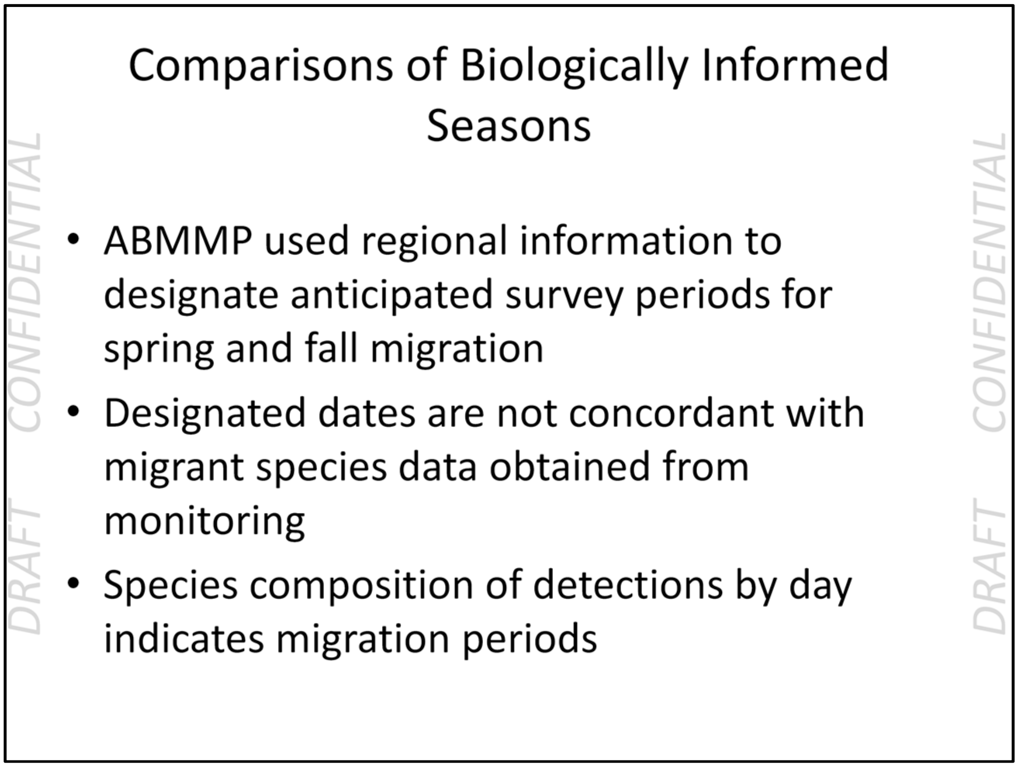
2 Year Draft Analysis

Objective: Obtain meaningful seasonal comparisons

Step 1. Evaluate bird migratory seasons at Ivanpah

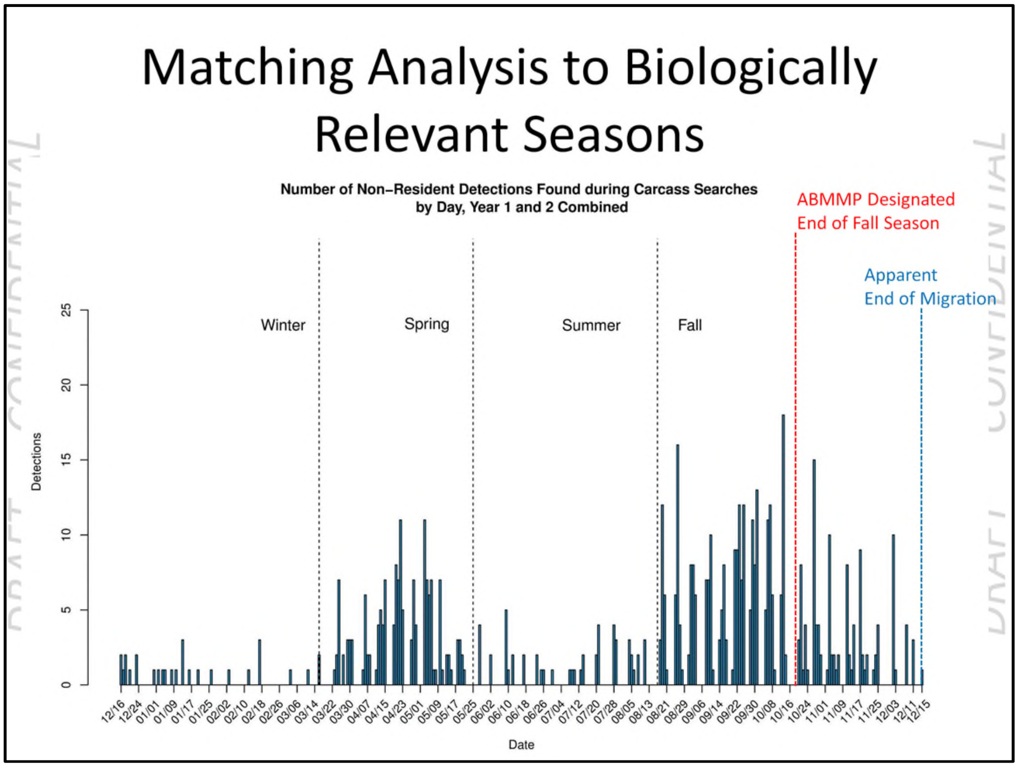
Step 2. Structure seasons to match migratory periods

Step 3. Calculate seasonally adjusted fatality estimates



Comparisons of Biologically Informed Seasons

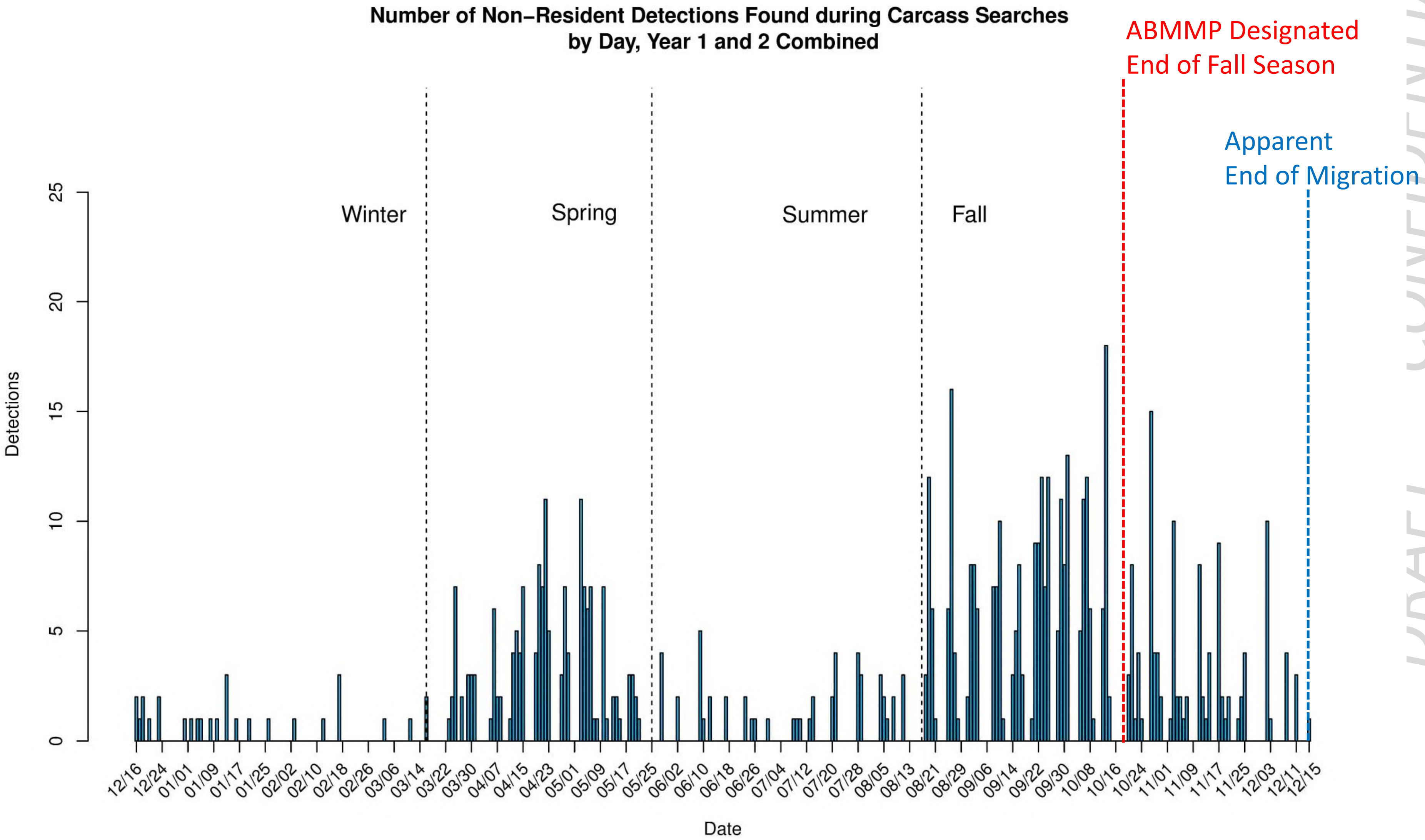
- ABMMP used regional information to designate anticipated survey periods for spring and fall migration
- Designated dates are not concordant with migrant species data obtained from monitoring
- Species composition of detections by day indicates migration periods



Matching Analysis to Biologically Relevant Seasons

-every bird species observed on site was classified as resident or non-resident based on seasonal occurrence site lead biologist
-year 1 and year 2 non-resident detections were aggregated by day
-each bar corresponds to the number of detections found on searches on a particular calendar day, irrespective of year
-red line shows end of "fall" season defined by ABMMP
-blue line shows end of period in which non-resident, migrant birds predominantly show up as detections
-Important note: each survey (or each bar) to the right of the red line corresponds to a search after a 21-day interval. Therefore, each bar represents a "look back" in time; for example
searches on December 03 are capturing fatalities from between November 12 to December 3
-thus, migration likely ends between November 12 and December 3 but based on the survey interval, December 15 is used to define the end of the fall season for analysis
-revised fall seasons dates align with broad patterns in regional migration reported from BirdCast during 2014 and 2015.
-fall migration presents more temporal variation
-survey dates must be comparable between years with season for meaningful comparison regardless of calendar date

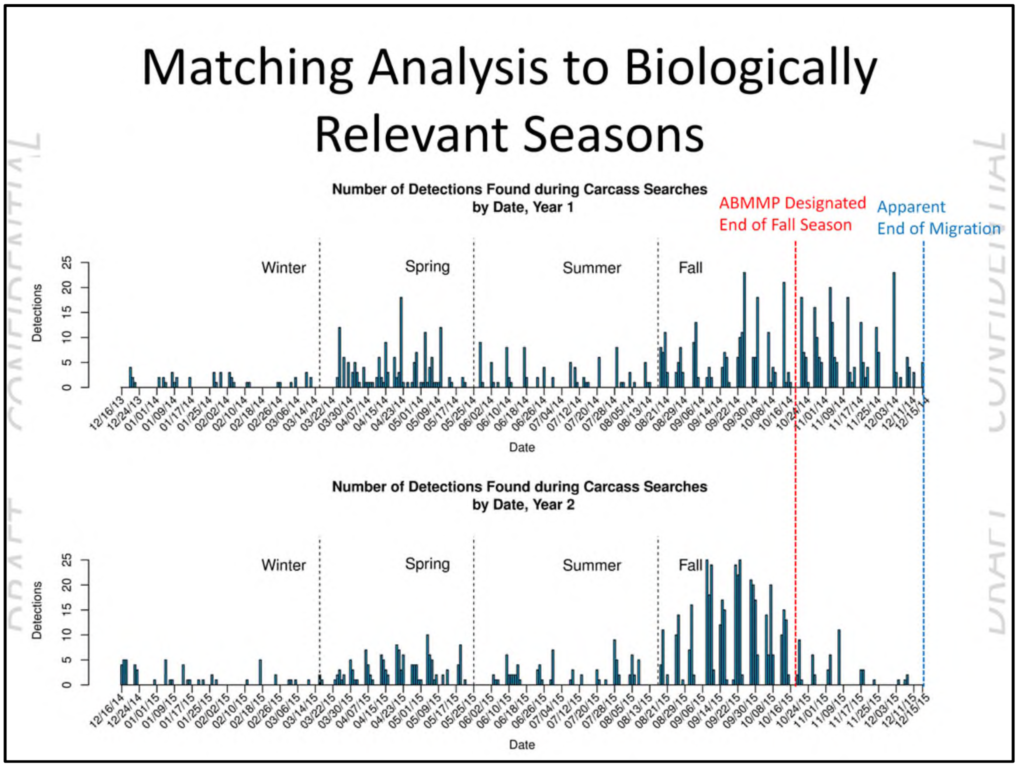
Matching Analysis to Biologically Relevant Seasons



Number of Non–Resident Detections Found during Carcass Searches by Day, Year 1 and 2 Combined

ABMMP Designated End of Fall Season

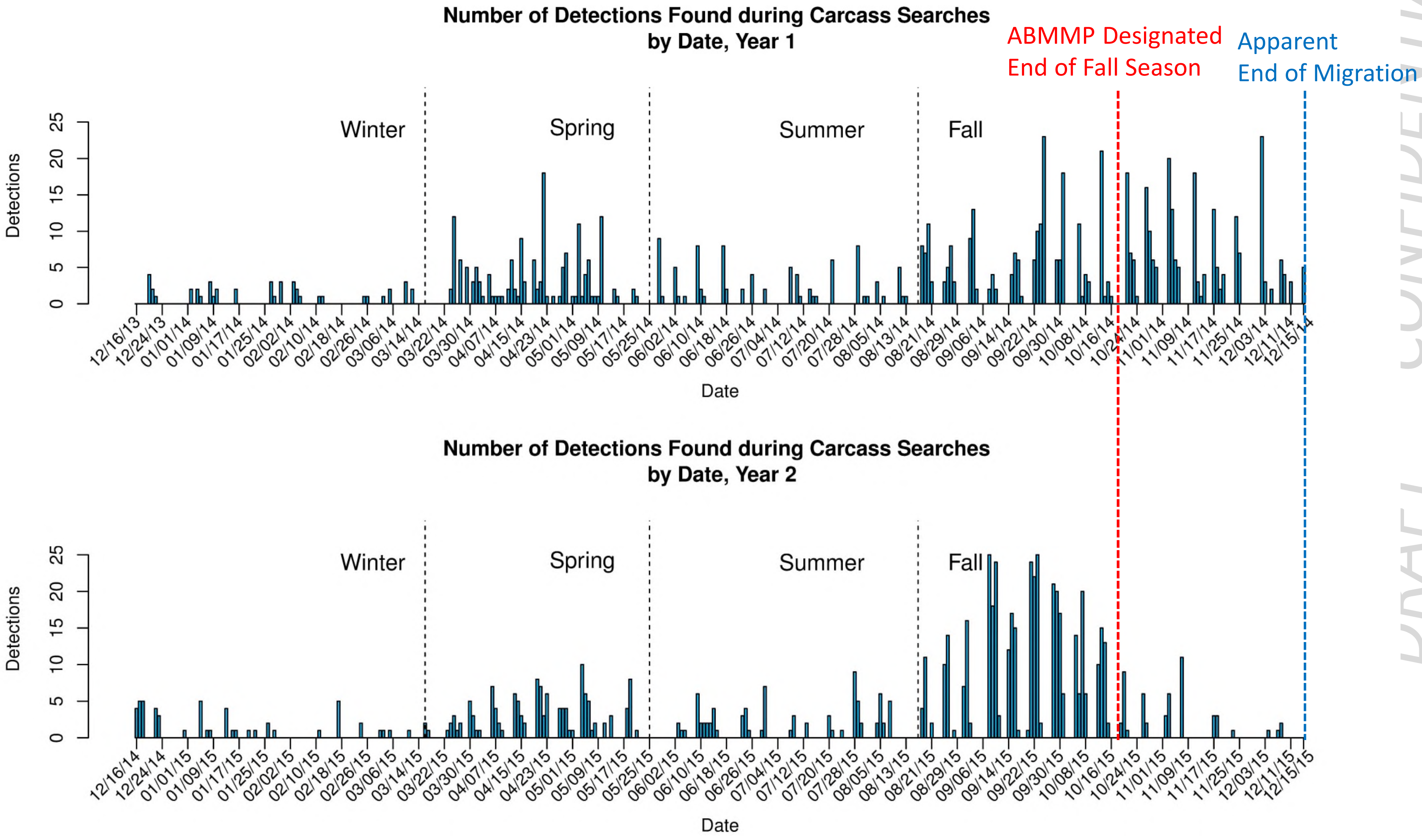
Apparent End of Migration



Matching Analysis to Biologically Relevant Seasons

-number of detections of all species also suggests fall migration extends beyond ABMMP end of fall season
-fall migration shows more temporal variation in migration intensity than spring migration
-although fall migration year 1 longer than year 2, season dates must be aligned for meaningful comparison
-spring migration season and summer season seem well defined by ABMMP season dates

Matching Analysis to Biologically Relevant Seasons

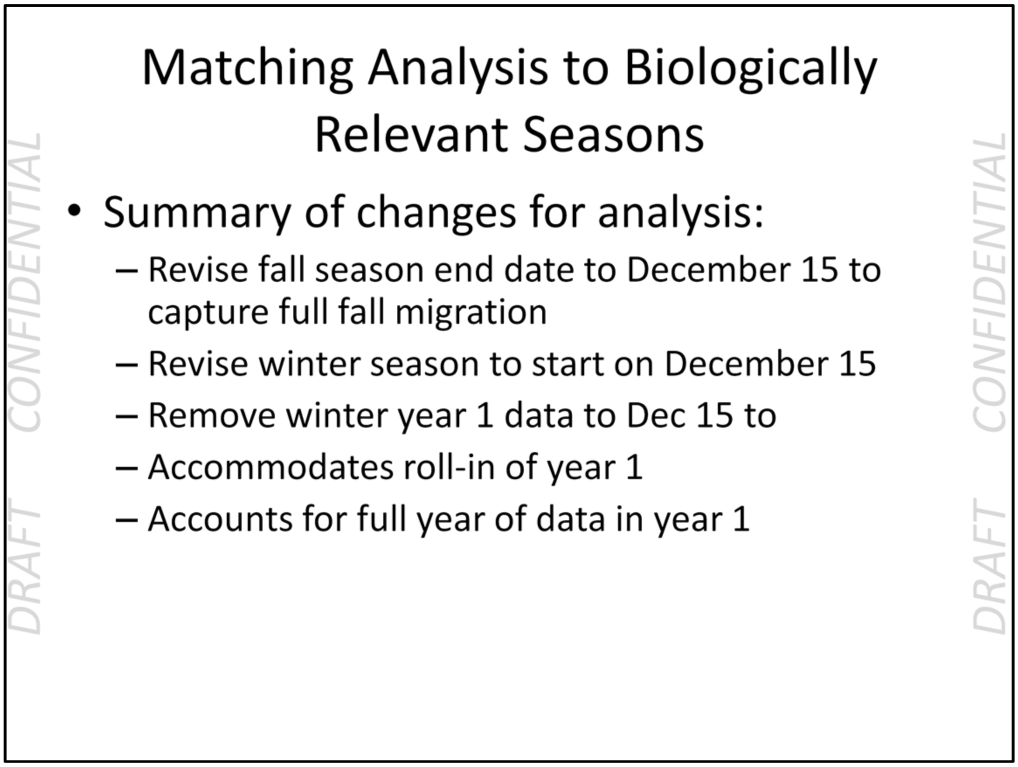


Number of Detections Found during Carcass Searches by Date, Year 1

Number of Detections Found during Carcass Searches by Date, Year 2

ABMMP Designated End of Fall Season

Apparent End of Migration



Matching Analysis to Biologically Relevant Seasons

- Summary of changes for analysis:
  - Revise fall season end date to December 15 to capture full fall migration
  - Revise winter season to start on December 15
  - Remove winter year 1 data to Dec 15 to
  - Accommodates roll-in of year 1
  - Accounts for full year of data in year 1

-change in fall/winter seasons dates allows for more comparable estimates between winter 1 and winter 2. Recall, unit 1 was monitored first in October 2013, followed by unit 3 in early December, and finally unit 2 in early January. Thus, effort and timing of surveys is nearly the same in winter 1 and winter 2 with revised season dates.

Notes on analysis

-The Huso estimator is designed to accommodate variation in search interval during the course of monitoring. The search interval associated with all carcasses found on a given search is calculated, and a survival model is used to estimate the average probability of persistence for each carcass. Therefore, no issues are presented by calculating estimates for a season with a variety of search intervals (i.e. 7-day search intervals in fall up to October 20, followed by 21-day search intervals until December 15).

-Changing the dates for fall/winter seasons does not affect the searcher efficiency or carcass persistence models used to adjust estimates. Biologically informed season dates are utilized to 'bin' fatalities in the most meaningful and consistent way for the purposes of comparing season and years of monitoring at Ivanpah. See below for treatment of searcher efficiency and carcass persistence

> **searcher efficiency**: searcher efficiency data were collected according to the study design and seasons defined in the ABMMP. The top searcher efficiency model has covariates for carcass size and location (2 visibility classes). Since there are no covariates for season or year, searcher efficiency is estimated independent of season dates. The same searcher efficiency model was used to produce annual estimates and seasonally adjusted estimates.

> **carcass persistence**: carcass persistence trial data were collected according to the study

design and seasons defined in the ABMMP. The carcass persistence models were fit for small birds and large birds separately; The top models included a covariate for season for small birds, and an intercept only model for large birds (i.e. no season or location effect). The same carcass persistence models were used to produce annual estimates and seasonally adjusted estimates. The seasons used in the small bird model were defined by the dates described in the ABMMP. Thus, small birds were adjusted for carcass persistence according to the ABMMP season date ranges.

Additional Documentation Attachment to Comment 2-F1
Attachment I-4

A **Review** of **Avian Monitoring** and **Mitigation** Information at Existing Utility-Scale Solar Facilities

Environmental Science Division

ANL/EVS-15/2

AR058868

About Argonne National Laboratory
Argonne is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC under contract DE-AC02-06CH11357. The Laboratory's main facility is outside Chicago, at 9700 South Cass Avenue, Argonne, Illinois 60439. For information about Argonne and its pioneering science and technology programs, see www.anl.gov.

DOCUMENT AVAILABILITY

Online Access: U.S. Department of Energy (DOE) reports produced after 1991 and a growing number of pre-1991 documents are available free via DOE's SciTech Connect (http://www.osti.gov/scitech/).

Reports not in digital format may be purchased by the public from the National Technical Information Service (NTIS):
U.S. Department of Commerce
National Technical Information Service
5301 Shawnee Road
Alexandria, VA 22312
www.ntis.gov
Phone: (800) 553-NTIS (6847) or (703) 605-6000
Fax: (703) 605-6900
Email: **orders@ntis.gov**

Reports not in digital format are available to DOE and DOE contractors from the Office of Scientific and Technical Information (OSTI):
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
www.osti.gov
Phone: (865) 576-8401
Fax: (865) 576-5728
Email: **reports@osti.gov**

ANL/EVS-15/2

A Review of Avian Monitoring and Mitigation Information at Existing Utility-Scale Solar Facilities

---

prepared by
Leroy J. Walston, Jr., Katherine E. Rollins, Karen P. Smith, and Kirk E. LaGory
Environmental Science Division, Argonne National Laboratory

Karin Sinclair, Craig Turchi, Tim Wendelin, and Heidi Souder
National Renewable Energy Laboratory

prepared for
U.S. Department of Energy, SunShot Initiative and Office of Energy Efficiency & Renewable Energy

April 2015

Additional Documentation Attachment to Comment 2-F1
Attachment I-4

CONTENTS

CONTENTS (Cont.)

FIGURES

TABLES

NOTATION

The following is a list of the acronyms, initialisms, and abbreviations (including units of measure) used in this document.

ACRONYMS, INITIALISMS, AND ABBREVIATIONS

ACRP	Airport Cooperative Research Program
ABPP	Avian and Bat Protection Plan
APLIC	Avian Power Line Interaction Committee
APP	Avian Protection Plan
BACI	Before-After Control-Impact
BBCS	Bird and Bat Conservation Strategy
BLM	Bureau of Land Management
BMP	Best Management Practice
CEC	California Energy Commission
CFR	*Code of Federal Regulations*
CSP	concentrating solar power
CVSR	California Valley Solar Ranch
ECPG	Eagle Conservation Plan Guidance
ESA	Endangered Species Act
FAA	Federal Aviation Administration
HTF	heat transfer fluid
ISEGS	Ivanpah Solar Electric Generating System
IR	Iberdrola Renewables, LLC
NEPA	National Environmental Policy Act
NREL	National Renewable Energy Laboratory
PSEGS	Palen Solar Electric Generating System
PV	photovoltaic
R&D	research and development
RPM	revolution per minute
SAM	System Advisor Model
USC	*United States Code*
USFWS	U.S. Fish and Wildlife Service
UV	ultraviolet
WEG	Wind Energy Guidelines

ACKNOWLEDGMENTS

This project was funded by the U.S. Department of Energy SunShot Initiative under contract DE-AC02-06CH11357. Stephanie Meyers, Ellen White, and Andrew Orr of Argonne National Laboratory provided technical assistance in report preparation. This report was improved on the basis of comments from the following reviewers:

- Brian Boroski, H.T. Harvey & Associates
- Joe Desmond, BrightSource Energy
- Marc Sydnor, Sydnor and Associates
- Sandra Brewer, BLM Nevada
- Joe Vieira, BLM Colorado
- Scott Murtishaw, California Public Utilities Commission
- Julie Falkner, Defenders of Wildlife
- Patrick Gilman, U.S. Department of Energy Wind and Water Power Technologies Office
- John Swaddle, College of William and Mary

SUMMARY

There are two basic types of solar energy technology: photovoltaic and concentrating solar power. As the number of utility-scale solar energy facilities using these technologies is expected to increase in the United States, so are the potential impacts on wildlife and their habitats. Recent attention is on the risk of fatality to birds. Understanding the current rates of avian mortality and existing monitoring requirements is an important first step in developing science-based mitigation and minimization protocols. The resulting information also allows a comparison of the avian mortality rates of utility-scale solar energy facilities with those from other technologies and sources, as well as the identification of data gaps and research needs.

This report will present and discuss the current state of knowledge regarding avian issues at utility-scale solar energy facilities by:

1. Summarizing available avian fatality data and issues;
2. Summarizing current monitoring activities and reporting requirements;
3. Summarizing avian mortality data for non-solar development activities;
4. Summarizing mitigation measures being used or considered by solar developers;
5. Evaluating mitigation measures that have been successfully employed for non-solar activities for those that may be effective for solar development;
6. Examining solar-technology-specific aspects of avian fatality, including solar flux associated with power towers; and
7. Recommending future steps.

Several federal and state regulations apply to the protection of birds at solar energy developments. Most birds are protected by the Migratory Bird Treaty Act, which prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when authorized by the U.S. Fish and Wildlife Service. Projects are also required to comply with state and federal regulations to protect threatened, endangered, and certain other species (e.g., Endangered Species Act, Bald and Golden Eagle Protection Act, Bureau of Land Management policy, and state wildlife codes). Because the potential for impact to birds and their populations depends largely on project size and location, specific requirements for threatened, endangered, and sensitive bird species are often considered on a project-specific basis.

Like many industrial activities, utility-scale solar energy development has the potential to impact, directly and indirectly, birds and bird communities in a number of ways, such as by habitat degradation, habitat loss, habitat fragmentation, and direct fatality. This report summarizes existing information about direct impacts, of which there are two general types: collision-related and solar-flux-related. Collision-related impacts may occur from all types of solar energy technologies. The effects of solar flux on birds have so far been observed only at facilities employing concentrated-solar-power towers.

Information and data summarized in this report were collected directly from solar energy companies, industry organizations, and state and federal regulatory agencies, as well as through Internet searches. Compared with other industries, there are relatively few reports that describe or quantify the interaction of birds with utility-scale solar power facilities. Most of the available information on solar-avian interactions is from projects in the southwest United States. In total, avian monitoring plans and/or fatality data are known to exist for 15 solar energy facilities (14 of them in the U.S.). Not all utility-scale solar energy developments in the United States are required to prepare project-specific avian monitoring protocols. A Bird and Bat Conservation Strategy (BBCS) may be part of a solar energy application when an environmental review indicates the need for one. The BBCS outlines an approach for assessing the risks for impacts to birds and bats, designing the facility to avoid and minimize risks, and monitoring avian activity and fatalities in the vicinity.

Evaluating avian mortality rates and patterns is important for comparing avian mortality risk for utility-scale solar facilities with that for other energy developments. However, as discussed in this report, data collected to date from utility-scale solar facilities are not adequate to support such evaluations and comparisons. Avian fatality data were available for seven solar energy facilities in the United States. Of these, systematic avian fatality data were available for only four.

Available project-specific data, discussed in this report, are presented in Appendix B. Existing monitoring requirements and mitigation measures employed by the solar industry and other industries are also presented in this report. Specific solar energy technological factors that have been identified and possibly associated with avian fatality, including solar flux, are discussed.

Standardization of data collection and methodology is essential for comparing avian mortality between projects and across industries. However, the paucity of information for solar energy facilities and its lack of standardization make it impossible to develop an industrywide avian mortality estimate or comparison with any scientific certainty. Standardized methods would increase certainty in mortality estimates by accounting for the following factors that may bias mortality calculation: searcher efficiency, search effort, predation and scavenging, and the role of background mortality.

On the basis of the findings presented in this report, several recommendations can be made to improve understanding of avian fatality issues at utility-scale solar energy facilities. There is a basic need to understand the cause of fatalities (e.g., collision, flux, and predation) within solar arrays and associated infrastructure for a variety of avian species. The findings presented in this report point to several recommendations for improving understanding of avian fatality issues at utility-scale solar energy facilities:

1. Not all utility-scale solar energy developments in the United States have been required to prepare and comply with project-specific avian monitoring protocols, particularly projects located on private lands. Available BBCSs revealed opportunities to improve consistency and standardization in avian monitoring and reporting protocols. Building upon lessons learned from the wind energy industry, adopting programmatic guidelines similar to those for wind energy would likely (a) promote standardized monitoring, data collection, and reporting throughout the solar energy industry; (b) promote compliance with relevant wildlife laws and regulations; (c) encourage scientifically rigorous survey, monitoring, assessment, and research designs proportionate to the risk to species of concern; (d) produce potentially comparable data from different geographical regions; and (e) mitigate potential adverse effects on species of concern and their habitats using avoidance, minimization, and habitat compensation strategies.

2. More systematic data from solar energy facilities across geographic regions will clarify avian risks of the solar industry and allow comparison with risks of other energy sources. Standardized monitoring methodologies and assessment approaches will vastly improve the scientific certainty of conclusions about avian risk and mortality; the types of birds impacted; the contribution of background mortality to fatality data sets; the influence of facility attraction to birds; and other factors, such as predation.

3. As efforts get under way to increase the amount and compatibility of avian mortality data collected from utility-scale solar facilities, researchers should seize the opportunity create science plans to tailor data collection to their research needs to inform future decisions about solar energy project siting and design. Such science plans should focus on (1) uncertainties related to avian risks and causative factors; (2) population-level impacts to migratory birds; (3) development of more effective inventory and monitoring techniques; and (4) guiding the development of pilot studies to assess causative factors, the potential to mitigate effects, and the implications of mitigation measures and best management practices to energy production.

Moving forward, the industry, federal and state agencies, and other stakeholders might all benefit from working collaboratively towards (1) developing and implementing useful and scientifically rigorous data collection program, (2) evaluating avian mortality related to utility-scale solar development and the causal effects, and (3) identifying appropriate mitigation measures to address identified issues.

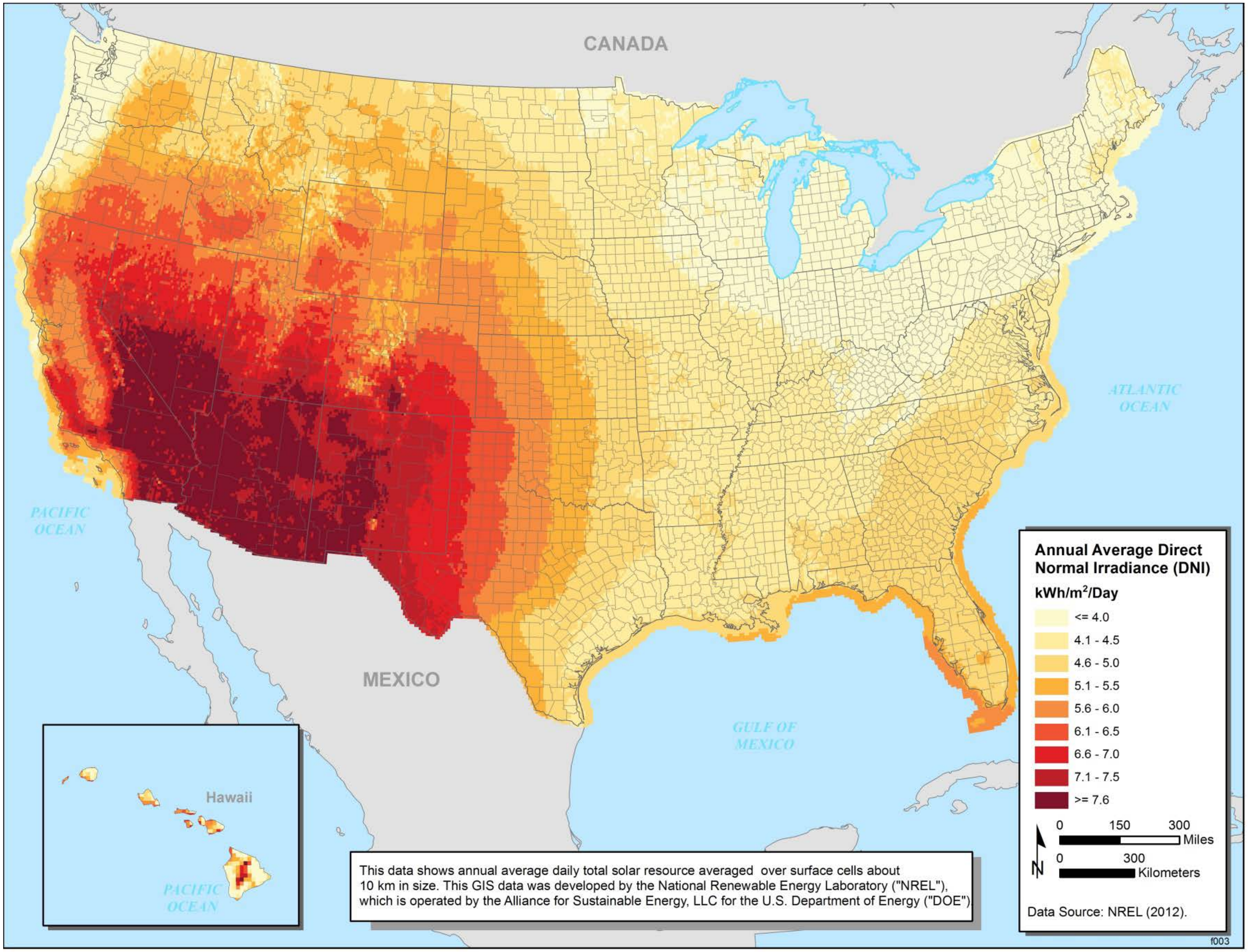
1 INTRODUCTION

Renewable energy development has been increasing as an alternative to fossil-fuel-based technologies, in large part to reduce toxic air emissions and carbon-dioxide-induced effects on climate (Shafiee and Topal 2009; Allison et al. 2014). According to the U.S. Energy Information Association (2014), electric generation from renewables in the United States has increased by more than 50% since 2004, and renewable energy sources currently provide approximately 14% of the nation’s electricity. Solar energy-based technologies represent a rapidly developing renewable energy sector that has seen exponential growth in recent years (Lewis 2007; Bolinger and Weaver 2013). Electrical generation from solar energy is expected to more than double between 2013 and 2015, with about two-thirds of new solar capacity built in California (EIA 2014).

Utility-scale solar energy projects generate electricity for delivery via the electric transmission grid and sale in the utility market. This differs from distributed solar energy systems which are designed at smaller scales (<1 MW). According to the Solar Energy Industries Association (SEIA 2014a), there currently are approximately 800 utility-scale solar energy projects (>1 MW) that are either planned, under construction, or in operations in the United States, representing more than 43 GW of electric capacity. Models developed by the National Renewable Energy Laboratory (NREL 2012) indicate the greatest solar resource potential in the United States is in the Southwest (Figure 1). Indeed, the SEIA (2014b) map in Figure 2 shows that most domestic utility-scale solar development is in Arizona, California, Colorado, Nevada, New Mexico, and Utah.

There are two basic types of solar energy technology: photovoltaic (PV) and concentrating solar power (CSP). Photovoltaic systems use cells to convert sunlight to electric current, whereas CSP systems use reflective surfaces to concentrate sunlight to heat a receiver. The heat is converted to electricity using a thermoelectric power cycle. CSP systems typically include power tower systems with heliostats (angled mirrors) and parabolic trough systems (parabolic mirrors). In the United States, most of the electricity produced by utility-scale solar energy projects through 2014 was generated using PV technologies (SEIA 2014b). An overview of utility-scale solar power systems is provided in Section 1.1.

Despite its benefits of reduced toxic and carbon emissions and renewable generation, utility-scale solar development can impact ecological systems and other environmental resources, including species and their habitats (Lovich and Ennen 2011; Hernandez et al. 2014). Recent studies have demonstrated that utility-scale solar developments represent a source of fatality for wildlife such as birds (e.g., Kagan et al. 2014); however, there are relatively few systematic and empirically based studies that address avian fatality issues at solar facilities (but see McCrary et al. 1986; WEST 2014).



This data shows annual average daily total solar resource averaged over surface cells about 10 km in size. This GIS data was developed by the National Renewable Energy Laboratory ("NREL"), which is operated by the Alliance for Sustainable Energy, LLC for the U.S. Department of Energy ("DOE").

Data Source: NREL (2012).

FIGURE 1 Solar Energy Potential in the United States (Source: NREL 2012)

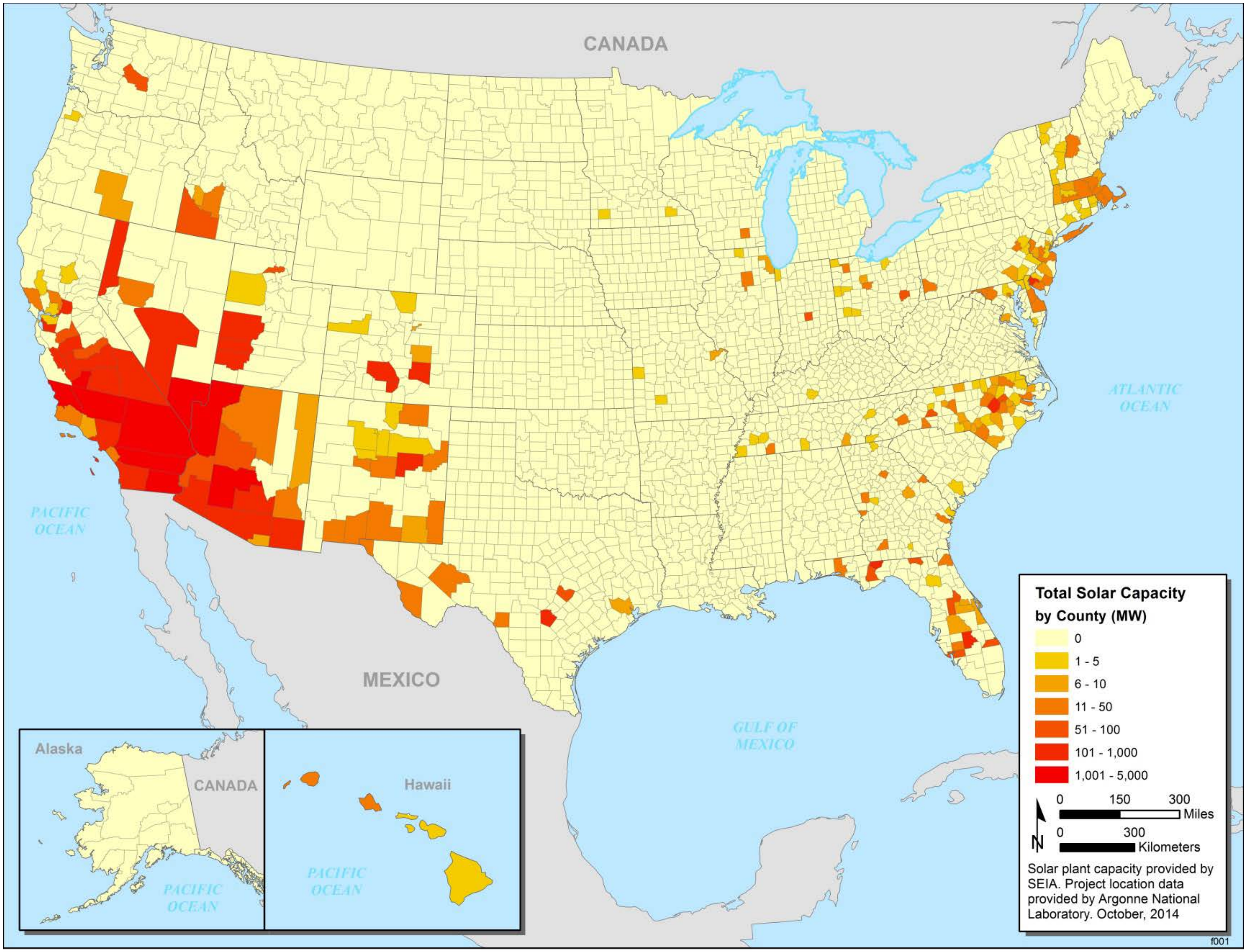


FIGURE 2 Total Solar Utility-Scale Energy Production Capacity (MW) by County (Source: SEIA 2014b)

Understanding current rates of avian mortality at utility-scale solar facilities and existing monitoring requirements is an important first step toward the development of science-based monitoring, avoidance, minimization, and mitigation protocols. Such an effort would aid in understanding the relative mortality rates compared with those from other technologies and sources, as well as the identification of data gaps and potential research needs. The purpose of this report is to summarize the current state of knowledge regarding avian issues at utility-scale solar energy facilities by:

1. Summarizing available avian fatality data and issues;
2. Summarizing current monitoring activities and reporting requirements;
3. Summarizing avian mortality data for non-solar development activities;
4. Summarizing mitigation measures being used or considered by solar developers;
5. Evaluating mitigation measures that have been successfully employed for non-solar activities for those that may be effective for solar development;
6. Examining solar-technology-specific aspects of avian fatality, including solar flux associated with power towers; and
7. Recommending future steps.

1.1 OVERVIEW OF UTILITY-SCALE POWER SYSTEMS

Utility-scale solar power systems are loosely defined as ground-mounted facilities larger than 1 MW_e that are tied directly to the transmission grid. Many facilities are larger than 1 MW_e, and the plants can range up to several hundred megawatts in size and cover hundreds of acres. The growing number of utility-scale solar facilities is a direct result of falling costs of the technologies and the desire to deploy more low-carbon, renewable power into the U.S. electric grid.

Solar power systems are divided into technologies that convert sunlight directly into electricity (PV technologies) and technologies that collect the sun’s light and convert it into thermal energy. PV systems generate power without any appreciable noise, pollution, or fuel consumption; involve few moving parts; and require little routine maintenance, especially when compared with other power-generation technologies. All PV systems consist of three basic subsystems: (1) PV modules; (2) inverters and power electronics; and (3) structural and wiring hardware, commonly referred to as the balance of system. PV modules are fundamentally the same, whether the system is mounted on a residential rooftop or in a large, utility-scale plant.

Solar thermal electric systems, also known as concentrating solar power (CSP) systems, first capture sunlight as heat and then convert the thermal energy into electricity via a thermoelectric power cycle. A CSP plant uses mirrors to focus sunlight onto a “receiver” that contains a flowing liquid, or heat transfer fluid (HTF). The reflectors may be made of glass mirrors or highly reflective polymer films. The hot HTF may be pumped to a storage tank or pumped directly to heat exchangers in the power block to produce steam. Electric power is made by spinning a steam turbine/generator. A major benefit of CSP technologies is the ability to efficiently store the hot HTF and retrieve it later to produce power in periods of poor or no sunlight. The various technologies are summarized in Table 1.

The cost of solar power technologies has fallen dramatically in the past few years due to new technology developments, lower manufacturing costs, and increased deployment volume. Utility-scale plants continue to represent the lowest installed cost and levelized cost of electricity for solar power. PV systems are the most prevalent and lowest-cost solar power technology. CSP systems with thermal energy storage provide more consistent power, with fewer challenges related to grid integration, but they currently have a higher levelized cost per kilowatt-hour.

The most obvious impact of a solar power plant is the occupied land area. Land area per megawatt of capacity depends on several factors, including the solar resource quality, technology, collector/module efficiency, and inclusion of thermal energy storage (for CSP). In general, solar plants occupy between 5 and 10 acres per megawatt of alternating current (MW_{ac}) capacity and between 3 and 4 acres per annual gigawatt-hour of generation (Ong et al. 2013). Including thermal energy storage in CSP plants increases land usage per capacity (acre/MW_{ac}), but decreases land usage per energy generation (acre/GWh). These effects of thermal storage occur because the collector field area increases (to allow charging of storage), and the annual power block operating time increases (when storage is discharged), but the power block size is unchanged. A comparison of land use per gigawatt-hour of generation indicates that utility-scale solar technology has a lower impact than other renewable-generation technologies (such as wind and hydropower) and is comparable to fossil extraction (such as coal extraction) (Fthenakis and Kim 2009).

1.2 REGULATORY CONTEXT

Federal and state regulations provide the legal framework for addressing avian fatality issues at solar energy facilities. Solar projects sited and designed with a federal nexus (i.e., constructed on public land) are required to use the National Environmental Policy Act (NEPA) process and any applicable state environmental planning regulations. Projects without a federal nexus are not subject to NEPA but may be subject to state-level environmental planning regulations. Other federal regulations include the Federal Land Policy and Management Act, Endangered Species Act (ESA), Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act, and policies of federal land managers such as the Bureau of Land Management special status species policy (BLM 2008). State regulations vary by state, but examples include state-level environmental planning requirements (e.g., the California Environmental Quality Act) and policies to protect state-listed special status wildlife (e.g., *California Fish and Game Code*, California Endangered Species Act, and *Nevada State Codes*).

TABLE 1 Common Utility-Scale Solar Technologies

Technology	Key Features	
PV fixed-tilt	• Simplest design, with no moving parts • Thin-film or silicon cells • No cooling water requirement	
PV tracking	• More sun-capturing efficiency because the PV panels rotate to follow the sun • Typically used with crystalline silicon cells • No cooling water requirement	
CSP parabolic trough	• Linear receivers with single-axis tracking • Can include thermal energy storage • Usually wet cooled • Most common and most mature CSP technology	
CSP power tower	• Two-axis tracking heliostats surround a central tower-mounted receiver • Can include thermal energy storage • More cost effective than parabolic troughs • Can be wet or dry cooled	

2 SUMMARY OF AVIAN FATALITY ISSUES AND STUDY METHODOLOGY

2.1 SUMMARY OF ISSUES

One commonality among utility-scale solar facilities of all technology types is that they occupy relatively large spatial footprints to capture the sun's energy. The development of utility-scale solar facilities, therefore, represents a large human land use in the environment, which has the potential to affect birds and bird communities in a number of ways and during all project phases (construction, operations, and decommissioning). The range of potential impacts from utility-scale solar projects on birds and other wildlife has been evaluated in the literature (e.g., Lovich and Ennen 2011; Hernandez et al. 2014) and in the *Final Programmatic Environmental Impact Statement for Solar Energy Development in Six Southwestern States* (BLM and DOE 2012). Like all industrial activities, utility-scale solar energy development has the potential to directly and indirectly impact birds and bird communities in a number of ways (Table 2). In general, direct impacts result from ground-disturbing activities at the project and are observable within the solar project footprint, whereas indirect impacts may extend beyond the solar project footprint as the result of factors such as runoff, water depletion, dust deposition, noise, or visual impacts.

A comprehensive literature review on avian issues at solar energy facilities and other industrial developments was conducted and has been documented in a separate bibliography (Walston et al. 2015). The literature review included peer-reviewed journal articles on avian fatalities from other sources (e.g., wind energy, building collisions), project-specific technical reports on avian monitoring and fatality at solar facilities, information on mitigation measures and best management practices (BMPs), and literature pertaining to avian behavioral patterns and habitat use. In addition to the bibliography, data and information were solicited from U.S. and international solar industry developers and industry organizations.

TABLE 2 Potential Impacts of Utility-Scale Solar Energy Development on Birds and Bird Communities

Direct Impacts	Indirect Impacts
Direct fatality of individual birds	Effects of noise (e.g., behavioral changes)
Direct onsite habitat destruction and/or modification	Road effects
Habitat fragmentation	Effects of altered fire regimes
	Effects of altered surface water and groundwater on habitat condition
	Effects of light pollution
	Effects of spills and pollution
	Effects of electromagnetic fields

Sources: Lovich and Ennen (2011); BLM and DOE (2012).

Although there are several types of direct and indirect impacts (Table 2), this report summarizes existing information of direct avian fatality at utility-scale solar facilities, which represents one of several impact factors. There are currently two known types of direct solar-related bird fatalities (McCrary et al. 1986; Hernandez et al. 2014; Kagan et al. 2014):

1. Collision-related fatality—fatality resulting from the direct contact of the bird with a project structure(s). This type of fatality has been documented at solar projects of all technology types.

2. Solar-flux-related fatality—fatality resulting from the burning/singeing effects of exposure to concentrated sunlight. Passing through the area of solar flux may result in: (a) direct fatality; (b) singeing of flight feathers that cause loss of flight ability, leading to impact with other objects; or (c) impairment of flight capability to reduce the ability to forage or avoid predators, resulting in starvation or predation of the individual (Kagan et al. 2014). Solar-flux-related fatality has been observed only at facilities employing power tower technologies.

The nature and magnitude of impacts on bird populations and communities are generally related to three primary project-specific factors: location, size, and technology (PV vs. CSP) (Lovich and Ennen 2011; BLM and DOE 2012). Bird abundance and activity vary by habitat availability and distribution of other physical features in the environment (e.g., terrain) (Flather and Sauer 1996). Therefore, the location of a solar energy project relative to bird habitats, such as migration flyways, wetlands, and riparian vegetation as well as the preservation or removal of habitat within arrays, could influence the impacts of solar energy development on birds; avoidance or minimization of siting in these sensitive areas can greatly reduce impacts on birds. The size of the solar project (acres) is a direct measure of the amount of surface disturbance and human activity. Thus projects with larger footprints are expected to have greater impacts on birds than projects with smaller footprints. Different solar technologies may vary in the types and magnitude of impacts on birds. For example, it has been hypothesized that projects employing wet cooling technologies would require greater amounts of water than dry cooling technologies, which may increase water demand and alter the availability of surface and groundwater sources to sustain bird habitats such as riparian vegetation (BLM and DOE 2012).

It has been hypothesized that solar-energy-related fatalities for some avian guilds result from bird attraction to the project site (e.g., Kagan et al. 2014). Projects that include evaporative cooling ponds may provide artificial habitat to birds and their prey (e.g., insects). Such projects may attract more birds to the site and result in a greater risk of collision with project structures (Lovich and Ennen 2011; BLM and DOE 2012). Glare and polarized light emitted by solar projects may also attract insects, which, in turn, could attract foraging birds. For example, insects may perceive polarized light as water bodies and may be attracted to such sources (Horváth et al. 2009). Lastly, it has also been hypothesized that utility-scale PV facilities may attract migrating waterfowl and shorebirds through what has been called the “lake effect” (Kagan et al. 2014), whereby migrating birds perceive the reflective surfaces of PV panels as bodies of water and collide with project structures as they attempt to land on the panels. To date, however, no empirical research has been conducted to evaluate the attraction of PV facilities to migrating birds.

The potential impacts of solar energy development on birds can be characterized by evaluating risks to populations and guilds and by understanding mortality risk from solar energy development in the context of mortality risk from other industrial developments. Despite the potential for avian fatality from solar energy development, there is currently little empirical data on avian fatality at solar facilities. Only one systematic study of avian fatality at a utility-scale solar energy facility occurs in the current peer-reviewed scientific literature (McCrary et al. 1986). However, more data have been recently collected at several current solar energy projects and have been synthesized (e.g., H.T. Harvey and Associates 2014a-d; WEST 2014).

Avian fatality at other industrial developments (e.g., energy developments, buildings, and transportation.) has been previously published in the peer-reviewed literature (e.g., Erickson et al. 2005, 2014; Loss et al. 2013; Smallwood 2013; Sovacool 2013). A summary of estimated avian fatalities from anthropogenic sources in the United States is provided in Table 3. To better understand the risk of avian fatality from solar energy development in the context of risks from other sources of fatality, it is important that empirical data be standardized to enable direct comparison among fatality sources. Thus, science-based monitoring designs should be developed to provide systematic collection of fatality data that can be used to calculate overall (e.g., site-wide) mortality estimates that can be compared with other sources of fatality. Systematic monitoring protocols have been identified for a number of solar energy projects through the development of project-specific BBCSs.

Most recent methods to calculate overall mortality estimates (Huso 2011) include factors related to the length of the monitoring period, survey effort, and monitoring frequency, size of the project, searcher efficiency, and the carcass persistence rate. Searcher efficiency is a metric to quantify the ability of searchers to detect carcasses. It typically refers to the percentage of carcasses observed by searchers relative to a known number of carcasses. Based on studies from other industries, factors like bird size and the presence of obstructions, such as vegetation and structures, may influence searcher efficiency (Ponce et al. 2010; Huso 2011). The carcass persistence rate is a metric to quantify the amount of time (usually days) that a carcass is available to be observed before it is scavenged by predators. On the basis of studies from other industries, factors like bird size and densities of predators, such as ravens, may influence carcass persistence estimates (Ponce et al. 2010; Smallwood et al. 2010; Huso 2011).

2.2 TYPES OF INFORMATION AND DATA AND DATA COLLECTED

Currently, there are several sources of information on the potential risks of solar energy development to birds. Project-specific environmental planning documents (e.g., those developed under NEPA or CEQA) describe bird abundance and activity at the project location and evaluate impacts of project development to those bird species and communities. If determined necessary by regulatory agencies, as part of the solar energy applicant’s required measures to reduce impacts, a Bird and Bat Conservation Strategy (BBCS) is prepared that describes in detail the measures to minimize avian fatality at the project. BBCSs are not required for some projects (e.g., those projects located on private lands) and therefore are not known to exist for all utility-scale solar energy projects. BBCSs document the methods to systematically monitor for avian abundance, activity, and fatality at the project location. Implementation of the systematic avian fatality monitoring described within a BBCS for a particular project typically commences following the completion of construction activities. A synthesis of currently available BBCSs for utility-scale solar energy projects is provided in Section 3.3.

There are two types of fatality data collected at a project depending on the nature of the observation—incidental and systematic. Incidental data include fatalities observed incidentally during other activities that were not part of focused systematic searches for carcasses. Systematic data include fatalities observed during the course of dedicated search efforts. The collection and reporting of both types of data may be required for a particular solar project through permits issued by state or federal

TABLE 3 Summary of Annual Avian Fatality Estimates in the United States

Form of Fatality	Erickson et al. 2005	Erickson et al. 2014	WEST 2014	Loss et al. 2013	Sovacool 2013	Smallwood 2013	Loss et al. 2014
Buildings and windows	550 million	—	98 million–980 million	—	97 million	—	365 million–988 million
Power lines	130 million	—	—	—	—	—	—
Cat predation	100 million	—	1.4 billion–3.7 billion	—	110 million	—	—
Vehicles/roads	80 million	—	89 million–340 million	—	—	—	—
Pesticides	67 million	—	—	—	72 million	—	—
Fossil fuel power plants	14 million	—	—	—	14.1 million	—	—
Communication towers	4.5 million	—	6.8 million[a]	—	4 million	—	—
Oil field wastewater disposal facilities	—	—	500,000–1 million	—	—	—	—
Nuclear power plants	—	—	—	—	332,323	—	—
Wind energy Facilities	28,500	368,000	209,059–330,010[a]	140,000–328,000	19,875	573,000	—
Aircraft	25,000	—	4,722	—	—	—	—

[a] Estimates include Canada.

— Not estimated

agencies, as a condition of the environmental review process, or as established in the BBCS. For example, documentation and reporting of incidental fatality observations at some projects may be required under the federal Migratory Bird Special Purpose Utility permit issued by the U.S. Fish and Wildlife Services (USFWS) (50 CFR Parts 10, 13, and 21.27). There may also be state requirements that govern the reporting of incidental avian fatality data. If available, the project-specific BBCS outlines the methods for collecting and reporting of systematic avian fatality data. In addition, at solar projects that do not have state or federal requirements to monitor and report avian fatalities, these activities may still be conducted on a voluntary basis. Depending on the project and regulatory agencies involved, fatality data may not be made publicly available.

For this report, information on avian monitoring and fatality at solar facilities was obtained using several methods.

1. The major solar energy projects database maintained by the Solar Energy Industries Association (2014b) was used to identify all solar projects in the United States and their attributes (land management, technology, status, etc.).

2. For projects with a federal nexus (e.g., developed on public land), information was requested from federal agencies and obtained from publicly available documents.

3. For projects without a federal nexus (e.g., developed on private land), information was requested from individual developers and/or operators and industry associations such as the Large-Scale Solar Association. Requests for information from industry representatives involved email correspondence and phone conversations.

4. A request for data and information at international solar energy facilities was made by emailing several international solar developers and industry representatives.

5. A comprehensive literature search was performed.

3 SUMMARY AND EVALUATION OF EXISTING AVIAN FATALITY DATA AND ASSOCIATED LIMITATIONS

The literature review reveals a scarcity of published, scientifically vetted information regarding large-scale solar plants and birds. A summary of data and information available at solar facilities, collected as of December 2014 using the methodology described in Section 2, is provided in Table 4. In total, avian monitoring plans and/or fatality data were known to exist for 15 solar energy facilities (14 U.S., 1 international). A summary of those U.S. solar facilities with available fatality data is provided in Table 5. Section 3.1 discusses the limitations of the fatality data, Section 3.2 presents a synthesis of these data, and Section 3.3 summarizes existing monitoring requirements and mitigation measures being employed at solar facilities.

3.1 LIMITATIONS OF AVAILABLE FATALITY DATA

Because avian activity and abundance are known to vary regionally (Somveille et al. 2013; Hurlbert and Haskell 2003; Kuvlesky et al. 2007), standardization of data collection methods and reporting units is essential for making avian mortality comparisons across studies and industries. Many fatality studies are confined to single locations or short time-frames, meaning that variation in weather, bird abundance, and quality of research can result in particularly high or low estimates of fatality leading to inaccurate extrapolations to different temporal periods or geographic scales (Sovacool 2009). In order to understand avian mortality risk at solar facilities in the context of other anthropogenic sources of avian fatality (e.g., Table 3), systematically-based solar-avian mortality estimates need to be calculated to account for potential biases that may occur as a result of survey design and project location. Factors that influence the calculation of avian mortality from survey efforts are summarized in Table 6 and are based upon the work by Huso (2011). These potential bias factors include variation in searcher efficiency, search effort, predation and scavenging, and the role of background mortality in the project’s vicinity. An incomplete understanding of these factors can lead to uncertainty in determining project-specific avian mortality risk. The factors presented in Table 6 represent the common forms of bias in avian mortality estimation and are not intended to reflect a comprehensive list of all factors that influence avian mortality. Mortality risk may also be influenced by the project’s geographic setting in relation to bird migration patterns, seasonal differences in avian activity and abundance, daytime versus nighttime effects, and other factors such as moon phase and weather.

Standardization of data across projects is necessary to systematically calculate an overall solar-avian mortality rate that could be used to understand the overall risk of avian mortality at solar facilities compared with other human installations. However, the available solar-avian fatality data evaluated in this report were too limited and inconsistent to provide an overall avian mortality estimate for the utility-scale solar industry. Of the known solar projects with available avian fatality data presented in Table 5, three projects have publicly available systematic survey results that can be used to estimate annual mortality (Ivanpah Solar Electric Generating System [ISEGS], California Valley Solar Ranch [CVSR], and California Solar One). The three solar facilities with systematic avian fatality data were inconsistent in survey design and methodology, which precluded data compilation to calculate overall avian mortality. Inconsistencies were largely related to (1) certainty in detecting fatalities and relating fatalities to the solar facility, (2) the role of predation and/or scavenging, and (3) the role of background mortality.

Incidental data, while useful in identifying general patterns of fatality, are not appropriate for estimating annual mortality rates due to the potential for biases to be present within incidental observations (e.g., searcher efficiency, scavenger removal; see Table 6). Based upon review of existing information, therefore, it was determined that the available solar-avian fatality data were too sparse and inconsistent to provide a meaningful assessment of overall avian mortality at solar facilities. More systematic study and efforts to standardize data through the development of systematic monitoring protocols are needed to make any conclusions about the avian risks of utility-scale solar development.

3.2 SUMMARY OF AVAILABLE AVIAN FATALITY DATA, MONITORING REQUIREMENTS, AND MITIGATION MEASURES AT EXISTING SOLAR FACILITIES

This section presents a summary of avian fatalities at U.S. solar energy facilities for which incidental or systematic avian fatality data were available. A summary of U.S. solar facilities with available incidental or systematic avian fatality data is provided in Table 5. See Appendix B (Table B.1) for a summary of avian mortality by species among the solar energy facilities reviewed in this report. Over 1,300 incidental and systematic avian fatality observations from seven utility-scale solar projects that were publicly available as of December 2014 were used in this section to evaluate general patterns of avian fatality. All six utility-scale solar facilities are located in the state of California. The data were collected and reported over various monitoring and observation periods from 2011 to 2014. The data used in these evaluations include both incidental and systematic avian mortality data. While only systematic data may be useful in calculating facility-wide avian mortality estimates, evaluations of both incidental and systematic data may reveal general patterns of avian fatality.

General patterns of fatality related to cause of death, taxonomic groups, residency, and status are presented below. Without more complete and systematic data on local avian abundance and activity near solar facilities, background mortality rates, and the role of predation (including scavenging), a more comprehensive scientific examination of these factors cannot be completed.

3.2.1 Cause of Death

The causes of death documented at solar facilities include solar flux, impact trauma, predation trauma, electrocution, and emaciation; however, the cause of death is often unknown (Kagan et al. 2014). With the exception of California Solar One, the cause of death could not be determined for the majority of bird deaths at all solar facilities. Solar flux was the second-ranked cause of death at the two power tower solar facilities (ISEGS and Solar One). Collision ranked second at Desert Sunlight, CVSR, and Genesis. At Topaz, predation ranked second. It is important to note that fatality observations made within these large solar facilities may not be caused by the project facilities. Cause of death could not be determined for over 50% of the fatality observations and many carcasses included in these analyses consisted only of feather spots (feathers concentrated together in a small area) or partial carcasses, thus making determination of cause of death difficult. It is anticipated that some unknown fatalities were caused by predation or some other factor unrelated to the solar project (e.g., H.T. Harvey and Associates 2014a-d; WEST 2014).

TABLE 4 Summary of Available Information on Avian Fatality and Monitoring at Utility-Scale Solar Facilities (January 2015)

Project Name	Location	Technology Type and MW (in Parentheses)	Current Status	Land Type	Available Avian Monitoring Plan	Known Collection of Avian Fatality Data
Mohave Solar	Harper Dry Lake, CA	CSP – Trough (250)	Operational – January 2015	Private	NA[a]	Yes – Incidental[b]
California Solar One	Daggett, CA	CSP – Power Tower (10)	Decommissioned in 1987	Private	NA	Yes – Systematic[c]
California Valley Solar Ranch	San Luis Obispo County, CA	PV (250)	Operational – Oct 2013	Private	Yes[d]	Yes – Systematic[e,f]
Campo Verde	Imperial County, CA	PV (139)	Operational – Oct 2013	Private	NA	Yes – Incidental[b]
Centinela Solar Energy	Imperial County, CA	PV (170)	Operational – August 2013	Private	Yes[g]	NA
Crescent Dunes	Nye County, NV	CSP – Power Tower (110)	Construction completed	Public	Yes[h]	Yes – Systematic[i]
Desert Sunlight	Desert Center, CA	PV (550)	Operating and under construction	Public	Yes[j]	Yes – Incidental[b]
Genesis	Blythe, CA	CSP – Trough (250)	1st Unit Operational – Nov. 2013 2nd Unit Operational – March 2014	Public	Yes[k]	Yes – Incidental[b,l]
Ivanpah Solar Electric Generating System (ISEGS)	San Bernardino County, CA	CSP – Power Tower (377)	Operational – Oct. 2013	Public	Yes[m]	Yes – Incidental[b,l] and systematic[n]
Palen Solar Electric Generating System (PSEGS)	Riverside County, CA	CSP – Power Tower (N/A)	Application submitted	Public	Yes[o]	NA

Project Name	Location	Technology Type and MW (in Parentheses)	Current Status	Land Type	Available Avian Monitoring Plan	Known Collection of Avian Fatality Data
Rice Solar	Riverside County, CA	CSP – Power Tower (150)	Under development	Private	Yes[p]	NA
Silver State North	Primm, NV	PV (50)	Operational – May 2012	Public	Yes[q]	NA
Silver State South	Primm, NV	PV (250)	Under construction	Public	Yes[r]	NA
Topaz Solar Farm	Carrizo Plains, CA	PV (550)	Under construction	Private	Yes[s]	Yes – Systematic[e]
Solar Demonstration Plant	Dimona, Israel	CSP – Power Tower	Operational – 2008	Unknown	NA	Yes[t]

[a] NA = not applicable.
[b] Source: USFWS (2014) – U.S. solar facilities with USFWS-issued SPUT permits.
[c] Source: McCrary et al. (1986).
[d] Source: H.T. Harvey & Associates (2011).
[e] Source: WEST (2014a).
[f] Source: H.T. Harvey & Associates (2014a).
[g] Source: JBR Environmental Consultants, Inc. (2011).
[h] Source: JBR Environmental Consultants, Inc. (2011).
[i] Sources: Personal communication between L. Walston (Argonne National Laboratory) and Rob Howe (SolaReserve). Preliminary avian fatality data have been collected but were not available for this report.
[j] Source: Ironwood Consulting (2010).
[k] Source: Tetra Tech (2011).
[l] Source: Monthly compliance reports submitted to the CEC (2014). See References (Section 7) for complete list of project-specific compliance reports.
[m] Source: Avian & Bat Monitoring and Management Plan - Ivanpah Solar Electric Generating System.
[n] Sources: H.T. Harvey & Associates (2014b-d).
[o] Source: Levenstein et al. (2014a).
[p] Source: CH2MHILL (2011).
[q] Source: Silver State Solar Power North, LLC (2011).
[r] Source: Ironwood Consulting (2013).
[s] Source: Althouse and Meade, Inc. (2011).
[t] Source: Labinger (2012).

TABLE 5 Summary of Available Avian Fatality Data at Utility-Scale Solar Facilities (as of December 2014)[a]

Project Name	Known Collection of Avian Fatality Data	Land Type	Survey Period	Incidental Fatalities	Systematic Fatalities (Unadjusted)
Mohave Solar	Yes – Incidental[b]	Private	Aug. 2013–March 2014	14	None collected
California Solar One	Yes – Systematic[c]	Private	May 1982–May 1983	NA	70
California Valley Solar Ranch	Yes – Systematic[d]	Private	Aug. 16, 2012–Aug. 15, 2013	NA	368[h]
Desert Sunlight	Yes – Incidental[e]	Public	Sept. 12, 2011–March 4, 2014	154	None collected
Genesis	Yes – Incidental[b]	Public	Jan. 2012–May 2014	183	None collected
Ivanpah	Yes – Systematic[f]	Public	Oct. 29, 2013–March 21, 2014	159	376 (includes 7 injured birds)
Topaz Solar Farm	Yes – Incidental and Systematic[g]	Private	Jan. 1, 2013 –Jan. 16, 2014	19	41

[a] Refer to Appendix B for a summary of avian fatality and monitoring at utility-scale solar facilities.

[b] Source: Monthly compliance reports submitted to the CEC (2014). See References (Section 7) for complete list of project-specific compliance reports.

[c] Source: McCrary et al. (1986).

[d] Source: H.T. Harvey & Associates (2014a).

[e] Source: First Solar (2014).

[f] Sources: H.T. Harvey & Associates (2014 b,c).

[g] Source: Althouse and Meade, Inc. (2014).

[h] This value includes fatalities from known and unknown causes at all project elements including background control plots, fence lines, generation tie-line, medium voltage lines, and arrays

TABLE 6 Factors Influencing Mortality Rate Calculation (Sources: Huso 2011; H.T. Harvey & Associates 2015; Avian & Bat Monitoring and Management Plan for the Ivanpah Solar Electric Generating System)

Factor	Description
Searcher efficiency	The percentage of fatalities found by individual searchers or teams of searchers. Mortality rate estimations are influenced by how well a searcher can detect the actual number of birds within the project. Searcher efficiency percentage is typically determined by conducting field trials, where a predetermined number of bird carcasses of various sizes are placed in the different areas throughout the project footprint and searchers record the number of birds detected. The adjustment for searcher efficiency is a common bias-correction tool employed in mortality estimation for many studies.
Search effort	The percentage of the project footprint surveyed over space and time. Overall mortality estimates are typically calculated for 100% of the project footprint's area. Therefore, surveys of less than 100% of the project often require an adjustment to estimate mortality across the entire footprint. Similarly, overall mortality estimates are calculated for a standard unit of time (e.g., annually). Therefore, surveys of different temporal periods often require adjustment to standardize mortality estimates on an annual basis.
Predation and scavenging	Predators and scavengers may transport carcasses on and off the project footprint, and may therefore contribute to uncertainty in mortality estimation. Carcass removal trials are commonly used to quantify the amount of time (days) that a carcass usually persists in the field before it is removed by predators and scavengers. The adjustment for carcass removal is a common bias-correction tool employed in mortality estimation for many studies. Recent studies have highlighted the potential for predators to transport carcasses to the project footprint from offsite locations, where the bird may have died from causes unrelated to the project. Understanding the role of this form of background mortality in the estimation of solar-avian mortality has been identified as a need for future research.
Background mortality	An estimate of natural avian mortality occurring independently from human-caused fatality. Some avian fatality observations within project footprints may be attributable to background mortality. To better understand background mortality and adjust project-related mortality estimates, background mortality is examined by surveying for avian fatality in offsite reference areas (i.e., control plots). Background mortality studies at utility-scale solar facilities have shown that a large portion of fatalities may be attributable to background and unrelated to the project. Mortality estimates at some solar facilities have been calculated with adjustments to account for background mortality.

3.2.2 Species Composition

The species composition of reported avian fatalities at the seven utility-scale solar facilities is summarized in Appendix B (Table B.1). Passerines were the taxonomic group most frequently found killed or injured at all six California solar energy facilities, ranging from 39.6% to 62.5% of the avian mortalities. Doves and pigeons had the next highest overall percentage; however, the order of rankings varied among facilities.

Water-dependent species (loons, grebes, rails, coots, shorebirds, waterbirds, and waterfowl) have been considered vulnerable to fatality at PV facilities because of the potential for them to confuse arrays for bodies of water (the lake effect hypothesis) (Kagan et al. 2014; WEST 2014). Based on the limited number of solar projects reviewed, observations of fatality by taxonomic groups were too inconsistent to test the lake-effect hypothesis. Overall, water-dependent species represented 11.2% of all fatalities, but there was high variability among solar facilities, ranging from 0.27% at CVSR to 45.5% at Desert Sunlight. At all three PV facilities (Topaz, Desert Sunlight, and CVSR), water-dependent species accounted for an average of 12.9% of fatalities, while at all three CSP facilities (ISEGS, Solar One, and Genesis) water-dependent species accounted for an average of 11.2% of mortalities. Water-dependent birds represented the greatest proportion of mortalities at only one facility (Desert Sunlight).

Although these preliminary fatality observations do not show a clear association between waterbird fatalities and the lake-effect hypothesis, the sample size (e.g., number of solar facilities) was too limited to allow for statistical analysis of this hypothesis. It is therefore too speculative using the existing data to make any conclusions about the influence of the lake effect or other factors that contribute to fatality of water-dependent birds. The activity and abundance of water-dependent species near solar facilities may depend on other site-specific or regional factors (such as the surrounding landscape) that have not yet been investigated (WEST 2014). It is important to note that not all fatality observations of water-dependent birds within the project footprint may have been caused by the project facility. Cause of death could not be determined for the majority of the fatality observations (Section 3.2.1).

A total of 20 birds (about 1.5%) found dead or injured at all six California solar energy facilities belonged to sensitive species (federally listed, state-listed, or BLM-sensitive). Two, Yuma clapper rail and yellow-billed cuckoo[1], were federally listed or candidates for listing under the ESA (and state-listed in California). Three fatalities of the California state-listed bank swallow, also considered a sensitive species by the U.S. Bureau of Land Management (BLM), also were detected. The remaining 15 avian fatalities were of BLM-sensitive species (brown pelican and burrowing owl). It is important to note that not all fatality observations of sensitive species were necessarily caused by the project facility. Cause of death could not be determined for the majority of the fatality observations (Section 3.2.1).

3.2.3 Residency

Avian mortalities were divided into two residency groups: resident (breeding, winter, or year-round resident) and migrant (passage migrant) (Appendix B, Table B.1). Residency was determined for each identified species based on NatureServe (2014) and the California Department of Fish and Wildlife (2014). The majority of avian fatalities at all facilities were of resident species. The percentage of fatalities that were residents ranged from 63.4% at Genesis to 93.5% at CVSR. The presence of migrants in the vicinity of solar facilities varies seasonally and may lead to seasonal variation of avian mortalities.

---

[1] At the time the fatality observation was made, the yellow-billed cuckoo was a candidate species for listing under the ESA. It is now federally listed as a threatened species under the ESA.

This trend was observed at ISEGS, where transient species accounted for a larger proportion of avian mortalities during the spring than at other times of the year.

3.3 EXISTING AVIAN MONITORING REQUIREMENTS, MITIGATION MEASURES, AND BEST PRACTICES AT SOLAR FACILITIES

This section presents an overview of existing avian fatality monitoring and reporting requirements, mitigation measures, and related BMPs, as identified in available solar project-specific BBCSs, Avian and Bat Protection Plan (ABPPs), or similar avian monitoring plans (hereafter, all such plans are referred to as "BBCSs"). The purpose of this section is to present the current measures used to minimize avian impacts at utility-scale solar energy facilities. As shown in Table 4, BBCSs were available for 10 solar energy facilities; these plans are summarized in Appendix B (Table B.2).

Most BBCSs required operators to conduct preconstruction surveys to assess baseline avian abundance and activities. Some plans established specific preconstruction monitoring requirements, such as the number of years and seasons of baseline data collection, collection of offsite baseline data, and minimum surveyor requirements. Nearly all plans included discussion of species-specific surveys for rare species and most acknowledged that the project would comply with ESA and state wildlife requirements, which could impose additional monitoring requirements.

BBCSs reported various approaches for evaluating avian risks from solar energy development. One important approach to evaluating project-specific impacts was through Before-After Control-Impact (BACI) studies (Smith 2002). Although few BBCSs reported specific plans for BACI evaluations, the majority of the BBCSs reported the collection of baseline information and complementary post-construction data collection at project and offsite locations that would permit a BACI analysis. In addition, while all BBCSs documented the collection and summation of avian fatality detections, several BBCSs reported on the use of specific statistical models to evaluate risk.

Requirements for specifying measures for avoidance, minimization, and mitigation, and BMPs to reduce avian mortality risks, varied among the BBCSs. These measures were identified based on project technology and location relative to the known presence of sensitive species and known avian abundance and activity patterns in the project area. Most projects generally described avoidance of sensitive bird habitats and nest locations. Several BBCSs included measures to minimize the effects of lighting on birds. Several BBCSs also discussed measures to minimize the risk of collision with transmission lines associated with project development. Solar projects with designs for cooling ponds included measures to reduce attraction of birds to the ponds. For projects where sensitive species may be present (e.g., burrowing owls, golden eagles), species-specific avoidance and minimization measures were identified.

4 EXAMPLES OF BEST MANAGEMENT AND OTHER PRACTICES FROM NON-SOLAR INDUSTRIES

This section presents examples of guidance, BMPs, and mitigation measures used for wind energy, power lines, and airports. The focus of this section is on actions used in non-solar industries to reduce avian fatalities, and how these actions might be applicable at solar facilities.

4.1 GUIDANCE, BEST MANAGEMENT PRACTICES, AND MITIGATION MEASURES FROM A SAMPLE OF NON-SOLAR APPLICATIONS

4.1.1 Wind Energy

Wind energy has been deployed in the United States for nearly four decades. Many lessons have been learned since the first wind farm came on line in 1978 in the Altamont Pass Wind Resource Area in California. The specific reasons birds collide with wind turbines remain unclear, but reducing avian collisions with wind turbines is of great importance to nearly all stakeholder groups involved in wind energy development. Proper siting is thought to be a valuable tool for decreasing avian collisions.

Operational minimization (curtailment) and acoustic deterrents have shown promise for reducing bat fatalities at wind facilities. It is unclear whether either of these strategies will be effective in reducing bird fatalities at wind facilities, as rigorous testing has not been conducted. Acoustic deterrents, in general, have not been successful in deterring birds in other applications, primarily due to the short-term nature of their effectiveness, and eventual rehabituation of the species. However, recent research to develop an acoustic deterrent to keep European starlings from foraging has shown promise. Both curtailment and acoustic deterrents may be viable options to reduce avian fatalities at solar facilities; however, research and field testing is needed to determine their efficacies.

To assist the wind energy industry, the USFWS (2012) released *Land-based Wind Energy Guidelines* (WEG), a guidance document for assessing potential adverse effects wind energy might have on species of concern and their habitats. These guidelines are intended to do many things, including promote compliance with relevant wildlife laws and regulations and encourage scientifically rigorous survey, monitoring, assessment, and research designs proportionate to the risk to species of concern. The WEG are intended to produce potentially comparable data across the nation and mitigate potential adverse effects on species of concern and their habitats, using avoidance, minimization, and habitat-compensation strategies. The guidelines are voluntary yet provide BMPs for site development, construction, retrofitting, repowering, and decommissioning.

The tiered approach described in the WEG is an iterative decision-making process for collecting information in increasing detail. The WEG assist wind developers in identifying species of concern that might be affected by their proposed project, including migratory birds, bats, bald and golden eagles and other birds of prey; prairie and sage grouse; and listed, proposed, or candidate endangered and threatened species. Wind energy development in some areas might be disallowed by federal law. Also, other areas may be inappropriate for development because they have been recognized as having high wildlife value based on their ecological rarity and intactness. Details on the five WEG tiers, listed below, can be found within the document. Although WEG guidelines are voluntary, project developers who follow the guidelines and ultimately have unexpected avian impact issues may be better positioned if enforcement actions are proposed by the USFWS.

The five WEG tiers are:

- Tier 1—Preliminary site evaluation (landscape-scale screening of possible project sites)
- Tier 2—Site characterization (broad characterization of one or more potential project sites)
- Tier 3—Field studies to document site wildlife and habitat , and to predict project impacts
- Tier 4—Post-construction studies to estimate impacts
- Tier 5—Other post-construction studies and research

In addition to its Land-based Wind Energy Guidelines, in 2013 the USFWS released the Eagle Conservation Plan Guidance (ECPG) (USFWS 2013). The ECPG provides specific, in-depth direction for conserving bald and golden eagles in the course of siting, constructing, and operating wind energy facilities. Eagles are federally protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (BGEPA).

The ECPG also calls for wind project developers to take a tiered (staged) approach to siting new projects, but is intended for use when applying for an incidental take permit under the BGEPA. The ECPG calls for preliminary landscape-level assessments to consider potential wildlife interactions, then to conduct site-specific surveys and risk assessments prior to construction. It also calls for monitoring all project operations and reporting eagle fatalities to the USFWS, state, and tribal wildlife agencies. Details on each of the stages can be found in the ECPG.

Both the WEG and ECPG took years to develop and adopt. Guidance documents comparable to these may be useful tools for solar project development, although at this time it is not clear that eagles are at risk from such facilities.

BMPs for renewable energy projects in the intermountain west by Jones (2012) were developed primarily for use by conservation organizations. These BMPs are intended to provide guidance to minimize impacts on species and habitats from wind and solar project development in the western United States and are fundamentally based on the best available science. The peer-reviewed Jones report gives special attention to western species and habitats, and its guidance focuses on siting, pre- and post-construction, and operational activities. The document points out that BMPs are not intended to be universally applied, but rather, site-specific assessments need to be conducted.

A number of states have adopted guidelines for wind energy development. While the process for developing state-level guidelines vary, they have many similarities: They are voluntary; they primarily focus on addressing adverse impacts on birds and bats; their objective is to provide a standardized framework for conducting assessments before, during, and after construction; and their results are intended to assess impacts on a broader spatial scale (since virtually all assessments are conducted at a project-specific level). Table 7 summarizes nine state guidelines.

TABLE 7 Summary Wind Energy Guidelines for Nine States

State	Preliminary Site Screening	Pre-Construction Survey Protocols	Impact Assessment and Mitigation	Post-Construction Monitoring and Reporting	Research	Principles for Habitat Mitigation	Reference
Arizona	Yes	Yes	Yes	Yes			AGFD 2009
California	Yes	Yes	Yes	Yes		Yes	CEC and CDFG 2007; Renewable Energy Action Team 2010
Minnesota		Yes		Yes			Mixon et al. 2014
Nebraska		Yes	Yes	Yes	Yes	Yes	NWWWG 2013
New York	Yes	Yes		Yes			NYSDEC 2009
Ohio	Yes	Yes	Yes	Yes			ODNR 2009; Norris 2012
Oregon	Yes	Yes	Yes	Yes		Yes	ODOE 2008
Pennsylvania		Yes		Yes		Yes	PGC 2013
Washington	Yes	Yes	Yes	Yes	Yes	Yes	WDFW 2009

Of the top 10 states expected to significantly contribute to DOE’s 20% wind energy by 2030 scenario (DOE 2008), only California and Minnesota have guidelines in place. Other top states, including Illinois, Iowa, Michigan, New Jersey, North Carolina, Oklahoma, Texas, and Wyoming, do not currently have such guidance. As the United States moves toward the 2030 scenario, it is a reasonable expectation that other states will adopt their own guidelines to address issues for both federal- and state-listed species.

4.1.2 Power Lines

The Avian Power Line Interaction Committee (APLIC) is an organization in the United States that serves as a focal point for avian interaction issues as they pertain to utilities. Formed in 1989 to address whooping crane collisions with power lines, the APLIC originally consisted of 10 utilities, Edison Electric Institute, the USFWS, and the National Audubon Society. Today, APLIC membership includes more than 50 utilities, Edison Electric Institute, the USFWS, Electric Power Research Institute, National Rural Electrical Cooperative Association, and Rural Utilities Service. Further, APLIC’s mission was expanded to address electrocution and collision fatality for many other avian species, especially raptors (APLIC 2014).

The APLIC released *Avian Protection Plan (APP) Guidelines* (2005) and *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006* (2006). Both of these documents are considered BMPs for reducing avian collisions and electrocutions with power lines. Like the USFWS’s Land-based Wind Energy Guidelines and Eagle Conservation Plan Guidance, the APLIC’s documents are voluntary and are intended to be used together. The Suggested Practices for Avian Protection on Power Lines is a multifaceted tool with aspects of problem definition; regulation and compliance; biological aspects of avian electrocution; power line design and avian safety; perching, roosting, and nesting issues; and development of an APP. The APLIC’s guidelines can serve as a valuable knowledge base to avoid, minimize, and mitigate adverse avian impacts at utility-scale solar projects.

Details of the various facets within the Practices can be found by reviewing the documents. However, components of an APP are worth mentioning here. An APP outlines a suite of principles designed to reduce avian interactions with electric utility facilities. Although each utility’s APP is different, the overall goal of any APP should be to reduce avian fatality. An APP may contain the following components: corporate policy; training; permit compliance; construction design standards; nest management; avian reporting system; risk assessment methodology; fatality reduction measures; avian enhancement options; quality control; public awareness; and key resources.

4.1.3 Airports

For the period 1990 to 2011, more than 115,000 wildlife strikes were reported to the Federal Aviation Administration (FAA). About 97% of all wildlife strikes reported to the FAA involved birds, about 2% involved terrestrial mammals, and less than 1% involved flying mammals (bats) and reptiles. Waterfowl (ducks and geese), gulls, and raptors (mainly hawks and vultures) are the bird species that cause the most damage to civil aircraft in the United States, while European starlings are responsible for the greatest loss of human life. Vultures and waterfowl cause the most losses to U.S. military aircraft (FAA 2014). Each year in the United States, wildlife strikes to civil aircraft cause about $718 million in damage to aircraft and about 567,000 hours of civil aircraft down time (FAA 2014). Globally, it is estimated that bird strikes cause annual economic impacts of $1.2 billion to commercial aircraft (Allan and Alex 2001; Ning and Chen 2014).

The FAA sponsored the development of a document that "reviews techniques for reducing bird collisions with aircraft and their relative effectiveness" (ACRP 2011). In addition, the FAA has web-based information on its R&D programs and a co-agency publication with the U.S. Department of Agriculture, *Wildlife Hazard Management at Airports: A Manual for Airport Personnel* (Cleary and Dolbeer 2005). The manual is a nearly 400-page document addressing everything from information in the FAA's bird strike database to how to implement and evaluate wildlife hazard mitigation programs.

The International Bird Strike Committee (IBSC 2007) is a voluntary association of "representatives from organizations whose mission is to improve commercial, military, and private aviation flight safety, by sharing knowledge and understanding concerning the reduction of the frequency and risk of collisions between aircraft, birds and other wildlife management practices." The IBSC's BMPs guide airports in wildlife hazard management, active wildlife control, organization and equipment for wildlife management activities, logging of wildlife management activities, wildlife strike reporting, and risk assessment.

The goal of the FAA's R&D program is to mitigate wildlife strikes with aircraft by providing practical resolutions in addition to timely, critical information for pilots and airport managers.
FAA research efforts are focused on four areas: (1) habitat management, (2) wildlife detection methods, (3) wildlife control techniques, and (4) systems integration. Some of these strategies may be applicable to addressing adverse bird impacts at utility-scale solar facilities.

4.2 AVIAN AND BAT PROTECTION PLANS IMPLEMENTED AT WIND FACILITIES

In addition to voluntary federal and state guidelines for reducing bird fatalities at wind facilities, the wind industry is beginning to implement ABPPs (now referred to as BBCSs) at both the company and project levels.

The origination of ABPPs within the wind industry is fairly recent, with the first company-wide ABPP being released by Iberdrola Renewables, Inc. (IR) in October 2008 (IR 2008). This ABPP pre-dates the WEG and is modeled after the APLIC APP, but is expanded to include bats and tailored to meet the needs of wind facilities. IR developed its voluntary ABPP in consultation with the USFWS and includes a corporate policy stating that the wind industry, as it deploys more turbines and project infrastructure across the U.S. landscape, must consider how best to develop projects in a manner to avoid, minimize, and mitigate for adverse impacts on birds and bats in order to ensure a sustainable industry. IR’s ABPP commits at the corporate level to:

- Implement and comply with its own comprehensive ABPP;
- Ensure its actions comply with all applicable state and federal laws, regulations, permits, and ABPP procedures;
- Follow procedures described in the ABPP during the development of all new wind projects in order to understand avian and bat risk at each site and to incorporate features to avoid or minimize impacts on these species;
- For development or operational projects acquired from third parties in merger or acquisition transactions, ensure through the due diligence and acquisition process that preproject or operational practices employed by third parties prior to IR ownership are consistent with the ABPP, or, if not consistent, document inconsistencies, develop a strategy for implementing ABPP practices, and implement ABPP practices as soon as practical;
- Document bird and bat mortalities and injuries at projects and/or structures in order to implement adaptive management actions as necessary;
- Provide information, training, and resources to improve staff knowledge and awareness of the requirements of the ABPP in order to support the ABPP’s successful implementation at both the company level and as applied at specific projects;
- Participate with public and private organizations in programs and scientific research to identify causes and effective controls of detrimental effects of bird and bat interactions with wind projects; and
- Continue to enhance the ABPP by applying lessons learned, research results, new technologies, and latest regulations and guidelines (IR 2008).

While IR is a model for company-level ABPP, incorporation of ABPP at the project level is becoming a more common practice for wind project developers. Project-specific ABPPs follow a common approach but are individualized for the species under consideration and the project location. Many ABPPs are aligned with the USFWS’s WEG, state-specific wind project guidelines, or other similar documents. ABPPs are also being implemented by the solar industry at the project level (see Appendix B for examples).

4.3 TECHNOLOGY SOLUTIONS THAT SHOW PROMISE AS DETERRENTS

Most technology solutions being investigated to reduce wildlife conflicts with wind energy facilities are classified as deterrents. Wildlife deterrents are broadly defined as management techniques that use aversive stimuli to prevent animals from utilizing human resources (Ramp et al. 2011; Schakner and Blumstein 2013). A deterrent stimulus is an aversive, harmful, fearful, or noxious stimulus that elicits a defensive response in a particular animal. This stimulus must create enough real or perceived risk such that the costs of using a resource outweigh foraging or use benefits (Götz and Janik 2011). There are four general classes of deterrents—acoustic, tactile, visual, and chemosensory (Schakner and Blumstein 2013). The following discussion describes each of these modalities and includes information on successes and failures.

4.3.1 Acoustic Deterrents

Acoustic deterrents work by producing a sound painful or distracting enough that it creates aversion and either makes an animal flee or prevents it from visiting an area all together. Acoustic deterrent devices are one of the most widespread nonlethal deterrent methods used, particularly in mammal/fishery conflicts (Fjalling et al. 2006; Schakner and Blumstein 2013). However, their effectiveness in reducing wildlife conflicts at wind energy facilities remains uncertain. In terms of avian collisions with wind turbines, there have been two main issues with using acoustic deterrents: (1) many bird species habituate to sound, so long-term effectiveness is unlikely, and (2) birds and humans hear within the same range, which means that whatever sound is used to deter birds, humans living nearby would also hear the sound (Dooling 2002). It is possible that acoustic deterrents could reduce collisions of migrating passerines because a flock of birds moving through a particular area would likely not habituate to a single noise event. Ultrasonic deterrents have been tried on a few avian species, including gulls and feral pigeons, but were unsuccessful (Soldatini et al. 2007; Eiermann and Heynen 2014).

Other research suggests some options may exist to deter specific bird species. Research on the use of an on-demand cannon system showed promise of deterring waterfowl from landing on oil sands tailing ponds (Ronconi and St. Clair, 2005). Playbacks of calls of various species have shown these methods may also be effective in a continuous playback mode (Ribot et al., 2011; Tupper et al. 2011). The efficacy of a sonic net to deter European starlings from foraging has shown promise (Diekman et al. 2013). Additionally, the use of randomized sounds is being tested, although results are not yet available.

4.3.2 Tactile Deterrents

Tactile deterrents involve physically creating pain or discomfort to induce aversion (Schakner and Blumstein 2013). There is a large body of information on the successes of tactile deterrents for nonflying animals, both marine and land based. However, there is very little information in the peer-reviewed literature on the successes of tactile deterrents with regard to flying animals. Tactile (perch) deterrents on power lines have been tried on raptors with some degree of promise (Slater and Smith 2010). However, some studies were complete failures for various reasons and included photo documentation of raptors actually perched on the perch deterrent (Prather and Messmer 2010). Studies have illustrated that avian perch deterrents are largely ineffective (Duarte et al. 2011), while other types of deterrents, such as electric shock devices, were only somewhat effective at deterring nuisance avian species (Seamans and Blackwell 2014).

4.3.3 Visual Deterrents

Among visual deterrents are novel or intense light, colors, and decoys. In the context of wind energy, a few visual deterrents have been tried or suggested to minimize avian collisions, including ultraviolet-reflective paint (Young et al. 2003), changes in FAA lighting (Gehring et al. 2009), and painting turbine blades different colors (Hodos 2003). Investigations by Hodos (2003) suggested that painting turbine blades combinations of black and white would reduce motion smear of the blades for turbines with high RPMs. Although large commercial-scale turbines have much lower RPMs and motion smear is not an issue, some wind developers in the European Union are in the midst of testing whether painting turbine blades will be effective at reducing avian collisions. To date, there are no published reports of success or failure. A steady-burn lighting regime was shown to reduce bird collisions with structures like meteorological and communication towers (Gehring et al. 2009). At this point, there is little evidence that UV paint and painting turbine blades are effective means for reducing avian collisions. Passerines constitute the largest group of birds at risk of colliding with wind turbines. Most of these collisions occur during their nocturnal migration, so UV paint on turbines would be irrelevant.

4.3.4 Chemosensory Deterrents

Chemosensory deterrents involve aversive scents or things that taste badly. Therefore, animals must have some sort of olfactory capacity for this type of deterrent to work. Although there is a wealth of literature on the use of chemosensory repellents (Kare 1961; Avery et al. 1995; Marples and Roper 1997; Mason et al. 1989; Stevens et al 1998; Engeman et al. 2002), conditioned taste or smell aversion methods to reduce human-wildlife conflicts have produced mixed results in terrestrial ecosystems (Shivik et al. 2003). Additional research is needed to identify chemosensory deterrents that could be effective in reducing avian impacts at solar facilities.

5 TECHNOLOGY-SPECIFIC FACTORS POTENTIALLY ASSOCIATED WITH AVIAN FATALITY

Some facility elements are common to all solar technologies (e.g., structural and wiring hardware, transmission lines, buildings, and roads), but many elements vary by technology. As discussed in Section 2.1, there are two primary types of solar-related avian fatality: collision-related and solar-flux-related fatality. This section discusses specific factors that have been identified as possibly being associated with these two types of fatality. In addition, the results of power tower flux modeling conducted, to provide context for possible ways to mitigate flux-related fatality as part of this study are discussed.

5.1 COLLISION-RELATED FATALITY FACTORS

Collision-related fatality has been observed at solar energy facilities of all technology types. Collisions may occur at any facility (solar or otherwise) with aboveground structures. In the case of solar plants these may include transmission lines, cooling towers, PV panels and poles, trough systems, heliostats, fencing, and buildings. Collisions may also occur at roadways with project vehicles.

At PV and CSP facilities, collision hazards to birds are greatest among the solar field arrays. It has been suggested that PV facilities may attract some species of birds through what has been called the “lake effect” (Kagan et al. 2014), whereby migrating birds perceive the reflective surfaces of PV panels as bodies of water and collide with project structures as they attempt to land on the panels. However, no empirical research has been conducted to confirm or refute this hypothesis.

The primary hazard to birds presented by power-cycle cooling systems is collision with the structures themselves. Cooling structures may also present attractive perching or nesting sites. Wet-cooled systems generally incorporate an evaporation pond to handle water blowdown from the cooling system. Such ponds may be attractive to wildlife, especially in a desert environment.

5.2 SOLAR-FLUX-RELATED FATALITY FACTORS

Based on the study of McCrary et al. (1986) at Solar One, and reported findings of dead birds at the ISEGS power tower facility in California, there appears to be a link between avian fatality and solar flux. Solar flux is a measure of the amount of solar energy passing through, or impinging on, an area. Direct ambient sunlight or “one sun” of flux is equal to about 1 kW per square meter (kW/m^2). Power towers generate regions of high solar flux near the tower/receiver as the reflected rays from multiple heliostats converge on the receiver. The receiver has a special surface coating that promotes efficient absorbance of sunlight. This coating makes the receiver appear black. However, when exposed to high solar flux, the receiver will glow due to the small fraction of sunlight that is not absorbed. In addition, one can often see scattered light from the reflected beams of the solar field due to a small amount of scattering from dust or other tiny particles in the air. This gives rise to the glow or cloud of light seen around power towers during certain phases of operation (Figure 3).

FIGURE 3 Glow of Scattering Sunlight from Heliostat Beams Converging on a Point Near the Tower During Operation of the Solar Two Demonstration Plant in 1996 (Photo credit: NREL)

At the solar receiver, flux levels can reach near 1,000 kW/m^2, or about 1,000 suns, and the flux drops off as one moves away from the receiver. Any object (e.g., receiver pipe, dust particle, bird) exposed to solar flux will absorb energy and be affected by that energy based on the object's size and optical properties (dark objects absorb sunlight better than light objects), its mass and thermal heat capacity (how much absorbed energy is required to generate a temperature increase), and its duration in the flux zone. The air temperature itself is virtually unaffected except in the immediate vicinity of the receiver. This is because air absorbs very little of the solar energy, and only air directly contacting the receiver is heated to any significant degree.

The amount of solar energy absorbed by an object in the region of solar flux can be calculated based on the area of the object exposed, intensity of the light, absorptivity of the object, length of exposure time, and mass of the object. However, predicting the amount of energy absorbed by a bird flying through the solar flux region is difficult given the variability of these many factors.

BrightSource Energy and the USFWS have performed preliminary tests on the effect of sunlight or heat, respectively, on bird feathers. As presented at the California Energy Commission (CEC) Joint Workshop held August 28, 2012 (BrightSource 2012), the BrightSource study indicated no observable effects on feathers exposed to 50 kW/m^2 of solar flux for 30 seconds. Higher flux levels caused visible effects within 20 to 30 seconds. The USFWS work, reported in Kagan et al. (2014), exposed feathers to hot air for 30-second durations. Visible effects were noted starting at temperatures of 400°C. Recall that air temperature in a zone of high flux is virtually unchanged from ambient conditions. Rather, these combined results suggest that the feathers themselves absorb sufficient energy during the 30-second test to reach a temperature sufficient to cause damage. Although these results are preliminary, they suggest that zones with flux greater than 50 kW/m^2 represent the region of concern for flux effects on birds. The actual effect on a given bird depends on a number of variables, including flight path, species, ambient conditions, and light intensity; further study is necessary to understand and refine this hazard threshold.

The following analysis of the flux profile in the vicinity of an operating power tower uses 50 kW/m^2 as a representative value.

5.3 POWER TOWER FLUX MODELING

Intense solar flux produced by reflected and concentrated sunlight has been documented to harm flying birds. For this report, NREL modeled a representative power tower based on the default molten-salt power tower provided in NREL's free System Advisor Model (SAM) (https://sam.nrel.gov/). The task required developing a methodology for generating solar flux maps not only at the receiver itself, but also in the airspace surrounding the receiver. These results and subsequent analysis using this methodology will be used to understand issues related to avian fatality connected with CSP power tower technology and potentially identify operating methodologies that may reduce the threat.

5.3.1 Description of Methodology

Two NREL-developed modeling tools, SolTrace (Wendelin 2003) and SolarPILOT, were used to generate flux contour maps for the default 100-MW$_e$ molten salt power tower found in SAM (version release date 2014-01-14). The default SAM power tower case is intended to be representative of commercial technology, but is not designed to mimic a specific CSP project. Similar analyses could be performed for other sizes of towers, but are beyond the scope for the purposes of this report. The default case assumes a cylindrical receiver and a surround field (heliostats surrounding the tower). An NREL developed power tower design tool, SolarPILOT, was used to construct an optimized solar field layout based on the SAM default conditions. The field layout is shown in Figure 4. The default power tower field is symmetric about the north-south direction. This is different from many existing and planned power towers, which often have nonsymmetric field layouts due to the effects of the surrounding terrain or proximity to neighboring power tower fields. The height and diameter of the receiver for this case are 20.41 m and 17.67 m, respectively. The optical height of the tower (defined by the distance from the ground to the center of the receiver cylinder) is 203 m. The default location for the power tower is Daggett, Calif., at an elevation of 588 m, latitude of 34.9 degrees, and longitude of −116.8 degrees. The following analysis was generated using weather file data for March 20 at noon (spring equinox) and assumed the DELSOL3 insolation model (Kistler 1986). The default heliostat size is 12.2 m by 12.2 m, divided into eight panels, each canted and focused at the heliostat slant range (heliostat to receiver straight-line distance). The example shown here is representative; the methodology could be employed for any solar field configuration.

The SAM-default heliostat-aim-point algorithm was used. Heliostats are always aimed at the center axis of the receiver. Heliostats distant from the tower deliver the largest images and are aimed, for the most part, at the vertical center of the receiver. (Because the heliostat mirrors are not perfect reflectors, the reflected image spreads with distance from the heliostat.) As the distance from the heliostat to tower decreases, heliostat images get smaller, and individual heliostats can be aimed to achieve the most uniform flux from top to bottom of the receiver. This algorithm, known as "Image Priority," vertically distributes individual heliostat images along the receiver height as a function of the image size. The exact aiming strategy used for operating power towers is proprietary but is assumed to be some variation of this algorithm.

Three different cases were analyzed: a full-load condition and two full-standby conditions. Full load implies that all heliostats, up to the rated power of the receiver, are targeted at the receiver. The full load condition used Image Priority aiming. The full-standby condition (all heliostat images removed from the receiver) was analyzed for Image Priority and Centerline aiming. Centerline aiming will be discussed in more detail in following sections. The full-load and full-standby cases bound the problem for purposes of this study. During daily startup, full standby may be used while other parts of the plant are start-up before initiating receiver warm-up. To heat the receiver tubes during transitions like preheating prior to establishing salt flow and during cooldown, a small subset of the heliostat population is used to preclude thermal shock from the sudden injection of salt flow, or to prevent freezing before draining is complete.

5.3.2 Results: Full-Load Case

Using the described SAM default power tower and aiming conditions for full load, SolarPILOT was used to generate flux maps for a series of expanding cylindrical surfaces surrounding the receiver and tower. The diametric range of these cylindrical surfaces extended from 20 m (just slightly larger than the receiver diameter) to 820 m. SolarPILOT generated flux map data for each of these cylindrical surfaces. Visual Basic Excel code was then written to post-process these data for purposes of developing maps of the solar flux (kW/m^2) on vertical planes in both the north-south and east-west directions. A map of the maximum flux as a function of position relative to tower, as viewed from above the field, was also produced. Contour levels of 2.5, 5, 10, 25, 50, and 150 kW/m^2 were used in all cases. Other analyses discussed in this report suggests that 50 kW/m^2 may be a threshold flux level of concern for birds; thus, special attention was given to that contour line.

It should be pointed out that the spillage (i.e., flux that misses the receiver and extends beyond it) was not quantified in this analysis. However, because of the divergent nature of this flux and the fact that spillage is designed to be minimal (< 2%) under operating conditions, flux levels are expected to be very small (as noted in a prior analysis [BrightSource 2012]). In future work, especially looking at standby aiming scenarios, it is recommended that spillage issue be addressed.

A map of the flux contours on the north-south plane, as seen from the east, is shown in Figure 5. Because there are more heliostats to the north (see Figure 4), constant flux levels extend farther from the receiver on the north side than on the south side. To the north, the 50-kW/m^2 level ends approximately 130 m from the receiver and 178 m from the ground. To the south, the 50-kW/m^2 zone extends only about 50 m from the receiver centerline.

Figure 6 is a map of the maximum flux in the vertical direction as a function of compass position. The “wavy” contour lines in Figure 6 occur because certain directions experience higher heliostat density with distance from the receiver.

5.3.3 Results: Full-Standby Cases

Two aiming scenarios were analyzed as full-standby cases. A common aiming algorithm used in standby conditions is to aim heliostats tangentially to a virtual cylindrical surface with the same height but somewhat larger diameter than the receiver (e.g., Ho et al. 2014). There could be numerous variations to this simple strategy, such as in the diameter of the virtual cylinder, the vertical aiming strategy on this surface, and whether all heliostats are rotated such that the aim-points are in the same direction (clockwise or counterclockwise). For purposes of this analysis, a 50-m-diameter cylindrical surface was assumed. The SAM-default receiver diameter is 17.67 m, so this cylinder is considerably larger than the receiver. Visual Basic Excel code was written to transform the heliostat aim-points so that all heliostats are aimed tangentially to this virtual cylindrical surface. A counterclockwise aiming strategy for all heliostat aim-points was assumed. SolTrace was used to verify this new aiming strategy (Wendelin 2003). Figure 7 is a ray-trace graphic showing rays incident on the virtual cylindrical surface as seen from above. The receiver is noted by the red circle. Note the counterclockwise direction of incident rays on the cylinder.

In the vertical direction, two different aiming components were considered. The first placed all the aim-points at the midpoint waist of the cylindrical surface (i.e., centerline). The second maintained the vertical components of the heliostats using Image Priority aiming (vertical smoothing of the flux). If one wishes to reduce the region of high flux, the second aiming strategy should result in a slightly lower peak flux than would the centerline aiming method.

Table 8 lists the peak flux values for the three cases. Full-load aiming generates the highest flux levels in the immediate vicinity of the receiver. Changing the full load aiming would impact power production from the plant. The two different full-standby modes have lower peak fluxes than full-load mode has, and Image Priority aiming shows lower peak flux than Centerline aiming. In addition, the airspace volume of flux less than 50 kW/m^2 is somewhat reduced with Image Priority aiming. While overall this is not a huge reduction, it does suggest that in partial- or full-standby operation, a variety of approaches could be used to reduce the size of this critical flux zone. These include further broadening of the flux in the vertical direction and/or varying the size of the virtual cylinder used in tangential aiming. A randomization of heliostat aim-points could also be employed, which could significantly reduce peak flux zones. Initial indications from one such trial used an aim point strategy that limited flux to less than 5 kW/m^2. In the weeks following this practice zero avian fatalities due to high flux were reported. In summary, any alternative standby aiming methodology should be designed to reduce the peak flux as well as the volume of airspace with flux exceeding the desired minimum threshold level, while at the same time minimizing negative impacts on plant operations. This analysis identifies a range of options that might accomplish these objectives. Further investigation is needed to identify the most attractive options.

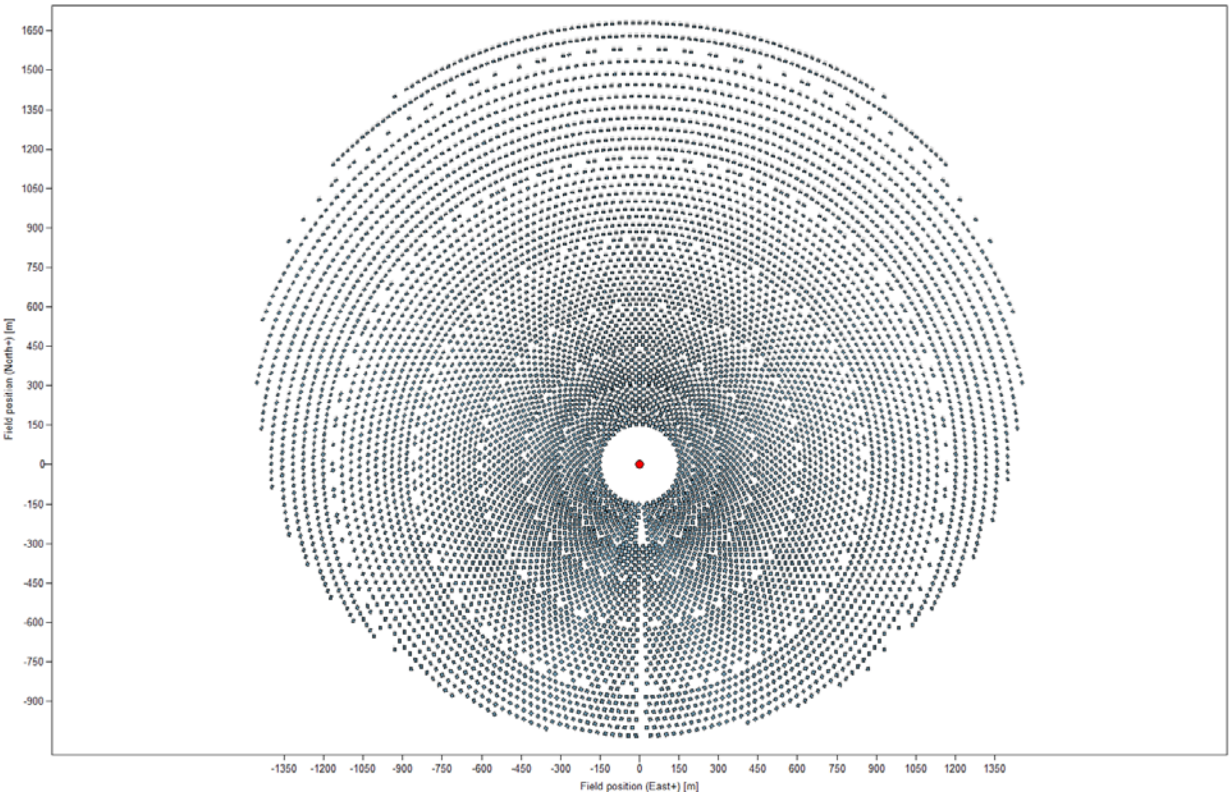


FIGURE 4 SAM Default 100-MW Molten Salt Power Tower Field Layout

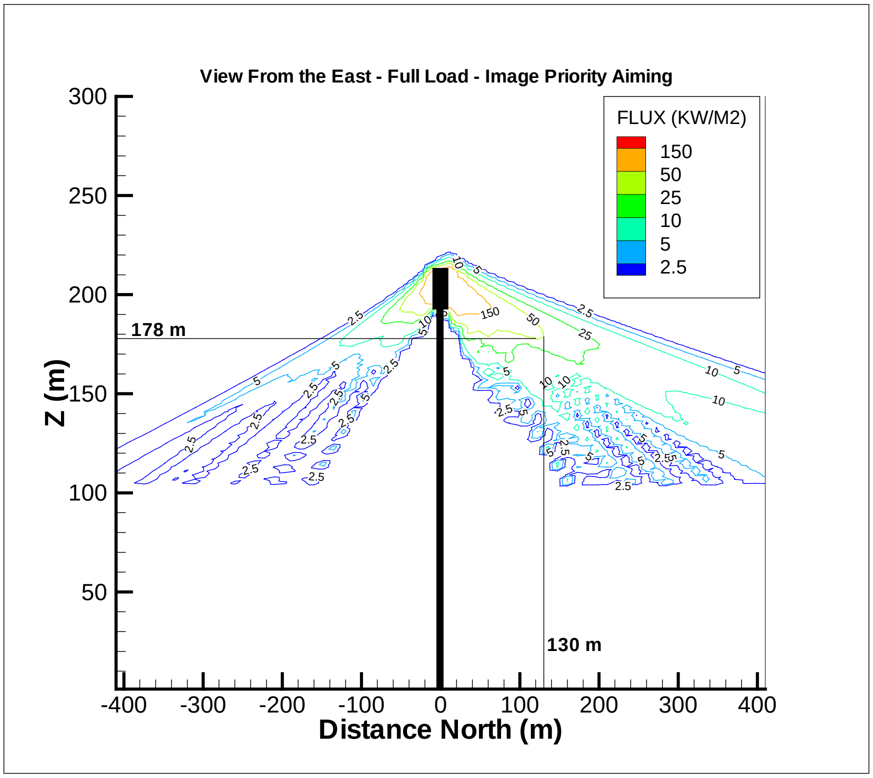


FIGURE 5 Full Load Flux on the North-South Plane as Seen from the East

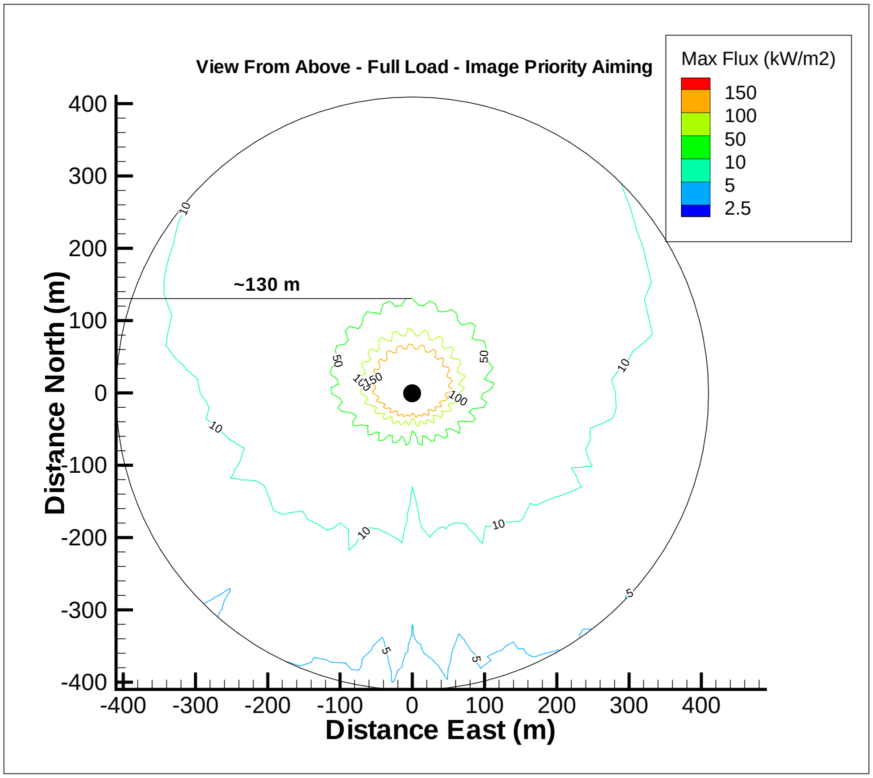


FIGURE 6 Maximum Full Load Flux as Seen from Above the Field

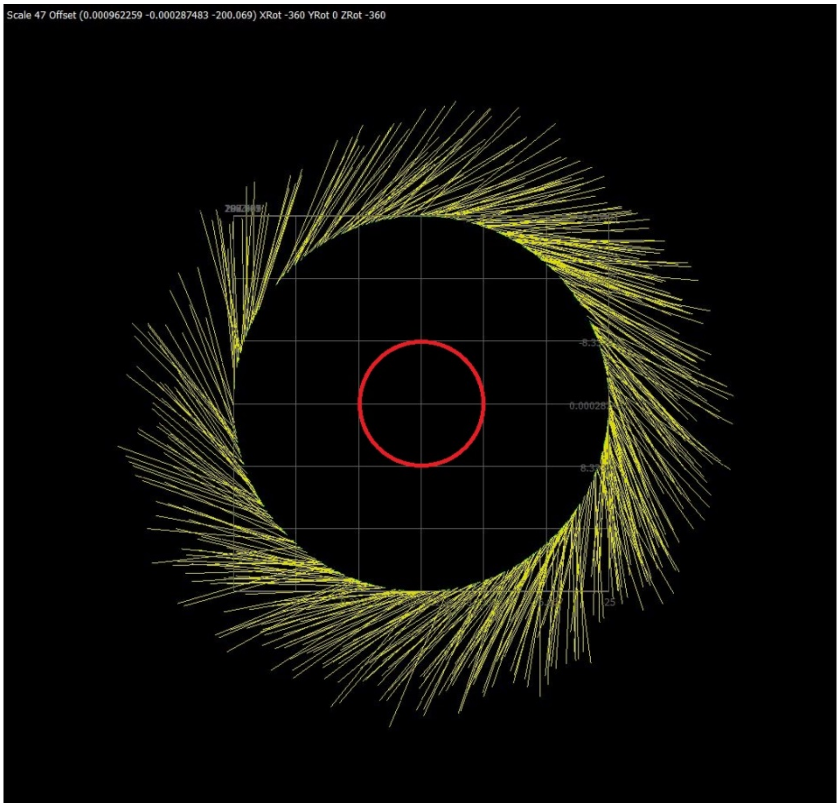


FIGURE 7 SolTrace Ray Trace of SAM Default Field Layout Showing Counterclockwise Tangential Aiming on 50-m-Diameter Virtual Cylindrical Surface. (The diameter of the actual receiver [red circle] is about 18 m.)

TABLE 8 Peak Flux Values for One Full Load and Two Full-Standby Cases[a]

Case	Peak Flux (kW/m^2)
Full Load – Image Priority Aiming	1,013
Full Standby – Centerline Aiming	665
Full Standby – Image Priority Aiming	430

[a] During full load, the peak flux is incident on the solar receiver. A switch to Image Priority aiming during full standby leads to a 35% decrease in peak flux that is generated near the receiver. The results suggest that alternative aiming strategies can be used to decrease the hazard presented by solar flux during standby.

6 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

6.1 SUMMARY AND CONCLUSIONS

6.1.1 Avian Fatality Issues and Study Methodology

Avian fatalities have been documented at solar energy facilities employing both PV and CSP technology types. Several federal and state regulations apply to the protection of birds at solar energy facilities. Most birds are protected by the Migratory Bird Treaty Act, which prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when authorized by the USFWS. Projects are also required to comply with state and federal regulations to protect threatened, endangered, and sensitive species (e.g., ESA, Bald and Golden Eagle Protection Act, BLM policy, and state wildlife codes). Mortality risks to threatened, endangered, and sensitive bird species are related to solar energy project size, location, and technology. Because the potential for impact to birds and their populations depends largely on project size and location, specific requirements for threatened, endangered, and sensitive bird species are often considered on a project-specific basis.

Like many industrial developments, utility-scale solar has the potential to impact birds and bird communities in a number of ways. There are two general types of direct solar-related bird fatality—collision-related and solar-flux-related. Collision-related impacts may occur for all types of solar energy technologies. The effects of solar flux on birds have been observed only at facilities employing power tower technologies.

Not all utility-scale solar energy developments in the United States are required to prepare and comply with project-specific avian monitoring protocols. If determined necessary through the project-specific environmental review process, as part of the solar energy applicant's required measures to reduce impacts, a BBCS may be prepared to better understand bird activity and abundance in the vicinity of a proposed solar energy project and minimize bird mortality risks. The BBCSs provide guidelines on the collection and reporting of avian fatality data, which may be incidental or systematic in nature. Despite efforts to obtain data and information from U.S. and international solar energy companies and organizations, little solar energy project-specific information on bird monitoring or fatality is publicly available.

6.1.2 Existing Avian Fatality Data and Associated Limitations

Evaluating patterns of avian fatality and mortality rates is important in order to understand bird mortality risk at solar energy facilities and in the context of risk from other energy developments. Based on results of data acquisition efforts, avian fatality data were available for seven solar energy facilities in the United States. Of these solar energy projects, systematic avian fatality data were available for four projects (only incidental data were available for the other three facilities). It is important to note that the synthesis of avian mortality in this report was based on publicly available data or information obtained through requests from solar energy companies and regulatory agencies. The information evaluated in this report does not constitute all the data that have been collected at U.S. and international solar energy facilities.

Standardization of data collection and methodology is essential to make avian mortality comparisons between projects and across industries. However, based on the paucity of existing information at solar energy facilities, it is not possible at this time to develop a solar industry-wide avian mortality estimate with any scientific certainty to make any conclusions about the risk of avian mortality at solar facilities compared with other industries and human developments. Additional systematic fatality data at solar energy facilities would be needed to better understand avian mortality risk at solar facilities.

In addition, certainty in mortality estimates will be improved through the development of standardized methods to account for the following factors that may bias mortality calculation: searcher efficiency, search effort, predation and scavenging, and the role of background mortality.

The majority of birds found killed or injured at solar facilities in southern California were passerines. The cause of death could not be determined for the majority of bird deaths, and many detections consisted only of feather spots. It has been hypothesized that feather spots found near perching/roosting structures may be incorrectly classified as fatalities when in fact they are the result of preening (WEST 2014). Feather spots may also represent predation events and not reflect direct solar-related fatality. At sites where a large proportion of the fatalities detected are identified on the basis of feather spots, assigning fatalities to a known cause of death such as predation is difficult. Further work is needed to develop standardized protocols for evaluating feather spot detections and assigning carcasses to causes of death at solar energy facilities.

On average across the six projects evaluated, approximately 54.4% of the known fatality detections were collision-related. The second-ranked cause of fatality among the six solar energy projects was predation. Approximately 26.9% of the known fatality detections were attributed to predation trauma, which may or may not be attributable to the facility. At power tower facilities (ISEGS and California Solar One), the percentage of solar-flux-related fatalities ranked higher than the percentage of predation-related fatalities, likely because birds affected by solar-flux are more easily identified by evidence of singeing.

Water-dependent species (loons, grebes, rails, coots, shorebirds, waterbirds, and waterfowl) have been postulated to be vulnerable to fatality at PV facilities because of the potential for them to confuse arrays for bodies of water (the lake effect hypothesis) (Kagan et al. 2014; WEST 2014). However, there was no consistent pattern of fatality by taxonomic groups among the solar energy facilities evaluated in this report to support or refute the lake effect hypothesis within the southern California region. Water-dependent species represented 11.3% of all recorded fatalities (as of December 2014), but there was high variability among PV facilities, with mortality ranging from 0.27% to 46.3%. Due to the limited and inconsistent dataset (i.e., six studies of incidental and systematic observations), it is too speculative to make any conclusions about the influence of the lake effect fatality of water-dependent birds. The activity and abundance of water-dependent species near solar facilities may depend on other site-specific and regional factors (such as the surrounding landscape) that have not yet been investigated (WEST 2014). Additional studies are needed to determine whether water-dependent species are especially vulnerable to fatality at PV facilities.

BBCSs from 10 solar energy projects were reviewed to present the current state of measures to minimize avian impacts at utility-scale solar energy facilities. There was variability among BBCSs in terms of ESA requirements for federally listed species, plans to conduct preconstruction baseline surveys, analytical methods, and documented mitigation measures and BMPs. In general, BBCS details were project-specific, managing the potential risks to birds and bird communities specific to the project's size (footprint), location, and technology.

6.1.3 Mitigation Measures and Best Management Practices Used in Other Industries

The availability and implementation of mitigation measures and BMPs to reduce impacts on wildlife, with a particular focus on bird and bat species, vary widely across human activities. Voluntary federal and state guidelines, ABPPs, and BBCS plans have been developed and implemented for many wind energy projects, in an industry that has experienced significant capacity additions since 2007. The emerging utility-scale solar industry could benefit, as well, from greater certainty about what assessments to conduct before, during, and after the construction of a solar project. Voluntary guidelines could prove to be quite useful as the industry expands. Several of the companies that are involved in utility-scale solar energy projects also develop wind energy projects, and some participated in the WEG development process. The WEG process was complex and took approximately seven years to complete. If federal guidelines are anticipated, a plan for a more streamlined process would benefit all parties.

In an effort to reduce electrocutions and collision fatalities at electric utility power lines, the APLIC, formed in 1989, developed voluntary BMPs that serve as a valuable knowledge base. Many of these BMPs will apply to utility-scale solar projects.

Collisions between birds and planes at airports can have significant safety and cost implications. The FAA has an active R&D program, but does not appear to have specific BMPs developed for addressing collisions with planes. Developed together with the U.S. Department of Agriculture, the *Manual for Airport Personnel* addresses a wide range of issues that may be encountered at an airport. The International Bird Strike Committee has also published BMPs, in large part based on FAA/USDA manual. Some of the strategies contained in the FAA R&D program may be applicable to addressing adverse bird and bat impacts occurring at utility-scale solar facilities.

The USFWS's WEG serve as the basis for the development of many ABPPs that are currently in use for wind energy projects. Following the tiered approach of the WEG, project-specific ABPPs are adapted to meet species- and habitat-specific considerations. In some cases, mitigation strategies have been implemented and research on the efficacy of these strategies (Tier 5) is ongoing. It is important to distinguish between post-construction monitoring utilizing scientifically rigorous and tested approaches (Tier 4), and R&D that is typically conducted within Tier 5. Ideally, the results from these Tier 5 activities should be made publicly available, preferably published in peer-reviewed journals.

A rush to require project developers to implement untested or unfounded mitigation strategies distracts from the opportunity to conduct scientifically rigorous research and contribute to the knowledge base to provide meaningful solutions. For the solar industry, participating in research to address wildlife impact challenges in the early stages of the growth of this energy sector may help avoid situations that the wind industry experienced, in which informative research was delayed or conducted under study designs that did not adequately address the issues.

6.1.4 Technology-Specific Factors Potentially Associated with Avian Fatality

Power towers are the only technology that has noted solar-flux-related avian fatalities. This report developed a flux-mapping methodology using SAM, SolarPILOT, and SolTrace to predict solar flux in the vicinity of a power tower receiver under full-load and full-standby modes. The method allows exploration of the effects of alternative aiming strategies on peak flux, as well as the airspace region exceeding specified threshold flux levels. These preliminary results compare well with previous analyses and suggest that various approaches to standby aiming could significantly reduce flux levels and their impact on avian fatality. Future work is recommended to determine the impact alternative aiming strategies have on plant operations, and to seek solutions that simultaneously minimize negative impacts on plant operations and zones of high flux that may be harmful to flying birds.

6.2 RECOMMENDATIONS

On the basis of the findings presented in this report, several recommendations can be made to improve understanding of avian fatality issues at utility-scale solar energy facilities. There is a basic need to understand the cause of fatalities (e.g., predation, collision, flux) associated with solar arrays and other infrastructure. Observations of available BBCSs at utility-scale solar facilities revealed opportunities to improve consistency and standardization in avian monitoring protocols. Not all utility-scale solar energy developments in the United States have been required to prepare and comply with project-specific avian monitoring protocols, particularly those projects located on private lands. Building upon lessons learned from the wind energy industry, a programmatic guideline similar to the WEG may help promote standardized monitoring and data collection throughout the solar energy industry. Adopting applicable guidelines from the WEG would help promote compliance with relevant wildlife laws and regulations and encourage scientifically rigorous survey, monitoring, assessment, and research designs proportionate to the risk to species of concern. Further, they should produce potentially comparable data across the nation and mitigate (including avoid, minimize, and compensate) for potential adverse effects on species of concern and their habitats.

The following should be considered when developing standardized inventory and monitoring protocols at utility-scale solar energy facilities:

- Distribution of habitat, species, and resources on the site and in adjacent areas
- Importance of project area relative to local, landscape, and region
- Resident and migrant use of site and surroundings
- Seasonal patterns of use
- Daytime versus nighttime effects
- Effects of project on resident and migratory species
- Direct, indirect, and cumulative effects
- Role of predators in carcass persistence and transport (on and off the facility)
- Distance effect (zone of influence)
- Background mortality rate
- Mortality rates attributable to project features
- Contributors to risk (technology and project feature-specific)
- Role of confounding factors (e.g., moon phase, weather)
- Use of indicator species to represent different categories of species
- Focus on statistically robust data collection rather than incidental or ad hoc reporting

Additional systematically collected fatality data at other solar energy projects in multiple regions would be needed to better understand avian mortality risk at solar facilities compared with other energy developments. More systematic study of utility-scale solar facilities is needed in order to make conclusions about avian risk and mortality, types of birds impacted, contribution of background mortality to mortality estimates, influence of facility attraction to birds (e.g., lake effect), and other factors such as predation could be improved through the development of standardized monitoring methodologies and assessment approaches.

The opportunity exists for the development of a science plan to focus future research on systematic data collection to better understand impacts, causal factors, and feasible mitigation measures and BMPs to inform future decisions about solar energy project siting and design. Such science plans should focus on uncertainties related to avian risks and causative factors, population-level impacts to migratory birds, development of more effective inventory and monitoring techniques, and guide the development of pilot studies to assess the implications of mitigation measures and BMPs to energy production.

Moving forward, the industry, federal and state agencies, and other stakeholders might all benefit from working collaboratively towards (1) developing and implementing useful and scientifically rigorous data collection program, (2) evaluating avian mortality related to utility-scale solar development and the causal effects, and (3) identifying appropriate mitigation measures to address identified issues.

7 REFERENCES

Airport Cooperative Research Program (ACRP), 2011, *Bird Harrassment, Repellent, and Deterrent Techniques for Use on and Near Airports, A Synthesis of Airport Practice*, Synthesis Report 23. Transportation Resarch Board, Sponsored by the Federal Aviation Administration, Washington, D.C.

Allan, J., and P. Alex, 2001, "The Costs of Bird Strikes to Commercial Aviation," presented at Bird Strike North American Conference, Calgary, Alberta, Canada.

Allison, T.D., T.L. Root, and P.C. Frumhoff, 2014, "Thinking Globally and Siting Locally – Renewable Energy and Biodiversity in a Rapidly Warming World," *Climatic Change* 126: 1–6.

Althouse and Meade, Inc., 2011, *Final Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan for the Topaz Solar Farm, San Luis Obispo County, California*, prepared for Topaz Solar Farms, LLC, Sept.

Althouse and Mede, Inc., 2014, *Topaz Solar Farms 2013 Fourth Quarter/Second Annual Report for Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan*, prepared for Topaz Solar Farms, LLC, Aug.

APLIC (Avian Power Line Interaction Committee), 2005, *Avian Protection Plan Guidelines*, joint document prepared by Edison Electric Institute's APLIC and U.S. Fish and Wildlife Service.

APLIC, 2006, *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006*, joint document prepared by Edison Electric Institute's APLIC, Washington, D.C., and the California Energy Commission, Sacramento, Calif.

APLIC, 2014, *APLIC Mission Statement*, www.aplic.org/resources.php.

AGFD (Arizona Game and Fish Department), 2009, *Guidelines for Reducing Impacts to Wildlife from Wind Energy Development in Arizona*, Phoenix, Ariz.

Avery, M.L., D.G. Decker, J.S. Humphrey, E. Aronov, S.D. Linscombe, and M.O. Way, 1995, "Methyl Anthranilate as a Rice Seed Treatment to Deter Birds," *Journal of Wildlife Management*, 59: 50–56.

Avian & Bat Monitoring and Management Plan—Ivanpah Solar Electric Generating System, Nov., 2013, http://docketpublic.energy.ca.gov/PublicDocuments/07-AFC-05C/TN201315_20131122T160942_Ivanpah_Avian_Monitoring_Plan_rev_12.PDF.

Bolinger, M., and S. Weaver, 2013, *Utility-Scale Solar 2012*, LBNL-6408E, Lawrence Berkeley National Laboratory, Sept.

BrightSource Energy, 2012, "Flux Impacts on Avian Species," presentation at California Energy Commission Joint Workshop, Aug. 28.

BLM (Bureau of Land Management), 2008, *Manual 6840, Special Status Species Management*, Washington, D.C.

BLM and DOE (Bureau of Land Management and U.S. Department of Energy), 2012, *Final Programmatic Environmental Impact Statement for Solar Energy Development in Six Southwestern States*, FES 12-24, DOE/EIS-0403, July.

California Department of Fish and Wildlife (CDFW). 2014. California Wildlife Habitat Relationships. Available at https://www.dfg.ca.gov/biogeodata/cwhr/. Accessed December 8, 2014.

CEC (California Energy Commission), 2014, *California Energy Commission Docket/Siting List*, www.energy.ca.gov/dockets/, accessed Nov. 17, 2014.

CEC and CDFG (California Department of Fish and Game), 2007, *California Guidelines for Reducing Impacts to Birds and Bats for Wind Energy Development*, Commission Final Report, CEC-700-2007-008-CMF.

CH2MHILL, 2011, *Biological Resources Mitigation Implementation and Monitoring Plan for the Rice Solar Energy Project, Riverside County, California* , 09-AFC-10C.

Cleary, E.C., and R.A. Dolbeer, 2005, *Wildlife Hazard Management at Airports: A Manual for Airport Personnel*, U.S. Department of Agriculture National Wildlife Research Center – Staff Publications.

Dieckman, E. A., Skinner, E., Mahjoub, G., Swaddle, J., & Hinders, M. (2013, June). Benign exclusion of birds using acoustic parametric arrays. In *Proceedings of Meetings on Acoustics* (Vol. 19, No. 1, p. 010063). Acoustical Society of America.

DOE (U.S. Department of Energy), 2008, *20% Wind by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply*, http://energy.gov/sites/prod/files/2013/12/f5/41869.pdf.

Dooling, R., 2002, *Avian Hearing and the Avoidance of Wind Turbines*, NREL/TP-500-30844, National Renewable Energy Laboratory.

Duarte, J., M.A. Farfan, J.M. Vargas, and R. Real, 2011, "Evaluation of Wires as Deterrents for Preventing House Martin Nesting on Buildings," *International Journal of Pest Management* 57(2): 147–151.

EIA (U.S. Energy Information Administration), 2014, *Electric Power Monthly, with Data for July 2014*, www.eia.gov/electricity/monthly/pdf/epm.pdf, accessed Sept. 25, 2014.

Eiermann, S.J., and D. Heynen, 2014, "Effect of an Ultrasound Device on the Behavior and the Stress Hormone Corticosterone in Feral Pigeons," *Journal of Pest Science* 87: 315–322.

Engeman, R.M., J. Peterla, and B. Constantin, 2002, *Methyl Anthranilate Aerosol for Dispersing Birds from the Flight Lines at Homestead Air Reserve Station*, U.S. Department of Agriculture National Wildlife Research Center – Staff Publications.

Erickson, W.P., G.D. Johnson, and D.P. Young, Jr., 2005, *A Summary and Comparison of Bird Mortality from Anthropogenic Causes with an Emphasis on Collisions*, General Technical Report PSW-GTR-191, U.S. Department of Agriculture, Forest Service.

Erickson, W.P., M.M. Wolfe, K.J. Bay, D.H. Johnson, and J.L. Gehring, 2014, "A Comprehensive Analysis of Small-Passerine Fatalities from Collision with Turbines at Wind Energy Facilities," *PLoS ONE* 9(9):e107491.

FAA (Federal Aviation Administration), 2014, *Wildlife Hazard Mitigation Research and Development*, http://www.faa.gov/airports/airport_safety/wildlife/rd/.

First Solar, 2014, *Desert Sunlight Avian Mortality Data*, email correspondence between A. Beck (First Solar, Manager of Environmental Compliance, First Solar) and L. Walston (Argonne National Laboratory, Argonne, Ill.), June 23.

Fjalling, A., M. Wahlberg, and H. Westerberg, 2006, "Acoustic Harassment Devices Reduce Seal Interaction in the Baltic Salmon-Trap, Net Fishery," *ICES Journal of Marine Science* 63:1751–1758.

Flather, C.H., and J.R. Sauer, 1996, "Using Landscape Ecology to Test Hypotheses about Large-Scale Abundance Patterns in Migratory Birds," *Ecology* 77:28–35.

Fthenakis, V., and H.C. Kim, 2009, "Land Use and Electricity Generation: A Life-Cycle Analysis," *Renew. Sustain. Energy Rev.* 13(6–7): 1465–1474, Aug.

Gehring, J., P. Kerlinger, and A.M. Manville, 2009, "Communication Towers, Lights, and Birds: Successful Methods of Reducing the Frequency of Avian Collisions," *Ecological Society of America* 19(2): 505–514.

Götz, T., and V.M. Janik, 2011, "Repeated Elicitation of the Acoustic Startle Reflex Leads to Sensitisation in Subsequent Avoidance Behaviour and Induces Fear Conditioning," *BioMed Central Neuroscience* 12: 30.

Hernandez, R.R., et al., 2014, "Environmental Impacts of Utility-Scale Solar Energy," *Renewable and Sustainable Energy Reviews* 29: 766–779.

H.T. Harvey & Associates, 2011, *Avian and Bat Protection Plan for the California Valley Solar Ranch Project*, Fresno, Calif.

H.T. Harvey & Associates, 2014a, *California Valley Solar Ranch Project Avian and Bat Protection Plan Annual Postconstruction Fatality Report (16 August 2012 – 15 August 2013)*, Project #3326-03, prepared for HPR II, March.

H.T. Harvey & Associates, 2014b, *Ivanpah Solar Electric Generating System Avian & Bat Monitoring Plan; 2013–2014 Winter Report (29 October 2013 – 21 March 2014)*, Project #2802-07, prepared for Solar Partners I, II, and VIII, June.

H.T. Harvey & Associates, 2014c, *Ivanpah Solar Electric Generating System Avian & Bat Monitoring Plan; 2014 Spring Report (23 March 2014 – 22 May 2014)*, Project #2802-07, prepared for Solar Partners I, II, and VIII, Aug.

H.T. Harvey & Associates, 2014d, *Ivanpah Solar Electric Generating System Avian & Bat Monitoring Plan; 2014 Summer Report (23 May – 17 August 2014)*, Project #2802-07, prepared for Solar Partners I, II,and VIII, Dec.

H.T. Harvey & Associates, 2015, *Memorandum: Applying control plot data to adjust avian fatality rates at the 250 MW California Valley Solar Ranch photovoltaic facilities.*

Ho, C.K., C.A. Sims, and J.M. Christian, 2014, *Evaluation of Glare at the Ivanpah Solar Electric Generating System*, SAND2014-15847, Sandia National Laboratories, July.

Hodos, W., 2003, Minimization of Motion Smear: Reducing Avian Collisions with Wind Turbines, Subcontractor Report NREL/SR-500-33249, National Renewable Energy Laboratory.

Horváth, G., G. Kriska, P. Malik, and B. Robertson, 2009, "Polarized Light Pollution: A New Kind of Ecological Photopollution," *Frontiers in Ecology and the Environment* 7:317–325.

Hurlbert, A.H., and J.P. Haskell, 2003, "The Effect of Energy and Seasonality on Avian Species Richness and Community Composition," *The American Naturalist* 161(1):83–97.

Huso, M.M.P., 2011, "An Estimator of Wildlife Fatality from Observed Carcasses," *Environmetrics* 22: 318-329.

IBSC (International Bird Strike Committee), 2007, *Best Management Practices for Airport Wildlife Control*, adapted by the Steering Committee of Bird Strike Committee-USA from Standards for Aerodrome Bird/Wildlife Control developed by IBSC, E. Cleary (Principal Compiler), http://www.birdstrike.org/meetings/BMP.htm#_Toc169661965.

IR (Iberdrola Renewables, LLC), 2008, *Avian and Bat Protection Plan*, Portland, Ore., http://iberdrolarenewables.us.files.s3.amazonaws.com/pdf/Signed_ABPP_10-28-08.pdf, accessed Oct. 21, 2014.

Ironwood Consulting, 2010, *Avian and Bat Protection Plan, Desert Sunlight Solar Farm Project*, BLM Case File Number CACA-48649, Riverside County, Calif., prepared by Ironwood Renewables, Portland, Ore., for Desert Sunlight Holdings, Aug.

Ironwood Consulting, 2013, *Bird and Bat Conservation Plan, Silver State Solar Power South,* Project #NVN-085801, prepared for Bureau of Land Management, Feb.

JBR Environmental Consultants, Inc., 2011, *Avian and Bat Protection Plan: Crescent Dunes Solar Energy Project, Nye County, NV,* prepared by JBR, for Tonopah Solar Energy, May.

Jones, A., 2012, *Best Management Practices for Siting, Developing, Operating, and Monitoring Renewable Energy in the Intermountain West: A Conservationist's Guide*, Wild Utah Project, Salt Lake City, Utah, March.

Kagan, R.A., T.C. Viner, P.W. Trail, and E.O. Espinoza, 2014, *Avian Mortality at Solar Energy Facilities in Southern California: A Preliminary Analysis*, National Fish and Wildlife Forensics Laboratory, April.

KARE, M.R. 1961. Bird repellent. United States Patent No. 2,967,128.

Kistler, B.L., 1986, *A User's Manual for DELSOL3: A Computer Code for Calculating the Optical Performance and Optimal System Design for Solar Thermal Central Receiver Plants,* SAND86-8018, Sandia National Laboratories, Nov.

Kuvlesky, Jr., W., et al., 2007, "Wind Energy Development and Wildlife Conservation: Challenges and Opportunities," *The Journal of Wildlife Management* 71(8):2487–2498.

Labinger, Z., 2012, *Assessment of Potential Impacts to Birds from a Solar Thermal Power Plant, Dimona, Israel*, Interim Report-Spring Survey 2012, prepared for BrightSource Industries, Israel.

Levenstein, K., A. Chatfield, D. Riser-Espinoza, and W. Erickson, 2014, *Draft Bird and Bat Conservation Strategy for the Palen Solar Electric Generating System*, Western EcoSystems Technology, Inc., Cheyenne, Wyo., http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202487_20140623T143117_Ex1139__Draft_Bird_and_Bat_Conservation_Strategy.pdf.

Lewis, N.S., 2007, "Toward Cost-Effective Solar Energy Use," *Science* 315:798–801.

Loss, S.R., et al., 2013, "Estimates of Bird Collision Mortality at Wind Facilities in the Contiguous United States," *Biological Conservation* 168:201–209.

Loss, S.R., et al., 2014, "Bird-Building Collisions in the United States: Estimates of Annual Mortality and Species Vulnerability," *The Condor* 116:8–23.

Lovich, J.E., and J.R. Ennen, 2011, "Wildlife Conservation and Solar Energy Development in the Desert Southwest, United States," *BioScience* 61:982–992.

Marples and Roper, 1997, "Sour Grapes: Methyl Anthranilate as Feeding Repellent for Birds," in *Hands-On Chemical Ecology: Simple Field and Laboratory Exercises*, Springer New York, LCC.

Mason, J.R., M.A. Adams, and L. Clark, 1989, "Anthranilate Repellency to Starlings: Chemical Correlates and Sensory Perception," *Journal of Wildlife Management* 53: 55–64.

McCrary, M.D., R.L. McKernan, R.W. Schreiber, W.D. Wagner, and T.C. Sciarrotta, 1986, "Avian Mortality at a Solar Energy Power Plant," *Journal of Field Ornithology* 57: 135–141.

Mixon, K.L., J. Schrenzel, D. Pile, R. Davis, R. Doneen, L. Joyal, N. Kestner, M. Doperalski, and J. Schladweiler, 2014, *Avian and Bat Survey Protocols for Large Wind Energy Conversion Systems in Minnesota*, Minnesota Department of Natural Resources, New Ulm, Minn.

NatureServe, 2014, *NatureServe Explorer: An Online Encyclopedia of Life*, http://explorer.natureserve.org/, accessed December 8, 2014.

Ning, H., and W. Chen, 2014, "Bird Strike Risk Evaluation at Airports," *Aircraft Engineering and Aerospace Technology: An International Journal* 86(2):129–137.

Norris, J., 2012, *Amendment to the On-Shore Bird and Bat Pre- and Post-Construction Monitoring Protocol for Commercial Wind Energy Facilities in Ohio*, Ohio Department of Natural Resources, Columbus, Ohio, June.

NREL (National Renewable Energy Laboratory), 2012, "Lower 48 and Hawaii DNI, 10 KM Resolution, 1998 to 2009," map in "Dynamic Maps, GIS Data, and Analysis Tools: Solar Data" database, www.nrel.gov/gis/data_solar.html, accessed Nov. 17, 2014.

NWWWG (Nebraska Wind and Wildlife Working Group), 2013, *Guidelines for Wind Energy and Wildlife Resource Management in Nebraska*, http://outdoornebraska.ne.gov/wildlife/pdfs/newwguidelines.pdf.

NYSDEC (New York State Department of Environmental Conservation) Division of Fish, Wildlife, and Marine Resources, 2009, *Guidelines for Conducting Bird and Bat Studies at Commercial Wind Energy Projects*, Albany, N.Y.

ODNR (Ohio Department of Natural Resources), 2009, *On-Shore Bird and Bat Pre- and Post-Construction Monitoring Protocol for Commercial Wind Energy Facilities in Ohio: An Addendum to the Ohio Department of National Resource's Voluntary Cooperative Agreement*, Columbus, Ohio.

ODOE (Oregon Department of Energy), 2008, *Oregon Columbia Plateau Ecoregion Wind Energy Siting and Permitting Guidelines*, Salem, Ore.

Ong, S., C. Campbell, P. Denholm, R. Margolis, and G. Heath, 2013, *Land-Use Requirements for Solar Power Plants in the United States,* NREL/TP-6A20-56290, National Renewable Energy Laboratory, Golden, Colo., June.

PGC (Pennsylvania Game Commission), 2013, *Wind Energy Voluntary Cooperation Agreement: Amendment I*, Harrisburg, Penn.

Ponce, C., J.C. Alonso, G. Argandoña, A. García Fernández, and M. Carrasco, 2010, "Carcass Removal by Scavengers and Search Accuracy Affect Bird Mortality Estimates at Powerlines," *Animal Conservation* 13: 603–612.

Prather, P.R., and T.A. Messmer, 2010, "Raptor and Corvid Response to Power Distribution Line Perch Deterrents in Utah," *Journal of Wildlife Management* 74(4): 796–800.

Ramp, D., C.G. Foale, E. Roger, D.B. Croft, 2011, "Suitability of Acoustics as Non-lethal Deterrents for Macropodids: The Influence of Origin, Delivery, and Anti-Predator Behaviour," *Wildlife Research* 38: 408–418.

Renewable Energy Action Team, 2010, *Best Management Practices and Guidance Manual: Desert Renewable Energy Projects*, California Energy Commission, California Department of Fish and Game, U.S. Bureau of Land Management, and U.S. Fish and Wildlife Service.

Ribot, R.F.H., M.L. Berg, K.L. Buchanan, and A.T.D. Bennett, 2011, "Fruitful Use of Bioacoustic Alarm Stimuli as a Deterrent for Crimson Roseallas (*Playcercus elegans*)," *Emu* 111(4): 360–367.

Ronconi, R.A., and C. St. Clair, 2005, "Efficacy of a Radar-Activated On-Demand System for Deterring Waterfowl from Oil Sands Tailings Ponds," *Journal of Applied Ecology*, 43(1):111–119.

Schakner, Z.A., and D.T. Blumstein, 2013, "Behavioral Biology of Marine Mammal Deterrents: A Review and Prospectus," *Biological Conservation* 167:380–389.

Seamans, T.W., and B.F. Blackwell, 2014, "Electric Shock Strips as Bird Deterrents: Does Experience Count?" *International Journal of Pest Management* 57(4):357–362.

SEIA (Solar Energy Industries Association), 2014a, *Major Solar Projects List Fact Sheet*, www.seia.org/research-resources/major-solar-projects-list, accessed Nov. 21, 2014.

SEIA, 2014b, *Major Solar Projects in the United States*, www.seia.org/sites/default/files/resources/PUBLIC%20Major%20Projects%20List%202014-8-19.pdf, accessed Sept. 5, 2014.

Shafiee, S., and E. Topal, 2009, "When Will Fossil Fuel Reserves Be Diminished?," *Energy Policy* 37:181–189.

Shivik, J.A., A. Treves, and P. Callahan, 2003, “Nonlethal Techniques for Managing Predation: Primary and Secondary Repellents,” *Conservation Biology* 17:1531–1537.

Silver State Solar Power North, 2011, *Avian Protection Plan*, Silver State Solar Project, Project #NVN-085077, prepared for the Bureau of Land Management, May.

Slater, S.J., and J.P. Smith, 2010, “Effectiveness of Raptor Perch Deterrents on an Electrical Transmission Line in Southwest Wyoming,” *Journal of Wildlife Management* 74(5):1080–1088.

Smallwood, K.S., 2013, “Comparing Bird and Bat Fatality-Rate Estimates among North American Wind-Energy Projects,” *Wildlife Society Bulletin* 37:19–33.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. Didonato, 2010, “Novel Scavenger Removal Trials Increase Wind Turbine-Caused Avian Fatality Estimates,” *Journal of Wildlife Management* 74:1089–1097.

Smith, E.P., 2002, “BACI Design,” in: El-Shaarawi, A.H., and W.W. Piegorsch (eds.), *Encyclopedia of Environmetrics*, Wiley, Chichester, England, pp. 141–148.

Soldatini, C., Y.V. Albores-Barajas, P. Torricelli, and D. Mainardi, 2007, “Testing the Efficacy of Deterring Systems in Two Gull Species,” *Applied Animal Behaviour Science* 1(10):330–340.

Somveille, M., A. Manica, S.H.M. Butchart, and A.S.L. Rodrigues, 2013, “Mapping Global Diversity Patterns for Migratory Birds,” *PLoS ONE* 8(8):e70907.

Sovacool, B.K., 2009, “Contextualizing Avian Mortality: A Preliminary Appraisal of Bird and Bat Fatalities from Wind, Fossil-Fuel, and Nuclear Electricity,” *Energy Policy* 37:2241–2248.

Sovacool, B.K., 2013, “The Avian Benefits of Wind Energy: A 2009 Update,” *Renewable Energy* 49: 19–24.

Stevens, G.R., L. Clark, and R.A. Weber, 1998, “The Use of Aerosol Repellents as an Avian Deterrent Strategy,” *Proceedings of the Eighteenth Vertebrate Pest Conference (1998)*. Paper 20. http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1019&context=vpc18.

Tetra Tech, 2011, *Bird and Bat Conservation Strategy, Genesis Solar Energy Project, East Riverside County, California*, prepared for Genesis Solar, revised March 2014, http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-08C/TN201879_20140317T152343_Genesis_Solar_BBCS.pdf.

Thomas, L., S.T. Buckland, E.A. Rexstad, J.L. Laake, S. Strindberg, S.L. Hedley, J.R. Bishop, T.A. Marques, and K.P. Burnham, 2010, “Distance Software: Design and Analysis of Distance Sampling Surveys for Estimating Population Size,” *Journal of Applied Ecology* 47: 5–14.

Tupper, S.K., Cummings, J., Andelt, W, Werner, S., Harness, R. 2011. Evaluation of Sonic Dissuader to Reduce Damaage by Pileated Woodpeckers. *Wildlife Society Bulletin* 35 (1): 40 -44.

USFWS (U.S. Fish and Wildlife Service), 2012, *Land-Based Wind Energy Guidelines*, OMB Control No. 1018-0148, 82 pp.

USFWS, 2013, *Eagle Conservation Plan Guidance: Land-based Wind Energy*, Volume 2, 113 pp.

USFWS, 2014, Solar SPUT Data, email correspondence between Heather Beeler (Eagle Permit Coordinator, USFWS) and Leroy Walston (Ecologist, Argonne National Laboratory), Sept. 22, 2014.

Walston, L., E.M. White, S.A. Meyers, C. Turchi, and K. Sinclair, 2015, *Bibliography of Literature Regarding Avian Issues Associated with Solar and Wind Energy Development and Other Activities*, prepared by Argonne National Laboratory and the National Renewable Energy Laboratory, Mar.

WDFW (Washington Department of Fish and Wildlife), 2009, *Washington Department of Fish and Wildlife Wind Power Guidelines*, Olympia, Wash. 35 pp.

Wendelin, T., 2003, "SolTRACE: A New Optical Modeling Tool for Concentrating Solar Optics," *Proceedings of ISEC 2003,* American Society of Mechanical Engineers.

WEST (Western EcoSystems Technology, Inc.), 2014, *Sources of Avian Mortality and Risk Factors Based on Empirical Data from Three Photovoltaic Solar Facilities*, prepared by Western EcoSystems Technology, Inc., June 17.

Young, Jr., D. P., W.P. Erickson, M.D. Strickland, R.E. Good, and K.J. Sernka, 2003, *Comparison of Avian Responses to UV-Light-Reflective Paint on Wind Turbines*, National Renewable Energy Laboratory Subcontractor Report NREL/SR-500-32840, 67 pp.

APPENDIX A:

Glossary

APPENDIX A:

Glossary

Adaptive Management – A structured, iterative process of robust decision making in the face of uncertainty, with an aim to reduce uncertainty over time via system monitoring. The goal is to decrease avian mortality — Deterrence and BMPs are tested in this framework and monitored to determine whether they are efficacious.

Best Management Practices (BMPs) – Practices the facility can undertake (such as panel or mirror positioning) to decrease risk/impacts to species.

Carcass Removal/Scavenging Rates – The probability that a carcass will be removed before a searcher has the opportunity to observe it. Often described as the mean number of days that a carcass will remain before being scavenged.

Compensatory Mitigation – The provision of compensatory land/monetary or other actions that are intended to offset the impacts of the action.

Concentrating Solar Power (CSP) – A system which captures solar energy as heat before converting it into electricity by a thermo-electric power cycle.

Deterrent – A measure used to repel avian species from a site, such as bird spikes or auditory/chemosensory repellents.

Direct Impact – An impact observable within the solar project footprint resulting from ground-disturbing activities or operation of the project.

Fatality – Death or the occurrence of death.

Feather Spot – Feathers concentrated together in a small area and considered an avian fatality. Feather spots have been defined as two or more primary flight feathers, five or more tail feathers, or 10 or more feathers of any type concentrated together in an area of 1 square meter or smaller. The definition can vary among studies.

Incidental Data – Fatalities observed incidentally during other activities that were not part of focused systematic searches for carcasses.

Indirect Impact – An impact that may extend beyond the solar project footprint.

Lake Effect Hypothesis – The hypothesis that water-dependent bird species may potentially mistake the extensive solar arrays for water features on which the birds can land, usually at night. Such collisions, often do not result in direct mortality, but the birds sometimes cannot take off after collisions because they are adapted to take off from water, not dry land.

Mitigation – A broad category of measures/techniques used to decrease or avoid impacts (includes BMPs).

Monitoring – Studies designed to determine mortality at sites.

Mortality – The relative frequency of deaths in a specific population (death rate).

Photovoltaic (PV) – A system that converts sunlight directly into electricity.

Searcher Efficiency – The probability that a searcher will find a carcass during a systematic survey.

Solar Flux – A measure of the amount of solar energy passing through, or impinging on, a specific area.

Systematic Data – Fatalities observed during the course of dedicated search efforts.

Utility-scale – Loosely defined as ground-mounted facilities larger than 1 megawatt that are tied directly to the transmission grid.

Water-Dependent Species – Bird species dependent on aquatic habitats to complete portions of their life cycles (shorebirds, marshbirds, wading birds, seabirds, and waterfowl).

APPENDIX B:

Summary of Avian Fatality Data and Monitoring Plans Developed for Utility-Scale Solar Facilities

APPENDIX B:

Summary of Avian Fatality Data and Monitoring Plans Developed for Utility-Scale Solar Facilities

B.1 Summary of Avian Fatality Data

Table B.1 presents a summary of avian fatality data collected at utility-scale solar facilities in the U.S. All facilities reported in this table are located in southern California. This table serves as a summary of all reported avian fatality observations at seven utility-scale solar facilities between 2011 and 2014. The data presented in Table B.1 were collected over various time periods and monitoring intervals. Fatality observations at the solar facilities were not based on consistent survey approaches and include incidental and systematic observations.

TABLE B.1 Summary of Avian Fatality by Species for Seven Solar Energy Facilities in the United States for the period 2011-2014. Observations were recorded at solar facilities from various monitoring periods and includes results of incidental and systematic surveys.[a]

Species	Species Group	Residency Status	Total Number of Detections	Percent Composition by Solar Facility (%)							Overall Composition (%)
				California Solar One	CVSR	Desert Sunlight	Genesis	Mojave Solar	Ivanpah	Topaz	
American avocet	Water-Dependent Bird	Migrant	7	0	0	4.54	0	0	0	0	0.51
American coot	Water-Dependent Bird	Resident	26	2.86	0.27	3.25	2.72	14.3	1.67	3.33	1.88
American kestrel	Raptor	Resident	20	1.43	0.54	0.65	3.27	0	1.87	0	1.45
American pipit	Passerine	Resident	4	0	0.27	0	0	0	0.56	0	0.29
Anna's hummingbird	Other	Resident	14	0	0	0	0	0	2.62	0	1.01
Ash-throated flycatcher	Passerine	Resident	5	0	0	1.95	0	0	0.37	0	0.36
Bank swallow	Passerine	Migrant	4	0	0	0	0	0	0.75	0	0.29
Barn owl	Raptor	Resident	9	0	0.27	0.65	2.72	0	0	3.33	0.65
Barn swallow	Passerine	Migrant	8	2.86	0	0	0	0	1.12	0	0.58
Bewick's wren	Passerine	Resident	1	0	0	0	0	0	0.18	0	0.07
Black phoebe	Passerine	Resident	1	0	0	0	0.55	0	0	0	0.07
Black-throated grey warbler	Passerine	Migrant and Resident[b]	2	0	0	0	0.55	0	0.18	0	0.14
Black-and-white warbler	Passerine	Migrant	1	0	0	0	0	0	0.18	0	0.07
Black-crowned night-heron	Water-Dependent Bird	Resident	1	0	0	0.65	0	0	0	0	0.07

Species	Species Group	Residency Status	Total Number of Detections	Percent Composition by Solar Facility (%)							Overall Composition (%)
				California Solar One	CVSR	Desert Sunlight	Genesis	Mojave Solar	Ivanpah	Topaz	
Black-headed grosbeak	Passerine	Migrant	3	0	0	0.65	0.55	0	0.18	0	0.22
Black-necked stilt	Water-Dependent Bird	Resident	2	2.86	0	0	0	0	0	0	0.14
Black-tailed gnatcatcher	Passerine	Resident	1	0	0	0.65	0	0	0	0	0.07
Black-throated sparrow	Passerine	Resident	18	0	0	0	0	0	3.36	0	1.30
Blue-gray gnatcatcher	Passerine	Resident	3	0	0	0	0	0	0.56	0	0.22
Blue-winged teal	Water-Dependent Bird	Resident	6	1.43	0	0.65	1.09	0	0.37	0	0.43
Bonaparte's gull	Water-Dependent Bird	Migrant	2	1.43	0	0	0	7.14	0	0	0.14
Brewer's blackbird	Passerine	Resident	19	7.14	0.27	1.3	1.09	0	1.67	0	1.37
Brewer's sparrow	Passerine	Resident	4	0	0	0	0	0	0.75	0	0.29
Broad-tailed hummingbird	Other	Resident	1	0	0	0	0	0	0.18	0	0.07
Brown pelican	Water-Dependent Bird	Resident	6	0	0	2.59	1.09	0	0	0	0.43
Brown-headed cowbird	Passerine	Resident	17	0	0	1.3	7.1	0	0.37	0	1.23
Bufflehead	Water-Dependent Bird	Resident	2	0	0	0	0.55	7.14	0	0	0.14
Bullock's	Passerine	Resident	8	0	0	0	4.37	0	0	0	0.58

Species	Species Group	Residency Status	Total Number of Detections	Percent Composition by Solar Facility (%)							Overall Composition (%)
				California Solar One	CVSR	Desert Sunlight	Genesis	Mojave Solar	Ivanpah	Topaz	
oriole											
Burrowing owl	Raptor	Resident	7	0	0.82	1.3	0	0	0	3.33	0.51
Cactus wren	Passerine	Resident	2	0	0	0	0	0	0.37	0	0.14
California gull	Water-Dependent Bird	Migrant	1	0	0	0	0	7.14	0	0	0.07
California quail	Other	Resident	2	0	0.54	0	0	0	0	0	0.14
Calliope hummingbird	Other	Resident	4	0	0	0	0	0	0.75	0	0.29
Cassin's vireo	Passerine	Migrant	1	0	0	0	0	0	0.18	0	0.07
Chipping sparrow	Passerine	Resident	3	0	0	0	0	0	0.56	0	0.22
Clark's grebe	Water-Dependent Bird	Resident	1	0	0	0	0.55	0	0	0	0.07
Cliff swallow	Passerine	Migrant and Resident[c]	20	2.86	0	0	4.37	0	1.87	0	1.45
Common gallinule	Water-Dependent Bird	Resident	1	0	0	0	0	0	0.18	0	0.07
Common loon	Water-Dependent Bird	Migrant	8	0	0	2.59	1.64	0	0.18	0	0.58
Common merganser	Water-Dependent Bird	Resident	1	0	0	0.65	0	0	0	0	0.07
Common poorwill	Other	Resident	4	0	0	1.95	0	0	0.18	0	0.29
Common raven	Passerine	Resident	44	0	6.25	3.25	0	7.14	0.37	21.67	3.18
Common yellowthroat	Passerine	Migrant	7	0	0.54	1.3	0	0	0.56	0	0.51
Cooper's hawk	Raptor	Resident	4	0	0	0	0.55	7.14	0.37	0	0.29
Costa's	Other	Resident	18	0	0	1.3	0	0	2.99	0	1.30

Species	Species Group	Residency Status	Total Number of Detections	Percent Composition by Solar Facility (%)							Overall Composition (%)
				California Solar One	CVSR	Desert Sunlight	Genesis	Mojave Solar	Ivanpah	Topaz	
hummingbird											
Dark-eyed junco	Passerine	Resident	1	1.43	0	0	0	0	0	0	0.07
Domestic pigeon	Doves/Pigeons	Resident	2	0	0	0	1.64	0	0	0	0.14
Double-crested cormorant	Water-Dependent Bird	Migrant	3	0	0	1.95	0	0	0	0	0.22
Eared grebe	Water-Dependent Bird	Resident	30	15.71	0	7.14	2.18	7.14	0.37	1.67	2.17
Eurasian collared dove	Doves/Pigeons	Resident	3	0	0	0	0.55	0	0.37	0	0.22
European starling	Passerine	Resident	9	5.71	1.1	0	0	0	0	1.67	0.65
Fox sparrow	Passerine	Migrant	1	0	0.27	0	0	0	0	0	0.07
Gadwall	Water-Dependent Bird	Resident	1	0	0	0	0.55	0	0	0	0.07
Great blue heron	Water-Dependent Bird	Migrant	4	0	0	0	2.18	0	0	0	0.29
Great egret	Water-Dependent Bird	Resident	1	0	0	0.65	0	0	0	0	0.07
Great horned owl	Raptor	Resident	2	0	0.54	0	0	0	0	0	0.14
Greater roadrunner	Other	Resident	20	0	0	0	1.09	0	3.18	1.67	1.45
Great-tailed grackle	Passerine	Resident	9	0	0	2.59	0.55	0	0.75	0	0.65
Green-tailed towhee	Passerine	Resident	1	0	0	0	0	0	0.18	0	0.07
Green-winged teal	Water-Dependent	Resident	3	0	0	0	1.64	0	0	0	0.22

Species	**Species Group**	**Residency Status**	**Total Number of Detections**	**Percent Composition by Solar Facility (%)**							**Overall Composition (%)**
				California Solar One	**CVSR**	**Desert Sunlight**	**Genesis**	**Mojave Solar**	**Ivanpah**	**Topaz**	
	Bird										
Hermit thrush	Passerine	Resident	1	0	0	0	0.55	0	0	0	0.07
Hermit warbler	Passerine	Migrant	5	0	0	0	0.55	0	0.75	0	0.36
Herring gull	Water-Dependent Bird	Resident	2	0	0	0	1.09	0	0	0	0.14
Horned grebe	Water-Dependent Bird	Resident	1	0	0	0	0.55	0	0	0	0.07
Horned lark	Passerine	Resident	132	4.28	26.36	1.95	0	0	3.18	20	9.54
House finch	Passerine	Resident	83	5.71	13.59	1.3	0.55	0	3.92	8.33	6.00
House sparrow	Passerine	Resident	1	0	0.27	0	0	0	0	0	0.07
House wren	Passerine	Resident	1	0	0	0	0.55	0	0	0	0.07
Lapland longspur	Passerine	Resident	1	0	0	0	0	0	0.18	0	0.07
Lazuli bunting	Passerine	Migrant	4	0	0	0	0	0	0.75	0	0.29
lesser goldfinch	Passerine	Resident	5	0	0	0	1.64	0	0.18	1.67	0.36
Lesser nighthawk	Other	Resident	16	0	0	0.65	1.64	0	2.24	0	1.16
Lesser scaup	Water-Dependent Bird	Resident	1	0	0	0.65	0	0	0	0	0.07
Lincoln’s sparrow	Passerine	Resident	5	0	0.27	0	0.55	0	0.56	0	0.36
Loggerhead shrike	Passerine	Resident	17	0	0.54	3.89	0	0	1.67	0	1.23
Long-eared owl	Raptor	Resident	2	0	0.27	0.65	0	0	0	0	0.14
MacGillivray's warbler	Passerine	Migrant	4	1.43	0.27	0	0.55	0	0.18	0	0.29
Marsh wren	Passerine	Resident	1	0	0	0	0.55	0	0	0	0.07
Mourning dove	Doves/Pigeo	Resident	208	8.57	29.89	3.25	5.46	0	13.08	11.66	15.03

Species	**Species Group**	**Residency Status**	**Total Number of Detections**	**Percent Composition by Solar Facility (%)**							**Overall Composition (%)**
				California Solar One	**CVSR**	**Desert Sunlight**	**Genesis**	**Mojave Solar**	**Ivanpah**	**Topaz**	
	ns										
Nashville warbler	Passerine	Migrant	4	0	0.27	0	0	0	0.56	0	0.29
Northern flicker	Other	Resident	4	0	0.27	0	0	7.14	0.37	0	0.29
Northern mockingbird	Passerine	Resident	1	0	0	0	0	0	0.18	0	0.07
Northern rough-winged swallow	Passerine	Resident	7	0	0	0	0.55	0	1.12	0	0.51
Olive-sided flycatcher	Passerine	Resident	2	0	0	0	0	0	0.37	0	0.14
Orange-crowned warbler	Passerine	Resident	2	0	0	0	1.09	0	0	0	0.14
Peregrine falcon	Raptor	Resident	1	0	0	0	0	0	0.18	0	0.07
Phainopepla	Passerine	Resident	1	0	0	0	0	0	0.18	0	0.07
Pied-billed grebe	Water-Dependent Bird	Resident	5	0	0	1.3	1.64	0	0	0	0.36
Pine siskin	Passerine	Resident	2	0	0	0	0	0	0.37	0	0.14
Prairie falcon	Raptor	Resident	1	0	0	0.65	0	0	0	0	0.07
Red-tailed hawk	Raptor	Resident	3	0	0.54	0	0.55	0	0	0	0.22
Red-breasted merganser	Water-Dependent Bird	Migrant	1	0	0	0.65	0	0	0	0	0.07
Red-necked phalarope	Water-Dependent Bird	Migrant	2	1.43	0	0.65	0	0	0	0	0.14
Red-winged Blackbird	Passerine	Resident	4	4.28	0	0.65	0	0	0	0	0.29
Ring-billed gull	Water-Dependent	Resident	2	0	0	0	1.09	0	0	0	0.14

Species	Species Group	Residency Status	Total Number of Detections	Percent Composition by Solar Facility (%)							Overall Composition (%)
				California Solar One	CVSR	Desert Sunlight	Genesis	Mojave Solar	Ivanpah	Topaz	
	Bird										
Rock dove	Doves/Pigeons	Resident	1	0	0	0	0	0	0.18	0	0.07
Rock pigeon	Doves/Pigeons	Resident	8	0	0	0	0	0	0.56	8.33	0.58
Rock wren	Passerine	Resident	1	0	0	0	0.55	0	0	0	0.07
Ruby-crowned kinglet	Passerine	Resident	1	0	0	0	0	7.14	0	0	0.07
Ruddy duck	Water-Dependent Bird	Resident	4	0	0	0.65	1.09	7.14	0	0	0.29
Rufous hummingbird	Other	Migrant	8	0	0	0	0	0	1.49	0	0.58
Sagebrush sparrow	Passerine	Resident	3	0	0	1.95	0	0	0	0	0.22
Savannah sparrow	Passerine	Resident	11	4.28	1.1	0.65	0	0	0.37	1.67	0.79
Say's phoebe	Passerine	Resident	5	0	0	0.65	1.64	0	0.18	0	0.36
Scott's oriole	Passerine	Resident	1	0	0	0	0	0	0.18	0	0.07
Short-eared owl	Raptor	Resident	3	0	0.82	0	0	0	0	0	0.22
Sora	Water-Dependent Bird	Resident	7	0	0	2.59	1.09	0	0	1.67	0.51
Spotted sandpiper	Water-Dependent Bird	Resident	1	0	0	0	0	0	0.18	0	0.07
Surf scoter	Water-Dependent Bird	Resident	1	0	0	0.65	0	0	0	0	0.07
Swainson's thrush	Passerine	Migrant	1	0	0.27	0	0	0	0	0	0.07
Townsend's warbler	Passerine	Migrant	16	0	0	1.95	0.55	0	2.24	0	1.16

Species	Species Group	Residency Status	Total Number of Detections	Percent Composition by Solar Facility (%)							Overall Composition (%)
				California Solar One	CVSR	Desert Sunlight	Genesis	Mojave Solar	Ivanpah	Topaz	
Tree swallow	Passerine	Migrant	20	0	0.27	0.65	6.01	0	1.61	0	1.45
Unknown	Unknown	Unknown	150	8.57	4.9	5.84	17.48	0	14.57	10	10.84
Vaux's swift	Other	Migrant	2	1.43	0	0	0	0	0.18	0	0.14
Verdin	Passerine	Resident	6	0	0	0.65	0	0	0.93	0	0.43
Violet-green swallow	Passerine	Resident	6	0	0	0	0	0	1.12	0	0.43
Warbling vireo	Passerine	Migrant	1	0	0.27	0	0	0	0	0	0.07
Western grebe	Water-Dependent Bird	Resident	20	0	0	11.68	0	14.3	0	0	1.45
Western kingbird	Passerine	Resident	1	0	0	0	0	0	0.18	0	0.07
western meadowlark	Passerine	Resident	35	1.43	6.79	0.65	0.55	0	1.3	0	2.53
Western tanager	Passerine	Migrant	9	0	0	1.95	0.55	0	0.93	0	0.65
Western wood pewee	Passerine	Resident	1	0	0	0	0	0	0.18	0	0.07
White-crowned sparrow	Passerine	Resident	17	2.86	0	1.95	0.55	0	2.06	0	1.23
White-faced ibis	Water-Dependent Bird	Resident	1	0	0	0.65	0	0	0	0	0.07
White-throated swift	Other	Resident	8	2.86	0	0	0.55	0	0.93	0	0.58
White-winged dove	Doves/Pigeons	Resident	3	0	0	0.65	1.09	0	0	0	0.22
Wilson's warbler	Passerine	Migrant	13	1.43	0	3.25	0.55	0	1.12	0	0.94
Wood duck	Water-Dependent Bird	Resident	1	0	0	0	0	7.14	0	0	0.07
Yellow warbler	Passerine	Migrant	8	0	0.54	0	1.64	0	0.56	0	0.58
Yellow-billed	Other	Resident	1	0	0	0	0	0	0.18	0	0.07

Species	Species Group	Residency Status	Total Number of Detections	Percent Composition by Solar Facility (%)							Overall Composition (%)
				California Solar One	CVSR	Desert Sunlight	Genesis	Mojave Solar	Ivanpah	Topaz	
cuckoo											
Yellow-breasted chat	Passerine	Migrant	1	0	0	0	0	0	0.18	0	0.07
Yellow-headed blackbird	Passerine	Resident	13	2.86	0	1.95	3.82	0	0.18	0	0.94
Yellow-rumped warbler	Passerine	Resident	49	2.86	0.82	0.65	0	0	8.04	0	3.54
Yuma clapper rail	Water-Dependent Bird	Resident	1	0	0	0.65	0	0	0	0	0.07
Total			**1384**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

[a] Data presented from available reports as of December 2014. Sources: Genesis: fatalities recorded in available Monthly Compliance Reports submitted to CEC; CVSR: H.T. Harvey & Associates (2014a); ISEGS: H.T. Harvey & Associates (2014b,c) and Monthly Compliance Reports submitted to CEC; Topaz: Althouse and Meade, Inc. (2014); Mohave Solar: Monthly Compliance Reports submitted to CEC; Desert Sunlight: SPUT reports, Ironwood Consulting, Inc. 2013a-b, and WEST 2014; Solar One: McCrary et al. (1986).

[b] Considered to be a resident near the Ivanpah facility and a migrant near the Genesis facility.

[c] Considered to be a resident near the Ivanpah facility and a migrant near the Genesis and Solar One facilities.

B.2 Summary of Avian and Bat Protection Plans at Utility-Scale Solar Facilities

This section presents an overview of existing avian fatality monitoring and reporting requirements and related BMPs (e.g., mitigation or conservation measures), as identified in available solar project-specific ABPPs. The purpose of this section is to present the current state of measures to minimize avian impacts at utility-scale solar energy facilities. A summary of solar facility ABPPs is provided in Table B.2. Monitoring measures and BMPs employed in other applications are discussed in Section 4.

On the basis of efforts to collect data and information described in Section 2.2, BBCSs or similar avian monitoring plans (hereafter, all such plans are referred to as “BBCSs”) were available for the following 10 solar energy facilities:

- Centinela
- Crescent Dunes
- Desert Sunlight
- Genesis
- Ivanpah Solar Electric Generating System (ISEGS)
- Palen Solar Electric Generating System (PSEGS)
- Rice Solar
- Silver State North
- Silver State South
- Topaz Solar Farm

Each monitoring plan was reviewed to identify measures used to monitor, analyze, and report avian fatalities. The following aspects of each plan were reviewed:

- The documented presence of threatened or endangered species listed under the ESA and specific monitoring requirements for those species;

- Plans to conduct pre-construction baseline surveys for bird activity and abundance;

- Analysis methods (models used, experimental design, methods, etc.); and

- Documented avoidance, minimization, and mitigation measures and BMPs.

TABLE B.2 Summary of Avian and Bat Protection Plans at Utility-Scale Solar Facilities

Project	Silver State South	Crescent Dunes	Genesis	Rice Solar	Topaz	Silver State North	Palen (PSEGS)	Ivanpah (ISEGS)	Desert Sunlight	Centinela
State	NV	NV	CA	CA	CA	NV	CA	CA	CA	CA
Technology	PV	Power tower	CSP - parabolic trough	Power tower	PV	PV	Power tower	Power tower	PV	PV
Acres	2,427	2,950	1,950	3,324	3,500	7,925	3,794	3,600	4,410	2,067
Year	2013	2011	2014	2011	2011	2011	2014	2013	2010	2012
ESA requirements	No ESA-listed species were described.	No ESA-listed species were described. However, the document mentions that all avian and bat species that are listed as threatened or endangered species will be protected.	No ESA-listed birds were documented in the study area.	No ESA-listed species were described. However, the document mentions that all species identified as rare, threatened, or endangered by the ESA and CESA will be protected.	No ESA-listed birds were documented in the study area.	No ESA-listed bird species were described. However, ESA Section 7 consultation for the desert tortoise was described.	No ESA-listed species were described. However, the document mentions that the BLM will coordinate with the USFWS to ensure that the plan meets ESA requirements.	No ESA-listed species were described. However, the document describes methods to conserve any state- and federally listed species observed on the site.	No ESA-listed bird species documented in the study area. The document discusses other state-listed and sensitive bird species.	Two ESA-listed bird species were discussed (southwestern willow flycatcher and Yuma clapper rail). Through ESA consultation with the USFWS, it was determined that the solar energy development “May affect, but not likely adversely affect” either species.
Baseline surveys	Yes	No pre-construction baseline surveys were reported.	Yes	Yes. Baseline surveys will be conducted before construction activities begin.	Yes	Yes. Surveys will be conducted to determine the presence of special-status and nesting birds.	Yes	No pre-construction baseline surveys were reported.	Yes	Yes
Number of monitoring years	4 (2010–2013)	NA[a]	3 (2007–2010)	NA	2 (2008–2010)	No formal pre-construction avian surveys have been conducted in the project area	2 (2013–2014)	2014-2015	1	2 (2009–2011)
Number of years/seasons of baseline monitoring	• 2010 (spring) - Golden Eagle Aerial Surveys; • 2011 (spring), 2012 (spring, fall) - Burrowing Owl Surveys; • 2012 (spring, fall), 2013 (winter, spring) - Avian Point Counts; • 2012 (winter, spring, fall), 2013 (winter, spring) - Golden Eagle Point Counts; • 2012, 2013 (winter, spring, fall) - Common Raven Point Counts; • 2013 (throughout breeding season) - Golden Eagle Nest Monitoring	NA	• Spring and winter 2009 avian point count surveys; • Golden eagle nest surveys: March 25–26 and April 2–3, 2010; March 23–24 and May 5–7, 2011 (2011 survey conducted for a different nearby project). • Western burrowing owl surveys: Phase I Habitat Assessment December 2007; Phase II burrow location 2009; Phase III breeding-season surveys spring 2009.	NA	• Nesting, wintering, protocol, and general bird surveys: March 2008–July 2010. • Aerial survey for golden eagle nests: 2010	NA	• Bird use count surveys: April–June 2013, August–December 2013, March–June 2014 • Small bird count surveys: April–June 2013, August-November 2013, March–June 2014 • Gila woodpecker surveys: April–June 2013 • Elf owl surveys: May–June 2013 • Habitat evaluation for elf owl and Gila woodpecker: July 2013 • Golden eagle surveys: March–August 2013, April–August 2014 • Golden eagle prey abundance surveys: April–June 2013	NA	Point count surveys - April– May 2010. Golden eagle surveys - April 2–3, 2010 and May 14, 2010. Nest Surveys - April 23-24 and May 20, 2010.	• Avian use and abundance survey: Winter and spring 2010 and 2011. • Burrowing owl surveys: 2009-2011 breeding seasons.

Table B.9 (Cont.)

Project	Silver State South	Crescent Dunes	Genesis	Rice Solar	Topaz	Silver State North	Palen	Ivanpah	Desert Sunlight	Centinela
Number of years/seasons of baseline monitoring (Cont.)							• Burrowing owl surveys: March–June 2009, April–June 2013 • Agricultural pond surveys: August–December 2013, March–June 2014 • Nocturnal radar surveys: August–October 2013, March–June 2014			
Offsite baseline surveys	The baseline avian surveys were conducted within the project site and a larger area surrounding the project site.	NA	Yes. Golden eagle surveys were conducted within a 16.1-km (10-mi) survey radius from the project site.	Yes	Yes	NA	Yes. A 1-mi buffer around the site was used for bird count surveys. Golden eagle surveys were conducted within a 10 mi buffer around the project site.	Yes. This plan details the onsite and offsite surveys to be conducted.	Yes	Yes
Models used	Bird point count data were used to develop distance models using the program DISTANCE. The model estimates total bird density on site by season.	The programs DISTANCE (Thomas et al. 2010) and MARK (White and Burnham 1999) were used to calculate distances from the transects and estimate total number of fatalities.	None reported.	None reported.	None reported.	None reported.	Model to assess risk to birds flying through regions of concentrated solar flux surrounding the two collection towers at the proposed PSEGS.	None reported.	None reported.	None reported.
Species-specific surveys	Two species received specific monitoring: burrowing owls and golden eagles.	None	Golden eagle and burrowing owl.	Golden eagle; burrowing owl; kit fox; badger; Couch's spadefoot toad; raven; desert tortoise	Burrowing owls, golden eagle nests,	Western burrowing owl pre-construction nest surveys will be conducted.	Golden eagle surveys; burrowing owl; desert tortoise	Western Burrowing owl and pre-construction nest surveys	Golden eagle; burrowing owl	Flat-tailed horned lizard, mountain plover, burrowing owl
Proposed Before-After Control-Impact (BACI) Studies	Yes	None reported.	None reported.	None reported.	None reported.	None reported.	None reported.	None reported.	None reported.	None reported.
Surveyor requirements	**Yes**	Yes	Yes	Yes	None reported.	None reported.	Yes	Yes	None reported.	
Reporting frequency	Monthly and quarterly.	None reported.	Monthly and quarterly.	Monthly	Quarterly	None reported.	Quarterly	Monthly and quarterly	Quarterly	Quarterly
Monitoring duration	During construction and 2–3 years post construction	No specific duration reported.	2 years post construction.	2 years post construction.	3-year construction period and 3 years post construction	No specific duration reported.	Minimum 3 years post construction.	Minimum 2 years post construction.	During construction and 5 years post construction	During construction and 1 year post construction.
Searcher efficiency trials	No measures to characterize searcher efficiency reported.	Yes	Yes	Yes	Yes	No measures to characterize searcher efficiency reported.	Yes	Yes	No measures to characterize searcher efficiency reported.	Yes
Carcass persistence trials	No measures to characterize carcass persistence reported.	Yes	Yes	Yes	Yes	No measures to characterize carcass persistence reported.	Yes	Yes	No measures to characterize carcass persistence reported.	No measures to characterize searcher efficiency reported.

Table B.9 (Cont.)

Project	Silver State South	Crescent Dunes	Genesis	Rice Solar	Topaz	Silver State North	Palen	Ivanpah	Desert Sunlight	Centinela
Template fatality /injury form	None reported.	Yes	Yes	Yes	Yes	None reported.	None reported.	Yes	None reported.	Yes
Data analysis	No detailed discussion of data analysis.	Two primary analyses would be conducted. The first would use the program DISTANCE to determine the most effective transect width to search for carcasses. The second would use the program MARK to estimate the total number of fatalities controlling for detection rate, scavenging rate, and proximity to the power tower.	To calculate the project-wide mortality rate (fatalities/MW/year) and the total project fatalities, using a mortality estimator (Huso 2011 or other appropriate statistical methods (e.g., Warren-Hicks, Komer-Nievergelt).	No detailed discussion of data analysis.	Bird utilization rates to be used in combination with bird mortality rates to calculate a Bird Risk Index. The Bird Risk Index would be used to identify project components that may require Adaptive Management and to assess those components that are successfully operating without impacts to birds.	No detailed discussion of data analysis.	Analyses will include preliminary adjusted mortality estimates, breakdown of fatalities by taxonomic group, resident or migratory status, location of fatality (e.g., tower, heliostats, road), and suspected cause of death (e.g.,. collision, flux). In addition, maps will be provided to display the spatial distribution of fatalities by taxonomic group and suspected cause of death. Gives a formula for determining overall mortality.	The total number of avian casualties will be estimated by adjusting for search frequency, removal bias (length of carcass persistence in the field), and searcher efficiency bias (percentage found).	No detailed discussion of data analysis.	Two primary analyses will be conducted. The first will use the program DISTANCE to determine the most effective transect width to search for carcasses. The second will use the program MARK to estimate total number of fatalities controlling for detection rate, scavenging rate, and proximity to project components.
Adaptive management	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Avoidance/ minimization/ mitigation measures	Measures include: • Avoidance of: locations with federally or state-listed sensitive species and areas frequently used by birds and their nesting areas; • Reduce noise impacts; • Avoid using lattice-type structures to minimize perching and nesting; • Avoid use of guy wires; • Focus facility lights downward (light management); • Place electric lines underground; • Avoid creation of roads; • Place netting over evaporation ponds (if needed).	Measures include: • Minimize lighting; • Construct evaporation ponds in a manner to discourage wading; • Install anti-perching devices at evaporation ponds; • Install visual deterrents; and • Avoid land-clearing activities.	Measures include: • Minimize perching and nesting opportunities; • Bury telecommunication lines to minimize the risk of bird collisions; • Increase visibility of aboveground transmission lines to reduce collisions; and • Minimize lighting.	Measures include: • Limit disturbance areas and perimeter fencing, minimize road and traffic impacts; • Minimize impacts of transmission alignments; • Avoid use of toxic substances; • Minimize lighting and noise impacts; • Avoid wildlife pitfalls; • Minimize standing water; • Implement worker guidelines; • Implement erosion control measures; • Monitor ground-disturbing activities; and • Regulate fugitive dust.	A suite of measures are provided to minimize project conflicts with birds and bats, protect birds and bats from harm due to construction and operation of the project, and enhance habitat in the project vicinity for birds and bats.	Measures include: • Pre-construction surveys; • Worker environmental awareness program; • Migratory birds and raptors impacts reduction measures; • Burrowing owl measures; • If eagle fatality occurs as a result of the project, First Solar will work with the agencies to identify appropriate compensatory mitigation to ensure that the no net loss standard is maintained.	Measures include: • Project design; • Worker Environmental Awareness Program; • Noise minimization; • Pre-construction nest surveys and avoidance measures; • Avian enhancement and conservation plan; • Burrowing owl Impact minimization.	Specific measures are not described. The document states that substantial resources have been committed toward the development and implementation of avoidance, minimization, and mitigation actions to benefit the conservation of avian resources[a].	Siting criteria, design features, and BMPs have been incorporated into the project that will provide significant avoidance and minimization measures into the project to reduce the potential for adverse effects on protected avian and bat species. Measures include: • Nest avoidance.	Avoidance, minimization, and mitigation measures will be implemented to avoid or minimize bird impacts during construction and operation of the project. Examples of such avoidance, minimization and mitigation measures include the following: • Designing project electric lines in accordance with Avian Power Line Interaction Committee (APLIC) design standards; • Conducting pre-construction surveys to avoid impacts on nesting birds; • Providing for the protection of suitable habitat to compensate for impacts on burrowing owl foraging habitat; • Installing flight diverters where overhead lines cross certain riparian areas; and

Table B.9 (Cont.)

Project	Silver State South	Crescent Dunes	Genesis	Rice Solar	Topaz	Silver State North	Palen	Ivanpah	Desert Sunlight	Centinela
Avoidance/ minimization/ mitigation measures (Cont.)										• Avoidance of suitable threatened and endangered species habitat (southwestern willow flycatcher and Yuma clapper rail), including seasonal buffers for construction activities.
Compliance with APLIC Guidelines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes- APLIC designs required as part of CEC permit process not detailed in ABMMP	Yes	Yes
Other related plans	Worker Environmental Awareness Plan, Raven Management Plan, Avian Mortality Monitoring Plan, Avian and Bat Fatality Monitoring Plan	Operations Plan (for evaporation ponds), Avian Protection Plan	Common Raven Monitoring, Management, and Control Plan; Nesting Bird Monitoring and Management Plan; Burrowing Owl Relocation and Mitigation Plan; Fire Prevention Plan; Weed Management Plan; Biological Resource Mitigation Implementation and Monitoring Plan (BRMIMP)	Raven Monitoring, Management, and Control Plan (BIO-17); Weed Management Plan (BIO-11); Revegetation Plan and Compensation for Impacts to Native Vegetation Communities (BIO-10); Special Status Plant Impact Avoidance and Minimization Plan; Desert Tortoise Translocation Plan (BIO-15); Evaporation Pond Design, Monitoring, and Management Plan (BIO-24); Burrowing Owl Monitoring and Mitigation Plan	Vegetation Management Plan (VMP); Topaz Habitat Restoration and Revegetation Plan; Bird Monitoring and Avoidance Plan; dust control pond management plan	Fire Management Plan; Noxious Weed Management and Rehabilitation Plan	Lighting Mitigation Plan; Nesting Bird Monitoring and Management Plan; Avian Enhancement and Conservation Plan; Retrofit Plan; Burrowing Owl Mitigation Plan; Eagle Protection Plan	CEC permits require Raven Management Plan, Closure, Revegetation and Rehabilititation Plan, Weed Management Plan, Special-Status Plant Protection and Monitoring Plan, Compensatory Mitigation Plan, Desert Tortoise Relocation/Translocation Plan, Biological Resources Mitigation Implementation and Monitoring Plan, Burrowing Owl Mitigation and Monitoring Plan	Common Raven Management Plan for the Desert Sunlight Solar Farm; Integrated Weed Management Plan	Burrowing Owl Mitigation and Monitoring Plan; Raven Control Plan

[a] Management actions must be feasible and commensurate with the impact. Some examples of measures include placement of visual and/or auditory bird flight diverters in critical locations, retrofitting power lines to APLIC standards, installing perch guards on overhead electric lines in the vicinity, modification of mirror resting angles, modifications to tower or other facility lighting.

Environmental Science Division
Argonne National Laboratory
9700 South Cass Avenue, Bldg. 240
Argonne, IL 60439-4854

www.anl.gov

U.S. DEPARTMENT OF
ENERGY

Argonne National Laboratory is a U.S. Department of Energy
laboratory managed by UChicago Argonne, LLC

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

California Valley Solar Ranch Project Fifth Quarterly Post-construction Avian and Bat Protection Plan Fatality Report 16 August 2013 to 15 November 2013

Prepared for:

HPR II, LLC
California Valley Solar Ranch
13505 Carissa Highway, Highway 58
Santa Margarita, CA 93453
Attn: Bill Cotton

Prepared by:

H. T. Harvey & Associates
Project # 3326-02

Prepared per:

Avian And Bat Protection Plan for the California Valley Solar Ranch Project

U.S. Fish and Wildlife Service
Biological Opinion (81420-2011-F-0511)
San Luis Obispo County
Conditional Use Permit (DRC2008-00097)

18 February 2014

Table of Contents

Figures

Tables

Appendices

Section 1.0 Introduction

Through adoption of Resolution #2011-119, the Board of Supervisors of San Luis Obispo County (the County) approved the California Valley Solar Ranch Project (CVSR Project) Conditional Use Permit (DRC 2008-00097) on 19 April 2011. The Conditional Use Permit is subject to the Conditions of Approval (COAs) set forth in Exhibit 6 attached to the Resolution.

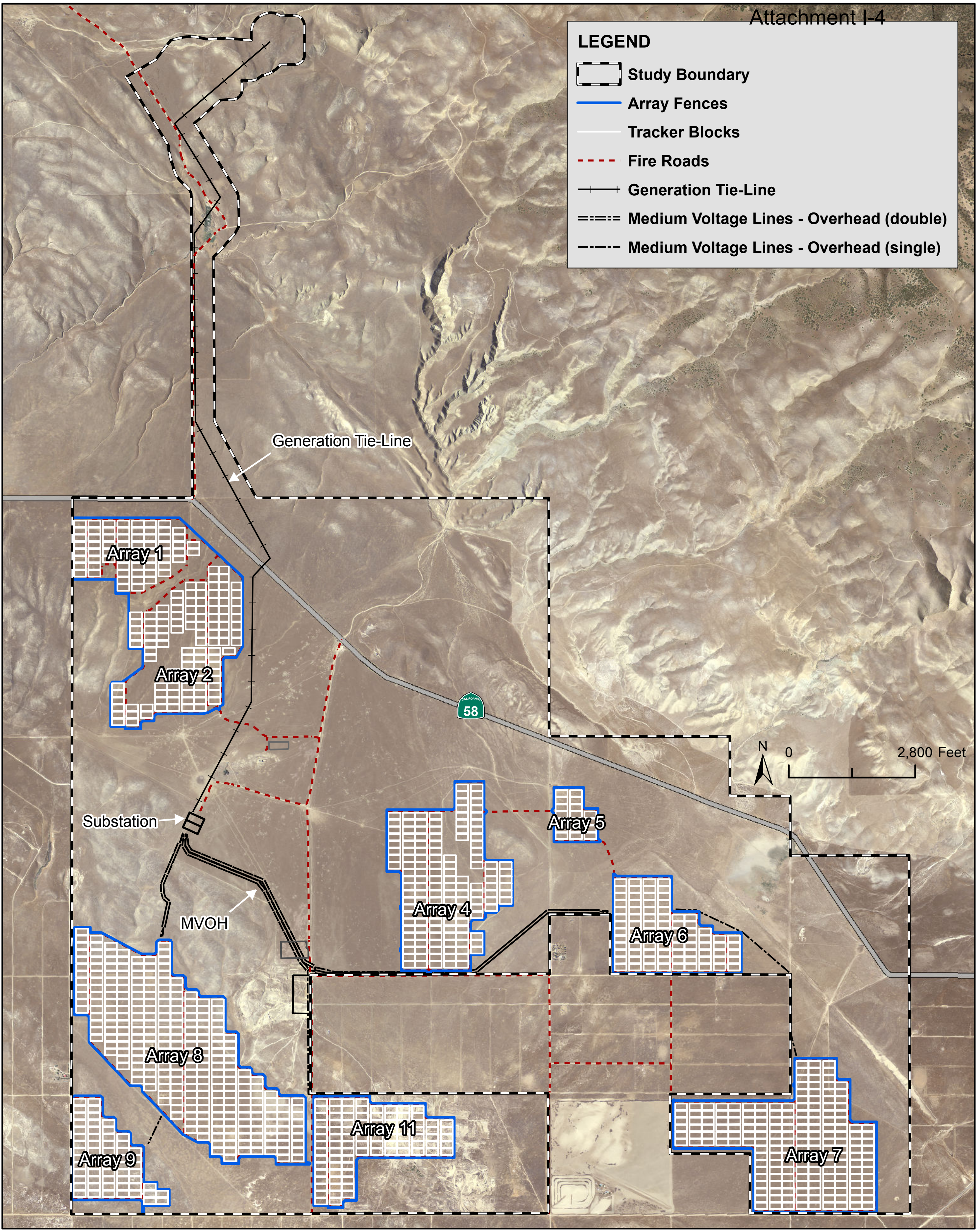
The Conditional Use Permit allows High Plains Ranch II, LLC (and any successor in interest for the life of the CVSR Project) to construct and operate a 250-megawatt photovoltaic solar power plant on an approximately 4685-acre (ac) site, located mostly south of State Route (SR) 58, about four miles (mi) east of Soda Lake Road, immediately north of the California Valley subdivision, in the Shandon-Carrizo planning area of San Luis Obispo County (CVSR site).

COA #58 of the CVSR Project Conditional Use Permit requires an Avian and Bat Protection Plan (ABPP) and a quarterly report detailing any Project-related bird or bat deaths or injuries detected during the monitoring study defined in COA #58c. To satisfy COA #58c, High Plains Ranch II, LLC, has prepared this Post-construction Avian and Bat Protection Plan Fatality Report, which documents the number of avian and bat fatalities counted during Project post-construction monitoring from 16 August through 15 November 2013.

The Project elements surveyed during this period were the Gen-tie Line; Medium-voltage Overhead (MVOH) Line; Evaporation Pond; Arrays 1, 2, 4, 5, 6, 7, 8, 9, and 11; and the perimeter fences and control plots associated with all arrays. This quarterly[1] report does not include the results of searcher efficiency trials, carcass removal trials, or data analyses, nor does it include detailed discussions. These features will be provided in the annual report.

---

[1] The quarters referred to are the monitoring quarters specified in the COA. The first four quarters were 16 August to 15 November 2012, 16 November 2012 to 15 February 2013, 16 February to 15 May 2013, and 16 May to 15 August 2013. The period covered by this report is 16 August to 15 November 2013, and the next quarter will be 16 November 2013 to 15 February 2014.



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Q1 2014\Figure 1 Project Site.mxd

HPR II

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

California Valley Solar Ranch
HTH 3326-01 Task 58c Post Construction Monitoring
Figure 1: Project Site with Gen-tie Line, MVOH Line and Nine Arrays

Section 2.0 Methods

Fatality surveys began at varying times; the commencement dates of surveys at all sites are listed in Table 1. Fatality surveys in Arrays 1, 2, 4, 5, and 8 and along the Gen-tie and MVOH Lines began before this reporting period. During initial surveys of Array 2 in 2013 only the Serengeti portion of the array was surveyed. Fatality surveys were expanded to 100% of Array 2 once the entire array became operational. Because Array 2 North is partially composed of the Serengeti, results for the Serengeti are reported as Array 2 North. Fatality surveys at the remaining sites (Arrays 6, 7, 9, and 11; associated perimeter fences and control plots; and the Evaporation Pond) began during the current period. With exception of Arrays 1 and 2, and the Gen-tie and MVOH Lines, all Project elements were surveyed at 20% coverage for each element area. Fatalities were counted when surveyors found smudge marks and feather spots (on a solar panel) or feather spots only on the ground; fur accompanied by flesh, blood, or bone; or a carcass. Feather spots are defined as two or more flight feathers, five or more tail feathers, or ten or more body feathers. Feathers spots not meeting these requirements but containing flesh, blood, or bone were also considered a fatality. Fatalities of non-avian or non-bat taxa were documented when found, but are not discussed in this report. However, all specimens including non-avian and non-bat fatalities were reported pursuant to state and federal salvage permit requirements. Additionally, fatalities of sensitive species were reported to the California Natural Diversity Database. All carcasses and feather spots were collected during each fatality survey, except in areas that overlapped with repeat surveys in Arrays 1 and 2 (see methods for "5-day Repeat Surveys").

Table 1. Fatality Survey Start Dates by Project Element

Project Element	Date Fatality Surveys Began
Gen-tie Line	6 June 2012
Array 1	20 September 2012
Array 1 Control Plot	1 November 2012
Arrays 1 and 2 Fence	25 September 2012
Array 2 North and South	27 November 2012
Array 2 Serengeti[2]	20 September 2012
Array 2 Control Plot	30 October 2012
20% of Array 8	7 January 2013
20% of Array 8 Fence	20 May 2013
Array 8 Control Plots	4 February 2013
20% of Array 4	9 January 2013
20% of Array 4 Fence	16 January 2013
20% of Array 4 Control Plots	6 February 2013
20% of Array 5	9 January 2013
20% of Array 5 Fence	16 January 2013

---

[2] Results for Array 2 Serengeti are reported as part of Array 2 North.

Project Element	**Date Fatality Surveys Began**
Gen-tie Line	6 June 2012
MVOH Line	30 January 2013
Array 6, Fence, and Control Plots	30 September 2013
Array 7, Fence, and Control Plots	10 October 2013
Array 9 and Fence	6 November 2013
Array 11, Fence, and Control Plots	6 November 2013
Evaporation Pond	11 November 2013

2.1 Weekly Fatality Searches

Weekly fatality searches were performed for the Evaporation Pond, Gen-tie Line; MVOH Line; Arrays 1, 2, 4, 5, 6, 7, 8, 9, and 11; and the perimeter fences and control plots associated with the arrays. Each week, random start locations were selected for each Project element using a random number generator. Random selection was based on tower number (Gen-tie Line), line segment (MVOH Line), numbered array corners (Solar Arrays), and numbered fence corners (perimeter fence).

A team of two biologists surveyed an approximately 30-meter- (m-) wide transect centered under the Gen-tie Line and an approximately 18-m-wide transect centered under the MVOH Line. Each person surveyed half the transect width and half the tower or pole radial areas for the Gen-tie and MVOH Lines. For the Gen-tie Line, each person walked approximately 3 m from the outer limits of the overhead powerline and searched a 15-m-wide transect for large birds and a 6-m-wide transect for small birds and bats. For the MVOH Line, each searcher walked directly under each line segment and searched an approximately 9-m-wide transect for small and large birds, and bats.

For array searches, teams of two biologists surveyed panel trackers together. The biologists walked into every other row of panels in each tracker, visually scanning that row and each adjacent row. Safety concerns prohibited searchers from crossing the drive arm, so upon reaching the drive arm, searchers turned around and continued to scan the next row as they proceeded out of the walk space between rows. Thus, searchers physically walked every other row and visually scanned adjacent rows to ensure full coverage.

Control plots were established on adjacent onsite Conservation Lands (these lands are within 0.6 mi or 1 kilometer [km] for all arrays except Arrays 5 and 9.). Control plots were not established for Arrays 5 or 9 because the 20% survey area for these arrays contained too few trackers to meet the control plot establishment guidelines set forth in the *Avian and Bat Fatality Monitoring Plan for the California Valley Solar Ranch Project, San Luis Obispo County, CA* (one control plot per 16 trackers searched). Each control plot is equivalent to the size of two tracker blocks. Wooden stakes were used to delineate mock panel trackers on the control plots, and searchers followed the same pattern and procedure used for walking panel trackers.

Fences surrounding all Arrays were surveyed by one biologist. Each week, the biologist walked the inside portion of the fence while scanning an approximately 6-m-wide belt centered on the fence.

The Evaporation Pond was surveyed by one biologist. Each week, the biologist walked the perimeter of the pond inside the fenced area while scanning the pond and an approximately 6-m-wide belt centered on the fence. Before entering the fenced area, the biologist also scanned the pond to assess avian activity.

2.2 5-day Repeat Surveys

In addition to regular weekly searches, a series of repeat searches was conducted. These 5-day repeat surveys were designed to fulfill several functions: 1) they serve to identify a portion of the fatalities missed by regular weekly searchers, 2) they give limited estimates for the permanence of both feather spots and carcasses, 3) they provide an independent estimate of site-wide fatalities, and 4) they help to provide an estimate of carcass deposition rates. Five-day repeat surveys were conducted on all Project elements subject to regular weekly searches, with the exception of the Gen-tie Line. The Gen-tie Line was not included in the 5-day repeat surveys because it is assumed that small birds and bats are unlikely to strike high-tension powerlines. Each of the remaining sites were subjected to 5-day repeat surveys once every 4 weeks, and surveys were organized so that a 5-day repeat survey was conducted for a different site each week. Because of the size of Array 2, combining the 5-day survey effort of Array 2 Serengeti with Array 2 North and South was not feasible. Therefore, 5-day repeat surveys of Array 2 Serengeti were conducted separately from those of Array 2 North and South. Because regular weekly searches of the Evaporation Pond started at the end of this quarter, no 5-day repeats of this Project Element occurred during this reporting period.

During each 5-day repeat survey period, searchers covered the same 25% portion of a given Project element for 5 consecutive days. Repeat surveys of arrays also included searches of the perimeter fences and control plots associated with each array.

Five-day repeat surveys were originally conducted in the same areas as regular weekly searches for all arrays. In June 2013, this protocol was changed, and four new, nonoverlapping areas were established for 5-day repeat surveys in all array areas, in order to keep the search interval at a constant span of 7 days for all weekly search areas. (In Arrays 1 and 2, and along the MVOH Line, however, overlapping search areas were unavoidable because weekly searches cover 100% of these arrays.) Under the revised protocol, feather spots and scavenged carcasses were still collected on the fifth day of each 5-day repeat survey, but any intact carcasses found were treated as carcass removal trial specimens: camera traps were placed by the carcasses to record the species of scavengers that visited the carcass and to monitor the persistence of the carcass past the 5-day span of the repeat surveys. One of the four blocks was selected at random for each 5-day search period. Because the new survey blocks were established in areas that had never been searched, the first day of each 5-

day repeat survey in the new areas was treated as a clearance search, and all fatalities found on the first day were removed from further analysis. However, for Arrays 1 and 2, the MVOH Line, and any blocks searched in previous months, data for fatalities found on the first day was collected. Because the actual date of deposition was unknown, these fatalities were removed after the first day and were not used to form persistence estimates. Likewise, these fatalities will not be included in modeling annual fatality estimates.

2.3 1-Day Repeat Surveys

One-day repeats were a second type of repeat survey designed to identify a portion of the fatalities missed by weekly searchers. One-day repeat surveys covered a randomly selected block comprising 25% of each element of the weekly search areas; for example, the 1-day repeat survey of Array 8 included a search of 25% of the 20% weekly search area within the array, fence, and associated control plots. These blocks were surveyed on the day following regular weekly searches, every other week (biweekly).

One-day repeat surveys were also conducted after each 5-day repeat survey, on either the last day of the 5-day survey or 1 day after completion of the 5-day survey. These 1-day repeat surveys were conducted to provide further estimates of the detectability of small bird and bat carcasses.

Section 3.0 Results

One hundred and three avian fatalities were counted between 16 August and 15 November 2013 in the surveyed operational portions of the Project site. Eighty of the avian fatalities were counted from feather spots, and 20 were counted from whole or partial carcasses. All fatalities were mapped (Figures 2 through 6), and a summary of the fatality searches was compiled (Table 2). Eighteen avian species, plus three unidentified small birds, including one unidentified warbler , were represented in the fatalities found at all survey areas (Appendix A). Mourning doves (*Zenaida macroura*) were the most numerous fatalities observed (39), with horned larks (*Eremophilia alpestris*) (12) and savannah sparrows (*Passerculus sandwichensis*) (11) less frequently observed (Appendix A). No bat fatalities were observed during this survey period.

The Gen-tie Line and the whole of Array 2 presented the most fatalities. Most of the avian fatalities found in all survey areas were indicated by feather spots. However, a small number of whole and partial carcasses were also discovered. In solar arrays, feather spots were observed on the ground near panels, but no fatalities were observed on the panels themselves and no signs of panel strikes (e.g., smudge marks, feathers, or flesh) were observed. In the few cases in which whole carcasses were found but no injuries were apparent, the cause of death was difficult to determine.

3.1 Weekly Fatality Searches

All Project elements were surveyed weekly, with the following exceptions:

- Array 8 was not surveyed on 2 September 2013, in observance of the Labor Day holiday.
- The Array 4 fence and control plot, and a section of Array 4, were not surveyed on 9 October 2013 because of inclement weather conditions.
- The Array 5 fence was not surveyed on 23 October 2013 because of staffing issues.
- Arrays 6 and 8 were not surveyed on 4 November 2013 because of inclement weather conditions.

Because surveys were conducted only on designated days as a part of the survey protocol, if a survey day (for example, a Wednesday when the Gen-tie Line is scheduled to be surveyed) was missed due to inclement weather or maintenance access issues, another weekly survey (a “make-up” survey) was not conducted.

Table 2. Summary of Avian Fatality Searches Conducted between 16 August and 15 November 2013, and Fatality Totals[3]

Project Element	Total Fatalities	Fatalities Counted from Feather Spots	Fatalities Indicated by Evidence Other than Feather Spots, and Notes
Array 1	13	12	One partial carcasses (partial wing) with bone and feathers was found; cause of death unknown.
Array 1 control	0	0	n/a
Array 2 North	17	13	Three partial carcasses were found.
Array 2 South	8	8	n/a
Array 2 control	2	1	One partial specimen with wing, feathers, bone, and internal organs was detected.
Array 1–2 fence	1	1	n/a
Array 4	10	9	One partial specimen with wing and clumps of contour feathers was detected.
Array 4 controls and fence	0	0	n/a
Array 5 and Array 5controls, and fence	0	0	n/a
Array 6	1	0	One partial specimen with wing parts and feathers was detected.
Array 6 controls and fence	0	0	n/a
Array 7	4	4	n/a
Array 7 control	1	1	n/a
Array 7 fence	1	0	One partial specimen, with a wing and flight and contour feathers, was detected.
Array 8 Circuit 2	9	7	Two partial specimens, each with one wing and contour feathers, were detected.
Array 8 control	0	0	n/a
Array 8 fence	1	0	One whole carcass was detected.
Array 9, and Array 9 controls and fence	0	0	n/a
Array 11, Array 11 controls and fence	0	0	n/a
Gen-tie Line	29	25	Four whole carcasses and four partial carcasses, consisting of scavenged remains, were found directly under the overhead powerline. Cause of death likely powerline strike.
MVOH Line	6	5	One whole carcass was found directly under the powerline. Cause of death likely powerline strike.
Evaporation Pond	0	0	n/a
Total Fatalities	**103**		

---

[3] This table only includes fatalities detected during fatality searches. Incidental fatalities are reported in the text of Section 8.1 and Table A-1 in the Appendix.

Thirteen avian fatalities were counted in Array 1 (Table 2; Figure 2). All but one fatality were counted from feather spots. One partial specimen was indicated by a partial wing, bone, and feathers. No fatalities were observed in control plots associated with Array 1.

Twenty-seven fatalities were counted in the Array 2 elements, including Array 2 North and South and the Array 2 control plots. Seventeen avian fatalities were counted in Array 2 North (Table 2; Figure 2). Three of these fatalities were counted from partial carcasses including one feather spot from a burrowing owl (*Athene cunicularia*), a California Species of Special Concern. Eight avian fatalities were counted in Array 2 South (Table 2; Figure 2), all based upon feather spots. One loggerhead shrike (*Lanius ludovicianus*), a California Species of Special Concern, accounted for one of these fatalities. Two fatalities, one feather spot and one partial carcass, were counted in control plots associated with Array 2.

One fatality was counted from a feather spot along the perimeter fence surrounding Arrays 1 and 2.

Ten avian fatalities were counted in Array 4 (Table 2; Figure 3). Nine of these fatalities were counted from feather spots and one was counted from a specimen consisting of a partial wing and several clumps of body feathers. No fatalities were observed along the Array 4 perimeter fence or control plots.

One partial specimen, consisting of wing parts and feathers, was found in Array 6 (Table 2; Figure 3). No fatalities were observed along the Array 6 perimeter fence or control plots.

Four fatalities were counted from feather spots in Array 7 (Table 2; Figure 3). One fatality was counted from a partial specimen, consisting of a wing and feathers, along the perimeter fence surrounding Array 7. One fatality was counted from a feather spot in a control plot associated with Array 7.

Nine fatalities were counted in Array 8 Circuit 2 (Table 2; Figure 4). Seven of these fatalities were counted from feather spots and two were counted from partial specimens consisting of a wing with flesh and body feathers. One whole carcass was counted along the perimeter fence surrounding Array 8. No fatalities were observed in control plots associated with Array 8.

Twenty-nine fatalities were counted along the Gen-tie Line (Table 2; Figure 5). Four of these fatalities were counted from whole carcasses, and two were counted from partial specimens, consisting of a partial wing and body feathers and a half carcass, respectively. All 29 fatalities were found directly, or nearly directly, under the Gen-tie Line.

Six fatalities were counted along the MVOH Line (Table 2; Figure 6). One fatality was counted from a whole carcass. All fatalities were found directly or nearly directly under the MVOH Line.

Three additional fatalities, one barn owl (*Tyto alba*), one mourning dove, and one burrowing owl, were found incidentally in Array 4 and Array 9 (Table A-1). All were counted from feather spots. The burrowing owl, found in Array 9, showed signs of possibly having been scavenged by a mammal: the feathers appeared to have been chewed or sheared. No evidence of panel strike was observed in any of these incidentally observed fatalities.

No fatalities were found during regular fatality searches of Arrays 5, 9, or 11, their associated perimeter fences, their control plots, or the Evaporation Pond.

3.2 5-day Repeat Surveys

During the 5-day repeat surveys, 24 avian fatalities were observed between 16 August and 15 November 2013 in the surveyed operational portions of the Project site (Table 3, at the end of this section). Of these 24 fatalities, three were found in Array 1, one was found on the combined fence for Arrays 1 and 2, one was found in Array 2 Serengeti, six were found in Array 2 North and South, two were found in Array 4, two were found in Array 5, one was found in Array 6, three were found in Array 8, two were found on the Array 8 Fence, and two were found on the MVOH Line. No fatalities were found in any of the other arrays. No bat fatalities were observed during this survey period.

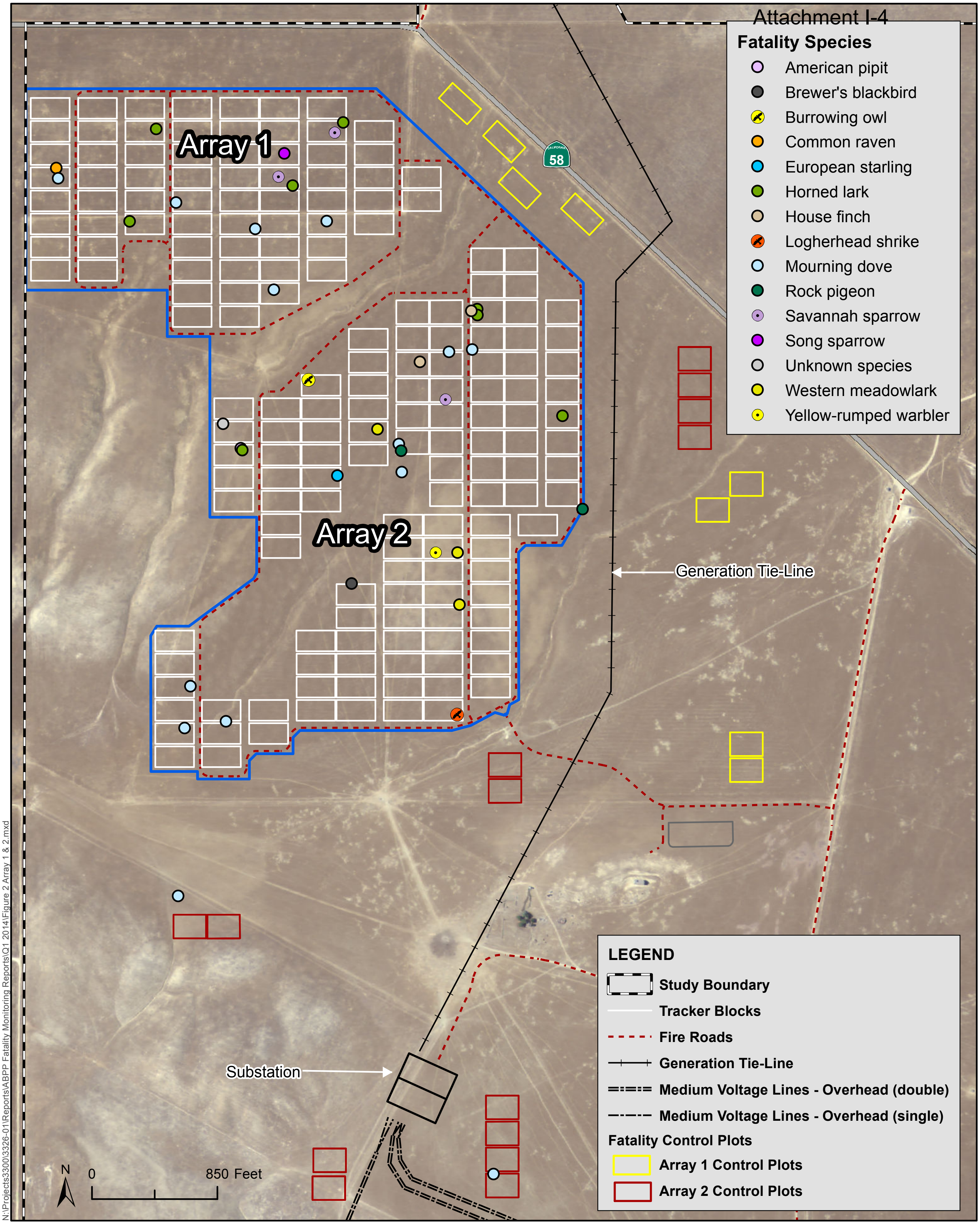
3.2.1 Array 1

Array 1 and its associated fence were surveyed three times during this reporting period: 26–30 August, 23–27 September, and 21–25 October. No fatalities were found during the first 5-day repeat search, but two were found during the week of 23 September (Table 3): a partial wing and feather spot of a house finch (*Carpodacus mexicanus*) were found, and the feather spot of a mourning dove was found. Both of these feather spots persisted until the fifth day of the survey, when they were collected. Both of these fatalities were likely overlooked by weekly searchers. During the week of 21 October, a common raven (*Corvus corax*) feather spot was found. This feather spot also persisted to day 5 of the survey interval, when it was collected by repeat searchers.

The carcass of a horned lark was found on 23 October 2013 on private land on the opposite side of the searched fenceline. The horned lark was partially lodged in the branches of a tumbleweed, and a small feather spot was present around the carcass. The carcass was gone the next day, but the feather spot persisted through the 5-day search interval. The camera trap failed to capture an image of the scavenger.

Additional Documentation Attachment to Comment 2-F1

Attachment I-4



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Q1 2014\Figure 2 Array 1 & 2.mxd

HPR II

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

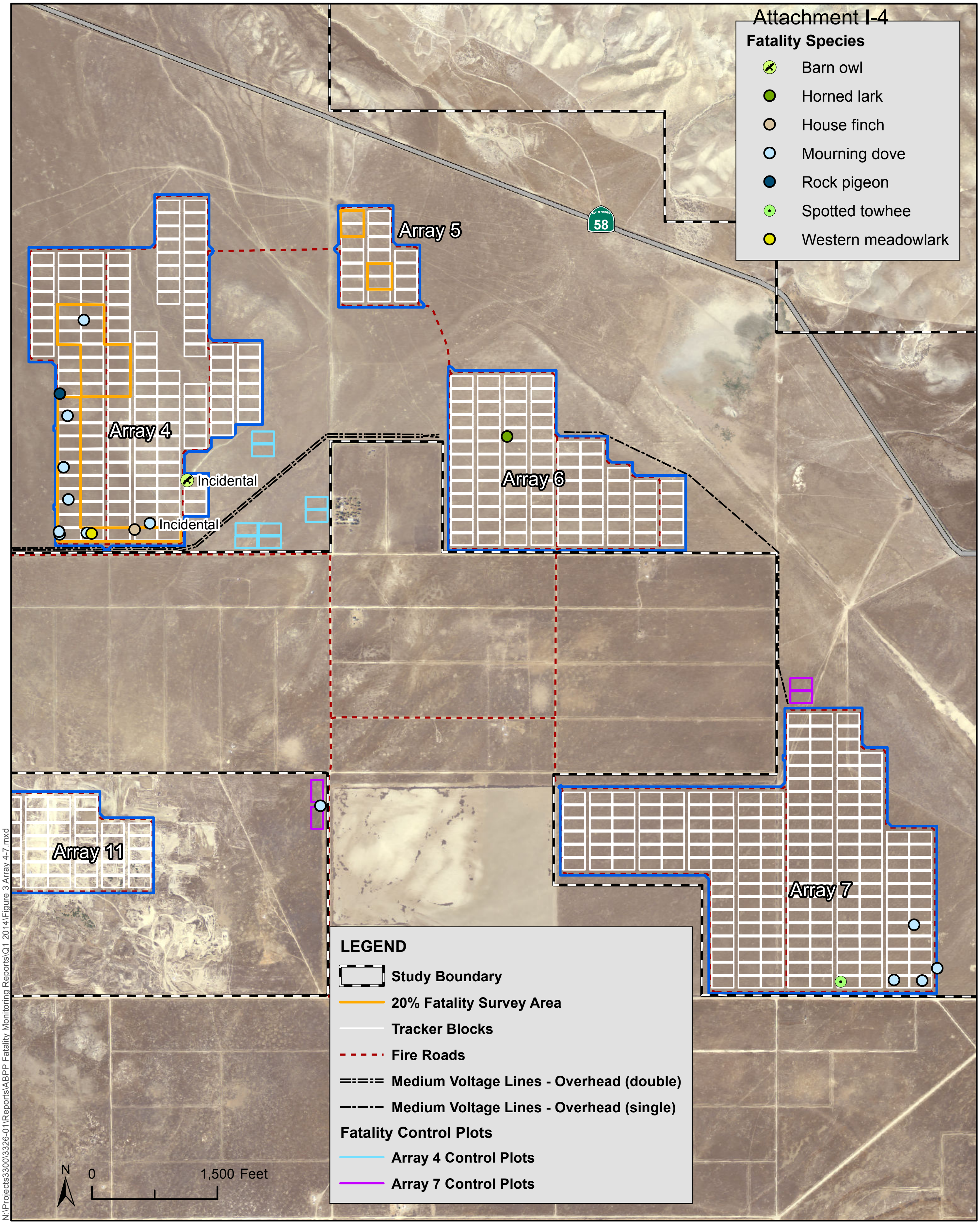
California Valley Solar Ranch

HTH 3326-01 Task 58c Post Construction Monitoring

Figure 2: Locations and Species of Post-construction Fatalities Observed in Arrays 1 and 2 between 16 August to 16 November 2013

Additional Documentation Attachment to Comment 2-F1

Attachment I-4



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Q1 2014\Figure 3 Array 4-7.mxd

HPR II

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

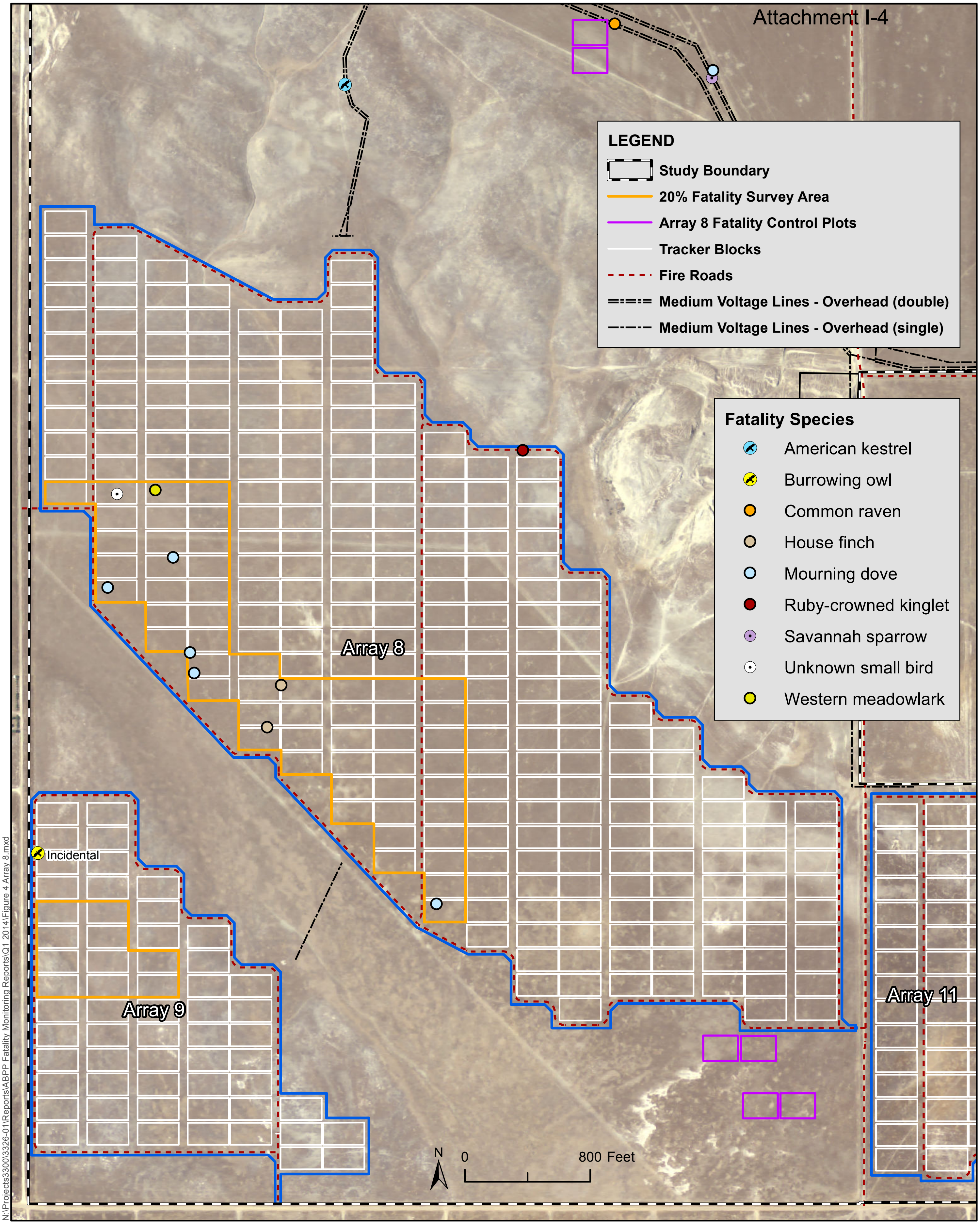
California Valley Solar Ranch

HTH 3326-01 Task 58c Post Construction Monitoring

Figure 3: Locations and Species of Post-construction Fatalities Observed in Arrays 4 and 5 between 16 August to 16 November 2013

Additional Documentation Attachment to Comment 2-F1

Attachment I-4



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Q1 2014\Figure 4 Array 8.mxd

HPR II

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

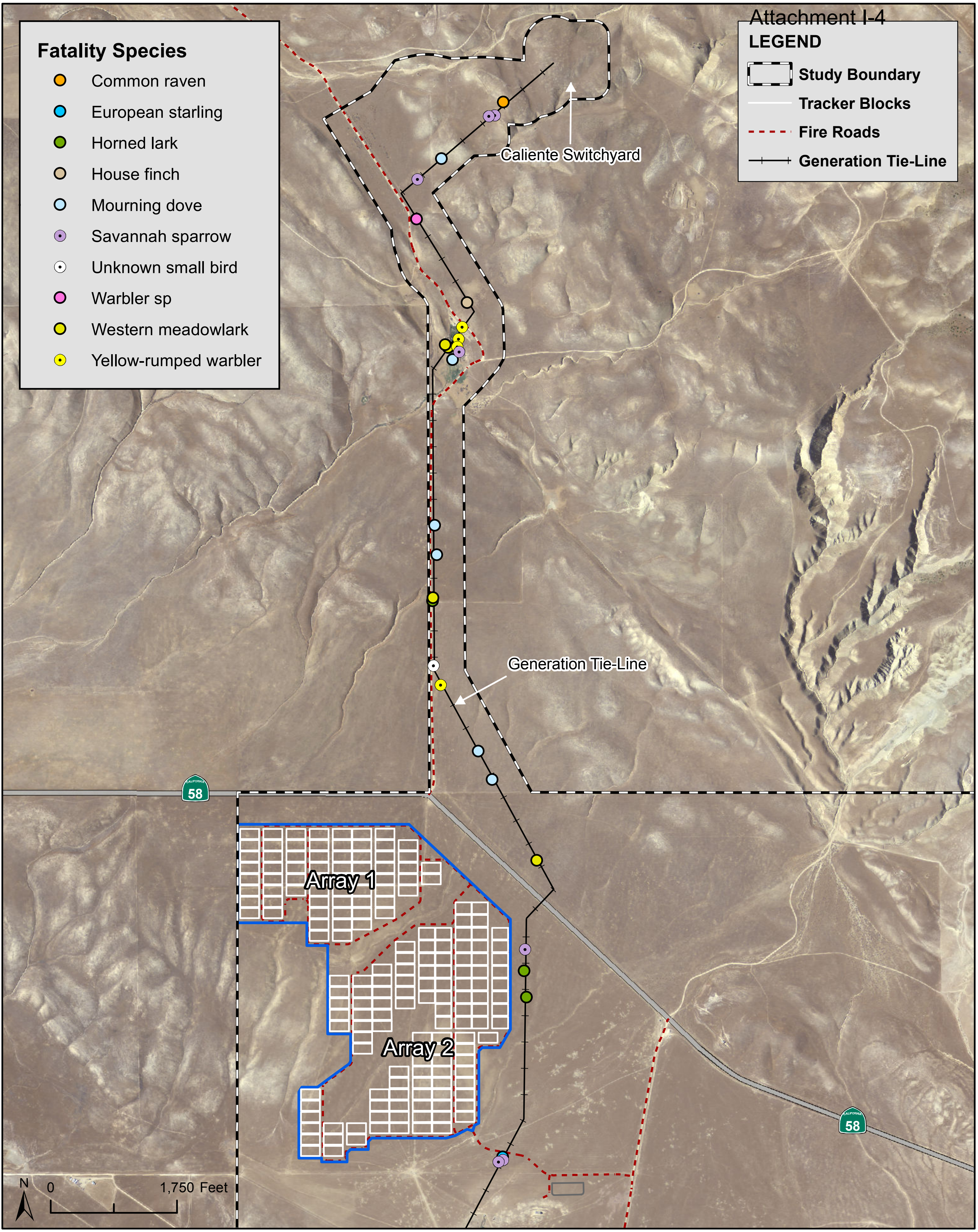
California Valley Solar Ranch

HTH 3326-01 Task 58c Post Construction Monitoring

Figure 4: Locations and Species of Post-construction Fatalities Observed in Array 8 between 16 August to 16 November 2013

Additional Documentation Attachment to Comment 2-F1

Attachment I-4



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Q1 2014\Figure 5 Gen-tie Area.mxd

HPR II

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

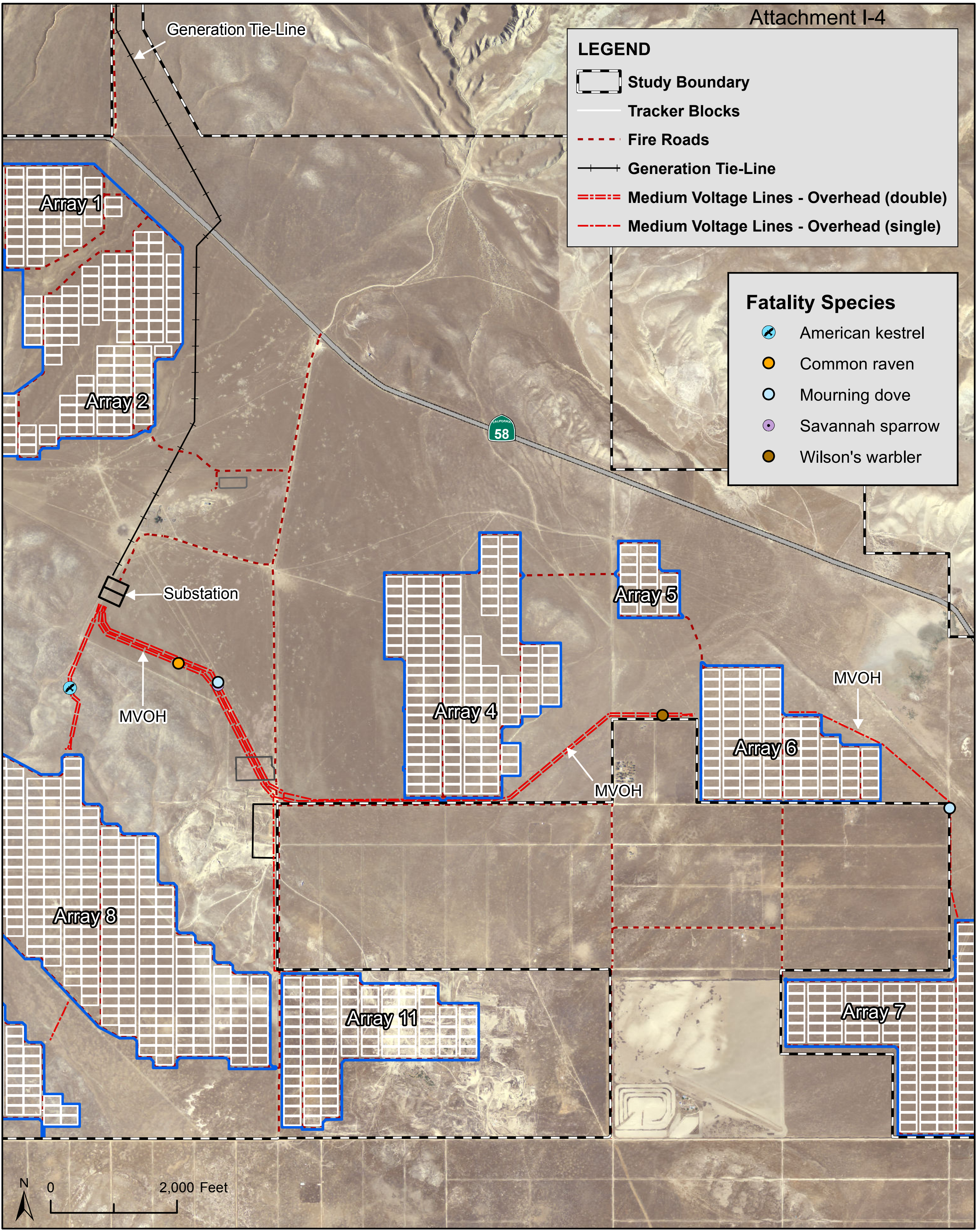
California Valley Solar Ranch

HTH 3326-01 Task 58c Post Construction Monitoring

Figure 5: Locations and Species of Post-construction Fatalities Observed along Gen-tie Line between [illegible] August to [illegible] November 2013

Additional Documentation Attachment to Comment 2-F1

Attachment I-4



N:\Projects3300\3326-01\Reports\ABPP Fatality Monitoring Reports\Q1 2014\Figure 6 MVOH Area.mxd

HPR II

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

California Valley Solar Ranch

HTH 3326-01 Task 58c Post Construction Monitoring

Figure 6: Locations and Species of Post-construction Fatalities Observed along MVOH Line between 15 August to 15 November 2013

3.2.2 Array 2 North and South

Array 2 North and South was also searched three times during this reporting period. During the week of 2 September, two fatalities were found. On 2 September, two horned lark feather spots were found in Array 2 South. During the second survey, the week of 30 September, three fatalities were found in Array 2 North. On 1 October, the feather spots of a horned lark and a mourning dove were both found, and both feather spots persisted until the fifth day of the survey. Both of these feather spots were likely overlooked by weekly searchers. On 2 October, the carcass of a horned lark was found. It was removed on 3 October by fatality searchers. During the final search period, the feather spot of a mourning dove was found on 1 November in Array 2 South. Because this was the final day of the 5-day survey, the feather spot was collected immediately.

3.2.3 Array 2 Serengeti

Array 2 Serengeti was searched three times during this reporting period. During the weeks of 23 September and 21 November, nothing was found. On 26 August, the feather spot of a mourning dove was found. Because it was found on the first day of the survey, it was collected immediately.

3.2.4 Array 4

Array 4 was searched four times during this reporting period. During the weeks of 19 August and 16 September, nothing was found. In the week of 14 October, the feather spot of a common raven was found. This feather spot persisted for the remainder of the 5-day search interval and was collected on the fifth day. On 14 November, the feather spot of a western meadowlark (*Sturnella neglecta*) was found. Some feathers were found on top of the solar panels, indicating a panel strike and/or avian scavenging. This feather spot was collected on the following day, the fifth day of the survey.

3.2.5 Array 5

Array 5 was also searched four times during this reporting period. During the weeks of 16 September and 14 October , no fatalities were found. On 21 August, a lark sparrow (*Chondestes grammacus*) was found in the array. This fatality persisted to the fifth day of the survey, when it was collected. On 11 November, the large feather spot of a house finch was found. Because it was found on the first day of the survey, it was collected immediately.

3.2.6 Array 6

Five-day repeats in Array 6 began for the first time on 4 November 2013. Therefore, only one survey was conducted during this period, and the feather spot of a rock pigeon was found on the fifth day of the survey, on 8 November 2013.

3.2.7 Array 8

Array 8 was surveyed four times during this reporting period, and three fatalities were found in the array, and two fatalities were found along the fence line. On 21 August, the feather spot of a horned lark was found, and on 22 August, the feather spot of a long-eared owl (*Asio otus*) was found. Both feather spots persisted until the fifth day of the survey, when they were collected. On 11 November 2013, the feather spot of a western meadowlark was found in the array. Because it was found on the first day of the survey, it was collected immediately.

On the 14 October, the feather spot of a mourning dove was found along the fence. On 11 November, the feather spot of a mourning dove was found along the fence. Because both of these feather spots were found on the first day of the 5-day survey, they were collected immediately.

3.2.8 MVOH Line

The MVOH Line was surveyed three times during this reporting period, and two fatalities were found. No fatalities were found during the weeks of 4 November or 9 September. On 7 October, two feather spots were found. Both feather spots were from western meadowlarks. Because they were found on the first day of the survey, they were collected immediately.

3.3 1-Day Repeat Surveys

3.3.1 Weekly Search Areas

During the 1-day repeat surveys of regular weekly search areas, conducted between 16 August and 15 November 2013, six avian fatalities were observed in the surveyed operational portions of the Project site (Table 4, at the end of this section). No bat fatalities were observed during this period. All fatalities were found in the 1-day repeat survey areas of Array 1, Array 2 North and South, Array 7, Array 8, and the Gen-tie Line; no fatalities were found in the 1-day repeat survey areas of any fencelines, control plots, or Array 2 Serengeti, Array 4, Array 5, Array 9, Array 11, or the MVOH Line.

3.3.1.1 Array 1

One avian fatality was found in Array 1 during this reporting period. On 18 October, the feather spot of a horned lark was found. This feather spot was judged to be older than 24 hours, and therefore was likely missed by weekly searchers.

3.3.1.2 Array 2 North and South

Two avian fatalities were found in Array 2 during this period. One, the feather spot of a mourning dove, was found on 11 September. The other, the feather spot of a horned lark, was found on 9 October, and likely was missed by weekly searchers.

3.3.1.3 Array 7

A partial wing and feather spot of a mourning dove were found together in Array 7 on 8 November 2013.

3.3.1.4 Array 8

The feather spot of a mourning dove was found on 17 September. It was likely missed by weekly searchers.

3.3.1.5 Gen-Tie Line

The feathers and partial wing of a house finch was found on 24 October 2013. Several feathers were ground into the dirt; therefore, the feather spot was judged to be older than a day, and was likely missed by regular searchers.

3.3.2 5-day Repeat Survey Areas

During the 1-day repeat surveys of 5-day search areas, conducted between 16 August and 15 November 2013, no bat fatalities were observed in the surveyed operational portions of the Project site, and only two avian fatalities were found (Table 5, at the end of this section). One fatality, the feather spot of a mourning dove, was found along the Array 8 fence on 18 October.

The second, the feather spot of a common raven, was found on in Array 9 on 8 November. Some feathers were sheared at the bottom, indicating a mammalian scavenger species. Both of these fatalities were missed by 5-day repeat searchers.

Table 3. Results of 5-Day Repeat Surveys Conducted between 16 August and 15 November 2013

Location	Survey Period	Date Fatality Detected	Number of Days that Fatality Persisted	Species	UTM Zone	Easting	Northing	Observation Details
Array 1	23–27 September	25 September	3	MODO	11S	233937	3915357	Feather spot consisting of two tail feathers, ten large body feathers, and four small neck feathers. Not found by weekly searchers.
Array 1	23–27 September	25 September	3	HOFI	11S	233869	3915427	Partial wing and feather spot consisting of 50 body feathers and scattered contour feathers, secondaries, and primaries. Not found by weekly searchers.
Array 1	21–25 October	23 October	3	CORA	11S	234160	3915703	Feather spot with 15 contour feathers.
Array 1–2 fence	21–25 October	23 October	3	HOLA	11S	234150	3913788	Whole carcass, wedged between tumbleweed on other side of fence.
Array 2 Serengeti	26-30 August	26 August	NA	MODO	11S	234458	3915140	Feather spot consisting of 5 primaries, 2 secondaries, and 16+ body feathers.
Array 2 North	31 September–4 October	1 October	4	MODO	11S	234178	3915346	Feather spot consisting of three flight feathers. Missed by weekly searchers.
Array 2 North	31 September–4 October	1 October	4	HOLA	11S	233974	3915178	Feather spot consisting of several flight and contour feathers. Missed by weekly searchers.
Array 2 North	31 September–4 October	2 October	2	HOLA	11S	234081	3915283	Whole carcass of adult male horned lark. No external injuries. Removed by biologist

Species Codes

CORA – common raven
HOFI – house finch
HOLA – horned lark
LASP – lark sparrow
LEOW – Long-eared owl
MODO – Mourning dove
ROPI – Rock pigeon
WEME – Western meadowlark

Location	Survey Period	Date Fatality Detected	Number of Days that Fatality Persisted	Species	UTM Zone	Easting	Northing	Observation Details
								on October 3.
Array 2 South	2-7 September	2 September	NA	HOLA	11S	234293	3914596	Feather spot consisting of 11 flight feathers.
Array 2 South	2-7 September	2 September	NA	HOLA	11S	234027	3914724	Feather spot of an adult male horned lark consisting of retrices, remiges, and many contour feathers.
Array 2 South	28 October–1 November	1 November	NA	MODO	11S	233977	3914544	Large feather spot consisting mostly of body feathers.
Array 4	14–18 October	16 October	3	CORA	11S	236160	3913218	Feather spot with 17 contour feathers.
Array 4	11–15 November	14 November	2	WEME	11S	236086	3913716	Feather spot with 100+ body feathers and 15+ wing and tail feathers. Feathers present on solar panel, indicating either panel strike or avian scavenging.
Array 5	19–23 August	21 August	3	LASP	11S	236818	3913588	Feather spot of adult lark sparrow consisting of retrices, remiges, and many contour feathers.
Array 5	11-15 November	11 November	NA	HOFI	11S	236620	3913535	Feather spot consisting of 20 primary and secondary feathers, 100+ body feathers, and beak.
Array 6	4–8 November	8 November	NA	ROPI	11S	237422	3912732	Feather spot consisting of 150+ belly, rump, and scapular feathers, five tail feathers, and ten or more primary and

Species Codes

CORA – common raven
HOFI – house finch
HOLA – horned lark
LASP – lark sparrow
LEOW – Long-eared owl
MODO – Mourning dove
ROPI – Rock pigeon
WEME – Western meadowlark

Location	Survey Period	Date Fatality Detected	Number of Days that Fatality Persisted	Species	UTM Zone	Easting	Northing	Observation Details
								secondary feathers.
Array 8	19-23 August	21 August		HOLA	11S	234095	3912508	Feather spot consisting of 15+ contour feathers in a widely spread feather spot
Array 8	19–23 August	22 August	2	LEOW	11S	233937	3912500	Feather spot consisting of contour and breast feathers.
Array 8	11-15 November	11 November	NA	WEME	11S	233768	3912809	Feather spot consisting of 200 breast and body feathers.
Array 8 Fence	14-18 October	14 October	NA	MODO	11S	234050	3912692	Feather spot consisting of 30+ contour feathers in three distinct clumps
Array 8 Fence	11-15 November	11 November	NA	MODO	11S	233369	3912447	Feather spot consisting of 30 body feathers and one tail feather.
MVOH Line	7-11 October	7 October	NA	WEME	11S	234591	3913326	Large feather spot consisting of 100 + body feathers and flight feathers.
MVOH Line	7-11 October	7 October	NA	WEME	11S	234781	3912925	Large feather spot consisting of approximately 15 body and tail feathers.

UTM = Universal Transverse Mercator.

Species Codes

CORA – common raven
HOFI – house finch
HOLA – horned lark
LASP – lark sparrow
LEOW – Long-eared owl
MODO – Mourning dove
ROPI – Rock pigeon
WEME – Western meadowlark

Table 4. Results of 1-Day Repeat Surveys Conducted in Weekly Search Areas between 16 August and 15 November 2013

Site	Date of Weekly Search	Date Fatality Detected	Species	UTM Zone	Easting	Northing	Observation Details
Array 1	10/17/2013	10/18/2013	HOLA	11S	233623	3915524	Feather spot (one covert and 15 flight feathers). Likely missed by regular weekly searchers.
Array 2 North	10/8/2013	10/9/2013	HOLA	11S	234013	3914941	Feather spot (~30 contour feathers). Missed by regular weekly searchers.
Array 2 South	9/10/2013	9/11/2013	MODO	11S	234145	3914884	Feather spot (~15 breast and contour feathers). Likely missed by regular weekly searchers.
Array 7	11/8/2013	11/9/2013	MODO	11S	238669	3911022	Partial wing and ten body feathers. Likely missed by regular weekly searchers.
Array 8	9/16/2013	9/17/2013	MODO	11S	233440	3912421	Feather spot (~30 body feathers). Likely missed by regular weekly searchers.
Gen-tie Line	10/23/2013	10/24/2013	HOFI	11S	238669	3911022	Feather spot and partial wing found directly between overhead lines. Likely missed by regular weekly searchers.

UTM = Universal Transverse Mercator.

Table 5. Results of 1-Day Repeat Surveys Conducted in 5-Day Search Areas between 16 August and 15 November 2013

Site	Date of Weekly Search	Date Fatality Detected	Species	UTM Zone	Easting	Northing	Observation Details
Array 8 Fence	10/17/2013	10/18/2013	MODO	11S	234147	3912526	Feather spot (~15 body feathers). Missed by 5-day repeat searchers.
Array 9	11/7/2013	11/8/2013	CORA	11S	233670	3911290	Feather spot (seven contour feathers in a clump). Feathers were sheared at the base, indicating mammalian scavenging. Missed by 5-day repeat searchers.

UTM = Universal Transverse Mercator.

Species Codes

CORA – common raven
HOFI – house finch
HOLA – horned lark
MODO – mourning dove

Section 4.0 Discussion

4.1 Weekly Fatality Searches

Given that the majority (approximately 80%, or 83 of 103) of the post-construction avian fatalities found during this quarter were feather spots, definitive causes of death were difficult to determine. Feather spots may indicate collision with a solar panel or a powerline, but in the absence of evidence of bodily injuries, it is impossible to determine the direct cause of death. For example, feather spots can indicate nonlethal panel strikes, with fatalities occurring when predators take advantage of a stunned bird. In this situation, although the cause of death is only indirectly related to the presence of the panels, it would be still be classified as being caused by a collision. Feather spots may also indicate that a lethal panel collision or powerline collision occurred, and that the body was later scavenged. Alternatively, feather spots may simply indicate direct mammalian or avian predation. Because no direct observations of predation or collisions were made during this period, causes of death could not be determined.

Mourning doves represented the highest number of fatalities in the arrays. This pattern corresponds with the mourning dove roosting activity often observed by fatality searchers during this quarter. Small flocks of mourning doves were frequently seen roosting under the solar panels, and when flushed, birds were observed quickly navigating through the panels. Mourning doves are well known as fast fliers, capable of sudden changes in altitude (Goodwin 1983). It is possible that, when fleeing in this highly cluttered environment, some birds may collide with the panels. Alternatively, the relatively higher numbers of fatalities for mourning doves may correspond to a high density of the species in the arrays. Mourning doves appear to favor the arrays for resting, as evidenced not only by their presence, but by their abundant sign (roosting and preening sites with abundant fecal droppings) in the arrays. Their prevalence may offer greater opportunities for avian and mammalian predators to prey on these birds. Most likely, the higher incidence of mourning dove fatalities is a combination of both factors.

Horned larks represented the second most frequently detected species of fatality. However, horned lark fatalities were much more numerous during the previous quarter. Large flocks were observed in surrounding Conservation Lands and around the Evaporation Pond. Although horned lark abundance on the Project site still appears to be high, they may be spending less time in the arrays, which could explain the change from the previous quarter.

Because surveys of the control plots detected background avian mortality, a corresponding percentage of the total fatalities found in each of the arrays was likely attributable to natural causes unrelated to the solar panels and other Project infrastructure. In the annual fatality report for 2014, the fatality estimate for the Project will be adjusted accordingly to reflect this background mortality.

Although assessing cause of death from feather spots is difficult, all feather spots found along the Gen-tie and MVOH Lines were located directly, or nearly directly, under these lines. This result suggests that all of these fatalities were caused by powerline collisions and that the remains found were indicative of scavenging, rather than predation. In all cases, whole carcasses found under the Gen-tie and MVOH Lines showed no signs of injury or illness. These individuals may have sustained internal injuries that were not visible. It is possible that predation by resident predators also contributed to some of these fatalities; however, study of a linear control would be necessary (allowing collection of background fatality information for a linear feature) to understand whether the observed rates and types of mortality are unique to the distribution lines or random.

Searchers continued to detect more fatalities along the Gen-tie Line than along the MVOH Line, as in previous quarters. Additionally, more migratory species (e.g., yellow-rumped warbler [*Dendroica coronata*] and savannah sparrow) were detected along the Gen-tie Line than along the MVOH Line or in any of the other Project elements. Many migratory species fly at night or in early morning hours (Bevanger 1994), and this behavior may increase their susceptibility to powerline collisions. Also, many of the Gen-tie Line fatalities were found in or near the tamarisk pond (*Tamarisk* spp.), which is located directly underneath the Gen-tie Line between Gen-tie Line Towers #17 and #18. This area provides habitat for nesting birds and is likely an attractive stopover for migratory birds. Therefore, it is possible that birds are at greater risk of powerline collisions because they are attracted in larger numbers to this area. Furthermore, since beginning fatality surveys in the pond, many old (preconstruction) feather spots have been detected in this area. So the pond is likely known to be regular source of prey by resident predators, and this may also contribute to the high number of fatalities in this area.

Consistent with the previous quarter, total fatalities were higher in the whole of Array 2 compared to Array 1 (both surveyed at 100%). The whole of Array 2 is almost twice as large as Array 1, so size is a likely factor in the differences of total fatalities. However, it is also possible that the Gen-tie Line, which is located directly east of and closest to Array 2, could be a source of avian carcasses for resident scavengers. In other words, Array 2 may provide a protected area where scavengers may consume carcasses found near the line. No fatalities were found in Array 5, which may be an effect of the small size of this array and the number of trackers (four) searched. Fatality rates in Arrays 4 and 8 (surveyed at 20%) were low compared with one another. Fatality rates in Arrays 6 and 7 were low, and no fatalities were found in Arrays 9 or 11, their associated fences or controls plots, or the Evaporation Pond. However, surveys of Arrays 6, 7, 9, and 11, and of the Evaporation Pond, did not begin until the middle or latter part of the reporting period. Therefore, it is too early to make any qualitative or quantitative inferences about these sites.

4.2 Repeat Surveys

Because of issues cited in the previous quarterly report, the protocol for 5-day and regular weekly searchers working in overlapping areas changed at the beginning of June 2013. Therefore, in this quarter, it was possible to determine the permanence of all feather spots and carcasses, whether or not they were detected during regular weekly searches. Although this quarter offered a relatively small sample size (N=22), the data suggest that the relative permanence of feather spots is much greater than that of carcasses. This finding is supported by the overall proportion of carcasses to feather spots found in the arrays.

A general assumption of fatality searches is that searchers are not 100% efficient at finding carcasses, because of both environmental and individual constraints (e.g., vegetation height, visual obstacles such as support poles for the arrays, and observer fatigue). The results of both the 1-day and the 5-day repeat surveys support this assumption: more than half of the finds in repeat searches were missed during the regular weekly searches. Although the number of fatalities found by weekly searchers but missed by repeat searchers was not examined, there are recorded cases of weekly searchers finding fatalities that repeat searchers did not find, so it is likely that searcher misses go in both directions. Also, the low rates of consistency between the findings of regular weekly searchers and those of repeat searchers suggest that search outcomes may be affected by both random differences and differences that vary by individual searcher. For example, a taller searcher will have a reduced field of vision into adjacent rows compared to a shorter searcher. This variation is unlikely to be fully compensated for, even through conscious efforts to look under the panels. Likewise, there are tradeoffs based on where searchers focus their field of vision: if a searcher focuses on tufts of tall grass on the sides of array rows, he or she may overlook fatalities directly underfoot, and vice versa.

In the context of the year, 5-day repeat searches serve to provide an independent estimate of fatalities that occur on site. Also, the ongoing nature of these surveys allows estimation of deposition rates over the year and during each season. The limited scope of this quarterly report does not allow for in-depth analysis of these rates, but both will be addressed in the annual report.

Section 5.0 Literature Cited

Bevanger, K. 1994. Bird interactions with utility structures: Collision and electrocution, causes and mitigation measures. Ibis 136(4):412–425.

Goodwin, D. 1983. Pigeons and Doves of the World, 3rd Edition. Cornell University Press, Ithaca, New York.

Appendix A. Weekly Fatality Search Results—16 August to 15 November 2013

Table A-1. Results of Fatality Searches from 16 August to 15 November 2013

Survey Date	ALPHA Code	Site	UTM Zone	Easting	Northing	Observation Details
10/23/2013	AMKE	MVOH Line	11S	233929	3913261	Feather spot: all feather types. At least >100 body feathers and >12 wing and tail feathers.
11/13/2013	CORA	MVOH Line	11S	234458	3913361	Feather spot: 30 body feathers.
11/13/2013	MODO	MVOHLine	11S	238157	3912540	Feather spot: five or six contours in clumps.
11/13/2013	MODO	MVOH Line	11S	234646	3913264	Feather spot: 50 body and three primary feathers.
8/28/2013	OCWA/WIWA	MVOH Line	11S	236786	3913033	Feather spot: 16 primaries and secondaries, four tail feathers, 40+ contour feathers.
10/2/2013	SAVS	MVOHLine	11S	234643	3913250	Whole carcass. No obvious sign of injury.
8/22/2013	CORA	Array 1	11S	233463	3915644	Feather spot: cluster of body feathers.
8/29/2013	HOLA	Array 1	11S	233950	3915592	Feather spot: ~20 body feathers.
9/19/2013	HOLA	Array 1	11S	234059	3915719	Feather spot: 12 flight feathers (primary, secondary, and tail). More than 20 contour feathers.
10/17/2013	HOLA	Array 1	11S	233611	3915529	Partial specimen: partial wing with bone and few contour feathers.
10/17/2013	HOLA	Array 1	11S	233672	3915718	Feather spot: 500+ contour/body feathers.
8/29/2013	MODO	Array 1	11S	233466	3915623	Feather spot: 40+ contour feathers, two rectrices, some coverts and scapulars.
9/19/2013	MODO	Array 1	11S	234018	3915516	Feather spot: 100+ body feathers, five tail feathers, and two flight feathers.

Species Codes

AMKE- American kestrel
AMPI – American pipit
BNOW – Barn owl
BRBL – Brewer's blackbird
BUOW – Burrowing owl
CORA - Common raven
EUST – European starling
HOFI – House finch
HOLA – Horned lark
LOSH – Loggerhead shrike
MODO – Mourning dove
OCWA/WIWA – Orange-crowned or Wilson's warbler
RCKI – Ruby-crowned kinglet
ROPI – Rock pigeon
SAVS – Savannah sparrow
SOSP – Song sparrow
SPTO – Spotted towhee
WEME – Western meadowlark
YRWA – Yellow-rumped warbler

Survey Date	ALPHA Code	Site	UTM Zone	Easting	Northing	Observation Details
9/19/2013	MODO	Array 1	11S	233904	3915378	Feather spot: 60+ body feathers, two tail feathers, and two wing coverts.
9/26/2013	MODO	Array 1	11S	233708	3915565	Feather spot: 100+ body feathers and 16+ flight feathers (primaries, secondaries, and retrices).
11/7/2013	MODO	Array 1	11S	233870	3915505	Feather spot: one wing and 20 body feathers.
10/10/2013	SAVS	Array 1	11S	233921	3915612	Feather spot: 10 flight and 75 body feathers (breast, coverts).
10/10/2013	SAVS	Array 1	11S	234040	3915699	Feather spot: 150 body feathers (belly, breast, and mantle coverts) and 20 flight feathers (primary, secondary, and tail).
10/17/2013	SOSP	Array 1	11S	233935	3915659	Feather spot: three wing and 75 contour feathers.
10/29/2013	ROPI	Array 1–2 Fence	11S	234527	3914904	Feather spot: 20 contour feathers.
11/5/2013	MODO	Array 2 control	11S	234298	3913537	Partial specimen: wing and feathers, bone, and heart. Twenty primaries and secondaries, one wing, ten tail, and 100+ body feathers.
11/12/2013	MODO	Array 2 control	11S	233665	3914133	Feather spot: 20 body feathers.
10/8/2013	AMPI	Array 2 North	11S	233825	3915053	Feather Spot: eight primary feathers in two clumps.
9/24/2013	BUOW	Array 2 North	11S	233969	3915190	Feather spot: breast feathers.
10/15/2013	EUST	Array 2 North	11S	234023	3914990	Feather spot: five to eight tail feathers, five to ten wing feathers, and 50+ contour feathers.
11/12/2013	HOFI	Array 2 North	11S	234201	3915219	Feather spot: 200–300 body feathers and three or four wing feathers.

Species Codes

AMKE- American kestrel
AMPI – American pipit
BNOW – Barn owl
BRBL – Brewer's blackbird
BUOW – Burrowing owl
CORA - Common raven
EUST – European starling
HOFI – House finch
HOLA – Horned lark
LOSH – Loggerhead shrike
MODO – Mourning dove
OCWA/WIWA – Orange-crowned or Wilson's warbler
RCKI – Ruby-crowned kinglet
ROPI – Rock pigeon
SAVS – Savannah sparrow
SOSP – Song sparrow
SPTO – Spotted towhee
WEME – Western meadowlark
YRWA – Yellow-rumped warbler

Survey Date	ALPHA Code	Site	UTM Zone	Easting	Northing	Observation Details
11/12/2013	HOFI	Array 2 North	11S	234311	3915321	Feather spot: five primaries attached together with very dried skin.
8/27/2013	HOLA	Array 2 North	11S	234323	3915324	Partial specimen: right wing with exposed bone and dried muscle tendons/ligaments.
9/3/2013	HOLA	Array 2 North	11S	234323	3915312	Feather spot: five tail feathers, five primaries, three secondaries, and 100+ body feathers.
9/10/2013	HOLA	Array 2 North	11S	234492	3915098	Partial specimen: two wings, five tail feathers, and 30+ body feathers.
10/15/2013	HOLA	Array 2 North	11S	233828	3915049	Feather spot: two secondaries and a few coverts.
8/27/2013	MODO	Array 2 North	11S	234310	3915241	Feather spot: seven tail feathers, 30 body feathers, and one primary.
9/24/2013	MODO	Array 2 North	11S	234156	3914993	Feather spot: five clumped body feathers; ten body feathers total. Two clumps of feathers as though plucked, one feather in sheath (not molted).
10/22/2013	MODO	Array 2 North	11S	234262	3915238	Feather spot: 20 contour feathers.
10/22/2013	MODO	Array 2 North	11S	234149	3915041	Feather spot: two wing feathers (secondaries).
9/24/2013	ROPI	Array 2 North	11S	234156	3915037	Feather spot: five secondary feathers and one clump of five body feathers.
10/15/2013	SAVS	Array 2 North	11S	234251	3915140	Partial specimen: partial wing (ten primary and secondary feathers), plus three tail feathers, five wing coverts, and 15 breast feathers.
10/29/2013	Unknown	Array 2 North	11S	233790	3915105	Partial specimen: pelvic bone.

Species Codes

AMKE- American kestrel
AMPI – American pipit
BNOW – Barn owl
BRBL – Brewer's blackbird
BUOW – Burrowing owl
CORA - Common raven
EUST – European starling
HOFI – House finch
HOLA – Horned lark
LOSH – Loggerhead shrike
MODO – Mourning dove
OCWA/WIWA – Orange-crowned or Wilson's warbler
RCKI – Ruby-crowned kinglet
ROPI – Rock pigeon
SAVS – Savannah sparrow
SOSP – Song sparrow
SPTO – Spotted towhee
WEME – Western meadowlark
YRWA – Yellow-rumped warbler

Survey Date	ALPHA Code	Site	UTM Zone	Easting	Northing	Observation Details
11/12/2013	WEME	Array 2 North	11S	234109	3915083	Feather spot: one primary feather and 30 belly, breast, and mantle feathers.
10/29/2013	BRBL	Array 2 South	11S	234045	3914766	Feather spot: 50+ body feathers.
9/10/2013	LOSH	Array 2 South	11S	234253	3914489	Feather spot: 30 flight feathers and 20 body feathers.
9/17/2013	MODO	Array 2 South	11S	233705	3914565	Feather spot: 30+ breast/body feathers, two secondaries, one tail feather, and one primary.
10/29/2013	MODO	Array 2 South	11S	233690	3914479	Feather spot: 15+ wing feathers and 300 body feathers.
10/29/2013	MODO	Array 2 South	11S	233776	3914490	Feather spot: two clumps of body feathers with six feathers in each clump.
11/12/2013	WEME	Array 2 South	11S	234266	3914715	Feather spot: four secondaries, 50+ breast and belly feathers, and 30+ mantle feathers.
11/12/2013	WEME	Array 2 South	11S	234266	3914823	Feather spot: two primaries and 50+ breast, belly, and mantle feathers
11/5/2013	YRWA	Array 2 South	11S	234220	3914825	Feather spot: five tail feathers, ten or more primaries and secondaries, 15+ rump feathers, and 50+ mantle, belly, and breast feathers.
11/7/2013	BNOW	Array 4	11S	236014	3912900	Feather spot: 20+ primary/wing feathers and 30+ body/contour feathers. Incidental observation.
8/28/2013	HOFI	Array 4	11S	235818	3912726	Feather spot: about 40 body feathers tightly clumped.
10/2/2013	MODO	Array 4	11S	235580	3912843	Feather spot: nine flight and body feathers.
10/23/2013	MODO	Array 4	11S	235566	3912961	Feather spot: three contour and 10–15 body feathers.

Species Codes

AMKE- American kestrel
AMPI – American pipit
BNOW – Barn owl
BRBL – Brewer's blackbird
BUOW – Burrowing owl
CORA - Common raven
EUST – European starling
HOFI – House finch
HOLA – Horned lark
LOSH – Loggerhead shrike
MODO – Mourning dove
OCWA/WIWA – Orange-crowned or Wilson's warbler
RCKI – Ruby-crowned kinglet
ROPI – Rock pigeon
SAVS – Savannah sparrow
SOSP – Song sparrow
SPTO – Spotted towhee
WEME – Western meadowlark
YRWA – Yellow-rumped warbler

Survey Date	ALPHA Code	Site	UTM Zone	Easting	Northing	Observation Details
10/30/2013	MODO	Array 4	11S	235544	3912717	Feather spot: 50+ body feathers and six contour and tail feathers.
11/13/2013	MODO	Array 4	11S	235542	3912727	Partial specimen: partial wing with clumps of wing coverts, plus body feathers.
11/13/2013	MODO	Array 4	11S	235587	3913148	Feather spot: four secondaries and 20 body feathers.
11/13/2013	MODO	Array 4	11S	235643	3912719	Feather spot: two primaries and 20 body feathers—some clumped
11/13/2013	MODO	Array 4	11S	235658	3913495	Feather spot: 300 body and ten wing feathers.
11/19/2013	MODO	Array 4	11S	235874	3912747	Feather spot: 200 + body feathers and 11 flight feathers. Incidental observation.
11/6/2013	ROPI	Array 4	11S	235561	3913230	Feather spot: four tail feathers and 75+ body feathers.
10/2/2013	WEME	Array 4	11S	235660	3912716	Feather spot: ten body feathers.
10/21/2013	HOLA	Array 6	11S	237187	3913020	Partial specimen: wing parts plus 30+ body, four tail, and 12–15 wing feathers.
10/31/2013	MODO	Array 7	11S	238532	3910993	Feather spot: 50 body feathers and six tail feathers.
10/31/2013	MODO	Array 7	11S	238635	3910988	Feather spot: 100 body feathers and 15 flight feathers.
11/7/2013	MODO	Array 7	11S	238612	3911192	Feather spot: 45 body feathers, plus one flight feather .
11/14/2013	SPTO	Array 7	11S	238337	3910994	Feather spot: ten or more tail feathers, five or more primaries and secondaries, and 50+ body feathers.

Species Codes

AMKE- American kestrel
AMPI – American pipit
BNOW – Barn owl
BRBL – Brewer's blackbird
BUOW – Burrowing owl
CORA - Common raven
EUST – European starling
HOFI – House finch
HOLA – Horned lark
LOSH – Loggerhead shrike
MODO – Mourning dove
OCWA/WIWA – Orange-crowned or Wilson's warbler
RCKI – Ruby-crowned kinglet
ROPI – Rock pigeon
SAVS – Savannah sparrow
SOSP – Song sparrow
SPTO – Spotted towhee
WEME – Western meadowlark
YRWA – Yellow-rumped warbler

Survey Date	ALPHA Code	Site	UTM Zone	Easting	Northing	Observation Details
10/24/2013	MODO	Array 7 Control	11S	236462	3911697	Feather spot: one tail feather, five or six wing feathers, and 20+ contour feathers.
11/7/2013	MODO	Array 7 fence	11S	238691	3911031	Partial specimen: part of wing, plus flight, secondary, and body feathers.
10/21/2013	HOFI	Array 8 Circuit 2	11S	233737	3912016	Feather spot: 18 body feathers.
10/21/2013	HOFI	Array 8 Circuit 2	11S	233767	3912097	Feather spot: ~15 wing and ~30 body feathers.
9/30/2013	MODO	Array 8 Circuit 2	11S	234055	3911662	Feather spot: hundreds of feathers of multiple types.
10/21/2013	MODO	Array 8 Circuit 2	11S	233592	3912166	Feather spot: two tail feathers, 15+ coverts, and 50+ body feathers.
10/21/2013	MODO	Array 8 Circuit 2	11S	233565	3912352	Feather spot: one wing feather, two contour feathers, and seven body feathers.
10/21/2013	MODO	Array 8 Circuit 2	11S	233599	3912126	Feather spot: 50–100 body feathers.
11/11/2013	MODO	Array 8 Circuit 2	11S	233436	3912298	Partial specimen: one wing attached to two contour feathers, plus a few additional body feathers.
9/16/2013	Unknown small bird	Array 8 Circuit 2	11S	234321	3911415	Partial specimen: wing held together by flesh, and ~100 body feathers.
10/14/2013	WEME	Array 8 Circuit 2	11S	233535	3912484	Feather spot: 50+ body feathers.
10/14/2013	RCKI	Array 8 fence	11S	234252	3912538	Whole carcass. No obvious sign of injury.
11/19/2013	BUOW	Array 9	11S	233283	3911787	Feather spot: Ten contour feathers were chewed or sheared. Incidental observation.
10/23/2013	CORA	Gen-tie Line	11S	234628	3918824	Feather spot: 15 wing feathers and a few body feathers.

Species Codes

AMKE- American kestrel
AMPI – American pipit
BNOW – Barn owl
BRBL – Brewer's blackbird
BUOW – Burrowing owl
CORA - Common raven
EUST – European starling
HOFI – House finch
HOLA – Horned lark
LOSH – Loggerhead shrike
MODO – Mourning dove
OCWA/WIWA – Orange-crowned or Wilson's warbler
RCKI – Ruby-crowned kinglet
ROPI – Rock pigeon
SAVS – Savannah sparrow
SOSP – Song sparrow
SPTO – Spotted towhee
WEME – Western meadowlark
YRWA – Yellow-rumped warbler

Survey Date	ALPHA Code	Site	UTM Zone	Easting	Northing	Observation Details
10/16/2013	EUST	Gen-tie Line	11S	234479	3914368	Feather spot: four or five wing feathers, two or three tail feathers, and 100–200 contour feathers.
10/9/2013	HOFI	Gen-tie Line	11S	234447	3917982	Feather spot: 15 primaries and 150 body feathers.
8/28/2013	HOLA	Gen-tie Line	11S	234595	3915151	Feather spot: about 50 body feathers and two secondaries.
9/11/2013	HOLA	Gen-tie Line	11S	234601	3915040	Feather spot: 75 body feathers, one tail feather, three primaries, and four secondaries.
10/16/2013	HOLA	Gen-tie Line	11S	234260	3916727	Feather spot: four wing feathers and 30+ contour feathers.
8/21/2013	MODO	Gen-tie Line	11S	234284	3916921	Feather spot: three tail feathers, 15+ flight feathers, and 50+ breast and body feathers.
8/21/2013	MODO	Gen-tie Line	11S	234279	3917046	Feather spot: fewer than five flight feathers and 30+ breast and body feathers.
9/4/2013	MODO	Gen-tie Line	11S	234487	3915964	Feather spot: three primaries, two secondaries, and ~20 body feathers.
10/23/2013	MODO	Gen-tie Line	11S	234378	3917743	Feather spot: 30 body feathers.
11/6/2013	MODO	Gen-tie Line	11S	234359	3918593	Feather spot: 30 body and wing feathers.
11/6/2013	MODO	Gen-tie Line	11S	234432	3916086	Feather spot: 15 body feathers.
10/2/2013	SAVS	Gen-tie Line	11S	234254	3918510	Whole carcass. No obvious sign of injury.
10/2/2013	SAVS	Gen-tie Line	11S	234404	3917782	Feather spot: 75 body feathers and 15 flight feathers. Wing bits.

Species Codes

AMKE- American kestrel
AMPI – American pipit
BNOW – Barn owl
BRBL – Brewer's blackbird
BUOW – Burrowing owl
CORA - Common raven
EUST – European starling
HOFI – House finch
HOLA – Horned lark
LOSH – Loggerhead shrike
MODO – Mourning dove
OCWA/WIWA – Orange-crowned or Wilson's warbler
RCKI – Ruby-crowned kinglet
ROPI – Rock pigeon
SAVS – Savannah sparrow
SOSP – Song sparrow
SPTO – Spotted towhee
WEME – Western meadowlark
YRWA – Yellow-rumped warbler

Survey Date	ALPHA Code	Site	UTM Zone	Easting	Northing	Observation Details
10/2/2013	SAVS	Gen-tie Line	11S	234478	3914356	Partial specimen: 100 body feathers (breast, mantle, rump, and coverts). Partial wing (15 primary and secondary feathers).
10/2/2013	SAVS	Gen-tie Line	11S	234459	3914349	Feather spot: 100+ body feathers (belly, breast, mantle, rump, and coverts) and 20 flight feathers (primaries and secondaries).
10/9/2013	SAVS	Gen-tie Line	11S	234601	3915243	Whole carcass. No obvious sign of injury.
10/16/2013	SAVS	Gen-tie Line	11S	234589	3918770	Whole carcass. No obvious sign of injury.
11/13/2013	SAVS	Gen-tie Line	11S	234564	3918767	Feather spot: 15+ flight feathers and 80 mantle, breast, and rump feathers.
8/28/2013	Unknown small bird	Gen-tie Line	11S	234254	3916454	Feather spot: about 15 body feathers.
9/25/2013	Warbler sp.	Gen-tie Line	11S	234246	3918342	Partial specimen: clump of small body feathers attached to spinal bone fragments.
10/16/2013	WEME	Gen-tie Line	11S	234361	3917795	Feather spot: ten wing, 150 body, and a few tail feathers.
10/16/2013	WEME	Gen-tie Line	11S	234262	3916740	Feather spot: ten wing, a few tail, and 300+ body feathers.
10/16/2013	WEME	Gen-tie Line	11S	234664	3915616	Partial specimen: partial wing, plus 20 wing, a few tail, and 100 contour feathers.
10/23/2013	WEME	Gen-tie Line	11S	234354	3917803	Feather spot: 15 body feathers.
10/9/2013	YRWA	Gen-tie Line	11S	234405	3917830	Partial specimen: half carcass, impaled by LOSH.

Species Codes

AMKE- American kestrel
AMPI – American pipit
BNOW – Barn owl
BRBL – Brewer's blackbird
BUOW – Burrowing owl
CORA - Common raven
EUST – European starling
HOFI – House finch
HOLA – Horned lark
LOSH – Loggerhead shrike
MODO – Mourning dove
OCWA/WIWA – Orange-crowned or Wilson's warbler
RCKI – Ruby-crowned kinglet
ROPI – Rock pigeon
SAVS – Savannah sparrow
SOSP – Song sparrow
SPTO – Spotted towhee
WEME – Western meadowlark
YRWA – Yellow-rumped warbler

Survey Date	ALPHA Code	Site	UTM Zone	Easting	Northing	Observation Details
10/16/2013	YRWA	Gen-tie Line	11S	234403	3917789	Feather spot: 15–20 wing feathers and 100+ body feathers.
10/23/2013	YRWA	Gen-tie Line	11S	234422	3917880	Feather spot: four wing feathers and 20 body feathers.
10/23/2013	YRWA	Gen-tie Line	11S	234281	3916371	Whole carcass. No obvious sign of injury.

UTM = Universal Transverse Mercator.

Species Codes
AMKE- American kestrel
AMPI – American pipit
BNOW – Barn owl
BRBL – Brewer’s blackbird
BUOW – Burrowing owl
CORA - Common raven
EUST – European starling
HOFI – House finch
HOLA – Horned lark
LOSH – Loggerhead shrike
MODO – Mourning dove
OCWA/WIWA – Orange-crowned or Wilson’s warbler
RCKI – Ruby-crowned kinglet
ROPI – Rock pigeon
SAVS – Savannah sparrow
SOSP – Song sparrow
SPTO – Spotted towhee
WEME – Western meadowlark
YRWA – Yellow-rumped warbler

Table A-2. Total Number of Fatalities for Each Species Detected during Post-construction Monitoring between 16 August and 15 November 2013 (Listed Here in Alphabetical Order)[4]

Species	Number of Fatalities
American kestrel	1
American pipit	1
Brewer's blackbird	1
Burrowing owl	1
Common raven	3
European starling	2
Horned lark	12
House finch	6
Loggerhead shrike	1
Mourning dove	39
Orange-crowned warbler/Wilson's warbler	1
Rock pigeon	3
Ruby-crowned kinglet	1
Savannah sparrow	11
Song sparrow	1
Spotted towhee	1
Unknown small bird	2
Warbler sp.	1
Western meadowlark	9
Yellow-rumped warbler	5
Total	103

---

[4] This table only includes fatalities detected during fatality searches. Incidental fatalities are reported in the text of Section 8.1 and Table A-1 in the Appendix.

Bibliography of **Literature for Avian Issues** in Solar and Wind Energy and Other Activities

Environmental Science Division

ANL/EVS-15/3

About Argonne National Laboratory
Argonne is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC under contract DE-AC02-06CH11357. The Laboratory's main facility is outside Chicago, at 9700 South Cass Avenue, Argonne, Illinois 60439. For information about Argonne and its pioneering science and technology programs, see www.anl.gov.

DOCUMENT AVAILABILITY

Online Access: U.S. Department of Energy (DOE) reports produced after 1991 and a growing number of pre-1991 documents are available free via DOE's SciTech Connect (http://www.osti.gov/scitech/).

Reports not in digital format may be purchased by the public from the National Technical Information Service (NTIS):

U.S. Department of Commerce
National Technical Information Service
5301 Shawnee Road
Alexandria, VA 22312
www.ntis.gov
Phone: (800) 553-NTIS (6847) or (703) 605-6000
Fax: (703) 605-6900
Email: **orders@ntis.gov**

Reports not in digital format are available to DOE and DOE contractors from the Office of Scientific and Technical Information (OSTI):

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
www.osti.gov
Phone: (865) 576-8401
Fax: (865) 576-5728
Email: **reports@osti.gov**

ANL/EVS-15/3

Bibliography of Literature for Avian Issues in Solar and Wind Energy and Other Activities

---

prepared by
Leroy J. Walston, Ellen M. White, and Stephanie A. Meyers
Environmental Science Division, Argonne National Laboratory

Craig Turchi and Karin Sinclair
National Renewable Energy Laboratory

prepared for
U.S. Department of Energy, SunShot Initiative and Office of Energy Efficiency & Renewable Energy

April 2015

Bibliography of Literature for Avian Issues in Solar and Wind Energy and Other Activities

Utility-scale solar energy has been a rapidly expanding energy sector in the United States in recent years and is expected to continue to grow. In 2014, concerns were raised over the risk of avian fatalities associated with utility-scale solar plants. With funding from the U.S. Department of Energy SunShot Program, Argonne National Laboratory and the National Renewable Energy Laboratory studied the issue and released *A Review of Avian Monitoring and Mitigation Information at Existing Utility-Scale Solar Facilities* (ANL/EVS-15/2, March 2015). A comprehensive literature review included peer-reviewed journal articles on avian fatalities from solar energy facilities and other sources (e.g., wind energy, building collisions, etc.), project-specific technical reports on avian monitoring and fatality at solar facilities, information on mitigation measures and best management practices, and literature pertaining to avian behavioral patterns and habitat use. The source citations are listed in this bibliography; they are current through December 2014.

The publications are organized by topic. Those with broader applicability are listed under more than one. The topics include:

1. Avian Monitoring and Fatality at Solar Energy Facilities
2. Solar Energy Project-Specific References
3. Avian Monitoring and Fatality at Wind Energy Facilities
4. Avian Fatality from Sources Other Than Solar and Wind Energy Development

Publications Listed by Topic

Avian Monitoring and Fatality at Solar Energy Facilities

Althouse and Meade, Inc. 2011. *Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan for the Topaz Solar Farm*. Prepared for Topaz Solar Farms, LLC.

American Bird Conservancy. 2014. “Grant Sizemore Comments: Avian Mitigation Plan Clarification.” Palen Solar Power Project. July 10. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202675_20140710T070709_Grant_Sizemore_Comments_Avian_Mitigation_Plan_Clarification.pdf.

BrightSource Energy, Inc. 2012. “Flux Impacts on Avian Species.” Presentation at the Joint Workshop for the Rio Mesa Solar Electric Generating Facility and Hidden Hills Solar Electric Generating System. California Energy Commission. August 28. http://docketpublic.energy.ca.gov/PublicDocuments/Regulatory/11-AFC-2%20Hidden%20Hills/2012/Aug/TN%2068362%2008-28-12%20Applicant%27s%20Submitted%20Power%20Point%20Presentation%20for%20August%2028,%20%202012%20Joint%20Workshop.pdf.

BrightSource Energy, Inc. 2013. “Injured Northern Rough-Winged Swallow Found Colosseum Rd.” http://docketpublic.energy.ca.gov/PublicDocuments/07-AFC-05C/TN200643_20130930T090220_Injured_NRWS_report_8132013.pdf.

California Energy Commission. 2014. “Ivanpah Solar Electric Generating System: Avian & Bat Technical Advisory Committee Meeting Notes.”

California Energy Commission. 2014. “Energy Commission Staff Opening Brief (Reopened Evidentiary Record).” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN203018_20140829T143735_Energy_Commission_Staff_Reply_Brief_Reopened_Evidentiary_Record.pdf.

California Energy Commission. 2014. “Energy Commission Staff Prehearing Conference Statement and Statement of Unresolved Issues.” Palen Solar Power Project. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202775_20140721T123737_CEC_Staff_Prehearing_Conference_Statement.pdf.

California Energy Commission. 2014. “Energy Commission Staff Rebuttal Testimony: Palen Solar Electric Generating System.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202773_20140718T165158_Staff's_Rebuttal_Testimony.pdf.

California Energy Commission. 2014. “Ivanpah Solar Electric Generating System (Ivanpah) Avian & Bat Technical Advisory Committee (TAC) Meeting July 2014.” Meeting notes. http://docketpublic.energy.ca.gov/PublicDocuments/07-AFC-05C/TN203002_20140828T125219_Ivanpah_Solar_Electric_Generating_System_Ivanpah_Avian__Bat_Tec.pdf.

Cardoso, T. 2013. “Estimation of 90% Confidence Bounds for Avian Mortality Estimates at Ivanpah 1.” Memorandum from T. Cardoso, TerraStat Consulting Group, to D. Johnston, H.T. Harvey & Associates. Aug. 13. ftp://lgftp.harveyecology.com/DesertSun/TerraStat_Estimation%20of%20CIs%20for%20avian%20mortality%20studies%20at%20Ivanpah%20I_HTH%20Tech%20Memo%20Aug2013.pdf

Center for Biological Diversity. 2014. “Intervenor Center for Biological Diversity Exhibit 3140: Corrections to Opening Testimony of K. Shawn Smallwood, Ph.D.” Palen Solar Power Project. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202698_20140714T133427_Exh_3140_Corrections_to_Opening_Testimony.pdf.

Center for Biological Diversity. 2014. “Opening Brief of Intervenor Center for Biological Diversity After Reopened Hearings.” Palen Solar Power Project. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202935_20140815T145913_Center_Opening_Brief_for_Reopened_Hearings.pdf.

Center for Biological Diversity. 2014. “Prehearing Conference Statement for Reopened Hearings and Updated Exhibit List, Exhibit 3150.” Palen Solar Power Project. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202780_20140721T154601_Center_Prehearing_Conf_Statement_and_updated_exhibit_list.pdf.

Center for Biological Diversity. 2014. “Reply Brief of Intervenor Center for Biological Diversity After Reopened Hearings.” Palen Solar Power Project. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN203017_20140829T143539_Center_Reply_Brief_Reopened_Hearings.pdf.

CH2MHILL. 2011. *Biological Resources Mitigation Implementation and Monitoring Plan for the Rice Solar Energy Project, Riverside County, California*. Prepared for Rice Solar Energy, LLC. www.energy.ca.gov/sitingcases/ricesolar/compliance/submittals/BRMIMP_072511.pdf.

Chatfield, A., D. Riser-Espinoza, and W. Erickson. 2014. *Draft Bird and Bat Conservation Strategy for the Palen Solar Electric Generating System*. Prepared by Western EcoSystems Technology, Inc. (WEST) for Palen Solar Holdings, LLC. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202487_20140623T143117_Ex1139__Draft_Bird_and_Bat_Conservation_Strategy.pdf.

Chow, L. 2012. *Desert Sunlight Solar Project Weekly Progress Report, Biological Resources Desert Center, California: October 22–October 28, 2012*. Ironwood Consulting, Inc. www.firstsolar.com/~/media/documents/projects/desert%20sunlight/biological%20monitoring/weekly%20biological%20monitoring%20report%2010-28-2012.ashx.

Clarke, C. 2014. “April Was Bad Month for Birds at Ivanpah Solar.” *Rewire*. May 26. www.kcet.org/news/rewire/solar/concentrating-solar/april-was-bad-month-for-birds-at-ivanpah-solar.html.

Clarke, C. 2014. “Deconstructing the Dispute Over Ivanpah Bird Kill Numbers.” *Rewire*. Aug. 21. www.kcet.org/news/rewire/commentary/dispute-over-ivanpah-bird-kill-numbers-based-on-misunderstanding-of-science.html.

CSP World. 2014. “BrightSource Responds to Critics about Bird Deaths at Ivanpah CSP Plant.” Aug. 20. www.csp-world.com/news/20140820/001368/brightsource-responds-critics-about-bird-deaths-ivanpah-csp-plant.

Cunningham, L., and K. Emmerich. 2014. “Regional Bird Migration Numbers for Desert Center, August, 2014.” Basin and Range Watch. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202975_20140825T001316_Regional_Bird_Migration_Numbers_for_Desert_Center_August_2014.pdf.

DeVault, T.L., et al. 2014. “Bird Use of Solar Photovoltaic Installations at US Airports: Implications for Aviation Safety.” *Landscape and Urban Planning* 122 (February): 122–128. doi:10.1016/j.landurbplan.2013.11.017.

DRECP Independent Science Advisors. 2010. *Recommendations of Independent Science Advisors for The California Desert Renewable Energy Conservation Plan (DRECP)*. DRECP-1000-2010-008-F. Prepared for Renewable Energy Action Team. www.energy.ca.gov/2010publications/DRECP-1000-2010-008/DRECP-1000-2010-008-F.PDF.

DuHamel, J. “Avian Mortality from Solar Farms.” *Wryheat*. http://wryheat.wordpress.com/2014/04/18/avian-mortality-from-solar-farms/.

Eddy, S. 2014. “Avian Mortality Thresholds for Solar Thermal Projects.” Letter to California Energy Commission from Large-Scale Solar Association. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202826_20140728T144609_Shannon_Eddy_Largescale_Solar_Association_Comments_Avian_Mortal.pdf.

GalatiBlek LLP. 2014. “Exhibit 1134 – Palen Solar Electric Generating System Biological Resources Supplemental Opening Testimony: Avian Impacts.” http://docketpublic.energy.ca.gov/

PublicDocuments/09-AFC-07C/TN202482_20140623T135337_Ex1134__Biological_Resources_Supplemental_Opening_Testimony_Wal.pdf.

GalatiBlek LLP. 2014. "Exhibit 1157 – Anthropogenic Sources of Avian Mortality, Palen Solar Power Project." http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202506_20140623T163654_Ex1157__Anthropogenic_Sources_of_Avian_Mortality.pdf.

GalatiBlek LLP. 2014. "Exhibit 1166 – Palen Solar Power Project – Project Description Supplemental Rebuttal Testimony." http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202727_20140718T120137_Exhibit_1166__Project_Description_Supplemental_Rebuttal_Testimo.pdf.

GalatiBlek LLP. 2014. "Exhibit 1173 – Biological Resources Supplemental Rebuttal Testimony – Avian Impacts and Mitigation." http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202736_20140718T124754_Ex1173__Biological_Resources_Supplemental_Rebuttal_Testimony_%E2%80%93.pdf.

GalatiBlek LLP. 2014. "Exhibit 1178 – Biological Resources Supplemental Rebuttal Testimony – Curtailment Infeasibility, Performance Standards and Polarized Light." http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202743_20140718T130154_Ex1178__Biological_Resources_Supplemental_Rebuttal_Testimony_%E2%80%93.pdf.

GalatiBlek LLP. 2014. "Exhibit 1186 – Biological Resources Supplemental Rebuttal Testimony." http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202747_20140718T131515_Ex1186__Biological_Resources_Supplemental_Rebuttal_Testimony__D.pdf.

GalatiBlek LLP. 2014. "Exhibit 1203 – Summary of ISEGS Bird and Bat Mortality – January through June 2014." http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202808_20140725T130451_Ex1203__Summary_of_ISEGS_Bird_and_Bat_Mortality__January_throug.pdf.

GalatiBlek LLP. 2014. "ISEGS and PSEGS Flux-Related Mortality Estimates Comparison Table." http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202817_20140725T151721_ISEGS_and_PSEGS_FluxRelated_Mortality_Estimates_Comparison_Table.pdf.

GalatiBlek LLP. 2014. "Palen Solar Holdings, LLC's Updated Compilation of Avian Data as of 3-21-14: 2012/2013/2014 Avian Mortality Information for the Genesis, Desert Sunlight, and ISEGS Projects." http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN201901_20140321T124028_Palen_Solar_Holdings_LLC%27s_Updated_Compilation_of_Avian_Data_as.pdf.

GalatiBlek LLP. 2014. "Revised Exhibit 1133 – Updated Avian Comparison Table." http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202481_20140623T132042_Exhibit_1133__Updated_Avian_Comparison_Table.pdf.

Genesis Solar, LLC. 2013. Genesis Solar Energy Project monthly compliance reports, July – December. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=09-AFC-08C.

Genesis Solar, LLC. 2014. Genesis Solar Energy Project monthly compliance reports, January – March. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=09-AFC-08C.

Heritage Environmental Consultants. 2012. Centinela Solar Energy Project Bird and Bat Conservation Strategy. Prepared for the Bureau of Land Management. http://centinelasolar.com/DocsInfo/Interconnection%20Facilities/Plan%20of%20Development%20for%20Project%20Components%20on%20BLM%20Land/POD%20Appendices/Appendix%20G%20-%20Bird%20and%20Bat%20Conservation%20Strategy.pdf.

H.T. Harvey & Associates. 2013. *Avian & Bat Monitoring and Management Plan, Ivanpah Solar Electric Generating System*. Prepared for Solar Partners I, LLC; Solar Partners II, LLC; and Solar Partners VIII, LLC.

H.T. Harvey & Associates. 2013. *California Valley Solar Ranch Project First Quarterly Post-Construction Avian and Bat Protection Plan Fatality Report, 16 August to 15 November 2012*. Prepared for HPR II, LLC. ftp://lgftp.harveyecology.com/DesertSun/HTH_CVSR%20Fatality%20Report%20Q1_April2013.pdf.

H.T. Harvey & Associates. 2013. *California Valley Solar Ranch Project Second Quarterly Post-Construction Avian and Bat Protection Plan Fatality Report, 16 November 2012 to 15 February 2013*. Prepared for HPR II, LLC.

H.T. Harvey & Associates. 2013. *Desert Sunlight Solar Farm Carcass Detectability Study*. Prepared for First Solar, Inc.

H.T. Harvey & Associates. 2014. *Ivanpah Solar Electric Generating System Avian & Bat Monitoring Plan 2013–2014 Winter Report (29 October 2013 – 21 March 2014)*. Prepared for Solar Partners I, II, and VIII.

H.T. Harvey & Associates. 2014. *Ivanpah Solar Electric Generating System Avian & Bat Monitoring Plan 2014 Spring Report*. Prepared for Solar Partners I, II, and VIII.

Huizar, M. 2013. Ivanpah Solar Electric Generating System monthly compliance reports 34, 37–39. BrightSource Energy. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=07-AFC-05C.

Huizar, M. 2014. Ivanpah Solar Electric Generating System monthly compliance report s 40–44, NRG Energy Services. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=07-AFC-05C.

Huso, M.M.P., N. Som, and L. Ladd. 2012. *Fatality Estimator User's Guide*. U.S. Geological Survey Data Series 729. http://pubs.usgs.gov/ds/729/pdf/ds729.pdf.

Ironwood Consulting, Inc. 2010. Avian and Bat Protection Plan Desert Sunlight Solar Farm Project. BLM CASE FILE NUMBER CACA-48649. Prepared for Desert Sunlight Holdings, LLC.

Ironwood Consulting, Inc. 2011. *Desert Sunlight Solar Farm Project: California Desert Conservation Area Plan Amendment and Final Environmental Impact Statement*. *Appendix H: Biological Resources*.

Prepared for Desert Sunlight Holdings, LLC. http://www.blm.gov/style/medialib/blm/ca/pdf/palmsprings/desert_sunlight.Par.85858.File.dat/H-Bio_Rsrcs.pdf.

Ironwood Consulting, Inc. 2013. *Desert Sunlight Solar Project 2013 Second Quarter Report for Biological Resources Monitoring*. Prepared for Bureau of Land Management and Silver State Solar Power South, LLC.

Ironwood Consulting, Inc. 2013. Desert *Sunlight Solar Project 2013 Third Quarter Report for Biological Resources Monitoring*. Prepared for Bureau of Land Management and Silver State Solar Power South, LLC. www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fwww.firstsolar.com%2F~%2Fmedia%2Fdocuments%2Fprojects%2Fdesert%2520sunlight%2Fbiological%2520monitoring%2Fweekly%2520biological%2520monitoring%2520report%25203rd%2520quarter%2520-%2520september%25202013.ashx&ei=xa0AVf_dG8GLNqD0gcgF&usg=AFQjCNGU8j6GomfHS-d7cwFfKTlTui7hKA&sig2=D6b-eenorKIqTING3z2otA&bvm=bv.87920726,d.eXY.

Ironwood Consulting, Inc., and Corvus Ecological Consulting, LLC. 2013. *Silver State Solar South Avian and Bat Mortality Monitoring Plan*. Prepared for Bureau of Land Management and Silver State Solar Power South, LLC . www.blm.gov/pgdata/etc/medialib/blm/nv/field_offices/las_vegas_field_office/energy/silver_state_south.Par.96025.File.dat/SilverState_BBCS_FINAL.pdf.

JBR Environmental Consultants, Inc. 2011. *Avian and Bat Protection Plan Crescent Dunes Solar Energy Project*. Prepared for Tonopah Solar Energy, LLC.

Kagan, R.A., et al. Avian Mortality at Solar Energy Facilities in Southern California: A Preliminary Analysis. National Fish and Wildlife Forensics Laboratory. http://alternativeenergy.procon.org/sourcefiles/avian-mortality-solar-energy-ivanpah-apr-2014.pdf.

Levenstein, K., A. Chatfield, W. Erickson, and K. Bay. 2014. Fall 2013 Avian Field Surveys for the Palen Solar Electric Generating System, Final Report. Prepared for Palen Solar Holdings, LLC.

Levenstein, K., and C. Nations. 2014. “Palen Solar Electric Generating System, Riverside County, California.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202002_20140410T162022_Fall_2013_Avian_Field_Surveys_for_Palen_Solar_Electric_Generati.pdf.

Lovich, J.E., and J.R. Ennen. 2011. “Wildlife Conservation and Solar Energy Development in the Desert Southwest, United States.” *BioScience* 61 (12): 982–992. doi:10.1525/bio.2011.61.12.8.

McCrary, M.D., et al. 1986. “Avian Mortality at a Solar Energy Power Plant.” Journal of Field Ornithology 57 (2): 135–41.

Mojave Solar, LLC. 2013. Mojave Solar Project monthly compliance reports, July 2013 – November 2013. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=09-AFC-05C.

Mojave Solar, LLC. 2014. Mojave Solar Project monthly compliance reports, December 2013– May 2014. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=09-AFC-05C.

Northrup, J.M., and G. Wittemyer. 2013. “Characterizing the Impacts of Emerging Energy Development on Wildlife, with an Eye toward Mitigation.” *Ecology Letters* 16 (1): 112–125. doi:10.1111/ele.12009.

Palen Solar Holdings, LLC. 2014. “Avian Mortality Information from 2012/2013 Monthly or Quarterly Compliance Reports.” *Compilation of Avian Data at Various Solar Projects*. California Energy Commission. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN201710_20140210T162936_Palen_Solar_Holdings_LLC%27s_Compilation_of_Avian_Data_at_Various.pdf.

Rice Solar Energy, LLC. 2014. Rice Solar Energy Project monthly compliance reports 8–12. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=09-AFC-10C.

Sandstrom, B. 2014. *Desert Sunlight Solar Project Weekly Progress Report Biological Resources Desert Center, California February 10 – February 16, 2014*. Ironwood Consulting, Inc. http://www.firstsolar.com/~/media/documents/projects/desert%20sunlight/biological%20monitoring/weekly%20biological%20monitoring%20report%2002-16-2014.ashx.

Sierra Club. 2014. “Re: Docket No. 09-AFC-07C: Palen Solar Power Project – Compliance, Comments of Sierra Club,” July 29. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202849_20140729T214157_Sierra_Club_Comments_Sierra_Club_Additional_Comments.pdf.

Silver State Solar Power North, LLC. 2011. *Avian Protection Plan: Silver State Solar Project.* Prepared for the Bureau of Land Management.

Smallwood, K. S. 2013. “Testimony of K. Shawn Smallwood, Ph.D., on Behalf of Laborers’ International Union of North America, Local Union No. 1184.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-06C/TN201152_20131108T155000_Testimony_of_K_Shawn_Smallwood_PhD.pdf.

Smallwood, K.S. 2014. “Exhibit 3128 – Testimony of K. Shawn Smallwood, Ph.D.” Palen Solar Power Project. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-06C/TN201152_20131108T155000_Testimony_of_K_Shawn_Smallwood_PhD.pdf.

Smallwood, K.S. 2014. “Exhibit 3144 – Rebuttal Testimony of K. Shawn Smallwood, Ph.D.” Palen Solar Power Project. www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fdocketpublic.energy.ca.gov%2FPublicDocuments%2F09-AFC-07C%2FTN202764_20140718T151349_Exh_3144__Smallwood_Rebuttal_Testimony.pdf&ei=m7gAVfPQGIHfgwSz3IOYAg&usg=AFQjCNE79wu_AtB1Nv5RODf6EGIVwVNMzQ&sig2=6kVs2rQMOFFE3AWfWGPz9Q&bvm=bv.87920726,d.eXY.

Tetra Tech. 2014. *Revised Bird and Bat Conservation Strategy, Genesis Solar Energy Project, Eastern Riverside County, California. Prepared for Genesis Solar, LLC*. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-08C/TN201879_20140317T152343_Genesis_Solar_BBCS.pdf.

United Nations Environment Programme (UNEP) / Convention on Migratory Species (CMS). 2014. *Renewable Energy Technologies and Migratory Species: Guidelines for Sustainable Deployment*. UNEP/CMS/COP11/Doc.23.4.3.2. www.cms.int/sites/default/files/document/Doc_10_2_2_Guidelines_Renewable_Energy_E.pdf.

U.S. Fish and Wildlife Service. 2011. “Biological Opinion on the Proposed Topaz Solar Farm, San Luis Obispo County, California.” www.slocounty.ca.gov/Assets/PL/Optisolar-Topaz+Solar+Farm/usfws_opinion.pdf.

U.S. Fish and Wildlife Service. 2014. “Comments on the California Energy Commission’s Supplemental Staff Assessment and Testimony for the Proposed Palen Solar Electric Generating System Project (09-AFC-07C).” August 7. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202896_20140808T151634_USFWS_Comments_with_Enclosure.pdf.

U.S. Fish and Wildlife Service. 2014. “Enclosure for USFWS Comments on the California Energy Commission’s Supplemental Staff Assessment and Testimony for the Proposed Palen Solar Electric Generation Biological Resources.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202896_20140808T151634_USFWS_Comments_with_Enclosure.pdf.

Western EcoSystems Technology, Inc. (WEST). 2014. *Review of Potential Bird Deterrent Strategies for Large Scale Solar Facilities*. Prepared for Palen Solar Holdings, LLC. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN201838_20140307T084759_Palen_Solar_Holdings_LLC%27s_Review_of_Potential_Bird_Deterrent_S.pdf.

Western EcoSystems Technology, Inc. (WEST). 2014. *Sources of Avian Mortality and Risk Factors Based on Empirical Data from Three Photovoltaic Solar Facilities*.

Woody, T. 2014. “How to Stop Solar Power Plants from Incinerating Birds.” *The Atlantic*. April 28. www.theatlantic.com/technology/archive/2014/04/how-to-stop-solar-power-plants-from-incinerating-birds/361318/.

Solar Energy Project-Specific References

Blythe Solar

GalatiBlek LLP. 2010. *Blythe Solar Power Project*. http://w.gosolarcalifornia.org/2010publications/CEC-700-2010-004/CEC-700-2010-004-REV1-SUP.PDF.

Crescent Dunes

JBR Environmental Consultants, Inc. 2011. *Avian and Bat Protection Plan Crescent Dunes Solar Energy Project*. Prepared for Tonopah Solar Energy, LLC.

Desert Sunlight

Brown, P. 2010. “Regarding: Initial Bat Habitat Survey for Solar One Desert Sunlight Solar Farm,” March 30.

Chow, L. 2012. Desert Sunlight Solar Project Weekly Progress Report Biological Resources Desert Center, California October 22–October 28, 2012. Ironwood Consulting, Inc.

“Desert Sunlight Solar Farm Avian and Bat Mortality, Injury, and Relocation as of June 17, 2013.”

GalatiBlek LLP. 2014. “Avian Mortality Information for the Genesis, Desert Sunlight, and ISEGS Projects.”

GalatiBlek LLP. 2014. “Exhibit 1133 – Updated Avian Comparison Table.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202481_20140623T132042_Exhibit_1133__Updated_Avian_Comparison_Table.pdf.

GalatiBlek LLP. 2014. “Revised Exhibit 1133 – Updated Avian Comparison Table.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202481_20140623T132042_Exhibit_1133__Updated_Avian_Comparison_Table.pdf.

H.T. Harvey & Associates. 2013. Desert Sunlight Solar Farm Carcass Detectability Study. Prepared for First Solar, Inc.

Ironwood Consulting, Inc. 2010. *Avian and Bat Protection Plan Desert Sunlight Solar Farm Project. BLM CASE FILE NUMBER CACA-48649*. Prepared for Desert Sunlight Holdings, LLC.

Ironwood Consulting, Inc. 2010. *Biological Resources Technical Report, Desert Sunlight Solar Farm Project*. Prepared for Desert Sunlight Holdings, LLC.

Ironwood Consulting, Inc. 2011. *Desert Sunlight Solar Farm Project: California Desert Conservation Area Plan Amendment and Final Environmental Impact Statement*. *Appendix H: Biological Resources*. Prepared for Desert Sunlight Holdings, LLC. http://www.blm.gov/style/medialib/blm/ca/pdf/palmsprings/desert_sunlight.Par.85858.File.dat/H-Bio_Rsrcs.pdf.

Ironwood Consulting, Inc. 2013. *Desert Sunlight Solar Project 2013 Second Quarter Report for Biological Resources Monitoring*. Prepared for Bureau of Land Management and Silver State Solar Power South, LLC.

Ironwood Consulting, Inc. 2013. *Desert Sunlight Solar Project 2013 Third Quarter Report for Biological Resources Monitoring*. Prepared for Bureau of Land Management and Silver State Solar Power South, LLC. www.firstsolar.com/~/media/documents/projects/desert%20sunlight/biological%20monitoring/weekly%20biological%20monitoring%20report%203rd%20quarter%20-%20september%202013.ashx.

Palen Solar Holdings, LLC. 2014. “Avian Mortality Information from 2012/2013 Monthly or Quarterly Compliance Reports.” *Compilation of Avian Data at Various Solar Projects*. California Energy

Commission. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN201710_20140210T162936_Palen_Solar_Holdings_LLC%27s_Compilation_of_Avian_Data_at_Various.pdf.

Sandstrom, B. 2014. *Desert Sunlight Solar Project Weekly Progress Report Biological Resources Desert Center, California February 10 – February 16, 2014*. Ironwood Consulting, Inc. www.firstsolar.com/~/media/documents/projects/desert%20sunlight/biological%20monitoring/weekly%20biological%20monitoring%20report%2002-16-2014.ashx.

WEST, Inc. 2014. *Sources of Avian Mortality and Risk Factors Based on Empirical Data from Three Photovoltaic Solar Facilities*.

Genesis Solar

Bernhardt, T. 2010. "Genesis Solar Energy Project-Docket Number 09-AFC-8." http://dhtlral.gosolarcalifornia.org/sitingcases/genesis_solar/documents/applicant/2010-06-11_Applicants_Fall_2009+Spring_2010_Biological_Resources_Technical_Report_TN-57130.PDF.

Clarke, C. 2014. "Another Huge Solar Plant Goes Online in California's Desert." KCET.org. May 5. http://www.kcet.org/news/rewire/solar/concentrating-solar/another-huge-solar-plant-goes-online-in-desert.html.

GalatiBlek LLP. 2014. "Avian Mortality Information for the Genesis, Desert Sunlight, and ISEGS Projects."

GalatiBlek LLP. 2014. "Exhibit 1133 – Updated Avian Comparison Table." http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202481_20140623T132042_Exhibit_1133__Updated_Avian_Comparison_Table.pdf.

GalatiBlek LLP. 2014. "Revised Exhibit 1133 – Updated Avian Comparison Table." http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202481_20140623T132042_Exhibit_1133__Updated_Avian_Comparison_Table.pdf.

Palen Solar Holdings, LLC. 2014. "Avian Mortality Information from 2012/2013 Monthly or Quarterly Compliance Reports." *Compilation of Avian Data at Various Solar Projects*. California Energy Commission. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN201710_20140210T162936_Palen_Solar_Holdings_LLC%27s_Compilation_of_Avian_Data_at_Various.pdf.

Tetra Tech. 2014. *Revised Bird and Bat Conservation Strategy, Genesis Solar Energy Project, Eastern Riverside County, California. Prepared for Genesis Solar, LLC*. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-08C/TN201879_20140317T152343_Genesis_Solar_BBCS.pdf.

Ivanpah (ISEGS)

BrightSource Energy, Inc. 2013. "Injured Northern Rough-Winged Swallow Found Colosseum Rd." http://docketpublic.energy.ca.gov/PublicDocuments/07-AFC-05C/TN200643_20130930T090220_Injured_NRWS_report_8132013.pdf.

California Energy Commission. 2014. “Ivanpah Solar Electric Generating System (Ivanpah) Avian & Bat Technical Advisory Committee (TAC) Meeting July 2014.” Meeting notes. http://docketpublic.energy.ca.gov/PublicDocuments/07-AFC-05C/TN203002_20140828T125219_Ivanpah_Solar_Electric_Generating_System_Ivanpah_Avian__Bat_Tec.pdf.

Cardoso, T. 2013. “Estimation of 90% Confidence Bounds for Avian Mortality Estimates at Ivanpah 1.” Memorandum from T. Cardoso, TerraStat Consulting Group, to D. Johnston, H.T. Harvey & Associates. Aug. 13. ftp://lgftp.harveyecology.com/DesertSun/TerraStat_Estimation%20of%20CIs%20for%20avian%20mortality%20studies%20at%20Ivanpah%20I_HTH%20Tech%20Memo%20Aug2013.pdf.

Clarke, C. 2014. “April Was Bad Month for Birds at Ivanpah Solar.” *Rewire*. May 26. www.kcet.org/news/rewire/solar/concentrating-solar/april-was-bad-month-for-birds-at-ivanpah-solar.html.

Clarke, C. 2014. “Deconstructing the Dispute Over Ivanpah Bird Kill Numbers.” *Rewire*. Aug. 21. www.kcet.org/news/rewire/commentary/dispute-over-ivanpah-bird-kill-numbers-based-on-misunderstanding-of-science.html.

Connell, L. 2014. “Exhibit 8033 – The Ivanpah ASRS Report.” NASA Aviation Safety Reporting System. Nov. 1. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202568_20140623T162711_Exhibit_8033_The_Ivanpah_ASRS_Report.pdf.

CSP World. 2014. “BrightSource Responds to Critics about Bird Deaths at Ivanpah CSP Plant.” Aug. 20. www.csp-world.com/news/20140820/001368/brightsource-responds-critics-about-bird-deaths-ivanpah-csp-plant.

GalatiBlek LLP. 2014. “Avian Mortality Information for the Genesis, Desert Sunlight, and ISEGS Projects.”

GalatiBlek LLP. 2014. “Exhibit 1203 – Summary of ISEGS Bird and Bat Mortality – January through June 2014.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202808_20140725T130451_Ex1203__Summary_of_ISEGS_Bird_and_Bat_Mortality__January_throug.pdf.

GalatiBlek LLP. 2014. “ISEGS and PSEGS Flux-Related Mortality Estimates Comparison Table.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202817_20140725T151721_ISEGS_and_PSEGS_FluxRelated_Mortality_Estimates_Comparison_Table.pdf.

GalatiBlek LLP. 2014. “Revised Exhibit 1133 – Updated Avian Comparison Table.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202481_20140623T132042_Exhibit_1133__Updated_Avian_Comparison_Table.pdf.

Ho, C.K., C.A. Sims, and J.M. Christian. 2014. “Exhibit 1191 – Ivanpah SEGS Heliostat Positioning Plan Report.” Sandia National Laboratories. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202734_20140718T130035_Ex1191__Ivanpah_SEGS_Heliostat_Positioning_Plan_Report.pdf.

Howard, J. 2014. “Solar Power Plant Glare.” Letter from Federal Aviation Administration. April 22. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202582_20140624T100838_Department_of_Transportation_Federal_Aviation_Administration_So.pdf.

H. T. Harvey & Associates. 2013. *Avian & Bat Monitoring and Management Plan, Ivanpah Solar Electric Generating System*. Prepared for Solar Partners I, LLC; Solar Partners II, LLC; and Solar Partners VIII, LLC.

H. T. Harvey & Associates. 2014. *Ivanpah Solar Electric Generating System Avian & Bat Monitoring Plan 2013–2014 Winter Report (29 October 2013 – 21 March 2014)*. Prepared for Solar Partners I, II, and VIII.

H.T. Harvey & Associates. 2014. *Ivanpah Solar Electric Generating System Avian & Bat Monitoring Plan 2014 Spring Report*. Prepared for Solar Partners I, II, and VIII.

Huizar, M. 2013. Ivanpah Solar Electric Generating System monthly compliance reports 34, 37–39. BrightSource Energy. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=07-AFC-05C.

Huizar, M. 2014. Ivanpah Solar Electric Generating System monthly compliance report s 40–44, NRG Energy Services. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=07-AFC-05C.

Kuiken, C., et al. 2009. *HIV Sequence Compendium 2009*. Los Alamos, New Mexico: Los Alamos National Laboratory, Theoretical Biology and Biophysics. www.hiv.lanl.gov/content/sequence/HIV/COMPENDIUM/2009/sequence2009.pdf.

Palen Solar Holdings, LLC. 2014. “Avian Mortality Information from 2012/2013 Monthly or Quarterly Compliance Reports.” *Compilation of Avian Data at Various Solar Projects*. California Energy Commission. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN201710_20140210T162936_Palen_Solar_Holdings_LLC%27s_Compilation_of_Avian_Data_at_Various.pdf.

Rollins, D. 2014. “Request for Ivanpah Report.” Email from D. Rollins (Federal Aviation Administration) to J. Adams (California Energy Commission). June 10. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202585_20140624T110131_Email_Re_Request_for_Ivanpah_Report_dated_June_10_2014.pdf.

Mojave Solar

Mojave Solar, LLC. 2013. Mojave Solar Project monthly compliance reports, July 2013 – November 2013. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=09-AFC-05C.

Mojave Solar, LLC. 2014. Mojave Solar Project monthly compliance reports, December 2013– May 2014. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=09-AFC-05C.

Palen Solar Electric Generating System (PSEGS)

Adams Broadwell Joseph & Cardozo. 2014. “Exhibit 6000 – Testimony of William J. Perez on Behalf of CURE on Overriding Considerations.” www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fdocketpublic.energy.ca.gov%2FPublicDocuments%2F09-AFC-07C%2FTN202571_20140623T163923_Exh_6000_Testimony_of_William_J_Perez_on_Behalf_of_CURE_on_Over.pdf&ei=xekAVbi5IMKrggT774CICw&usg=AFQjCNGurStTSDmZUm9OfO3tFjDxBUc7wg&sig2=-GFNZHTD8_wHBo55V7JACA&bvm=bv.87920726,d.eXY.

American Bird Conservancy. 2014. “Grant Sizemore Comments: Avian Mitigation Plan Clarification.” Palen Solar Power Project. July 10. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202675_20140710T070709_Grant_Sizemore_Comments_Avian_Mitigation_Plan_Clarification.pdf.

Ballmer, G. 2014. “Exhibit 3143 – Photo, Palen Solar Power Project.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202761_20140718T150749_Exh_3143_Photo.pdf.

BrightSource Energy, Inc. 2014. “Exhibit 1167 – Palen Solar Power Project Revised Phasing Plan.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202726_20140718T120346_Exhibit_1167__Revised_Plasing_Plan.pdf.

California Energy Commission. 2014. “Energy Commission Staff Opening Brief (Reopened Evidentiary Record).” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202934_20140815T144215_Palen_Opening_Brief__Reopener__FINAL.pdf.

California Energy Commission. 2014. “Energy Commission Staff Prehearing Conference Statement and Statement of Unresolved Issues.” Palen Solar Power Project. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202775_20140721T123737_CEC_Staff_Prehearing_Conference_Statement.pdf.

California Energy Commission. 2014. “Energy Commission Staff Rebuttal Testimony: Palen Solar Electric Generating System.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202773_20140718T165158_Staff's_Rebuttal_Testimony.pdf.

California Energy Commission. 2014. “Energy Commission Staff Reply Brief (Reopened Evidentiary Record).” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN203018_20140829T143735_Energy_Commission_Staff_Reply_Brief_Reopened_Evidentiary_Record.pdf.

California Energy Commission. 2014. Palen Solar Generating System glare video. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202700_20140714T162643_Glare_Video.pdf.

California Energy Commission. 2013. *Palen Solar Electric Generating System, Revised Presiding Member’s Proposed Decision*. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN201434_20131213T150623_Presiding_Member's_Proposed_Decision.pdf.

California Unions for Reliable Energy. 2014. “Prehearing Conference Statement of California Unions for Reliable Energy.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202779_20140721T163139_Prehearing_Conference_Statement.pdf.

Celli, K. 2014. “PSEGS Glint and Glare Impacts to Aviation Will Also Be Considered under the Topic of Traffic and Transportation,” Memorandum from California Energy Commission. July 2.

Center for Biological Diversity. 2014. “Exhibit 3146 – Reply Testimony of Bill Powers P.E.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202768_20140718T152848_Exh_3146_Powers_Rebuttal_Testimony.pdf.

Center for Biological Diversity. 2014. “Intervenor Center for Biological Diversity Exhibit 3140: Corrections to Opening Testimony of K. Shawn Smallwood, Ph.D.” Palen Solar Power Project. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202698_20140714T133427_Exh_3140_Corrections_to_Opening_Testimony.pdf.

Center for Biological Diversity. 2014. “Opening Brief of Intervenor Center for Biological Diversity After Reopened Hearings.” https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CCEQFjAA&url=http%3A%2F%2Fdocketpublic.energy.ca.gov%2FPublicDocuments%2F09-AFC-07C%2FTN202935_20140815T145913_Center_Opening_Brief_for_Reopened_Hearings.pdf&ei=wfcAVZCOCMX_gwTZioCYCg&usg=AFQjCNEq-lX3Lqq1qnwIvvjzI8oXzZeR7Q&sig2=DBnodZ7toqWVePUPEmgbmQ&bvm=bv.87920726,d.eXY.

Center for Biological Diversity. 2014. “Prehearing Conference Statement for Reopened Hearings and Updated Exhibit List, Exhibit 3150.” Palen Solar Power Project. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202780_20140721T154601_Center_Prehearing_Conf_Statement_and_updated_exhibit_list.pdf.

Center for Biological Diversity. 2014. “Reply Brief of Intervenor Center for Biological Diversity After Reopened Hearings.” Palen Solar Power Project. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN203017_20140829T143539_Center_Reply_Brief_Reopened_Hearings.pdf.

CH2M HILL. 2014. “Ex. 1168 – Palen Solar Power Project – Estimated Construction Personnel By Month Phase I.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202729_20140718T122652_Ex_1168__Estimated_Construction_Personnel_By_Month_Phase_I.pdf.

Chatfield, A., D. Riser-Espinoza, and W. Erickson. 2014. *Draft Bird and Bat Conservation Strategy for the Palen Solar Electric Generating System*. Prepared by WEST, Inc. , for Palen Solar Holdings, LLC. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202487_20140623T143117_Ex1139__Draft_Bird_and_Bat_Conservation_Strategy.pdf.

California Energy Commission. “CUL-1 Including Cover Letter, Palen Solar Power Project.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202766_20140718T152648_CUL1_including_Cover_letter.pdf.

Connelly, S. 2014. “Opposition to the Palen Solar Project.” Public comment memorandum to California Energy Commission. Aug. 4. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN203062_20140914T132951_Scott_Connelly_Comments_Adverse_impacts_of_Palen_Project.pdf.

Cunningham, L., and K. Emmerich. 2014. “Regional Bird Migration Numbers for Desert Center, August, 2014.” Basin and Range Watch. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202975_20140825T001316_Regional_Bird_Migration_Numbers_for_Desert_Center_August_2014.pdf.

Delfino, K. 2014. “Re: Docket No. 09-AFC-07C: Palen Solar Electric Generating System,” July 29.

GalatiBlek LLP. 2014. Anthropogenic Sources of Avian Mortality, Palen Solar Power Project – Compliance. 09-AFC-07C.

Emmerich, K. 2014. “Basin and Range Watch Opening Testimony of Kevin Emmerich.”

GalatiBlek LLP. 2014. “Exhibit 1134 – Biological Resources Supplemental Opening Testimony Wally P. Erickson and Dr. Ken Levenstein Â€“ Avian Impacts.”

GalatiBlek LLP. 2014. “Exhibit 1166 –Palen Solar Power Project – Project Description Supplemental Rebuttal Testimony.”

GalatiBlek LLP. 2014. “Exhibit 1178 – Biological Resources Supplemental Rebuttal Testimony – Curtailment Infeasibility, Performance Standards and Polarized Light.”

GalatiBlek LLP. 2014. “Exhibit 1171 – Cultural Resources Supplemental Rebuttal Testimony, Palen Solar Power Project.”

GalatiBlek LLP. 2014. “Exhibit 1173 – Biological Resources Supplemental Rebuttal Testimony – Avian Impacts and Mitigation.”

GalatiBlek LLP. 2014. “Exhibit 1176 – Biological Resources Supplemental Rebuttal Testimony – Insects.”

GalatiBlek LLP. 2014. “Exhibit 1177 – Summary and Analysis of CBD Exhibit 3108.”

GalatiBlek LLP. 2014. “Exhibit 1179 – Alternative Supplemental Rebuttal Testimony.”

GalatiBlek LLP. 2014. “Exhibit 1181 – Overriding Considerations Supplemental Rebuttal Testimony – Thermal Energy Storage.”

GalatiBlek LLP. 2014. “Exhibit 1186 – Biological Resources Supplemental Rebuttal Testimony.”

GalatiBlek LLP. 2014. “Exhibit 1187 – Traffic and Transportation Rebuttal Testimony Glint and Glare Pilot Opinion.”

GalatiBlek LLP. 2014. “ISEGS and PSEGS Flux-Related Mortality Estimates Comparison Table.”

GalatiBlek LLP. 2014. Palen Solar Holdings, LLC’s Compilation of Avian Data at Various Solar Projects.

GalatiBlek LLP. 2014. “Palen Solar Holdings, LLC’s Motion to Reopen Evidentiary Record and Scheduling Order.”

GalatiBlek LLP. 2014. “Palen Solar Holdings, LLC’s Prehearing Conference Statement.”

GalatiBlek LLP. 2014. “Palen Solar Holdings, LLC’s Reply Brief.”

GalatiBlek LLP. 2014. Palen Solar Holdings, LLC’s Updated Compilation of Avian Data at Various Solar Projects as of 02-26-14.

Gonzales, S. 2014. “Re: Docket No. 09-AFC-07C: Palen Solar Electric Generating System,” July 30.

Levenstein, K., et al. 2014. *Fall 2013 Avian Field Surveys for the Palen Solar Electric Generating System, Final Report*. Prepared for Palen Solar Holdings, LLC.

Levenstein, K., and C. Nations. 2014. “Palen Solar Electric Generating System, Riverside County, California.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202002_20140410T162022_Fall_2013_Avian_Field_Surveys_for_Palen_Solar_Electric_Generati.pdf.

Page, J. 2013. “Determination of No Hazard to Air Navagation, Solar Tower Unit 1, Dated 07/18/2013.” Federal Aviation Administration.

Page, J. 2013. “Determination of No Hazard to Air Navigation, Solar Tower Unit 2, Dated 07/18/2013.” Federal Aviation Administration.

Pratt, G. 2014. “Ex. 3142 Rebuttal Testimony of Gordon Pratt PhD, Re: Impacts to Flying Invertebrates (Insects) from the Proposed Palen Solar Electric Generating System.”

Rollins, D. 2014. “Palen Aeronautical Study.” Email with attached Palen Aeronutical Study from D. Rollins (Federal Aviation Administration) to J. Adams (California Energy Commission). June 9.

Sandia National Laboratories. 2002. *Final Test and Evaluation Results from the Solar Two Project*. SAND2002-0120.

Shteir, S. 2014. “NPCA Comments on Palen PMPD to Supplement Existing Submitted Comments.” National Parks Conservation Association.

Shute, Mihaly & Weinberger LLP. 2014. Exhibits 8028–8032. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=09-AFC-07C .

Shute, Mihaly & Weinberger LLP. 2014f. “Exhibits 8035 and 8036. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=09-AFC-07C Shute, Mihaly & Weinberger LLP. 2014g.

Sierra Club. 2014. “Re: Docket No. 09-AFC-07C: Palen Solar Power Project – Compliance, Comments of Sierra Club,” July 29. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202849_20140729T214157_Sierra_Club_Comments_Sierra_Club_Additional_Comments.pdf.

Sizemore, G. 2014. “Avian Mitigation Plan Clarification.” Letter from American Bird Conservancy to California Energy Commission. July 10. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202754_20140718T135226_Ex1182__Letter_from_American_Bird_Conservancy_Grant_Sizemore_to.pdf.

Smallwood, K.S. 2013. “Testimony of K. Shawn Smallwood, Ph.D., on Behalf of Laborers’ International Union of North America, Local Union No. 1184.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-06C/TN201152_20131108T155000_Testimony_of_K_Shawn_Smallwood_PhD.pdf.

Smallwood, K.S. 2014. “Exhibit 3128 Testimony of K. Shawn Smallwood, Ph.D.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-06C/TN201152_20131108T155000_Testimony_of_K_Shawn_Smallwood_PhD.pdf.

Smallwood, K.S. 2014. “Exhibit 3144 – Rebuttal Testimony of K. Shawn Smallwood, Ph.D.” Palen Solar Power Project. www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fdocketpublic.energy.ca.gov%2FPublicDocuments%2F09-AFC-07C%2FTN202764_20140718T151349_Exh_3144__Smallwood_Rebuttal_Testimony.pdf&ei=m7gAVfPQGIHfgwSz3IOYAg&usg=AFQjCNE79wu_AtB1Nv5RODf6EGIVwVNMzQ&sig2=6kVs2rQMOFFE3AWfWGPz9Q&bvm=bv.87920726,d.eXY.

U.S. Fish and Wildlife Service. 2014. “Comments on the California Energy Commission’s Supplemental Staff Assessment and Testimony for the Proposed Palen Solar Electric Generating System Project (09-AFC-07C).” August 7. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202896_20140808T151634_USFWS_Comments_with_Enclosure.pdf.

U.S. Fish and Wildlife Service. 2014. “Enclosure for USFWS Comments on the California Energy Commission’s Supplemental Staff Assessment and Testimony for the Proposed Palen Solar Electric Generation Biological Resources.” http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202896_20140808T151634_USFWS_Comments_with_Enclosure.pdf.

Rice Solar Energy Project

CH2MHILL. 2011. *Biological Resources Mitigation Implementation and Monitoring Plan for the Rice Solar Energy Project, Riverside County, California*. Prepared for Rice Solar Energy, LLC. www.energy.ca.gov/sitingcases/ricesolar/compliance/submittals/BRMIMP_072511.pdf.

Rice Solar Energy, LLC. 2014. Rice Solar Energy Project monthly compliance reports, April –August, 2014. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=09-AFC-10C.

Silver State North and South

Ironwood Consulting, Inc. 2013. *Bird and Bat Conservation Plan Silver State Solar Power South*. BLM Case File Numbers: NVN-089530, NVN-085801. Prepared for Bureau of Land Management and Silver State Solar Power South, LLC. www.blm.gov/pgdata/etc/medialib/blm/nv/field_offices/las_vegas_field_office/energy/silver_state_south.Par.96025.File.dat/SilverState_BBCS_FINAL.pdf.

Ironwood Consulting, Inc., and Corvus Ecological Consulting, LLC. 2013. *Silver State Solar South Avian and Bat Mortality Monitoring Plan*. Prepared for Bureau of Land Management and Silver State Solar Power South, LLC . www.blm.gov/pgdata/etc/medialib/blm/nv/field_offices/las_vegas_field_office/energy/silver_state_south.Par.96025.File.dat/SilverState_BBCS_FINAL.pdf.

Silver State Solar Power North, LLC. 2011. *Avian Protection Plan Silver State Solar Project*. Prepared for the Bureau of Land Management.

Topaz Solar Farm

Althouse and Meade, Inc. 2011. *Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan for the Topaz Solar Farm*. Prepared for Topaz Solar Farms, LLC.

Aspen Environmental Group. 2011. *Final Environmental Impact Report for the Topaz Solar Farm Project – Executive Summary*. Prepared for County of San Luis Obispo. www.slocounty.ca.gov/Assets/PL/Optisolar-Topaz+Solar+Farm/execsummary.pdf.

Aspen Environmental Group. 2011. *Topaz Solar Farm Project: C.6 Biological Resources*. Prepared for County of San Luis Obispo.

California Department of Fish and Game. “Topaz Solar Farm Incidental Take Permit No. 2081-2011-041-04.” www.slocounty.ca.gov/Assets/PL/Optisolar-Topaz+Solar+Farm/cdfg.pdf.

California Department of Fish and Wildlife. 2014. *Topaz Solar Farm Conservation Lands Habitat Mitigation and Monitoring Plan: 2013 Annual Report*. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=78198.

U.S. Fish and Wildlife Service. 2011. Biological Opinion on the Proposed Topaz Solar Farm, San Luis Obispo County, CA.

Avian Monitoring and Fatality at Wind Energy Facilities

Alamont Survey Protocols. 2007. “Altamont Pass Wind Resource Area Bird and Bat Mortality Monitoring Protocols.”

Allison, T.D., T.L. Root, and P.C. Frumhoff. 2014. “Thinking Globally and Siting Locally – Renewable Energy and Biodiversity in a Rapidly Warming World.” *Climatic Change* 126(1-2): 1–6. doi:10.1007/s10584-014-1127-y.

American Bird Conservancy. 2011. “Massive Bird Kill at West Virginia Wind Farm Highlights National Issue.” October 28. http://www.abcbirds.org/newsandreports/releases/111028.html.

American Wind Wildlife Institute. 2014. *Wind Turbine Interactions with Wildlife and Their Habitats, A Summary of Research Results and Priority Questions*. http://awwi.org/resources/summary-of-wind-wildlife-interactions-2/.

Anderson, R., et al. 1999. *Studying Wind Energy/Bird Interactions: A Guidance Document Metrics and Methods for Determining or Monitoring Potential Impacts on Birds at Existing and Proposed Wind Energy Sites*. Prepared for the Avian Subcommittee and National Wind Coordinating Committee.

Anderson, R., et al. 2004. *Avian Monitoring and Risk Assessment at the Tehachapi Pass Wind Resource Area. Period of Performance: October 2, 1996 – May 27, 1998*. NREL/SR-500-36416. Prepared for the National Renewable Energy Laboratory.

Anderson, R., et al. 2005. *Avian Monitoring and Risk Assessment at the San Gorgonio Wind Resource Area.* NREL/SR-500-38054. Prepared for the National Renewable Energy Laboratory.

Baerwald, E.F., and R. M.R. Barclay. 2009. “Geographic Variation in Activity and Fatality of Migratory Bats at Wind Energy Facilities.” *Journal of Mammology* 90(6): 1341–1349.

Bellebaum, J., et al. 2013. “Wind Turbine Fatalities Approach a Level of Concern in a Raptor Population.” *Journal for Nature Conservation* 21(6): 394–400. doi:10.1016/j.jnc.2013.06.001.

California Energy Commission. 2007. *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development Commission*. Final Report.

Chatfield, A., W. Erickson, and K. Bay. 2009. *Avian and Bat Fatality Study Dillon Wind-Energy Facility Riverside County, California, Final Report March 26, 2008 – March 26, 2009*. WEST, Inc.

Chatfield, A., W. Erickson, and K. Bay. 2010. *Avian and Bat Fatality Study at the Alite Wind-Energy Facility Kern County, California, Final Report June 15, 2009 – June 15, 2010*. WEST, Inc.

Clarke, C. 2013. “4 Reasons Why It’s a Bad Argument to Say Cats Kill More Birds Than Wind Turbines.” Basin and Range Watch. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202759_20140718T144346_Ex_4008_4_Reasons_Why_it's_a_Bad_Argument_to_Say_Cats_Kill_More.pdf.

Curry & Kerlinger, LLC. 2006. *Post-Construction Avian and Bat Fatality Monitoring Study for the High Winds Wind Power Project, Two Year Report*. Prepared for High Winds, LLC, FPL Energy.

Deru, M.P., and P. Torcellini. 2007. *Source Energy and Emission Factors for Energy Use in Buildings*. National Renewable Energy Laboratory Golden, CO.

DRECP Independent Science Advisors. 2010. *Recommendations of Independent Science Advisors for The California Desert Renewable Energy Conservation Plan (DRECP)*. DRECP-1000-2010-008-F. Prepared for Renewable Energy Action Team. www.energy.ca.gov/2010publications/DRECP-1000-2010-008/DRECP-1000-2010-008-F.PDF.

Erickson, W.P., et al. 2000. *Avian and Bat Mortality Associated with the Vansycle Wind Project, Umatilla County, Oregon 1999 Study Year Final Report*. Prepared for Umatilla County Department of Resource Services and Development.

Erickson, W.P., et al. 2001. *Avian Collisions with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States*. RESOLVE, Inc.(US). http://www.osti.gov/scitech/biblio/822418.

Erickson, W., A. Chatfield, and K. Bay. 2009. *Review of Avian Studies in the Tehachapi Wind Resource Area Kern County, California*. WEST, Inc.

Erickson, W.P., et al. 2014. "A Comprehensive Analysis of Small-Passerine Fatalities from Collision with Turbines at Wind Energy Facilities." *PLoS ONE* 9(9): e107491. doi:10.1371/journal.pone.0107491.

GalatiBlek LLP. 2014. "Bird Mortality at Wind Energy Facilities in Southwestern U.S." www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA &url=http%3A%2F%2Fdocketpublic.energy.ca.gov%2FPublicDocuments%2F09-AFC-07C%2FTN202525_ 20140623T163229_Ex1156__Bird_Mortality_at_Wind_Energy_Facilities_in_Southwester.pdf&ei=3woBVf_HCovRggSE34FA&usg=AFQjCNFXQKJ_-eEZOUghdGm0M6nsgUpgWg&sig2=BtanieBJe7PDzj3xQq H2YQ&bvm=bv.87920726,d.eXY.

H.T. Harvey & Associates. 2013. *Bird and Bat Movement Patterns and Mortality at the Montezuma Hills Wind Resource Area, Final Project Report*. Prepared for the California Energy Commission.

Johnson, G.D., et al. 2000. *Avian Monitoring Studies at the Buffalo Ridge, Minnesota Wind Resource Area: Results of a 4-Year Study*. Final Report. WEST, Inc.

Johnson, G.D., et al. 2003. "Mortality of Bats at a Large-Scale Wind Power Development at Buffalo Ridge, Minnesota." *American Midland Naturalist* 150(2): 332–342.

Jones, N.F., and L. Pejchar. 2013. "Comparing the Ecological Impacts of Wind and Oil & Gas Development: A Landscape Scale Assessment." *PLoS ONE* 8 (11): e81391. doi:10.1371/journal.pone.0081391.

Kerlinger, P., et al. 2006. *Post-Construction Avian and Bat Fatality Monitoring Study for the High Winds Wind Power Project Solano County, California: Two Year Report*. Curry & Kerlinger, LLC.

Kerlinger, P., et al. 2009. *Post-Construction Avian Monitoring Study for the Shiloh I Wind Power Project Solano County, California*. Final Report. Prepared for Aberdrola Renewables.

Kerns, J., and P. Kerlinger. 2004. *Post-Construction Avian Monitoring Study for the Shiloh I Wind Power Project Solano County, California*. Final Report. Prepared for FPL Energy and Mountaineer Wind Energy Center.

Köppel, J., et al. 2014. “Cautious but Committed: Moving Toward Adaptive Planning and Operation Strategies for Renewable Energy’s Wildlife Implications.” *Environmental Management* 54(4): 744–755. doi:10.1007/s00267-014-0333-8.

Korner-Nievergelt, F., et al. 2011. “A New Method to Determine Bird and Bat Fatality at Wind Energy Turbines from Carcass Searches.” *Wildlife Biology* 17(4): 350–363.

Kuvlesky, W.P., et al. “Wind Energy Development and Wildlife Conservation: Challenges and Opportunities.” *Journal of Wildlife Management* 12.

Leslie, D., J. Schwartz, and B. Karas. 2012. *Altamont Pass Wind Resource Area Bird Fatality Study, Bird Years 2005–2010*. ICF International.

Martin, G.R. 2011. “Understanding Bird Collisions with Man-Made Objects: A Sensory Ecology Approach.” *Ibis* 153(2): 239–254.

Northrup, J.M., and G. Wittemyer. 2013. “Characterizing the Impacts of Emerging Energy Development on Wildlife, with an Eye towards Mitigation*.” Ecology Letters* 16(1): 112–125. doi:10.1111/ele.12009.

Pagel, J.E., et al. 2013. “Bald Eagle and Golden Eagle Mortalities at Wind Energy Facilities in the Contiguous United States.” *Journal of Raptor Research* 47(3): 311–315. doi:10.3356/JRR-12-00019.1.

Péron, G., et al. 2013. “Estimation of Bird and Bat Mortality at Wind-Power Farms with Superpopulation Models.” Edited by Jason Matthiopoulos. *Journal of Applied Ecology* 50(4): 902–911. doi:10.1111/1365-2664.12100.

Schirmacher, M.R., Edward et al. 2009. *Patterns of Bat Fatality at the Casselman Wind Project in South-Central Pennsylvania 2008 Annual Report*. Prepared for Bats and Wind Energy Cooperative and the Pennsylvania Game Commission.

Shoenfeld, P. “Suggestions Regarding Avian Mortality Extrapolation.”

Smallie, J. 2012. “Avifauna Impact Assessment.” http://cesnet.co.za/pubdocs/Peddie%20Wind%20 Energy%20Project%20CB%2018.12.12/Avifauna%20Impact%20Assessment.pdf.

Smallwood, K.S. 2007. “Estimating Wind Turbine-Caused Bird Mortality.” *Journal of Wildlife Management* 71(8): 2781–2791. doi:10.2193/2007-006.

Smallwood, K.S. 2013. “Comparing Bird and Bat Fatality-Rate Estimates among North American Wind-Energy Projects.” *Wildlife Society Bulletin* 37(1): 19–33. doi:10.1002/wsb.260.

Smallwood, K.S., and C. Thelander. 2008. “Bird Mortality in the Altamont Pass Wind Resource Area, California.” *Journal of Wildlife Management* 72(1): 215–23. doi:10.2193/2007-032.

Smallwood, K.S., and B. Karas. 2009. “Avian and Bat Fatality Rates at Old-Generation and Repowered Wind Turbines in California.” *Journal of Wildlife Management* 73(7): 1062–1071. doi:10.2193/2008-464.

Smallwood, K.S., et al. 2010. “Novel Scavenger Removal Trials Increase Wind Turbine-Caused Avian Fatality Estimates.” Journal of Wildlife Management 74 (5): 1089–1097. doi:10.2193/2009-266.

Sovacool, B.K. 2009. “Contextualizing Avian Mortality: A Preliminary Appraisal of Bird and Bat Fatalities from Wind, Fossil-Fuel, and Nuclear Electricity.” *Energy Policy* 37(6): 2241–2248. doi:10.1016/j.enpol.2009.02.011.

Sovacool, B.K. 2013. “The Avian Benefits of Wind Energy: A 2009 Update.” *Renewable Energy* 49 (January): 19–24. doi:10.1016/j.renene.2012.01.074.

Strickland, D., et al. 2011. *Comprehensive Guide to Studying Wind Energy/Wildlife Interactions*. Prepared for the National Wind Coordinating Collaborative.

Thompson, J., and K. Bay. 2012. *Post-Construction Fatality Surveys For the Dry Lake II Wind Project*. Prepared by WEST, Inc., for Iberdrola Renewables, LLC.

UNEP/CMS Secretariat. 2014. *Renewable Energy Technologies and Migratory Species: Guidelines for Sustainable Deployment*. UNEP/CMS/COP11/Doc.23.4.3.2.

U.S. Fish and Wildlife Service. 2012. *U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines*.

Warren-Hicks, W., et al. 2013. *Improving Methods for Estimating Fatality of Birds and Bats at Wind Energy Facilities, Public Interest Energy Research (PIER) Program Final Project Report*. CEC-500-2012-086. Prepared by California Wind Energy Association for California Energy Commission.

WEST, Inc. 2004. *Stateline Wind Project Wildlife Monitoring Final Report July 2001 – December 2003*. Prepared for FPL Energy.

Willis, C.K.R., et al. 2010. “Bats Are Not Birds and Other Problems with Sovacool’s (2009) Analysis of Animal Fatalities due to Electricity Generation.” *Energy Policy* 38: 2067–2069.

Avian Fatality from Sources Other than Solar and Wind Energy

Associated Press. 2014. “San Francisco to Tally Bird-into-Window Death Toll,” Aug. 21.

Clarke, C. 2013. “4 Reasons Why It’s a Bad Argument to Say Cats Kill More Birds Than Wind Turbines.” Basin and Range Watch. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202759_20140718T144346_Ex_4008_4_Reasons_Why_it's_a_Bad_Argument_to_Say_Cats_Kill_More.pdf.

Klem Jr., D., 2008. “Avian Mortality at Windows: The Second Largest Human Source of Bird Mortality on Earth.” In *Proceedings Fourth International Partners in Flight Conference*. pp. 244–251. http://www.muhlenberg.edu/main/academics/biology/faculty/Klem/aco/documents/Klem_PIF09-Final-rec-1-XII-09.pdf.

Longcore, T., et al. 2012. “An Estimate of Avian Mortality at Communication Towers in the United States and Canada.” *PLoS ONE* 7(4): e34025. doi:10.1371/journal.pone.0034025.

Longcore, T., et al. 2013. “Avian Mortality at Communication Towers in the United States and Canada: Which Species, How Many, and Where?” *Biological Conservation* 158(February): 410–419. doi:10.1016/j.biocon.2012.09.019.

Loss, S.R., et al. 2014. “Bird–building Collisions in the United States: Estimates of Annual Mortality and Species Vulnerability.” *The Condor* 116(1): 8–23. doi:10.1650/CONDOR-13-090.1.

Manville, I.I., et al. 2005. “Bird Strike and Electrocutions at Power Lines, Communication Towers, and Wind Turbines: State of the Art and State of the Science-next Steps toward Mitigation.” www.treesearch.fs.fed.us/pubs/32105.

Silva, J.P., et al. 2014. “A Spatially Explicit Approach to Assess the Collision Risk between Birds and Overhead Power Lines: A Case Study with the Little Bustard.” *Biological Conservation* 170(February): 256–263. doi:10.1016/j.biocon.2013.12.026.

Sizemore, G. 2014. “Avian Mitigation Plan Clarification.” Letter from American Bird Conservancy to California Energy Commission. July 10. http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN202754_20140718T135226_Ex1182__Letter_from_American_Bird_Conservancy_Grant_Sizemore_to.pdf.

Environmental Science Division
Argonne National Laboratory
9700 South Cass Avenue, Bldg. 240
Argonne, IL 60439-4854

www.anl.gov

Argonne National Laboratory is a U.S. Department of Energy
laboratory managed by UChicago Argonne, LLC

J. Field Ornithol., 57(2):135–141

AVIAN MORTALITY AT A SOLAR ENERGY POWER PLANT

By Michael D. McCrary, Robert L. McKernan,
Ralph W. Schreiber, William D. Wagner,
and Terry C. Sciarrotta

In 1979, the United States Department of Energy, in conjunction with the Southern California Edison Company (SCE) and the Los Angeles Department of Water and Power, initiated the construction of Solar One, the world's largest solar energy power plant (Fig. 1). Until the construction of Solar One, the use of the sun's energy to produce electrical power had not been attempted on this scale, and the environmental hazards of operation of a solar power plant were unknown. In this paper we report on bird mortality at Solar One.

STUDY AREA AND METHODS

Solar One is a 10 megawatt, central receiver solar power plant consisting of a 32-ha field of 1818, 6.9 × 6.9 m mirrors (heliostats) which concentrate sunlight on a centrally located, tower-mounted boiler, 86 m in height (Fig. 1). The reflective surface area of each heliostat is approximately 40 m^2, and the total for all heliostats is approximately 72,500 m^2. When not directed at the tower during morning startup, testing, and maintenance, some or all of the heliostats are focused on standby points, four small areas (approximate diameter = 5 m) of sky around the tower at a height of 80 m. Temperatures within the standby points vary with the number of heliostats focused on them and the reflectivity of an object placed within them, but the temperature can be high enough to burn feathers and small insects.

Solar One is located in the Mojave Desert, 4 km east of Daggett, San Bernardino County, California (34°52′N, 116°51′W). The dominant desert plant community in this area is creosote bush (*Larrea divaricata*) scrub, although abandoned and active agricultural fields (alfalfa) and extensive (53 ha) evaporation ponds (Fig. 1) are adjacent to Solar One.

We visited Solar One approximately once per week (2–3 days per visit) on 6 occasions from 3 May through 8 June 1982 and on 34 occasions from 16 September 1982 through May 1983. During each visit 1–2 observers searched the facility for any evidence of bird mortality. Although searches were not conducted in a fixed pattern, the entire facility was covered during each visit. Bird carcasses were readily found because of the sparse vegetation and level ground of Solar One. Experiments involving the placement of 19 bird carcasses of various species within and just outside (<200 m) the fenced facility were conducted in May and September 1982 to measure the rate of bird carcass removal by scavengers. These carcasses were checked periodically until removed by scavengers or decomposed.

FIGURE 1. Aerial view of Solar One: (A) heliostat field, (B) central receiver tower, (C) evaporation ponds. Tower height = 86 m, diameter of field = 765 m.

To determine the impact of bird mortality on local populations, 1–2 observers conducted surveys of relative avian abundance within an area of approximately 150 ha surrounding Solar One, concentrating on the facility grounds (32 ha), evaporation ponds, and agricultural fields. These surveys were conducted on at least 2 d per visit for 3–4 h/d.

RESULTS

Solar One related animal mortality.—During approximately 40 wks of study, we documented 70 bird fatalities involving 26 species at Solar One (Table 1). The mean rate of mortality between visits was 1.7 birds ± 1.8 SD (n = 40, range 0–7). Results of the scavenger bias experiments indicate that from 10–30% of carcasses were removed between searches, thus, the actual rate of mortality may have been from 1.9–2.2 birds. Two causes of avian mortality were identified at Solar One, colliding with structures and burning from standby points.

The most frequent form of avian mortality was from collisions with Solar One structures. We documented 57 (81%) bird deaths (20 species) from collisions (Table 1). In most cases the cause of death was determined by the presence of broken bones (usually mandibles or wings) found through external examination. From the location of birds in relation to structures, most (>75%) died from colliding with the mirrored heliostats, although a dead Blue-winged Teal (*Anas discors*) with a broken wing was found on a platform of the receiver tower. On one occasion

TABLE 1. Avian mortality from burning and collisions at Solar One, 1982–1983.

Burn fatalities		Collision fatalities	
Species	Number of individuals	Species	Number of individuals
Vaux's Swift (*Chaetura vauxi*)	1	Eared Grebe (*Podiceps nigricollis*)	11
White-throated Swift (*Aeronautes saxatalis*)	2	Blue-winged Teal (*Anas discors*)	1
Hummingbird sp.	3	American Kestrel (*Falco sparverius*)	1
Cliff Swallow (*Hirundo pyrrhonota*)	2	American Coot (*Fulica americana*)	2
Barn Swallow (*Hirundo rustica*)	1	Black-necked Stilt (*Himantopus mexicanus*)	2
Barn Swallow (*Hirundo rustica*)	1	Sandpiper sp.	1
Yellow-rumped Warbler (*Dendroica coronata*)	1	Red-necked Phalarope (*Phalaropus lobatus*)	1
Wilson's Warbler (*Wilsonia pusilla*)	1	Bonaparte's Gull (*Larus philadelphia*)	1
Sparrow sp.	1	Mourning Dove (*Zenaida macroura*)	6
		Hummingbird sp.	1
		Horned Lark (*Eremophila alpestris*)	3
		European Starling (*Sturnus vulgaris*)	4
		Yellow-rumped Warbler (*Dendroica coronata*)	1
		MacGillivray's Warbler (*Oporornis tolmiei*)	1
		Savannah Sparrow (*Passerculus sandwichensis*)	3
		White-crowned Sparrow (*Zonotrichia leucophrys*)	2
		Dark-eyed Junco (*Junco hyemalis*)	1
		Red-winged Blackbird (*Agelaius phoeniceus*)	3
		Western Meadowlark (*Sturnella neglecta*)	1
		Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*)	2
		Brewer's Blackbird (*Euphagas cyanocephalus*)	5
		House Finch (*Carpodacus mexicanus*)	4
Total	13	Total	57

in May 1982 a Solar One employee observed 4 Mourning Doves (*Zenaida macroura*) die in a collision with a single heliostat.

Thirteen (19%) birds (7 species) died from burning in the standby points (Table 1). Although we never observed a bird fly through one of the standby points, the heavily singed flight and contour feathers indicated that the birds burned to death (Fig. 2). Six (46%) of these fatalities involved aerial foragers (swifts and swallows) which are apparently more susceptible to this form of mortality because of their feeding behavior. Three of these aerial foragers died during a 2-wk period in May 1982, corresponding with the presence of the highest numbers of swifts and swallows observed (>500 per d), and an extensive period of heliostat testing when the occurrence and intensity of standby points was probably greater than at other times.

Relative avian abundance.—During 102 d from May–June 1982 (18 d) and September 1982–May 1983 (84 d), we recorded 107 bird species (daily mean = 16.7 ± 6.1 SD, n = 102) in the immediate area (150 ha) of Solar One. The mean daily count for individuals was 314 ± 203 SD (range 148–1040). Most avian species recorded at Solar One were migrants and only 15 species are year-round residents, with Horned Larks (*Eremophila alpestris*), European Starlings (*Sturnus vulgaris*), and House Finches (*Carpodacus mexicanus*) the most common breeding birds.

Of the habitats surveyed in this study, the evaporation ponds were the most heavily used by birds. Seventy percent of all species were recorded at least once at the ponds, and 45% were recorded only at the ponds; the majority of daily counts recorded mostly waterbirds.

DISCUSSION

Creosote bush scrub, which characterizes much of the undisturbed portions of the Mojave Desert near Solar One, is usually only sparsely inhabited by birds. The avian community of similar habitat in Arizona is usually less than 20 species (Tomoff, Ecology 55:396–403, 1974). However, we recorded 107 species in the vicinity of Solar One, 15 of which breed in the area. The special attraction of Solar One to birds is most likely related to the presence of a large, man-made water impoundment and irrigated agricultural fields, both of which produce an abundance of insects. Naturally occurring open water sources in the Mojave Desert are rare and usually ephemeral, while the man-made ponds near Solar One are permanent.

The most frequent form of avian mortality at Solar One during this study was from collisions with structures, primarily heliostats. Avian collisions are an inevitable by-product of almost all man-made structures (see Avery et al., FWS/OBS-80/54, 1980). Reflective surfaces are especially prone to collisions (Klem, Ph.D. thesis, Southern Illinois Univ., Carbondale, 1979), and it is not surprising that collisions with mirrored heliostats occur on a somewhat regular basis considering the reflective surface area of Solar One.

A form of avian mortality unique to solar central receiver power plants is burning in standby points. Death after being burned was infrequent in occurrence at Solar One, being in part a function of the frequent absence and variable intensity of standby points and the number of aerial foragers (swifts and swallows) in the airspace over Solar One.

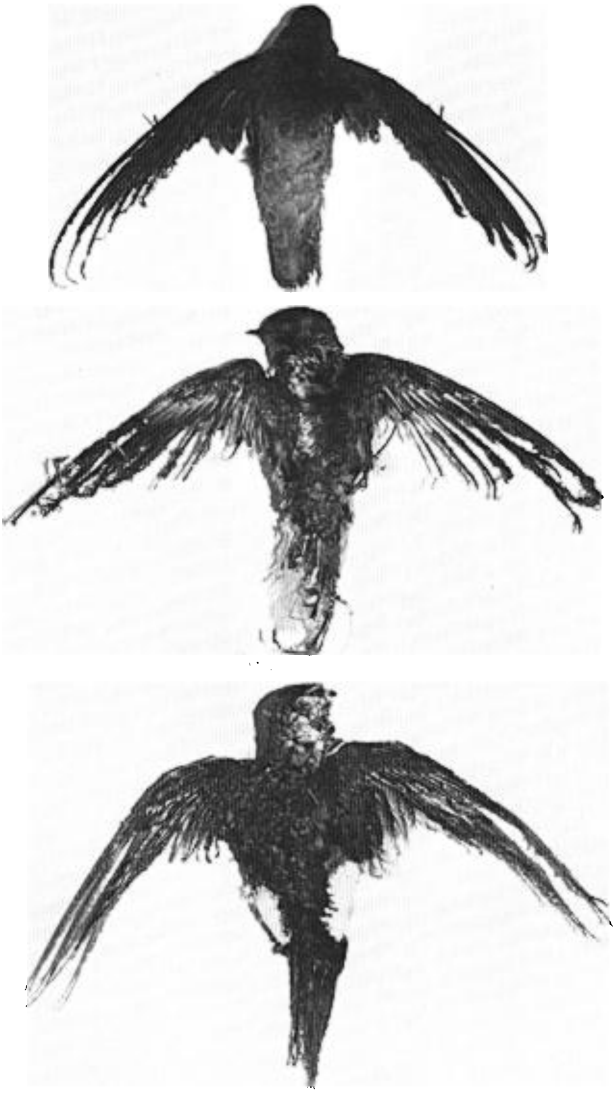


FIGURE 2. Three birds burned in standby points at Solar One. Top to bottom: Vaux's Swift (*Chaetura vauxi*), Barn Swallow (*Hirundo rustica*), and White-throated Swift (*Aeronautes saxatalis*). Note the heavily singed rectrices and remiges especially in the Barn Swallow.

Considering all known avian fatalities (70 birds) at Solar One during this study the impact of the facility on birds after construction appears minimal. Comparing the estimated rate of mortality (1.9–2.2 birds per wk) and mean relative avian abundance (314 birds per count) recorded in the vicinity of Solar One, only 0.6–0.7% of the local population present at any given time may have been affected during this study. The effect on the total population using the region in a year is obviously much less, but is unestimatable.

The results of this study suggest that, to reduce their impact on birds, future solar central receiver power plants in the Mojave Desert and other areas should not be sited in close proximity to open water or agricultural fields. The variety of species involved in avian mortality at Solar One indicates that caution should be taken when siting a solar power plant near populations of rare, threatened, or endangered species. If possible, the occurrence and intensity of standby points should be kept to a minimum. Since Solar One is only a 10 megawatt pilot facility, future projects designed to produce hundreds of megawatts will require several thousand heliostats and much taller receiver towers. The greater magnitude of these facilities may produce non-linear increases in the rate of avian mortality when compared to Solar One and extrapolations from this study should be made with caution. The removal of large tracts of desert from biological production for solar power generation and the ecological effects caused thereby should also be of concern.

SUMMARY

We studied avian mortality at an operating solar central receiver power plant in the Mojave Desert of southern California. During 40 wks of study we documented the deaths of 70 birds (26 species). The estimated mortality rate was 1.9–2.2 birds per week. Fifty-seven (81%) birds of 20 species died from collisions with Solar One structures, mainly the mirrored surfaces of heliostats. Thirteen (19%) birds (7 species) died from burns received by flying through standby points. The impact of this mortality on the local bird population is considered minimal (0.6–0.7% per wk).

ACKNOWLEDGMENTS

We thank J. Reeves (Research and Development, Southern California Edison Co.), P. Skvarna (SCE Site Manager of Solar One), D. Elliott (U.S. Department of Energy Project Director), and all other Solar One personnel for their valuable assistance on this project. P. Flanagan and G. Sawyer provided assistance in the field, and C. Barrows, P. Bloom, E. H. Burtt, Jr., J. Gore, and D. Klem provided editorial comments on the manuscript. This project was financially supported by a contract from the Southern California Edison Company to the Los Angeles County Museum of Natural History Foundation.

Los Angeles County Museum of Natural History, Section of Ornithology, 900 Exposition Blvd., Los Angeles, California 90007 (MDM, RLM, RWS, WDW); *Southern California Edison Company, Research and Development, P.O. Box 800, Rosemead, California 91770* (TCS). Received 1 Oct. 1985; accepted 24 Jan. 1986.

Post-construction Avian Mortality Monitoring Report for the Campo Verde Solar Project

First Quarter 2014

Prepared By:

Heritage Environmental Consultants, LLC

1 Introduction

The Campo Verde Solar Project is a solar photovoltaic (PV) energy generating facility (Solar Energy Facility) and an associated electrical transmission line (Gen-Tie Line) in southern Imperial County, California. The solar project is located on private lands and the gen-tie line is located on private and federal lands managed by the Bureau of Land Management (BLM). These are referred to collectively as the "Project."

A Bird and Bat Conservation Strategy (BBCS) was prepared that addresses activities potentially occurring during construction and operation of the Project (Heritage 2013). The BBCS was reviewed and approved by the U.S. Fish and Wildlife Service (FWS), California Department of Fish and Wildlife (CDFW), and BLM. The purpose of the Campo Verde BBCS was to develop and implement a program to identify and avoid risks to avian and bat species that could result from construction and operation of the Project. The goal of this BBCS was to implement a series of best practices, in order to construct and operate the Project to avoid or reduce risk to birds, bats and their habitats.

The post-construction avian mortality monitoring program was set up to comply with the methodology prescribed in the BBCS (Heritage 2013). The methodology is described in Section 6.1 of the BBCS and was approved by the FWS and CDFW. Quarterly reports documenting results of the monitoring program are required for the first year of program, and annually thereafter. Monitoring began in October 2013 just after completion of construction. This report is the second of four quarterly reports.

1.1 Project Description

The general location of the Project is approximately 7 miles southwest of the city of El Centro, Imperial County, California (**Figure 1**). The Project is south of I-8, west of Drew Road, and northeast and south of the Westside Main Canal. The Project consists of two component parts: (i) the Solar Energy Facility and (ii) an approximately 0.9-mile, 230-kilovolt (kV) aboveground, electrical gen-tie line and associated facilities that electrically connects the Solar Energy Facility on private land with the Imperial Valley Substation (IV Substation) located on federal land managed by the BLM.

The Solar Energy Facility is approximately 1,443 acres in size and uses First Solar PV modules that are generally non-reflective and convert sunlight into direct current (DC) electricity. The DC output of multiple rows of PV modules is collected through one or more combiner boxes and directed to an inverter that converts the DC electricity to alternating current (AC) electricity. From the inverter, the generated energy flows to a transformer where it is stepped up to distribution level voltage (approximately 34.5 kV). Multiple transformers are connected in parallel via 34.5 kV lines to the Project substation, where the power is stepped up to 230 kV. This substation is located at the southern end of the Solar Energy Facility near Liebert Road. The Gen-Tie Line connects the Project substation to the Imperial Valley Substation approximately 0.9 miles to the south.

The Gen-Tie Line uses double-circuit tubular steel monopole structures. Tower structure heights range from 100 to 135 feet. One side of the double-circuit structures currently supports three two- bundle conductors and one shield wire. Typical overall structure widths are approximately 20 feet.

Additional Documentation Attachment to Comment 2-F1
Attachment I-4

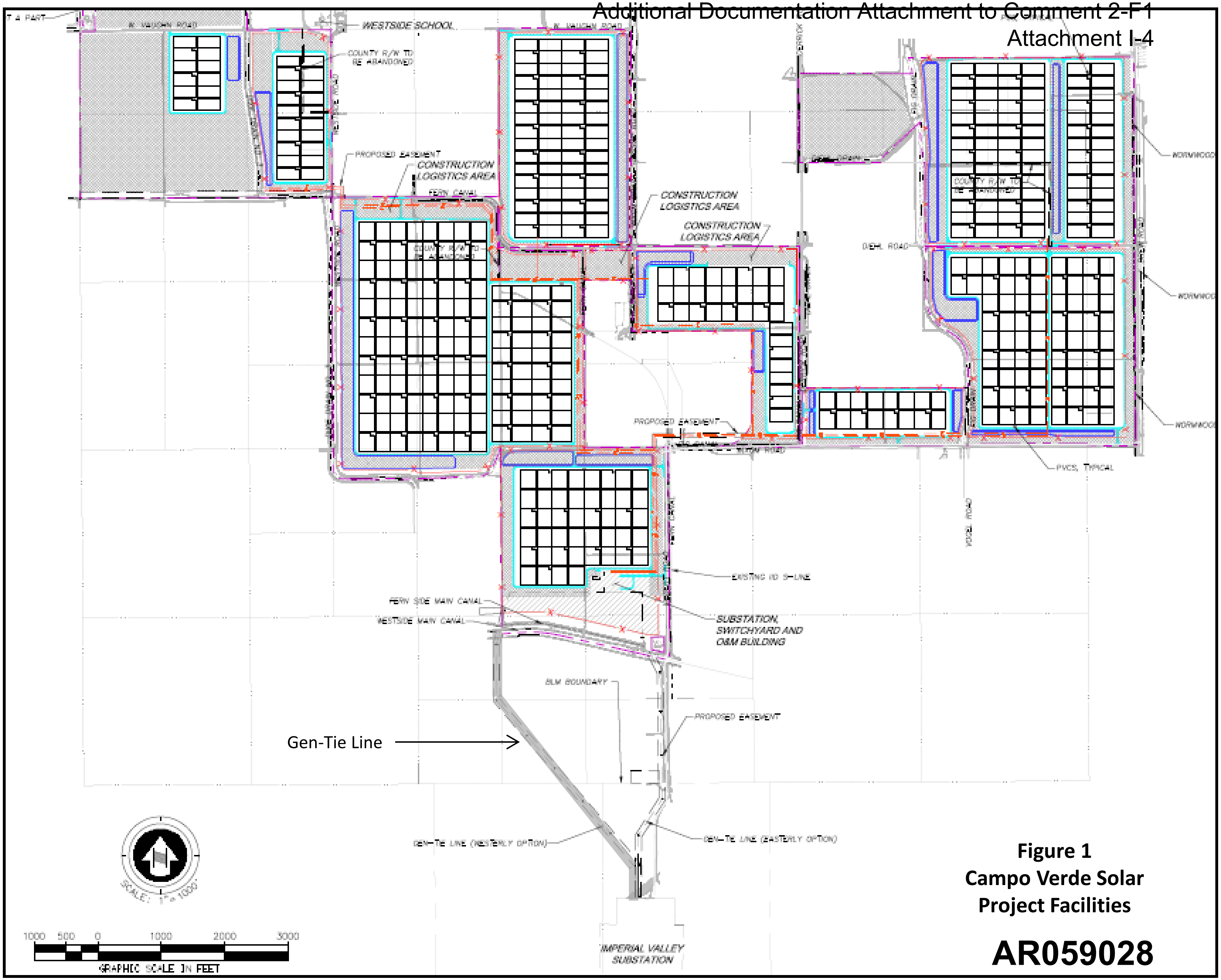


Figure 1
Campo Verde Solar
Project Facilities

2 Methods

Monitoring of the Project was performed in order to document and report avian mortalities and identify areas of concern by tracking both the specific locations where mortalities occur as well as the extent of such mortalities. The monitoring program for the Project is based on the FWS guidance entitled "Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach" (FWS 2012) with modifications, and was approved by FWS.

2.1 Transect Sampling

Sampling transects were established for both the gen-tie line and solar field. For each kilometer of Gen-Tie Line, 300-meter transects were randomly established along the Gen-Tie Line allowing for approximately 30 percent of the Gen-Tie Line to be sampled. Transects were positioned along the centerline of the Gen-Tie Line. For the Campo Verde Solar Energy Facility, transects were also positioned to result in approximately 30-percent coverage of the site with no less than eight transects placed within the solar field itself. Transect selection was systematic randomized. The entire perimeter of the panel arrays was also surveyed during each survey period in addition to the interior transects.

Transects were surveyed for 7 consecutive days each month and each transect was surveyed once daily. Because of the large number of transects, sampling periods were 14-days; the first half of transects were walked for 7- day period and the second half for another 7 day period. One qualified observer walked along the pre-determined transects searching for bird/bat carcasses. When a carcass was observed, a GPS location was recorded at the carcass, the species was identified, the perpendicular distance from the transect to the carcass was measured, and information regarding carcass condition per FWS (2012) was recorded using paper datasheets. Once data were collected at a carcass, the observer returned to the pre-determined transect and continued with the survey.

The original protocol stated that each carcass would be marked uniquely and inconspicuously with tape and permanent marker to assess "recapture" rates. However, both the state scientific collection permit (SCP) and the federal special purpose utility permit (SPUT) enabling surveyors to handle carcasses were still being processed during this sampling period so no mark-recapture data was collected. Scavenger removal trials and searcher efficiency trials were also not performed due to the lack of handling permits. Therefore, all estimates presented in this report represent mortality estimates that are uncorrected for observer bias and scavenger removal rates. Future reports will address these biases, once permits are approved by the FWS and CDFW.

2.2 Analysis

Two primary analyses were proposed for mortality estimation. The first analysis used Program DISTANCE to determine the most effective transect width to search for carcasses. Distance models examined a variety of detection functions and used Aikake's Information Criterion (AIC)[1] for model selection. Most modeling used a 5% upper truncation to remove outliers. Specific model components are discussed in **Section 3.2**.

The second analysis would use Program MARK to estimate total number of mortalities controlling for detection rate, scavenging rate, and proximity to Project components. However, as described above, handling permits have not been approved by either the FWS or CDFW. Thus, mark-recapture protocols could not be implemented. Future reports will contain a mark-recapture analysis, pending approval of handling permits. Alternative analysis packages may be considered (as opposed to Program MARK); see **Section 4.4** for additional discussion of potential statistical analyses.

---

[1] AIC measures the relative quality of a given model by assessing both the model's complexity as well as the model goodness-of-fit to the observed data. Lower AIC values indicate higher quality models. Typically AIC values are compared among several possible models to select the "best" model or models.

Project mortality estimates rely on measuring a daily mortality rate that can be used as the basis for all mortality estimates. To calculate the corrected project mortality estimate, we did not count all mortalities observed during day 1 of the 7-day search period under the assumption that the those mortalities represent "bleed through" from the period prior to 24 hours preceding the first search. To accurately generate a rate, all mortalities used for this analysis need to have occurred within the 24 hours preceding discovery. Mortalities observed during the subsequent 6 days were then up-corrected to adjust for time not searched (since the search period captured 6 out of 28, 30 or 31 days each month), producing a time-corrected mortality estimate for each month.

Because taxonomic analyses do not use a rate, but are instead only concerned with the overall breakdown in mortalities, these analyses used all recorded mortality data, including those mortalities observed during day 1 of the 7-day search period. The use of these data from day one assumes that there is not persistence bias for different taxa of birds. Once scavenger removal trials are approved, this assumption can be tested and analyses will be adjusted if necessary.

3 Results

3.1 Overall Mortalities Observed

First quarter surveys for 2014 were conducted from January 11-24, 2014; February 8-21, 2014; and, March 8-21, 2014. A total of 17 avian mortalities were recorded. Seven (7) of these observed mortalities were recorded as "feather spots" (feather spots are defined as 10 or more feathers within a 1m^2 area suggestive of an avian mortality, see **Section 4.3**). **Table 1** provides a breakdown of mortalities by sampling period.

Table 1 – Observed Mortalities by Sampling Period

Mortality Type	January (1/11/14 – 1/24/14)	February (2/8/14 – 2/21/14)	March (3/8/14 – 3/21/14)	Q1 2014 TOTAL
Feather Spot Mortalities	6	1	0	7
Non-Feather Spot Mortalities	4	2	4	10
Total Mortalities	*10*	*3*	*4*	*17*

The inclusion of feather spots as observed mortalities is based on standard mortality monitoring protocols, which were largely developed for the wind energy industry. At wind energy facilities, the speed of the spinning blades can result in mortalities that leave very little detectible carcass behind, including only feather spots. Inclusion of feather spots as recorded mortalities at these facilities was intended to conservatively include mortalities caused by blade strikes that might otherwise go unrecorded. Potential bias resulting from the inclusion of feather spots in mortality data can arise from feather spots meeting the definition of a mortality but not actually resulting from an avian mortality. This bias can lead to overestimates of mortality rates. This bias is problematic in situations where feathers are commonly deposited in non-mortality related events but get included as incidents of avian morality (e.g. in and around common roost or perch sites, near active nests, etc.). Feather spots may also be caused by predation or attempted-predation events within a survey area. Based on the large proportion of feather spots observed during the Q4 2013 surveys (63%), observers used greater discretion when encountering feather spots to help mitigate this bias. Feather spots that strongly indicated a deposition of feathers that was unrelated to an avian mortality or injury were excluded from the database; in instances where observers were uncertain, the feathers spots were recorded as mortalities in order to be conservative. All of the following analyses present results that both include and exclude feather spots to present the full range of possible mortalities. Additional discussion regarding the use of feather spot data can be found in **Section 4.3**.

3.2 Effective Transect Width

DISTANCE analyses were performed using the data pooled across the three-month sampling period and **Table 2** presents the results of the DISTANCE analysis. It is important to note that none of the models fit the data well and model parameters were constrained to obtain monotonicity[2] in several cases. Additionally, sample sizes were very small during Q1 of 2014, further limiting the reliability of the DISTANCE analysis. Models were run using all observed mortalities, only non-feather spot mortalities, and excluding the north-south oriented perimeter transects (since the effective transect width is likely to

---

[2] DISTANCE analyses rely on the modeling of a detection function. This detection function models the change in probability of detecting a carcass as the distance from the transect increases. This type of modelling relies on the assumption that the detection function is monotonic. Monotonic means that the probability of detection *only* changes in one direction (decreases) with increasing distance from the transect. If the detection probability goes up and down as distance from the transect increases, then the results violate this assumption of monotonicity. Program DISTANCE automatically constrains certain model parameters to obtain monotonicity but the resulting model may have a poor fit to the observed data.

be significantly larger than for transects located in the interior of the solar arrays). However, sample sizes were too small to produce reliable model results for the non-feather spot dataset and the interior transects only dataset. Therefore, only the models run with the full dataset (with upper 5% truncation) are provided below.

The a priori[3] estimate of effective transect width was approximately 7.5 meters (this represents the width of two panel rows measured from the bottom of the panel immediately north of the designated transects to the bottom of the second panel to the south of the transect). Generally, the most likely models were consistent with that assumption. Sample sizes were small for all models run this quarter and model results should be used with a high degree of caution (e.g. note that modeled density was rounded to 0.00 for all model definitions indicating very low densities – i.e. low sample sizes).

Table 2 – Distance Analysis Results – includes feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*	3	112.55	0.00	0.00	0.00-0.00	14.27
Uniform – Cosine	0	112.94	0.39	0.00	0.00-0.00	34.10
Uniform – Polynomial	0	112.94	0.39	0.00	0.00-0.00	34.10
Half Normal – Polynomial	1	114.09	1.54	0.00	0.00-0.00	26.69
Half Normal – Hermit*	1	114.09	1.54	0.00	0.00-0.00	26.69

*Some parameters were constrained to obtain monotonicity.

3.3 Searcher Bias

As described above, permits allowing observers to handle bird carcasses were not in place during these surveys. As such, no searcher bias estimates were generated and overall mortality estimates were not adjusted to reflect searcher bias.

3.4 Scavenger Removal Bias

As described above, permits allowing observers to handle bird carcasses were not in place during these surveys. As such, no scavenger removal trials were completed and overall mortality estimates were not adjusted to reflect scavenger removal bias.

3.5 Corrected Project Mortality Estimate

Results from surveys conducted each month were used to generate discrete mortality estimates for each month surveyed. Monthly and overall project mortality estimates only used data from search days 2-7 (see **Section 2.2**). Monthly mortality estimates were used in order to detect seasonal variations in mortality rates. Also, data are presented to reflect estimates with and without feather spots, as discussed earlier. For the remainder of this section, mortality values are presented as "number of mortalities excluding feather spots"/"number of mortalities inclusive of feather spots".

While results of the DISTANCE analyses were less than conclusive, they were at least consistent with the a priori assumption of a minimum 7.5 meter effective transect width. Transect layout, in consideration of this assumed effective transect width, was designed to sample 30% of the overall PV array area. The time-corrected mortality estimates for each month were again up-corrected to account for the area not

---

[3] "A priori" hypotheses are those hypothesis developed based on a theoretical and logical understanding of the system in question and not based on empirical results. That is, a priori hypothesis are those generated before any results have been collected.

surveyed. Since no searcher efficiency or scavenger removal bias corrections were performed, this time- and area-corrected mortality estimate represents the overall monthly project mortality estimate. Mortality estimates were rounded to the nearest whole number. **Table 4** summarizes the corrected mortality estimates by month.

3.5.1 January Mortalities

A total of 1/5 mortalities were detected during days 2-7 of the January surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in January) and area surveyed, the overall monthly project mortality estimate for January was 17/86.

3.5.2 February Mortalities

A total of 1/2 mortalities were detected during days 2-7 of the February surveys. Correcting for time (the 6 day survey period represents approximately 21% of the total days in February) and area surveyed, the overall monthly project mortality estimate for February was 16/31.

3.5.3 March Mortalities

A total of 1/1 mortalities were detected during days 2-7 of the March surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in March) and area surveyed, the overall monthly project mortality estimate for March was 17/17.

3.5.4 First Quarter 2014 Corrected Mortality Estimates

After applying time and area corrections to the mortality counts for each month the overall project mortality estimate for the first quarter of 2014 is 50/134 birds.

Table 4 – Corrected Mortalities by Month

	January		February		March		Q1 Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 2-7)	1	5	1	2	1	1	3	8
Corrected Mortality Estimate	17	86	16	31	17	17	50	134

3.6 Taxonomic Composition of Observed Mortalities

The following analyses use all observed mortalities including those detected on search day 1 since the taxonomic composition is not a rate-dependent analysis (see **Section 2.2**).

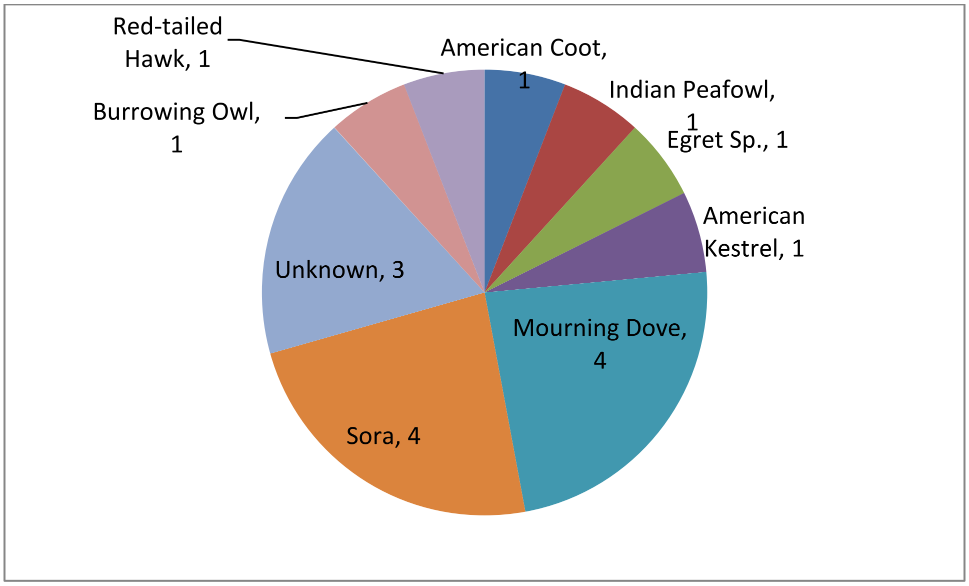
Table 5 – Raw Mortalities by Month (includes data from all search days)

	January		February		March		Q1 2014 Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 1-7)	4	10	2	3	4	4	10	17

3.6.1 Mortalities Including Feather Spots

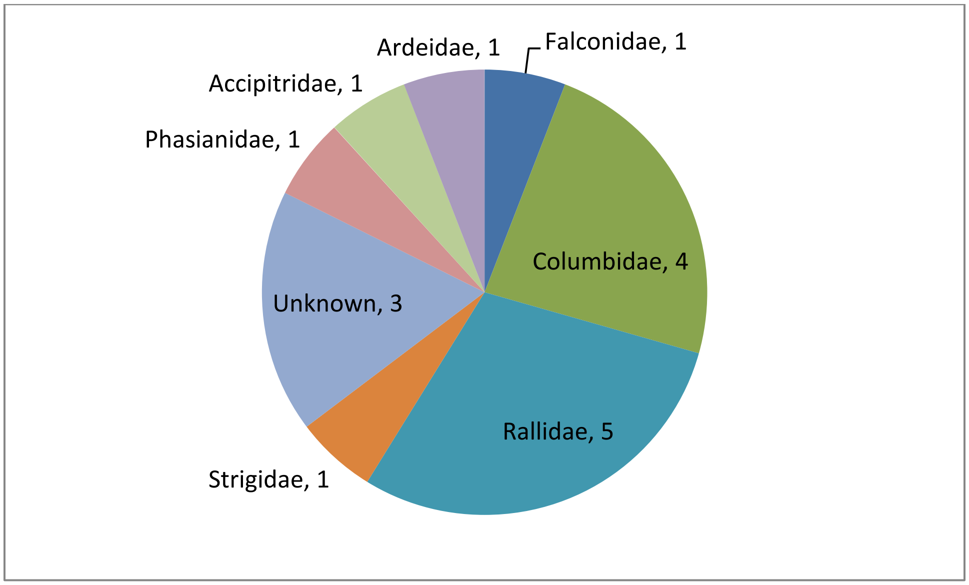
A total of 17 mortalities were observed when feather spots were included in the data set. Four (4) of these mortalities (24%) could not be identified to species. Of the 13 carcasses that could be identified to species, the most commonly observed species were Mourning Dove (*Zenaida macroura*; 4 mortalities; 31% of mortalities identified to species level) and Sora (*Porzana Carolina*; 4 mortalities; 31% of mortalities identified to species level). **Figure 2** presents the breakdown of observed mortalities by species.

Figure 2 – Mortalities by Species (includes feather spots)



Fourteen (14) of the 17 observed mortalities could be identified to the family level. Of these 14 mortalities, the families Rallidae (5 mortalities; 36% of mortalities identified to family level) and Columbidae (4 mortalities; 29% of mortalities identified to family level) were the most commonly observed mortalities. **Figure 3** presents the breakdown of observed mortalities by family.

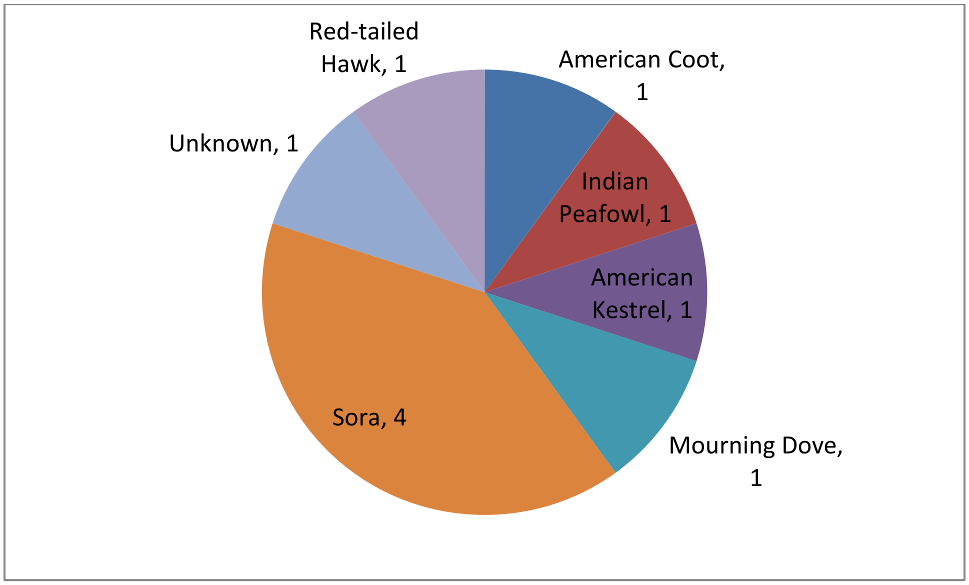
Figure 3 – Mortalities by Family (includes feather spots)



3.6.2 Mortalities Excluding Feather Spots

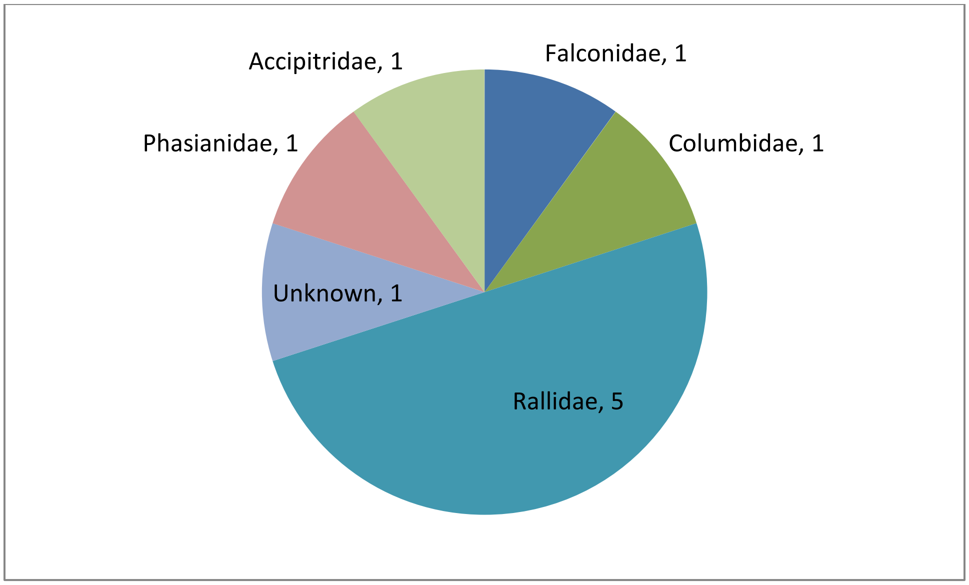
A total of 10 mortalities were observed when feather spots were excluded from the data set. One (1) of these mortalities (10%) could not be identified to species. Of the 9 carcasses that could be identified to species, the most commonly observed species Sora (4 mortalities; 44% of mortalities identified to species). **Figure 4** presents the breakdown of observed mortalities by species.

Figure 4 - Mortalities by Species (excludes feather spots)



Nine (9) of the 10 observed mortalities could be identified to the family level. Of these mortalities, the family Rallidae (5 mortalities; 56% of mortalities identified to family level) was the most commonly observed mortality. **Figure 5** presents the breakdown of observed mortalities by family.

Figure 5 – Mortalities by Family (excludes feather spots)



4 Discussion

4.1 Mortality Estimates

Searcher efficiency and scavenger removal trials can only result in up-correcting results (since searchers cannot detect >100% of carcasses and scavengers are unlikely to deposit carcasses within a survey area). Because searcher efficiency and scavenger removal trials were not performed during the first quarter surveys, the degree of underestimation is unknown. As soon as the Campo Verde Project receives a SPUT permit from FWS and a SCP from CDFW, searcher efficiency and scavenger removal trials will begin.

4.2 Seasonal Variations

When the estimated mortality rates included feather spot mortalities there was a strong variation month to month. January mortalities accounted for 64% of all mortalities, whereas February and March each accounted for 23% and 13%, respectively. When feather spots were excluded, however, mortality rates were relatively consistent month to month, only ranging between 31-34% each month.

4.3 Evaluation of Methodological Changes

The following changes to the methodology were implemented during the Q1 2013 surveys.

1. Direct Measurement of Perpendicular Distance – Per the FWS protocol (FWS 2012), during the Q4 2013 surveys and the January 2014 surveys a geographic information system (GIS) was used to measure the perpendicular distance a carcass was located from a transect line. Given the relatively small effective transect width (~7.5m) compared to typical GPS accuracy (~3m), we felt that this method was unlikely to be the most accurate. Beginning in February of 2014, we began directly measuring the perpendicular distance in the field using tape measures. The errors in GIS measurement are suspected to have contributed to the lack of monotonicity in the model results from the Q4 2013 surveys as well as the Q1 2014 surveys (especially since 64% of the Q1 2014 mortalities occurred in January). Sample sizes from February and March are far too small to produce a reliable DISTANCE model that could test if the direct measurements have improved model fit. This methodological change will continue to be examined in future reports.
2. Feather Spots – As described in **Section 3.1**, feather spots were problematic in that it is unclear if all feather spots can truly be attributed to an avian mortality. It is presumed that some proportion of observed feather spots were the result of avian mortality potentially attributable to project operations or infrastructure; but this proportion is unknown. During collection of data in the fourth quarter 2013, a strict definition of a feather spot mortality was used (≥10 feathers within a 1m^2 area). Beginning with the February surveys, we gave observers greater discretion in determining whether observed feathers should be recorded as a likely mortality. This likely resulted in the exclusion of some feather spots where only a few feathers were present with no other evidence of mortality (flesh associated with the feathers, large groups of remiges, feathers from a species not commonly observed in the panel arrays, large numbers of feathers in a concentrated area). With greater discretion, observers still recorded feather spot mortalities but excluded those cases that just barely met the minimum criteria but did not show any other evidence that an avian mortality had occurred. In cases of any uncertainty, observers recorded feather spots as mortalities in order to generate conservative estimates of mortality. During the February and March surveys feather spot mortalities represented a lower proportion of total mortalities (33% and 0% respectively) compared to the Q1 results (63%).

4.4 Recommended Methodological Changes

The following changes are recommended to improve survey efficiency and accuracy as well as to improve data collection and analysis.

1. Searcher Efficiency and Scavenger Removal Bias – The results presented in this report are uncorrected for searcher efficiency and scavenger removal. Searcher efficiency at this site is

likely very high (near 100%) given the level ground and almost entirely unvegetated environment. As such, the searcher efficiency bias is unlikely to have resulted in a significant underestimate of mortality. However, scavenger removal rates are unknown and could be a source of bias. Numerous potential avian and mammalian scavengers are known to occur in and around the project site. Until scavenger removal trials are performed, the magnitude of this source of bias is unknown. As soon as state and federal permits are approved, these trials will be initiated.

2. Alternative Statistical Analysis Packages – Since the publication of the project BBCS (Heritage 2013), a potentially more robust mortality estimation program has been released for use with the statistical analysis software Program R, called *facilityCMR*. This program offers several potential advantages over the Warren-Hicks Estimator including analyzing covariance between searcher efficiency and scavenger removal rates and allowing for analysis of carcass condition. We propose using the *facilityCMR* software in future analyses, as soon as searcher efficiency and scavenger removal trials are permitted. This would be used in lieu of the Warren-Hicks Estimator and Program MARK and better reflects current FWS guidance on mortality studies at solar facilities.

5 Literature Cited

APLIC (Avian Power Line Interaction Committee). 2006. Suggested practices for avian protection on power lines: The state of the art in 2006. Washington, D.C. and Sacramento, CA: Edison Electric Institute, Avian Power Line Interaction Committee, and California Energy Commission.

California Energy Commission (CEC). 2002. *A Roadmap for PIER Research on Avian Collisions with Power Lines in California*. California Energy Commission Staff Report. December, 2002.

Drewitt, A. L., and R. H. W. Langston. 2006. Assessing the impacts of wind farms on birds. *Ibis.* 148:29-42.

FWS. 2012. Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach. December, 2012. 23pp.

Heritage Environmental Consultants, LLC (Heritage). 2012. Campo Verde Solar Energy Project Avian Survey Report. May 2012. 11 pp.

Heritage. 2013. Campo Verde Solar Project Bird and Bat Conservation Strategy. February, 2013. 185pp.

Hovarth, G., M. Blahò, A. Egri, G. Kriska, I. Seres, and B. Robertson. 2010. Reducing the maladaptive attractiveness of solar panels to polarotactic insects. *Conservation Biol.* 24(6): 1644-1653.

Ironwood Consulting, Inc. 2014. 2013 Annual Report for Biological Resources Monitoring, First Solar Desert Sunlight Project, Riverside County, BLM Case File Number CACA-48629, Biological Opinion# FWS-ERIV-08B0789-11F0041, 1 January – 31 December 2013. 188pp.

Janss, G. F. E. 2000. Avian mortality from power lines: A morphologic approach of a species-specific mortality. *Biological Conservation* 95: 353-359.

Manville II, A. M. 2005. Bird strikes and electrocution at power lines, communication towers, and wind turbines: State of the art and state of the science – next steps toward mitigation. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Martin, G.R. and J.M. Shaw. 2010. Bird collisions with power lines: Failing to see the way ahead? *Biological Conservation* 143: 2695–2702.

McCrary, M. D., R. L. McKernan, R. W. Schreiber, W. D. Wagner, and T. C. Sciarrota. 1986. Avian mortality at a solar energy power plant. *J. Field Ornithol.* 57(2): 135-141.

Rusz, P. J., H. H. Prince, R. D. Rusz, and G. A. Dawson. 1986. Bird collisions with transmission lines near power plant cooling pond. *Wildlife Society Bulletin*. 14: 441-444.

Savereno, A. J., L .A. Savereno, R. Boettcher, and S. M. Haig. 1996. Avian behavior and mortality at power lines in coastal South Carolina. *Wildlife Society Bulletin*. 24: 636-648.

Post-construction Avian Mortality Monitoring Report for the Campo Verde Solar Project

Second Quarter 2014 (April, May, June)

Prepared By:

Heritage Environmental Consultants, LLC

1 Introduction

The Campo Verde Solar Project is a solar photovoltaic (PV) energy generating facility (Solar Energy Facility) and an associated electrical transmission line (Gen-Tie Line) in southern Imperial County, California. The solar project is located on private lands and the gen-tie line is located on private and federal lands managed by the Bureau of Land Management (BLM). These are referred to collectively as the "Project."

A Bird and Bat Conservation Strategy (BBCS) was prepared that addresses activities potentially occurring during construction and operation of the Project (Heritage 2013). The BBCS was reviewed and approved by the U.S. Fish and Wildlife Service (FWS), California Department of Fish and Wildlife (CDFW), and BLM. The purpose of the Campo Verde BBCS was to develop and implement a program to identify and avoid risks to avian and bat species that could result from construction and operation of the Project. The goal of this BBCS was to implement a series of best practices, in order to construct and operate the Project to avoid or reduce risk to birds, bats and their habitats.

The post-construction avian mortality monitoring program was set up to comply with the methodology prescribed in the BBCS (Heritage 2013). The methodology is described in Section 6.1 of the BBCS and was approved by the FWS and CDFW. Quarterly reports documenting results of the monitoring program are required for the first year of program, and annually thereafter. Monitoring began in October 2013 just after completion of construction. This report is the third of four quarterly reports for the first survey year.

1.1 Project Description

The general location of the Project is approximately 7 miles southwest of the city of El Centro, Imperial County, California (**Figure 1**). The Project is south of I-8, west of Drew Road, and northeast and south of the Westside Main Canal. The Project consists of two component parts: (i) the Solar Energy Facility and (ii) an approximately 0.9-mile, 230-kilovolt (kV) aboveground, electrical gen-tie line and associated facilities that electrically connects the Solar Energy Facility on private land with the Imperial Valley Substation (IV Substation) located on federal land managed by the BLM.

The Solar Energy Facility is approximately 1,443 acres in size and uses First Solar PV modules that are generally non-reflective and convert sunlight into direct current (DC) electricity. The DC output of multiple rows of PV modules is collected through one or more combiner boxes and directed to an inverter that converts the DC electricity to alternating current (AC) electricity. From the inverter, the generated energy flows to a transformer where it is stepped up to distribution level voltage (approximately 34.5 kV). Multiple transformers are connected in parallel via 34.5 kV lines to the Project substation, where the power is stepped up to 230 kV. This substation is located at the southern end of the Solar Energy Facility near Liebert Road. The Gen-Tie Line connects the Project substation to the Imperial Valley Substation approximately 0.9 miles to the south.

The Gen-Tie Line uses double-circuit tubular steel monopole structures. Tower structure heights range from 100 to 135 feet. One side of the double-circuit structures currently supports three two- bundle conductors and one shield wire. Typical overall structure widths are approximately 20 feet.

Additional Documentation Attachment to Comment 2-F1
Attachment I-4

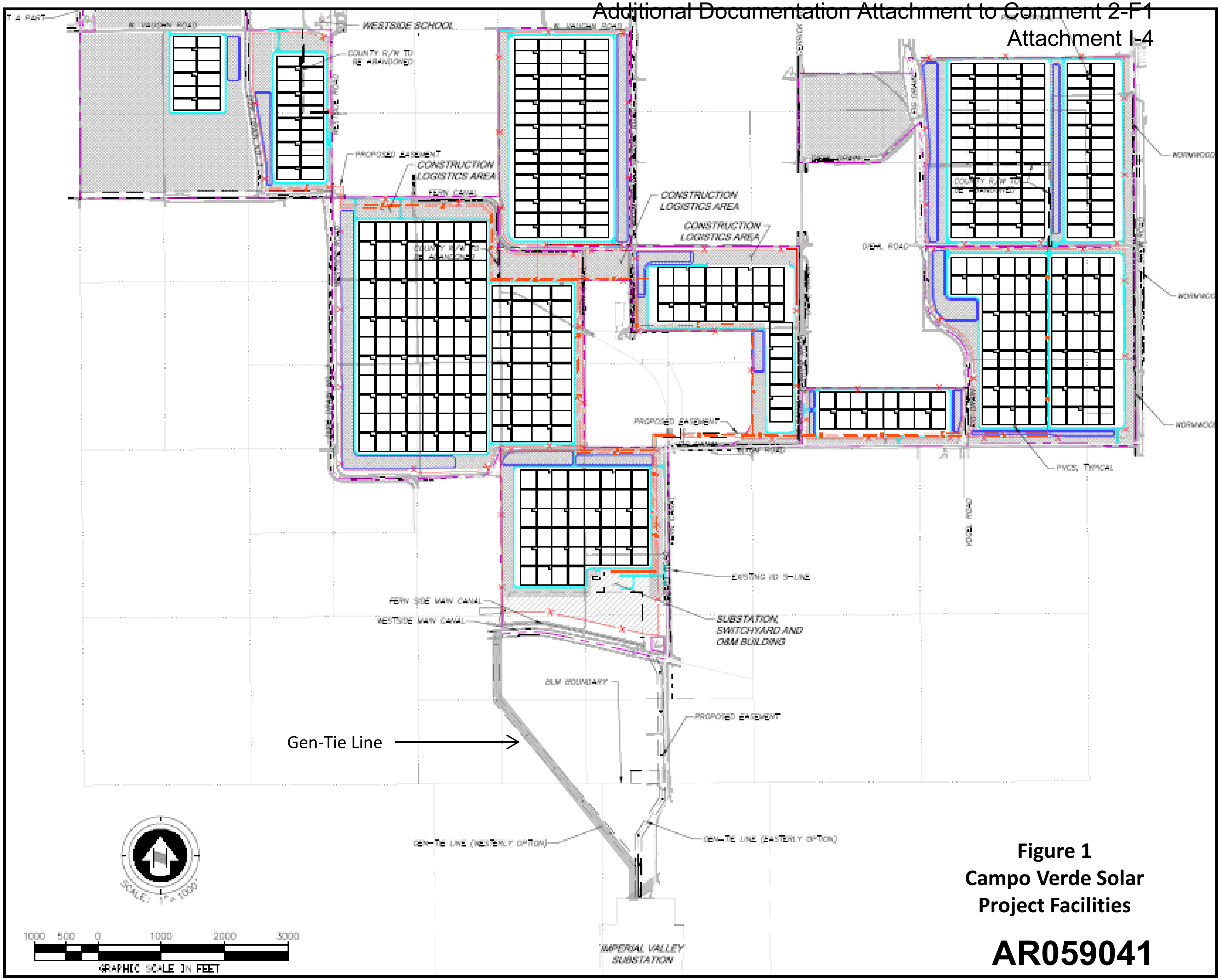


Figure 1
Campo Verde Solar
Project Facilities

2 Methods

Monitoring of the Project was performed in order to document and report avian mortalities and identify areas of concern by tracking both the specific locations where mortalities occur as well as the extent of such mortalities. The monitoring program for the Project is based on the FWS guidance entitled "Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach" (FWS 2012) with modifications, and was approved by FWS.

2.1 Transect Sampling

Sampling transects were established for both the gen-tie line and solar field. For each kilometer of Gen-Tie Line, 300-meter transects were randomly established along the Gen-Tie Line allowing for approximately 30 percent of the Gen-Tie Line to be sampled. Transects were positioned along the centerline of the Gen-Tie Line. For the Campo Verde Solar Energy Facility, transects were also positioned to result in approximately 30-percent coverage of the site with no less than eight transects placed within the solar field itself. Transect selection was systematic randomized. The entire perimeter of the panel arrays was also surveyed during each survey period in addition to the interior transects.

Transects were surveyed for 7 consecutive days each month and each transect was surveyed once daily. Because of the large number of transects, sampling periods were 14-days; the first half of transects were walked for 7- day period and the second half for another 7 day period. One qualified observer walked along the pre-determined transects searching for bird/bat carcasses. When a carcass was observed, a GPS location was recorded at the carcass, the species was identified, the perpendicular distance from the transect to the carcass was measured, and information regarding carcass condition per FWS (2012) was recorded using paper datasheets. Once data were collected at a carcass, the observer returned to the pre-determined transect and continued with the survey.

The original protocol stated that each carcass would be marked uniquely and inconspicuously with tape and permanent marker to assess "recapture" rates. However, both the state scientific collection permit (SCP) and the federal special purpose utility permit (SPUT) enabling surveyors to handle carcasses were still being processed during this sampling period so no mark-recapture data was collected. Scavenger removal trials and searcher efficiency trials were also not performed due to the lack of handling permits. Therefore, all estimates presented in this report represent mortality estimates that are uncorrected for observer bias and scavenger removal rates. Future reports will address these biases, once permits are approved by the FWS and CDFW.

2.2 Analysis

Two primary analyses were proposed for mortality estimation. The first analysis used Program DISTANCE to determine the most effective transect width to search for carcasses. Distance models examined a variety of detection functions and used Aikake's Information Criterion (AIC)[1] for model selection. Most modeling used a 5% upper truncation to remove outliers. Specific model components are discussed in **Section 3.2**.

The second analysis would use Program MARK to estimate total number of mortalities controlling for detection rate, scavenging rate, and proximity to Project components. However, as described above, handling permits have not been approved by either the FWS or CDFW. Thus, mark-recapture protocols could not be implemented. Future reports will contain a mark-recapture analysis, pending approval of handling permits. Alternative analysis packages may be considered (as opposed to Program MARK); see **Section 4.4** for additional discussion of potential statistical analyses.

---

[1] AIC measures the relative quality of a given model by assessing both the model's complexity as well as the model goodness-of-fit to the observed data. Lower AIC values indicate higher quality models. Typically AIC values are compared among several possible models to select the "best" model or models.

Project mortality estimates rely on measuring a daily mortality rate that can be used as the basis for all mortality estimates. To calculate the corrected project mortality estimate, we did not count all mortalities observed during day 1 of the 7-day search period under the assumption that the those mortalities represent "bleed through" from the period prior to 24 hours preceding the first search. To accurately generate a rate, all mortalities used for this analysis need to have occurred within the 24 hours preceding discovery. Mortalities observed during the subsequent 6 days were then up-corrected to adjust for time not searched (since the search period captured 6 out of 28, 30 or 31 days each month), producing a time-corrected mortality estimate for each month.

Because taxonomic analyses do not use a rate, but are instead only concerned with the overall breakdown in mortalities, these analyses used all recorded mortality data, including those mortalities observed during day 1 of the 7-day search period. The use of these data from day one assumes that there is not persistence bias for different taxa of birds. Once scavenger removal trials are approved, this assumption can be tested and analyses will be adjusted if necessary.

3 Results

3.1 Overall Mortalities Observed

Second quarter surveys for 2014 were conducted from April 14-27, 2014; May 9-22, 2014; and, June 14-27, 2014. A total of 10 avian mortalities were recorded. Three (3) of these observed mortalities were recorded as "feather spots". **Table 1** provides a breakdown of mortalities by sampling period.

Table 1 – Observed Mortalities by Sampling Period

Mortality Type	April (4/14/14 – 4/27/14)	May (5/9/14 – 5/22/14)	June (6/14/14 – 6/27/14)	Q2 2014 TOTAL
Feather Spot Mortalities	2	0	1	3
Non-Feather Spot Mortalities	2	1	4	7
Total Mortalities	*4*	*1*	*5*	*10*

The inclusion of feather spots as observed mortalities is based on standard mortality monitoring protocols, which were largely developed for the wind energy industry. At wind energy facilities, the speed of the spinning blades can result in mortalities that leave very little detectible carcass behind, including only feather spots. Inclusion of feather spots as recorded mortalities at these facilities was intended to conservatively include mortalities caused by blade strikes that might otherwise go unrecorded. Potential bias resulting from the inclusion of feather spots in mortality data can arise from feather spots meeting the definition of a mortality but not actually resulting from an avian mortality. This bias can lead to overestimates of mortality rates. This bias is problematic in situations where feathers are commonly deposited in non-mortality related events but get included as incidents of avian morality (e.g. in and around common roost or perch sites, near active nests, etc.). Feather spots may also be caused by predation or attempted-predation events within a survey area. Based on the large proportion of feather spots observed during the Q4 2013 and Q2 2014 surveys (63% and 41%, respectively), observers used greater discretion when encountering feather spots to help mitigate this bias. Feather spots that strongly indicated a deposition of feathers that was unrelated to an avian mortality or injury were excluded from the database; in instances where observers were uncertain, the feathers spots were recorded as mortalities in order to be conservative. All of the following analyses present results that both include and exclude feather spots to present the full range of possible mortalities.

3.2 Effective Transect Width

DISTANCE analyses were performed using the data pooled across the three-month sampling period and **Table 2** presents the results of the DISTANCE analysis. It is important to note that none of the models fit the data well and model parameters were constrained to obtain monotonicity[2] in several cases. Additionally, sample sizes were very small during Q2 of 2014, further limiting the reliability of the DISTANCE analysis. Models were run using all observed mortalities since sample sizes were far too small to run subdivided models.

---

[2] DISTANCE analyses rely on the modeling of a detection function. This detection function models the change in probability of detecting a carcass as the distance from the transect increases. This type of modelling relies on the assumption that the detection function is monotonic. Monotonic means that the probability of detection *only* changes in one direction (decreases) with increasing distance from the transect. If the detection probability goes up and down as distance from the transect increases, then the results violate this assumption of monotonicity. Program DISTANCE automatically constrains certain model parameters to obtain monotonicity but the resulting model may have a poor fit to the observed data.

The a priori[3] estimate of effective transect width was approximately 7.5 meters (this represents the width of two panel rows measured from the bottom of the panel immediately north of the designated transects to the bottom of the second panel to the south of the transect). Generally, the most likely models were consistent with or exceeded that assumption. Sample sizes were small for all models run this quarter and model results should be used with a high degree of caution (e.g. note that modeled density was rounded to 0.00 for all model definitions indicating very low densities – i.e. low sample sizes).

Table 2 – Distance Analysis Results – includes feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*	2	70.16	0.00	0.00	0.00-0.00	8.45
Uniform – Cosine*	3	75.93	5.76	0.00	0.00-0.00	20.55
Uniform – Polynomial*	4	78.49	8.33	0.00	0.00-0.00	22.05
Half Normal – Polynomial	1	79.08	8.92	0.00	0.00-0.00	29.19
Half Normal – Hermite	1	79.08	8.92	0.00	0.00-0.00	29.19

*Some parameters were constrained to obtain monotonicity.

3.3 Searcher Bias

As described above, permits allowing observers to handle bird carcasses had not been issued at the time of these surveys. As such, no searcher bias estimates were generated and overall mortality estimates were not adjusted to reflect searcher bias.

3.4 Scavenger Removal Bias

As described above, permits allowing observers to handle bird carcasses had not been issued at the time of these surveys. As such, no scavenger removal trials were completed and overall mortality estimates were not adjusted to reflect scavenger removal bias.

3.5 Corrected Project Mortality Estimate

Results from surveys conducted each month were used to generate discrete mortality estimates for each month surveyed. Monthly and overall project mortality estimates only used data from search days 2-7 (see **Section 2.2**). Monthly mortality estimates were used in order to detect seasonal variations in mortality rates. Also, data are presented to reflect estimates with and without feather spots, as discussed earlier. For the remainder of this section, mortality values are presented as "number of mortalities excluding feather spots"/"number of mortalities inclusive of feather spots".

While results of the DISTANCE analyses were less than conclusive, they were at least consistent with the a priori assumption of a minimum 7.5-meter effective transect width. Past quarterly DISTANCE analyses for this study have also supported the validity of the 7.5-meter transect. Transect layout, in consideration of this assumed effective transect width, was designed to sample 30% of the overall PV array area. The time-corrected mortality estimates for each month were again up-corrected to account for the area not surveyed. Since no searcher efficiency or scavenger removal bias corrections were performed, this time- and area-corrected mortality estimate represents the overall monthly project mortality estimate. Mortality

---

[3] "A priori" hypotheses are those hypothesis developed based on a theoretical and logical understanding of the system in question and not based on empirical results. That is, a priori hypothesis are those generated before any results have been collected.

estimates were rounded to the nearest whole number. **Table 4** summarizes the corrected mortality estimates by month.

3.5.1 April Mortalities

A total of 1/3 mortalities were detected during days 2-7 of the April surveys. Correcting for time (the 6 day survey period represents approximately 20% of the total days in April) and area surveyed, the overall monthly project mortality estimate for April was 17/50.

3.5.2 May Mortalities

A total of 1/1 mortalities were detected during days 2-7 of the May surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in May) and area surveyed, the overall monthly project mortality estimate for May was 17/17.

3.5.3 June Mortalities

A total of 3/3 mortalities were detected during days 2-7 of the June surveys. Correcting for time (the 6 day survey period represents approximately 20% of the total days in June) and area surveyed, the overall monthly project mortality estimate for June was 50/50.

3.5.4 Second Quarter 2014 Corrected Mortality Estimates

After applying time and area corrections to the mortality counts for each month the overall project mortality estimate for the second quarter of 2014 is 84/117 birds.

Table 4 – Corrected Mortalities by Month

	April		May		June		Q2 Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 2-7)	1	3	1	1	3	3	5	7
Corrected Mortality Estimate	17	50	17	17	50	50	84	117

3.6 Taxonomic Composition of Observed Mortalities

The following analyses use all observed mortalities including those detected on search day 1 since the taxonomic composition is not a rate-dependent analysis (see **Section 2.2**).

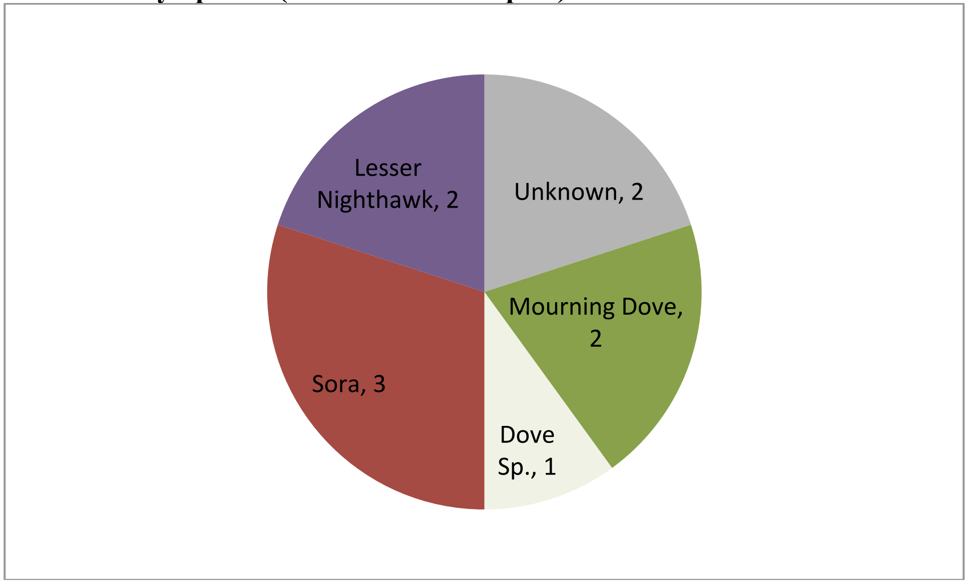
Table 5 – Raw Mortalities by Month (includes data from all search days)

	April		May		June		Q2 Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 1-7)	2	4	1	1	4	5	7	10

3.6.1 Mortalities Including Feather Spots

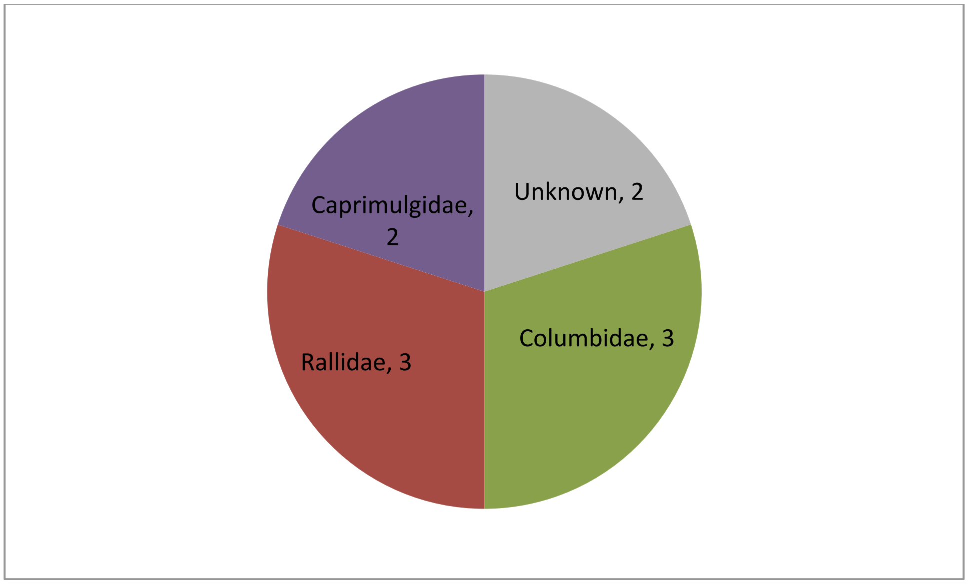
A total of 10 mortalities were observed when feather spots were included in the data set. Two (2) of these mortalities (20%) could not be identified to species. Of the 8 carcasses that could be identified to species, the most commonly observed species were Sora (*Porzana Carolina*; 3 mortalities; 37.5% of mortalities identified to species level), Mourning Dove (*Zenaida macroura*; 2 mortalities; 25% of mortalities identified to species level), and Lesser Nighthawk (*Chordeiles acutipennis*; 2 mortalities; 25% of mortalities identified to species level). **Figure 2** presents the breakdown of observed mortalities by species.

Figure 2 – Mortalities by Species (includes feather spots)



Eight (8) of the 10 observed mortalities could be identified to the family level. Of these 8 mortalities, the families Rallidae (3 mortalities; 37.5% of mortalities identified to family level) and Columbidae (3 mortalities; 37.5% of mortalities identified to family level) were the most commonly observed mortalities. **Figure 3** presents the breakdown of observed mortalities by family.

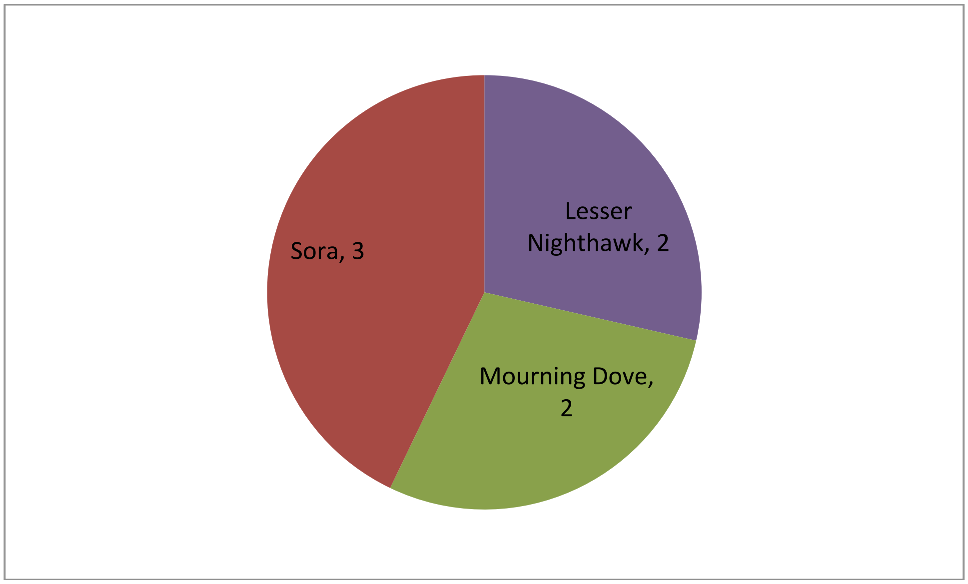
Figure 3 – Mortalities by Family (includes feather spots)



3.6.2 Mortalities Excluding Feather Spots

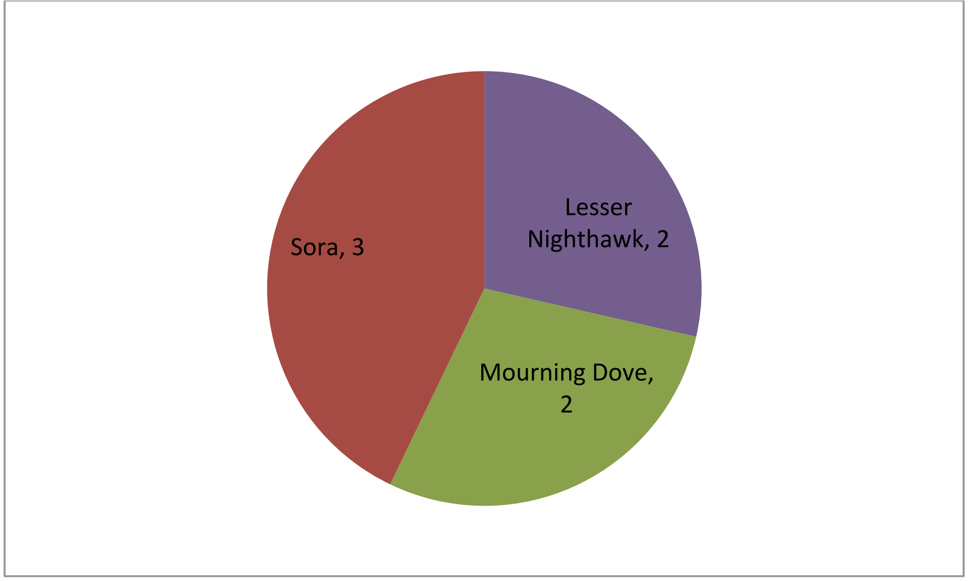
A total of 7 mortalities were observed when feather spots were excluded from the data set. All 7 of these mortalities (100%) could be identified to species. Of these 7 carcasses, the most commonly observed species was Sora (3 mortalities; 42.9% of mortalities identified to species). **Figure 4** presents the breakdown of observed mortalities by species.

Figure 4 - Mortalities by Species (excludes feather spots)



All 7 of the observed mortalities could be identified to the family level. Of these mortalities, the family Rallidae (3 mortalities; 42.9% of mortalities identified to family level) was the most commonly observed mortality. **Figure 5** presents the breakdown of observed mortalities by family.

Figure 5 – Mortalities by Family (excludes feather spots)



4 Discussion

4.1 Mortality Estimates

Searcher efficiency and scavenger removal trials can only result in up-correcting results (since searchers cannot detect >100% of carcasses and scavengers are unlikely to deposit carcasses within a survey area). Because searcher efficiency and scavenger removal trials were not performed during the second quarter surveys, the degree of underestimation is unknown. As soon as the Campo Verde Project receives a SPUT permit from FWS and a SCP from CDFW, searcher efficiency and scavenger removal trials will begin.

4.2 Seasonal Variations

When the estimated mortality rates included feather spot mortalities there was strong variation month to month, than as been observed in past quarterly summaries. May mortalities only accounted for 15% of all mortalities, whereas April and June each accounted for 60% each. When feather spots were excluded, mortality rates were more consistent month to month, only ranging between 15-43% each month. It should be noted that the sample size of observed mortalities was very low this quarter, making these types of analyses difficult to achieve high confidence levels.

4.3 Recommended Methodological Changes

The following changes are recommended to improve survey efficiency and accuracy as well as to improve data collection and analysis.

1. Searcher Efficiency and Scavenger Removal Bias – The results presented in this report are uncorrected for searcher efficiency and scavenger removal. Searcher efficiency at this site is likely very high (near 100%) given the level ground and almost entirely unvegetated environment. As such, the searcher efficiency bias is unlikely to have resulted in a significant underestimate of mortality. However, scavenger removal rates are unknown and could be a source of bias. Numerous potential avian and mammalian scavengers are known to occur in and around the project site. Until scavenger removal trials are performed, the magnitude of this source of bias is unknown. As soon as state and federal permits are approved, these trials will be initiated.
2. Alternative Statistical Analysis Packages – Since the publication of the project BBCS (Heritage 2013), a potentially more robust mortality estimation program has been released for use with the statistical analysis software Program R, called *facilityCMR*. This program offers several potential advantages over the Warren-Hicks Estimator including analyzing covariance between searcher efficiency and scavenger removal rates and allowing for analysis of carcass condition. We propose using the *facilityCMR* software in future analyses, as soon as searcher efficiency and scavenger removal trials are permitted. This would be used in lieu of the Warren-Hicks Estimator and Program MARK and better reflects current FWS guidance on mortality studies at solar facilities.

5 Literature Cited

APLIC (Avian Power Line Interaction Committee). 2006. Suggested practices for avian protection on power lines: The state of the art in 2006. Washington, D.C. and Sacramento, CA: Edison Electric Institute, Avian Power Line Interaction Committee, and California Energy Commission.

California Energy Commission (CEC). 2002. *A Roadmap for PIER Research on Avian Collisions with Power Lines in California*. California Energy Commission Staff Report. December, 2002.

Drewitt, A. L., and R. H. W. Langston. 2006. Assessing the impacts of wind farms on birds. *Ibis.* 148:29-42.

FWS. 2012. Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach. December, 2012. 23pp.

Heritage Environmental Consultants, LLC (Heritage). 2012. Campo Verde Solar Energy Project Avian Survey Report. May 2012. 11 pp.

Heritage. 2013. Campo Verde Solar Project Bird and Bat Conservation Strategy. February, 2013. 185pp.

Hovarth, G., M. Blahò, A. Egri, G. Kriska, I. Seres, and B. Robertson. 2010. Reducing the maladaptive attractiveness of solar panels to polarotactic insects. *Conservation Biol.* 24(6): 1644-1653.

Ironwood Consulting, Inc. 2014. 2013 Annual Report for Biological Resources Monitoring, First Solar Desert Sunlight Project, Riverside County, BLM Case File Number CACA-48629, Biological Opinion# FWS-ERIV-08B0789-11F0041, 1 January – 31 December 2013. 188pp.

Janss, G. F. E. 2000. Avian mortality from power lines: A morphologic approach of a species-specific mortality. *Biological Conservation* 95: 353-359.

Manville II, A. M. 2005. Bird strikes and electrocution at power lines, communication towers, and wind turbines: State of the art and state of the science – next steps toward mitigation. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Martin, G.R. and J.M. Shaw. 2010. Bird collisions with power lines: Failing to see the way ahead? *Biological Conservation* 143: 2695–2702.

McCrary, M. D., R. L. McKernan, R. W. Schreiber, W. D. Wagner, and T. C. Sciarrota. 1986. Avian mortality at a solar energy power plant. *J. Field Ornithol.* 57(2): 135-141.

Rusz, P. J., H. H. Prince, R. D. Rusz, and G. A. Dawson. 1986. Bird collisions with transmission lines near power plant cooling pond. *Wildlife Society Bulletin*. 14: 441-444.

Savereno, A. J., L .A. Savereno, R. Boettcher, and S. M. Haig. 1996. Avian behavior and mortality at power lines in coastal South Carolina. *Wildlife Society Bulletin*. 24: 636-648.

Post-construction Avian Mortality Monitoring Report for the Campo Verde Solar Project

---

Second Quarter 2014 (April, May, June)

Prepared By:

Heritage Environmental Consultants, LLC

1 Introduction

The Campo Verde Solar Project is a solar photovoltaic (PV) energy generating facility (Solar Energy Facility) and an associated electrical transmission line (Gen-Tie Line) in southern Imperial County, California. The solar project is located on private lands and the gen-tie line is located on private and federal lands managed by the Bureau of Land Management (BLM). These are referred to collectively as the "Project."

A Bird and Bat Conservation Strategy (BBCS) was prepared that addresses activities potentially occurring during construction and operation of the Project (Heritage 2013). The BBCS was reviewed and approved by the U.S. Fish and Wildlife Service (FWS), California Department of Fish and Wildlife (CDFW), and BLM. The purpose of the Campo Verde BBCS was to develop and implement a program to identify and avoid risks to avian and bat species that could result from construction and operation of the Project. The goal of this BBCS was to implement a series of best practices, in order to construct and operate the Project to avoid or reduce risk to birds, bats and their habitats.

The post-construction avian mortality monitoring program was set up to comply with the methodology prescribed in the BBCS (Heritage 2013). The methodology is described in Section 6.1 of the BBCS and was approved by the FWS and CDFW. Quarterly reports documenting results of the monitoring program are required for the first year of program, and annually thereafter. Monitoring began in October 2013 just after completion of construction. This report is the third of four quarterly reports for the first survey year.

1.1 Project Description

The general location of the Project is approximately 7 miles southwest of the city of El Centro, Imperial County, California (**Figure 1**). The Project is south of I-8, west of Drew Road, and northeast and south of the Westside Main Canal. The Project consists of two component parts: (i) the Solar Energy Facility and (ii) an approximately 0.9-mile, 230-kilovolt (kV) aboveground, electrical gen-tie line and associated facilities that electrically connects the Solar Energy Facility on private land with the Imperial Valley Substation (IV Substation) located on federal land managed by the BLM.

The Solar Energy Facility is approximately 1,443 acres in size and uses First Solar PV modules that are generally non-reflective and convert sunlight into direct current (DC) electricity. The DC output of multiple rows of PV modules is collected through one or more combiner boxes and directed to an inverter that converts the DC electricity to alternating current (AC) electricity. From the inverter, the generated energy flows to a transformer where it is stepped up to distribution level voltage (approximately 34.5 kV). Multiple transformers are connected in parallel via 34.5 kV lines to the Project substation, where the power is stepped up to 230 kV. This substation is located at the southern end of the Solar Energy Facility near Liebert Road. The Gen-Tie Line connects the Project substation to the Imperial Valley Substation approximately 0.9 miles to the south.

The Gen-Tie Line uses double-circuit tubular steel monopole structures. Tower structure heights range from 100 to 135 feet. One side of the double-circuit structures currently supports three two- bundle conductors and one shield wire. Typical overall structure widths are approximately 20 feet.

Additional Documentation Attachment to Comment 2-F1
Attachment I-4

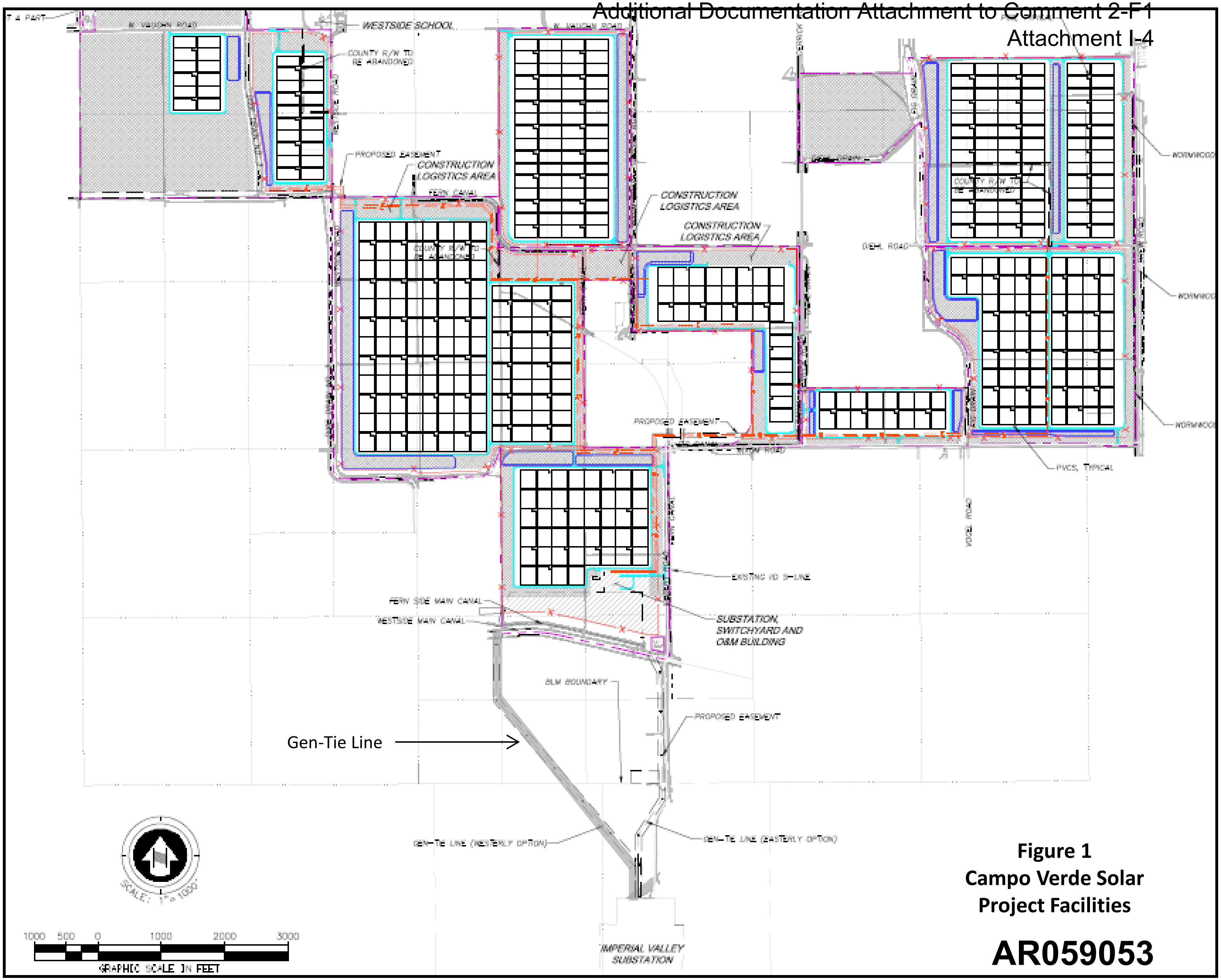


Figure 1
Campo Verde Solar
Project Facilities

2 Methods

Monitoring of the Project was performed in order to document and report avian mortalities and identify areas of concern by tracking both the specific locations where mortalities occur as well as the extent of such mortalities. The monitoring program for the Project is based on the FWS guidance entitled "Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach" (FWS 2012) with modifications, and was approved by FWS.

2.1 Transect Sampling

Sampling transects were established for both the gen-tie line and solar field. For each kilometer of Gen-Tie Line, 300-meter transects were randomly established along the Gen-Tie Line allowing for approximately 30 percent of the Gen-Tie Line to be sampled. Transects were positioned along the centerline of the Gen-Tie Line. For the Campo Verde Solar Energy Facility, transects were also positioned to result in approximately 30-percent coverage of the site with no less than eight transects placed within the solar field itself. Transect selection was systematic randomized. The entire perimeter of the panel arrays was also surveyed during each survey period in addition to the interior transects.

Transects were surveyed for 7 consecutive days each month and each transect was surveyed once daily. Because of the large number of transects, sampling periods were 14-days; the first half of transects were walked for 7- day period and the second half for another 7 day period. One qualified observer walked along the pre-determined transects searching for bird/bat carcasses. When a carcass was observed, a GPS location was recorded at the carcass, the species was identified, the perpendicular distance from the transect to the carcass was measured, and information regarding carcass condition per FWS (2012) was recorded using paper datasheets. Once data were collected at a carcass, the observer returned to the pre-determined transect and continued with the survey.

The original protocol stated that each carcass would be marked uniquely and inconspicuously with tape and permanent marker to assess "recapture" rates. However, both the state scientific collection permit (SCP) and the federal special purpose utility permit (SPUT) enabling surveyors to handle carcasses were still being processed during this sampling period so no mark-recapture data was collected. Scavenger removal trials and searcher efficiency trials were also not performed due to the lack of handling permits. Therefore, all estimates presented in this report represent mortality estimates that are uncorrected for observer bias and scavenger removal rates. Future reports will address these biases, once permits are approved by the FWS and CDFW.

2.2 Analysis

Two primary analyses were proposed for mortality estimation. The first analysis used Program DISTANCE to determine the most effective transect width to search for carcasses. Distance models examined a variety of detection functions and used Aikake's Information Criterion (AIC)[1] for model selection. Most modeling used a 5% upper truncation to remove outliers. Specific model components are discussed in **Section 3.2**.

The second analysis would use Program MARK to estimate total number of mortalities controlling for detection rate, scavenging rate, and proximity to Project components. However, as described above, handling permits have not been approved by either the FWS or CDFW. Thus, mark-recapture protocols could not be implemented. Future reports will contain a mark-recapture analysis, pending approval of handling permits. Alternative analysis packages may be considered (as opposed to Program MARK); see **Section 4.4** for additional discussion of potential statistical analyses.

---

[1] AIC measures the relative quality of a given model by assessing both the model's complexity as well as the model goodness-of-fit to the observed data. Lower AIC values indicate higher quality models. Typically AIC values are compared among several possible models to select the "best" model or models.

Project mortality estimates rely on measuring a daily mortality rate that can be used as the basis for all mortality estimates. To calculate the corrected project mortality estimate, we did not count all mortalities observed during day 1 of the 7-day search period under the assumption that the those mortalities represent "bleed through" from the period prior to 24 hours preceding the first search. To accurately generate a rate, all mortalities used for this analysis need to have occurred within the 24 hours preceding discovery. Mortalities observed during the subsequent 6 days were then up-corrected to adjust for time not searched (since the search period captured 6 out of 28, 30 or 31 days each month), producing a time-corrected mortality estimate for each month.

Because taxonomic analyses do not use a rate, but are instead only concerned with the overall breakdown in mortalities, these analyses used all recorded mortality data, including those mortalities observed during day 1 of the 7-day search period. The use of these data from day one assumes that there is not persistence bias for different taxa of birds. Once scavenger removal trials are approved, this assumption can be tested and analyses will be adjusted if necessary.

3 Results

3.1 Overall Mortalities Observed

Second quarter surveys for 2014 were conducted from April 14-27, 2014; May 9-22, 2014; and, June 14-27, 2014. A total of 10 avian mortalities were recorded. Three (3) of these observed mortalities were recorded as "feather spots". **Table 1** provides a breakdown of mortalities by sampling period.

Table 1 – Observed Mortalities by Sampling Period

Mortality Type	April (4/14/14 – 4/27/14)	May (5/9/14 – 5/22/14)	June (6/14/14 – 6/27/14)	Q2 2014 TOTAL
Feather Spot Mortalities	2	0	1	3
Non-Feather Spot Mortalities	2	1	4	7
Total Mortalities	*4*	*1*	*5*	*10*

The inclusion of feather spots as observed mortalities is based on standard mortality monitoring protocols, which were largely developed for the wind energy industry. At wind energy facilities, the speed of the spinning blades can result in mortalities that leave very little detectible carcass behind, including only feather spots. Inclusion of feather spots as recorded mortalities at these facilities was intended to conservatively include mortalities caused by blade strikes that might otherwise go unrecorded. Potential bias resulting from the inclusion of feather spots in mortality data can arise from feather spots meeting the definition of a mortality but not actually resulting from an avian mortality. This bias can lead to overestimates of mortality rates. This bias is problematic in situations where feathers are commonly deposited in non-mortality related events but get included as incidents of avian morality (e.g. in and around common roost or perch sites, near active nests, etc.). Feather spots may also be caused by predation or attempted-predation events within a survey area. Based on the large proportion of feather spots observed during the Q4 2013 and Q2 2014 surveys (63% and 41%, respectively), observers used greater discretion when encountering feather spots to help mitigate this bias. Feather spots that strongly indicated a deposition of feathers that was unrelated to an avian mortality or injury were excluded from the database; in instances where observers were uncertain, the feathers spots were recorded as mortalities in order to be conservative. All of the following analyses present results that both include and exclude feather spots to present the full range of possible mortalities.

3.2 Effective Transect Width

DISTANCE analyses were performed using the data pooled across the three-month sampling period and **Table 2** presents the results of the DISTANCE analysis. It is important to note that none of the models fit the data well and model parameters were constrained to obtain monotonicity[2] in several cases. Additionally, sample sizes were very small during Q2 of 2014, further limiting the reliability of the DISTANCE analysis. Models were run using all observed mortalities since sample sizes were far too small to run subdivided models.

---

[2] DISTANCE analyses rely on the modeling of a detection function. This detection function models the change in probability of detecting a carcass as the distance from the transect increases. This type of modelling relies on the assumption that the detection function is monotonic. Monotonic means that the probability of detection *only* changes in one direction (decreases) with increasing distance from the transect. If the detection probability goes up and down as distance from the transect increases, then the results violate this assumption of monotonicity. Program DISTANCE automatically constrains certain model parameters to obtain monotonicity but the resulting model may have a poor fit to the observed data.

The a priori[3] estimate of effective transect width was approximately 7.5 meters (this represents the width of two panel rows measured from the bottom of the panel immediately north of the designated transects to the bottom of the second panel to the south of the transect). Generally, the most likely models were consistent with or exceeded that assumption. Sample sizes were small for all models run this quarter and model results should be used with a high degree of caution (e.g. note that modeled density was rounded to 0.00 for all model definitions indicating very low densities – i.e. low sample sizes).

Table 2 – Distance Analysis Results – includes feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*	2	70.16	0.00	0.00	0.00-0.00	8.45
Uniform – Cosine*	3	75.93	5.76	0.00	0.00-0.00	20.55
Uniform – Polynomial*	4	78.49	8.33	0.00	0.00-0.00	22.05
Half Normal – Polynomial	1	79.08	8.92	0.00	0.00-0.00	29.19
Half Normal – Hermite	1	79.08	8.92	0.00	0.00-0.00	29.19

*Some parameters were constrained to obtain monotonicity.

3.3 Searcher Bias

As described above, permits allowing observers to handle bird carcasses had not been issued at the time of these surveys. As such, no searcher bias estimates were generated and overall mortality estimates were not adjusted to reflect searcher bias.

3.4 Scavenger Removal Bias

As described above, permits allowing observers to handle bird carcasses had not been issued at the time of these surveys. As such, no scavenger removal trials were completed and overall mortality estimates were not adjusted to reflect scavenger removal bias.

3.5 Corrected Project Mortality Estimate

Results from surveys conducted each month were used to generate discrete mortality estimates for each month surveyed. Monthly and overall project mortality estimates only used data from search days 2-7 (see **Section 2.2**). Monthly mortality estimates were used in order to detect seasonal variations in mortality rates. Also, data are presented to reflect estimates with and without feather spots, as discussed earlier. For the remainder of this section, mortality values are presented as "number of mortalities excluding feather spots"/"number of mortalities inclusive of feather spots".

While results of the DISTANCE analyses were less than conclusive, they were at least consistent with the a priori assumption of a minimum 7.5-meter effective transect width. Past quarterly DISTANCE analyses for this study have also supported the validity of the 7.5-meter transect. Transect layout, in consideration of this assumed effective transect width, was designed to sample 30% of the overall PV array area. The time-corrected mortality estimates for each month were again up-corrected to account for the area not surveyed. Since no searcher efficiency or scavenger removal bias corrections were performed, this time- and area-corrected mortality estimate represents the overall monthly project mortality estimate. Mortality

---

[3] "A priori" hypotheses are those hypothesis developed based on a theoretical and logical understanding of the system in question and not based on empirical results. That is, a priori hypothesis are those generated before any results have been collected.

estimates were rounded to the nearest whole number. **Table 4** summarizes the corrected mortality estimates by month.

3.5.1 April Mortalities

A total of 1/3 mortalities were detected during days 2-7 of the April surveys. Correcting for time (the 6 day survey period represents approximately 20% of the total days in April) and area surveyed, the overall monthly project mortality estimate for April was 17/50.

3.5.2 May Mortalities

A total of 1/1 mortalities were detected during days 2-7 of the May surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in May) and area surveyed, the overall monthly project mortality estimate for May was 17/17.

3.5.3 June Mortalities

A total of 3/3 mortalities were detected during days 2-7 of the June surveys. Correcting for time (the 6 day survey period represents approximately 20% of the total days in June) and area surveyed, the overall monthly project mortality estimate for June was 50/50.

3.5.4 Second Quarter 2014 Corrected Mortality Estimates

After applying time and area corrections to the mortality counts for each month the overall project mortality estimate for the second quarter of 2014 is 84/117 birds.

Table 4 – Corrected Mortalities by Month

	April		May		June		Q2 Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 2-7)	1	3	1	1	3	3	5	7
Corrected Mortality Estimate	17	50	17	17	50	50	84	117

3.6 Taxonomic Composition of Observed Mortalities

The following analyses use all observed mortalities including those detected on search day 1 since the taxonomic composition is not a rate-dependent analysis (see **Section 2.2**).

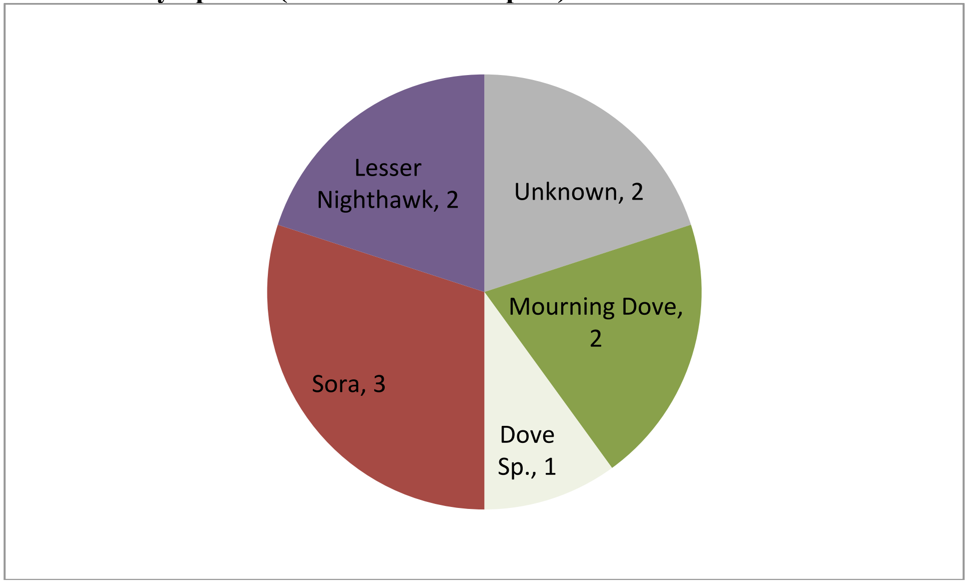
Table 5 – Raw Mortalities by Month (includes data from all search days)

	April		May		June		Q2 Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 1-7)	2	4	1	1	4	5	7	10

3.6.1 Mortalities Including Feather Spots

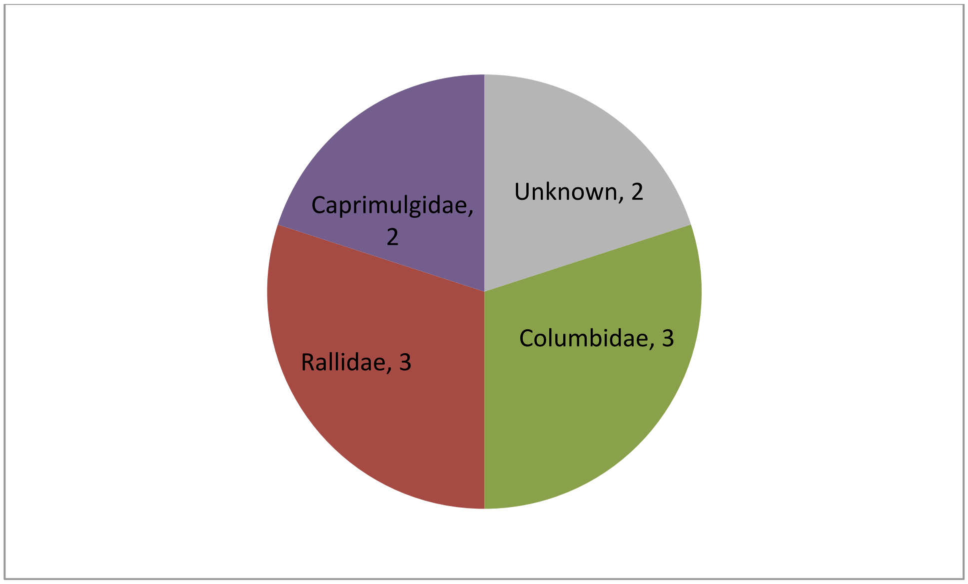
A total of 10 mortalities were observed when feather spots were included in the data set. Two (2) of these mortalities (20%) could not be identified to species. Of the 8 carcasses that could be identified to species, the most commonly observed species were Sora (*Porzana Carolina*; 3 mortalities; 37.5% of mortalities identified to species level), Mourning Dove (*Zenaida macroura*; 2 mortalities; 25% of mortalities identified to species level), and Lesser Nighthawk (*Chordeiles acutipennis*; 2 mortalities; 25% of mortalities identified to species level). **Figure 2** presents the breakdown of observed mortalities by species.

Figure 2 – Mortalities by Species (includes feather spots)



Eight (8) of the 10 observed mortalities could be identified to the family level. Of these 8 mortalities, the families Rallidae (3 mortalities; 37.5% of mortalities identified to family level) and Columbidae (3 mortalities; 37.5% of mortalities identified to family level) were the most commonly observed mortalities. **Figure 3** presents the breakdown of observed mortalities by family.

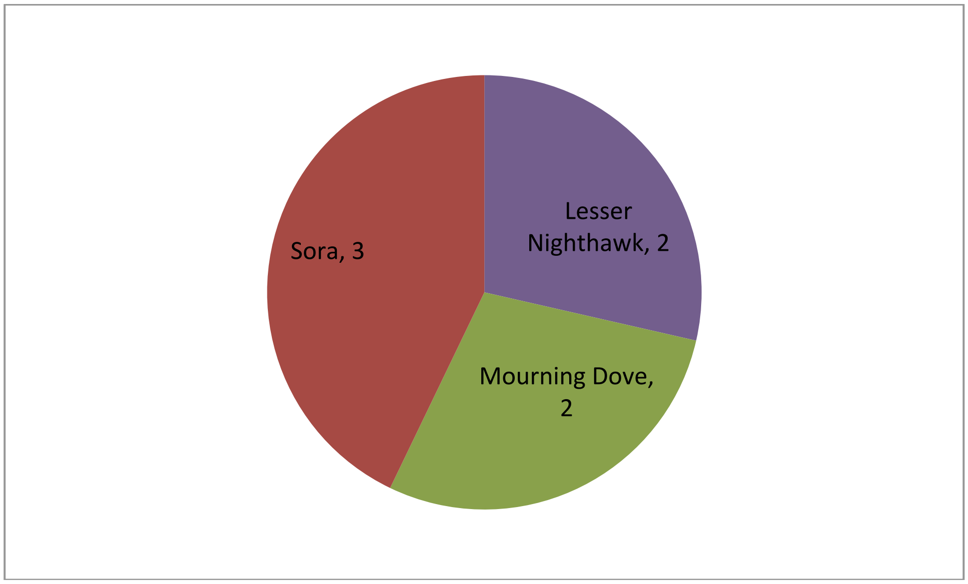
Figure 3 – Mortalities by Family (includes feather spots)



3.6.2 Mortalities Excluding Feather Spots

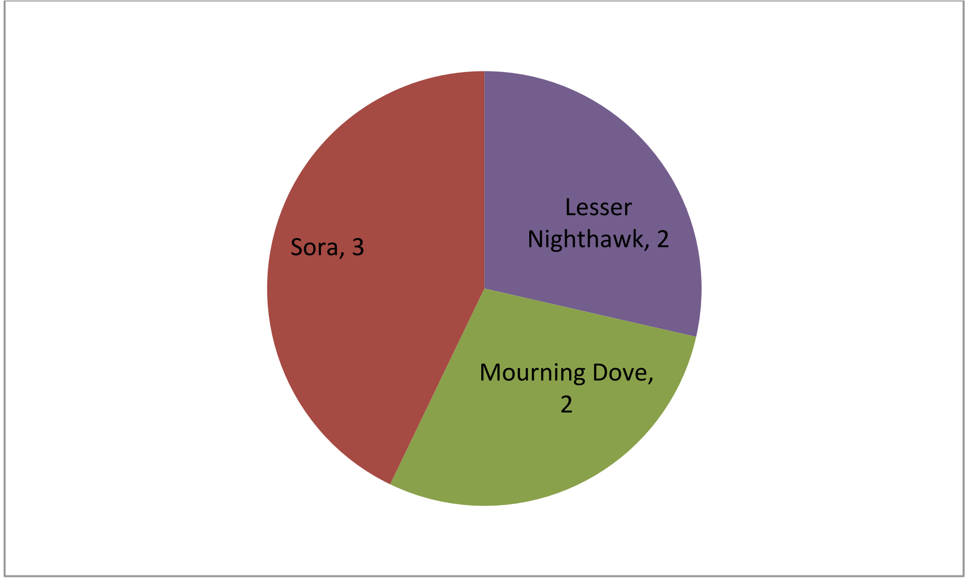
A total of 7 mortalities were observed when feather spots were excluded from the data set. All 7 of these mortalities (100%) could be identified to species. Of these 7 carcasses, the most commonly observed species was Sora (3 mortalities; 42.9% of mortalities identified to species). **Figure 4** presents the breakdown of observed mortalities by species.

Figure 4 - Mortalities by Species (excludes feather spots)



All 7 of the observed mortalities could be identified to the family level. Of these mortalities, the family Rallidae (3 mortalities; 42.9% of mortalities identified to family level) was the most commonly observed mortality. **Figure 5** presents the breakdown of observed mortalities by family.

Figure 5 – Mortalities by Family (excludes feather spots)



4 Discussion

4.1 Mortality Estimates

Searcher efficiency and scavenger removal trials can only result in up-correcting results (since searchers cannot detect >100% of carcasses and scavengers are unlikely to deposit carcasses within a survey area). Because searcher efficiency and scavenger removal trials were not performed during the second quarter surveys, the degree of underestimation is unknown. As soon as the Campo Verde Project receives a SPUT permit from FWS and a SCP from CDFW, searcher efficiency and scavenger removal trials will begin.

4.2 Seasonal Variations

When the estimated mortality rates included feather spot mortalities there was strong variation month to month, than as been observed in past quarterly summaries. May mortalities only accounted for 15% of all mortalities, whereas April and June each accounted for 60% each. When feather spots were excluded, mortality rates were more consistent month to month, only ranging between 15-43% each month. It should be noted that the sample size of observed mortalities was very low this quarter, making these types of analyses difficult to achieve high confidence levels.

4.3 Recommended Methodological Changes

The following changes are recommended to improve survey efficiency and accuracy as well as to improve data collection and analysis.

1. Searcher Efficiency and Scavenger Removal Bias – The results presented in this report are uncorrected for searcher efficiency and scavenger removal. Searcher efficiency at this site is likely very high (near 100%) given the level ground and almost entirely unvegetated environment. As such, the searcher efficiency bias is unlikely to have resulted in a significant underestimate of mortality. However, scavenger removal rates are unknown and could be a source of bias. Numerous potential avian and mammalian scavengers are known to occur in and around the project site. Until scavenger removal trials are performed, the magnitude of this source of bias is unknown. As soon as state and federal permits are approved, these trials will be initiated.
2. Alternative Statistical Analysis Packages – Since the publication of the project BBCS (Heritage 2013), a potentially more robust mortality estimation program has been released for use with the statistical analysis software Program R, called *facilityCMR*. This program offers several potential advantages over the Warren-Hicks Estimator including analyzing covariance between searcher efficiency and scavenger removal rates and allowing for analysis of carcass condition. We propose using the *facilityCMR* software in future analyses, as soon as searcher efficiency and scavenger removal trials are permitted. This would be used in lieu of the Warren-Hicks Estimator and Program MARK and better reflects current FWS guidance on mortality studies at solar facilities.

5 Literature Cited

APLIC (Avian Power Line Interaction Committee). 2006. Suggested practices for avian protection on power lines: The state of the art in 2006. Washington, D.C. and Sacramento, CA: Edison Electric Institute, Avian Power Line Interaction Committee, and California Energy Commission.

California Energy Commission (CEC). 2002. *A Roadmap for PIER Research on Avian Collisions with Power Lines in California*. California Energy Commission Staff Report. December, 2002.

Drewitt, A. L., and R. H. W. Langston. 2006. Assessing the impacts of wind farms on birds. *Ibis.* 148:29-42.

FWS. 2012. Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach. December, 2012. 23pp.

Heritage Environmental Consultants, LLC (Heritage). 2012. Campo Verde Solar Energy Project Avian Survey Report. May 2012. 11 pp.

Heritage. 2013. Campo Verde Solar Project Bird and Bat Conservation Strategy. February, 2013. 185pp.

Hovarth, G., M. Blahò, A. Egri, G. Kriska, I. Seres, and B. Robertson. 2010. Reducing the maladaptive attractiveness of solar panels to polarotactic insects. *Conservation Biol.* 24(6): 1644-1653.

Ironwood Consulting, Inc. 2014. 2013 Annual Report for Biological Resources Monitoring, First Solar Desert Sunlight Project, Riverside County, BLM Case File Number CACA-48629, Biological Opinion# FWS-ERIV-08B0789-11F0041, 1 January – 31 December 2013. 188pp.

Janss, G. F. E. 2000. Avian mortality from power lines: A morphologic approach of a species-specific mortality. *Biological Conservation* 95: 353-359.

Manville II, A. M. 2005. Bird strikes and electrocution at power lines, communication towers, and wind turbines: State of the art and state of the science – next steps toward mitigation. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Martin, G.R. and J.M. Shaw. 2010. Bird collisions with power lines: Failing to see the way ahead? *Biological Conservation* 143: 2695–2702.

McCrary, M. D., R. L. McKernan, R. W. Schreiber, W. D. Wagner, and T. C. Sciarrota. 1986. Avian mortality at a solar energy power plant. *J. Field Ornithol.* 57(2): 135-141.

Rusz, P. J., H. H. Prince, R. D. Rusz, and G. A. Dawson. 1986. Bird collisions with transmission lines near power plant cooling pond. *Wildlife Society Bulletin*. 14: 441-444.

Savereno, A. J., L .A. Savereno, R. Boettcher, and S. M. Haig. 1996. Avian behavior and mortality at power lines in coastal South Carolina. *Wildlife Society Bulletin*. 24: 636-648.

Post-construction Avian Mortality Monitoring Report for the Campo Verde Solar Project

Fourth Quarter 2013

Prepared By:

Heritage Environmental Consultants, LLC

1 Introduction

The Campo Verde Solar Project is a solar photovoltaic (PV) energy generating facility (Solar Energy Facility) and an associated electrical transmission line (Gen-Tie Line) in southern Imperial County, California. The solar project is located on private lands and the gen-tie line is located on private and federal lands managed by the Bureau of Land Management (BLM). These are referred to collectively as the "Project."

A Bird and Bat Conservation Strategy (BBCS) was prepared that addresses activities potentially occurring during construction and operation of the Project (Heritage 2013). The BBCS was reviewed and approved by the U.S. Fish and Wildlife Service (FWS), California Department of Fish and Wildlife (CDFW), and BLM. The purpose of the Campo Verde BBCS was to develop and implement a program to identify and avoid risks to avian and bat species that could result from construction and operation of the Project. The goal of this BBCS was to implement a series of best practices, in order to construct and operate the Project to avoid or reduce risk to birds, bats and their habitats.

The post-construction avian mortality monitoring program was set up to comply with the methodology prescribed in the BBCS (Heritage 2013). The methodology is described in Section 6.1 of the BBCS and was approved by the FWS and CDFW. Quarterly reports documenting results of the monitoring program are required for the first year of program, and annually thereafter. Monitoring began in October 2013 just after completion of construction. This report is the first of four quarterly reports.

1.1 Project Description

The general location of the Project is approximately 7 miles southwest of the city of El Centro, Imperial County, California (**Figure 1**). The Project is south of I-8, west of Drew Road, and northeast and south of the Westside Main Canal. The Project consists of two component parts: (i) the Solar Energy Facility and (ii) an approximately 0.9-mile, 230-kilovolt (kV) aboveground, electrical gen-tie line and associated facilities that electrically connects the Solar Energy Facility on private land with the Imperial Valley Substation (IV Substation) located on federal land managed by the BLM.

The Solar Energy Facility is approximately 1,443 acres in size and uses First Solar PV modules that are generally non-reflective and convert sunlight into direct current (DC) electricity. The DC output of multiple rows of PV modules is collected through one or more combiner boxes and directed to an inverter that converts the DC electricity to alternating current (AC) electricity. From the inverter, the generated energy flows to a transformer where it is stepped up to distribution level voltage (approximately 34.5 kV). Multiple transformers are connected in parallel via 34.5 kV lines to the Project substation, where the power is stepped up to 230 kV. This substation is located at the southern end Solar Energy Facility near Liebert Road. The Gen-Tie Line connects the Project substation to the Imperial Valley Substation approximately 0.9 miles to the south.

The Gen-Tie Line uses double-circuit tubular steel monopole structures. Tower structure heights range from 100 to 135 feet. One side of the double-circuit structures currently supports three two- bundle conductors and one shield wire. Typical overall structure widths are approximately 20 feet.

Additional Documentation Attachment to Comment 2-F1

Attachment I-4

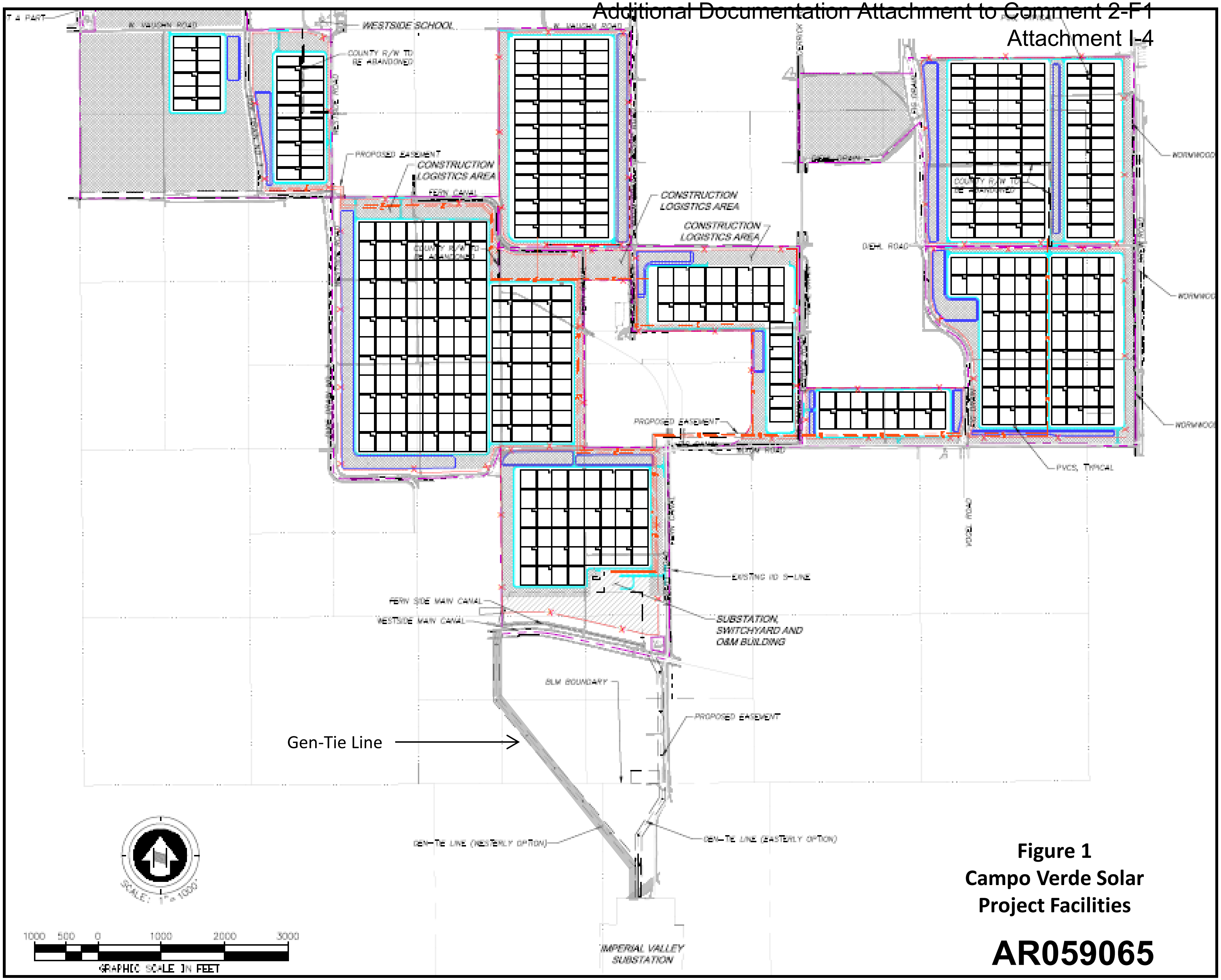


Figure 1
Campo Verde Solar
Project Facilities

2 Methods

Monitoring of the Project was performed in order to document and report avian mortalities and identify areas of concern by tracking both the specific locations where mortalities occur as well as the extent of such mortalities. The monitoring program for the Project is based on the FWS guidance entitled "Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach" (FWS 2012) with modifications, and was approved by FWS.

2.1 Transect Sampling

Sampling transects were established for both the gen-tie line and solar field. For each kilometer of Gen-Tie Line, 300-meter transects were randomly established along the Gen-Tie Line allowing for approximately 30 percent of the Gen-Tie Line to be sampled. Transects were positioned along the centerline of the Gen-Tie Line. For the Campo Verde Solar Energy Facility, transects were also positioned to result in approximately 30-percent coverage of the site with no less than eight transects placed within the solar field itself. Transect selection was systematic randomized. The entire perimeter of the panel arrays was also surveyed during each survey period in addition to the interior transects.

Transects were surveyed for 7 consecutive days each month and each transect was surveyed once daily. Because of the large number of transects, sampling periods were 14-days; the first half of transects were walked for 7- day period and the second half for another 7 day period. One qualified observer walked along the pre-determined transects searching for bird/bat carcasses. When a carcass was observed, a GPS location was recorded at the carcass (for DISTANCE analysis), the species was identified, and information regarding carcass condition per FWS (2012) was recorded using paper datasheets. Once data were collected at a carcass, the observer returned to the pre-determined transect and continued with the survey.

The original protocol stated that each carcass would be marked uniquely and inconspicuously with tape and permanent marker to assess "recapture" rates. However, both the state scientific collection permit (SCP) and the federal special purpose utility permit (SPUT) enabling surveyors to handle carcasses were still being processed during this sampling period so no mark-recapture data was collected. Scavenger removal trials and searcher efficiency trials were also not performed due to the lack of handling permits. Therefore, all estimates presented in this report represent mortality estimates that are uncorrected for observer bias and scavenger removal rates. Future reports will address these biases, once permits are approved by the FWS and CDFW.

2.2 Analysis

Two primary analyses were proposed for mortality estimation. The first analysis used Program DISTANCE to determine the most effective transect width to search for carcasses. Distance models examined a variety of detection functions and used Aikake's Information Criterion (AIC)[1] for model selection.

The second analysis would use Program MARK to estimate total number of mortalities controlling for detection rate, scavenging rate, and proximity to Project components. However, as described above, handling permits have not been approved by either the FWS or CDFW, thus mark-recapture protocols could not be implemented. Future reports will contain a mark-recapture analysis, pending approval of

---

[1] AIC measures the relative quality of a given model by assessing both the model's complexity as well as the model goodness-of-fit to the observed data. Lower AIC values indicate higher quality models. Typically AIC values are compared among several possible models to select the "best" model or models.

handling permits. Alternative analysis packages may be considered (as opposed to Program MARK); see **Section 4.3** for additional discussion of potential statistical analyses.

Project mortality estimates rely on measuring a daily mortality rate that can be used as the basis for all mortality estimates. To calculate the corrected project mortality estimate, we did not count all mortalities observed during day 1 of the 7-day search period under the assumption that the those mortalities represent "bleed through" from the period prior to 24 hours preceding the first search. To accurately generate a rate, all mortalities used for this analysis need to have occurred within the 24 hours preceding discovery. Mortalities observed during the subsequent 6 days were then up-corrected to adjust for time not searched (since the search period captured 6 out of 30 or 31 days each month), producing a time-corrected mortality estimate for each month.

Because taxonomic analyses do not use a rate, but are instead only concerned with the overall breakdown in mortalities, these analyses used all recorded mortality data, including those mortalities observed during day 1 of the 7-day search period. The use of these data from day one assumes that there is not persistence bias for different types of birds. Once scavenger removal trials are approved, this assumption can be tested and analyses will be adjusted if necessary.

3 Results

3.1 Overall Mortalities Observed

Fourth quarter surveys for 2013 were conducted from October 21 – November 3, 2013; November 11-23, 2013; and, December 7-20, 2013. A total of 36 avian mortalities were recorded. Twenty-three (23) of these observed mortalities were recorded as "feather spots" (defined as 10 or more feathers within a $1m^2$ area). All feather spots were assumed to be mortalities, though it is unlikely that they all represent a mortality. **Table 1** provides a breakdown of mortalities by sampling period.

Table 1 – Observed Mortalities by Sampling Period

Mortality Type	October (10/21/13 – 11/3/13)	November (11/11/13 – 11/23/13)	December (12/7/13 – 12/20/13)	Q4 2013 TOTAL
Feather Spot Mortalities	6	15	2	23
Non-Feather Spot Mortalities	8	2	3	13
Total Mortalities	*14*	*17*	*5*	*36*

The inclusion of feather spots as observed mortalities is based on standard mortality monitoring protocols, which were largely developed for the wind energy industry. At wind energy facilities, the speed of the spinning blades can result in mortalities that leave very little detectible carcass behind, including only feather spots. Inclusion of feather spots as recorded mortalities at these facilities was intended to conservatively include mortalities caused by blade strikes that might otherwise go unrecorded. Potential bias resulting from the inclusion of feather spots in mortality data can arise from feather spots meeting the definition of a mortality (in this case >10 feathers within $1m^2$) but not actually resulting from an avian mortality. This bias can lead to overestimates of mortality rates. This bias is problematic in situations where feathers are commonly deposited in non-mortality related events but get included as incidents of avian morality (e.g. in and around common roost or perch sites, near active nests, etc.). Feather spots may also be caused by predation or attempted-predation events within a survey area. In these cases, the mortality is recorded but the causal relation of that mortality to a project may be misrepresented.

A large proportion of mortalities recorded during the 2013 Q4 surveys were detected as feather spots (over 63% overall and over 88% of mortalities recorded in November). It is unclear if some or all of these feather spots can be accurately attributed to project-related causes, or whether they were actual mortalities. Unlike with wind energy facilities, there are not anticipated project-related mortality hazards that could be expected to result in only feather spot remains. Furthermore, during mortality surveys, biologists routinely observed multiple species perching and roosting on the panels, often times depositing large numbers of feathers. Wintering raptors are also common in the agricultural areas of the Imperial Valley and were routinely observed in and around the panel arrays. Thus, normal perching, roosting, predation and scavenging could account for a significant number of the observed feather spots. Conversely, some of the feather spots were identified as species that would not be expected to naturally occur within the panel arrays and were not previously observed in the interior of the agricultural fields during the pre-construction avian surveys (Heritage 2012). For these reasons, all of the following analyses present results that both include and exclude feather spots to present the full range of possible mortalities. Additional recommendations regarding the use of feather spot data in future surveys can be found in **Section 4.3**.

3.2 Effective Transect Width

DISTANCE analyses were performed using the data pooled across the three-month sampling period and **Tables 2 and 3** present the results of the DISTANCE analysis. It is important to note that none of the models fit the data well and model parameters were constrained to obtain monotonicity[2] in several cases. DISTANCE model fitting issues are discussed in greater detail in **Section 4.3**. The a priori[3] estimate of effective transect width was approximately 7.5 meters (this represents the width of two panel rows measured from the bottom of the panel immediately north of the designated transects to the bottom of the second panel to the south of the transect). Generally, the most likely models were consistent with that assumption. Corrections to the methods used to assess perpendicular distance are expected to improve model fit in future analyses and allow for a more accurate assessment of effective transect width (**Section 4.3**).

Table 2 – Distance Analysis Results – without feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*	2	73.19	0.00	0.150	0.031-0.721	6.24
Uniform – Cosine*	1	73.79	0.61	0.065	0.032-0.132	14.34
Uniform – Polynomial	0	74.19	1.00	0.043	0.077-0.305	22.00
Half Normal – Polynomial	1	74.41	1.22	0.064	0.129-0.369	14.76
Half Normal – Hermit*	1	74.41	1.22	0.064	0.129-0.369	14.76

*Some parameters were constrained to obtain monotonicity.

---

[2] DISTANCE analyses rely on the modeling of a detection function. This detection function models the change in probability of detecting a carcass as the distance from the transect increases. This type of modelling relies on the assumption that the detection function is monotonic. Monotonic means that the probability of detection *only* changes in one direction (decreases) with increasing distance from the transect. If the detection probability goes up and down as distance from the transect increases, then the results violate this assumption of monotonicity. Program DISTANCE automatically constrains certain model parameters to obtain monotonicity but the resulting model may have a poor fit to the observed data.

[3] "A priori" hypotheses are those hypothesis developed based on a theoretical and logical understanding of the system in question and not based on empirical results. That is, a priori hypothesis are those generated before any results have been collected.

Table 3 – Distance Analysis Results – with feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width
Hazard – Cosine*	2	196.39	0.00	0.394	0.175-0.885	6.75
Uniform – Cosine*	3	199.21	2.82	0.303	0.182-0.506	8.76
Uniform – Polynomial*	5	202.43	6.04	0.318	0.186-0.543	8.37
Half Normal – Polynomial	1	202.90	6.52	0.216	0.139-0.337	12.28
Half Normal – Hermit	1	202.90	6.52	0.216	0.139-0.337	12.28

*Some parameters were constrained to obtain monotonicity.

3.3 Searcher Bias

As described above, permits allowing observers to handle bird carcasses were not in place during these surveys. As such, no searcher bias estimates were generated and overall mortality estimates were not adjusted to reflect searcher bias.

3.4 Scavenger Removal Bias

As described above, permits allowing observers to handle bird carcasses were not in place during these surveys. As such, no scavenger removal trials were completed and overall mortality estimates were not adjusted to reflect scavenger removal bias.

3.5 Corrected Project Mortality Estimate

Results from surveys conducted each month were used to generate discrete mortality estimates for each month surveyed. Monthly and overall project mortality estimates only used data from search days 2-7 (see **Section 2.2**). Monthly mortality estimates were used in order to detect seasonal variations in mortality rates. Also, data are presented to reflect estimates with and without feather spots as discussed earlier. For the remainder of this section, mortality values are presented as "number of mortalities excluding feather spots"/"number of mortalities inclusive of feather spots".

While results of the DISTANCE analyses were less than conclusive, they were at least consistent with the a priori assumption of a minimum 7.5 meter effective transect width. Transect layout, in consideration of this effective transect width, was designed to sample 30% of the overall PV array area. The time-corrected mortality estimates for each month were again up-corrected to account for the area not surveyed. Since no searcher efficiency or scavenger removal bias corrections were performed, this time- and area-corrected mortality estimate represents the overall monthly project mortality estimate. Mortality estimates were rounded to the nearest whole number. **Table 4** summarizes the corrected mortality estimates by month.

3.5.1 October Mortalities

A total of 6/11 mortalities were detected during days 2-7 of the October surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in October) and area surveyed, the overall monthly project mortality estimate for October was 103/189.

3.5.2 November Mortalities

A total of 2/9 mortalities were detected during days 2-7 of the November surveys. Correcting for time (the 6 day survey period represents approximately 20% of the total days in November) and area surveyed, the overall monthly project mortality estimate for November was 33/150.

3.5.3 December Mortalities

A total of 3/5 mortalities were detected during days 2-7 of the December surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in December) and area surveyed, the overall monthly project mortality estimate for December was 52/86.

3.5.4 Fourth Quarter 2013 Corrected Mortality Estimates

After applying time and area corrections to the mortality counts for each month the overall project mortality estimate for the fourth quarter of 2013 is 188/426 birds.

Table 4 – Corrected Mortalities by Month

	October		November		December		Q4 Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 2-7)	6	11	2	9	3	5	11	25
Corrected Mortality Estimate	103	189	33	150	52	86	188	426

3.6 Taxonomic Composition of Observed Mortalities

The following analyses use all observed mortalities including those detected on search day 1 since the taxonomic composition is not a rate-dependent analysis (see **Section 3.2**).

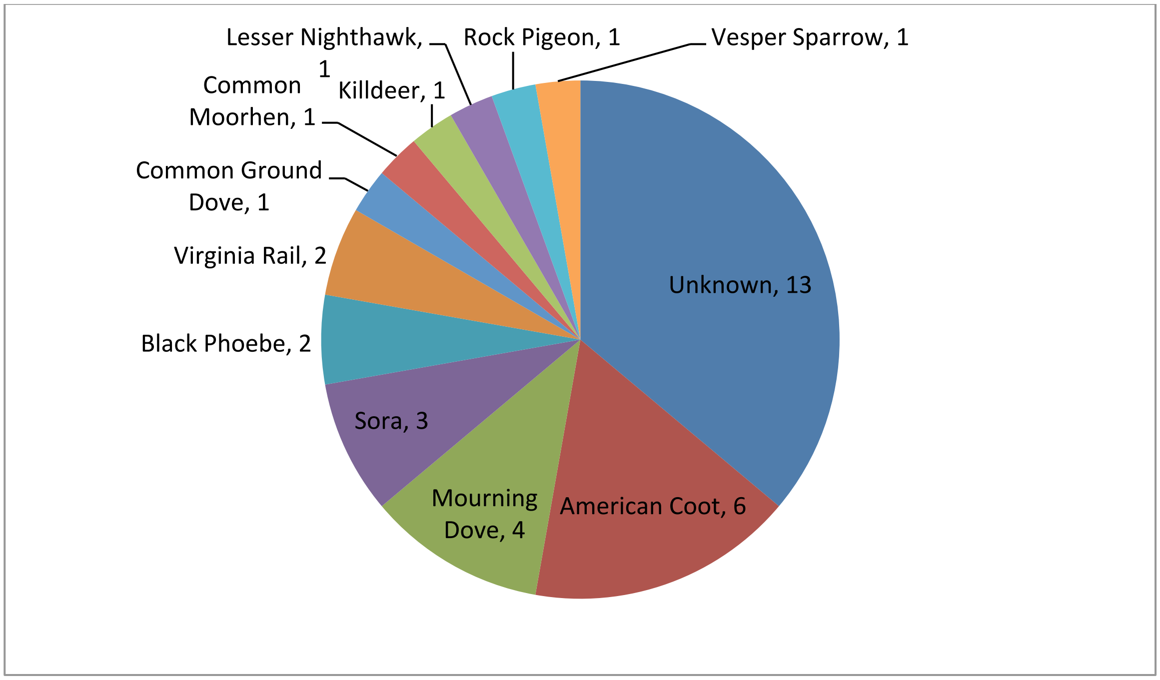
Table 5 – Raw Mortalities by Month (includes data from all search days)

	October		November		December		Q4 Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 1-7)	8	14	2	17	3	5	13	36

3.6.1 Mortalities Including Feather Spots

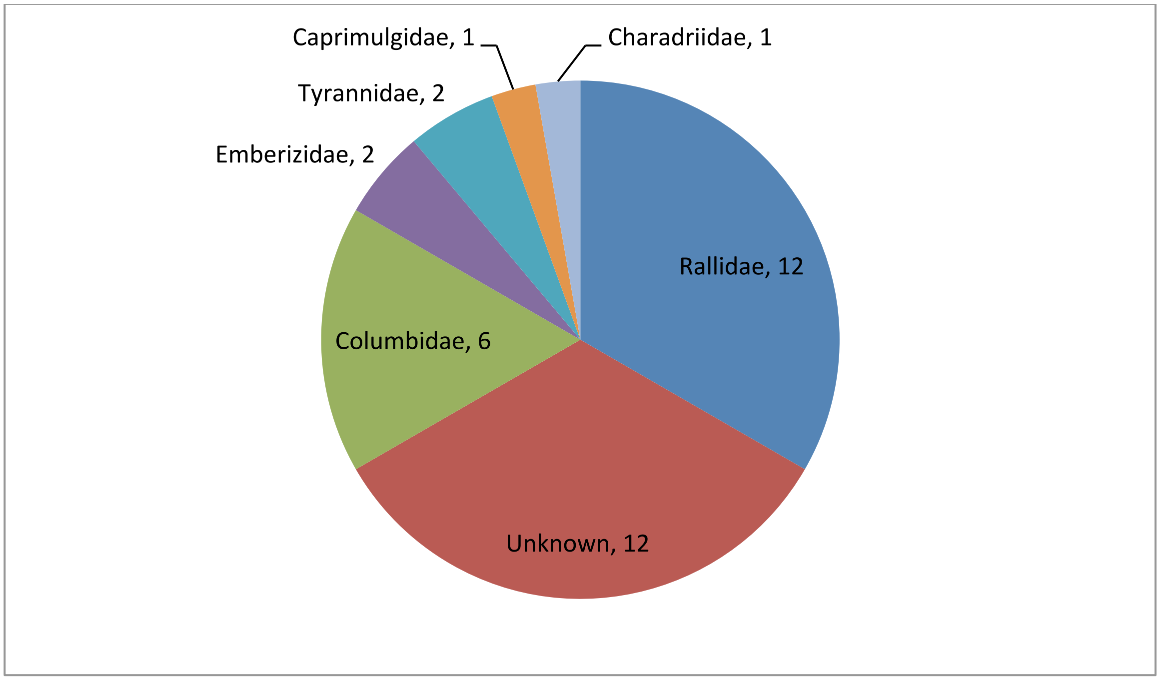
A total of 36 mortalities were observed when feather spots were included in the data set. Thirteen (13) of these mortalities (36%) could not be identified to species. Of the 23 carcasses that could be identified to species, the most commonly observed species were American Coot (*Fulica Americana*; 6 mortalities; 26% of mortalities identified to species level), Mourning Dove (*Zenaida macroura*; 4 mortalities; 18% of mortalities identified to species level), and Sora (*Porzana Carolina*; 3 mortalities; 13% of mortalities identified to species level). **Figure 2** presents the breakdown of observed mortalities by species.

Figure 2 – Mortalities by Species (includes feather spots)



Twenty-four (24) of the 36 observed mortalities could be identified to the family level. Of these 24 mortalities, the families Rallidae (12 mortalities; 50% of mortalities identified to family level), Columbidae (6 mortalities; 25% of mortalities identified to family level), and Emberizidae (2 mortalities; 9% of mortalities identified to family level) were the most commonly observed mortalities. **Figure 3** presents the breakdown of observed mortalities by family.

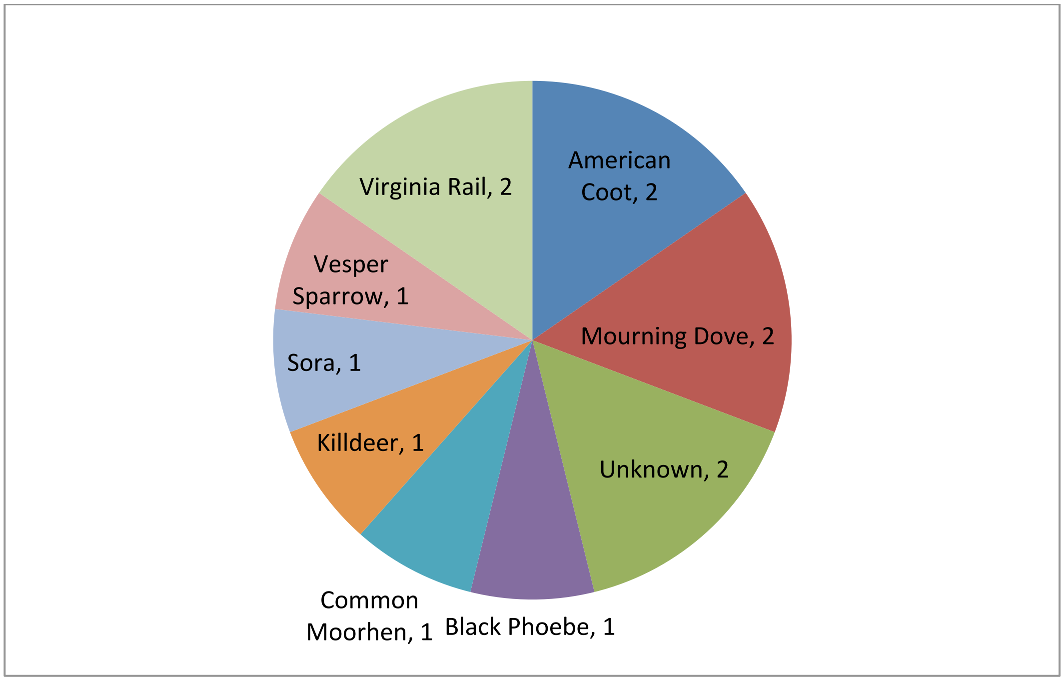
Figure 3 – Mortalities by Family (includes feather spots)



3.6.2 Mortalities Excluding Feather Spots

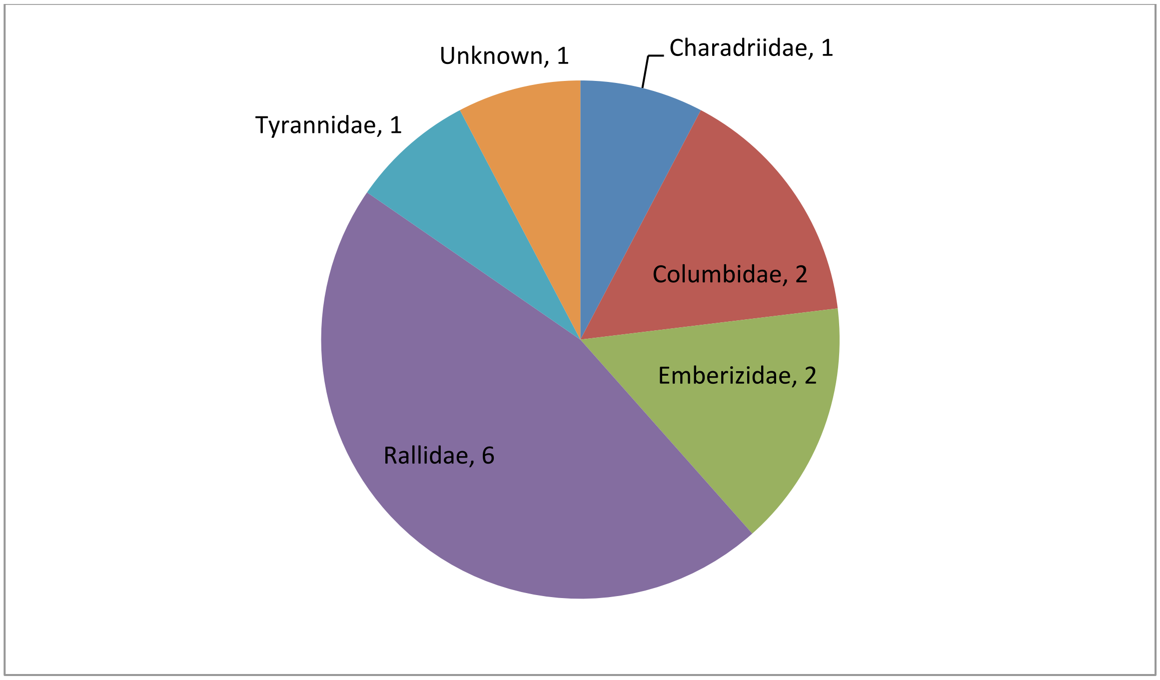
A total of 13 mortalities were observed when feather spots were excluded from the data set. Two (2) of these mortalities (15%) could not be identified to species. Of the 11 carcasses that could be identified to species, the most commonly observed species were American Coot (2 mortalities; 18% of mortalities identified to species level), Mourning Dove (2 mortalities; 18% of mortalities identified to species level), and Virginia Rail (*Rallus limicola*; 2 mortalities; 18% of mortalities identified to species). **Figure 4** presents the breakdown of observed mortalities by species.

Figure 4 - Mortalities by Species (excludes feather spots)



Twelve (12) of the 13 observed mortalities could be identified to the family level. As with the dataset that included feather spots, of these 12 mortalities, the families Rallidae (6 mortalities; 50% of mortalities identified to family level), Columbidae (2 mortalities; 17% of mortalities identified to family level), and Emberizidae (2 mortalities; 17% of mortalities identified to family level) were the most commonly observed mortalities. **Figure 5** presents the breakdown of observed mortalities by family.

Figure 5 – Mortalities by Family (excludes feather spots)



4 Discussion

4.1 Mortality Estimates

Searcher efficiency and scavenger removal trials can only result in up-correcting results (since searchers cannot detect >100% of carcasses and scavengers do not deposit carcasses within a survey area). Because searcher efficiency and scavenger removal trials were not performed during the fourth quarter surveys, the degree of underestimation is unknown. As soon as the Campo Verde Project receives a SPUT permit from FWS and a SCP from CDFW, searcher efficiency and scavenger removal trials will begin. There are no published reports or peer-reviewed articles documenting systematic mortality surveys at a solar photovoltaic facility to compare to the Campo Verde Project.

4.2 Seasonal Variations

A large proportion of the fourth quarter 2013 mortalities were observed in October (55% excluding feather spots; 44% including feather spots). Mortality rates appeared to decline with time. December only accounted for 28% of mortalities (excluding feather spots; 20% when feather spots were included).

4.3 Recommended Methodological Changes

The following changes are recommended to improve survey efficiency and accuracy as well as to improve data collection and analysis.

1. Direct Measurement of Perpendicular Distance – Per the FWS protocol (FWS 2012), a geographic information system was used to measure the perpendicular distance a carcass was located from a transect line. Given the relatively small effective transect width (~7.5m) compared to typical GPS accuracy (~3m), we feel that this method is unlikely to be the most accurate. For subsequent surveys we propose directly measuring the perpendicular distance in the field. The errors in measurement are suspected to have contributed to the lack of monotonicity in the model results.
2. Searcher Efficiency and Scavenger Removal Bias – The results presented in this report are uncorrected for searcher efficiency and scavenger removal. Searcher efficiency at this site is likely very high (near 100%) given the level ground and almost entirely unvegetated environment. As such, the searcher efficiency bias is unlikely to have resulted in a significant underestimate of mortality. However, scavenger removal rates are unknown and could be a source of bias. Numerous potential avian and mammalian scavengers are known to occur in and around the project site. Until scavenger removal trials are performed, the magnitude of this source of bias is unknown. As soon as state and federal permits are approved, these trials will be initiated.
3. Alternative Statistical Analysis Packages – Since the publication of the project BBCS (Heritage 2013), a potentially more robust mortality estimation program has been released for use with the statistical analysis software Program R, called facilityCMR. This program offers several potential advantages over the Warren-Hicks Estimator including analyzing covariance between searcher efficiency and scavenger removal rates and allowing for analysis of carcass condition. We propose using the facilityCMR software in future analyses, as soon as searcher efficiency and scavenger removal trials are permitted. This would be used in lieu of the Warren-Hicks Estimator and Program MARK and better reflects current FWS guidance on mortality studies at solar facilities.
4. Feather Spots – As described in **Section 3.1**, feather spots were problematic in that it is unclear if all feather spots can accurately be attributed to an avian mortality. It is presumed that some proportion of feather spots were the result of avian mortality potentially attributable to project operations or infrastructure; but this proportion is unknown. During collection of data in the fourth quarter 2013, a strict definition of a feather spot mortality was used (≥10 feathers within a $1m^2$ area). We propose giving observers greater discretion in determining whether observed

feathers should be recorded as a likely mortality. This would result in the exclusion of some feather spots where only a few feathers are present with no other evidence of mortality (flesh associated with the feathers, large groups of remiges, feathers from a species not commonly observed in the panel arrays, large numbers of feathers in a concentrated area). With greater discretion, observers would still record feather spot mortalities but could exclude those cases just barely meeting the minimum criteria but not showing any other evidence that an avian mortality has occurred. In cases of any uncertainty, observers would record feather spots as mortalities in order to generate conservative estimates of mortality.

5 Literature Cited

APLIC (Avian Power Line Interaction Committee). 2006. Suggested practices for avian protection on power lines: The state of the art in 2006. Washington, D.C. and Sacramento, CA: Edison Electric Institute, Avian Power Line Interaction Committee, and California Energy Commission.

California Energy Commission (CEC). 2002. *A Roadmap for PIER Research on Avian Collisions with Power Lines in California*. California Energy Commission Staff Report. December, 2002.

Drewitt, A. L., and R. H. W. Langston. 2006. Assessing the impacts of wind farms on birds. *Ibis.* 148:29-42.

FWS. 2012. Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach. December, 2012. 23pp.

Heritage Environmental Consultants, LLC (Heritage). 2012. Campo Verde Solar Energy Project Avian Survey Report. May 2012. 11 pp.

Heritage. 2013. Campo Verde Solar Project Bird and Bat Conservation Strategy. February, 2013. 185pp.

Hovarth, G., M. Blahò, A. Egri, G. Kriska, I. Seres, and B. Robertson. 2010. Reducing the maladaptive attractiveness of solar panels to polarotactic insects. *Conservation Biol.* 24(6): 1644-1653.

Ironwood Consulting, Inc. 2014. 2013 Annual Report for Biological Resources Monitoring, First Solar Desert Sunlight Project, Riverside County, BLM Case File Number CACA-48629, Biological Opinion# FWS-ERIV-08B0789-11F0041, 1 January – 31 December 2013. 188pp.

Janss, G. F. E. 2000. Avian mortality from power lines: A morphologic approach of a species-specific mortality. *Biological Conservation* 95: 353-359.

Manville II, A. M. 2005. Bird strikes and electrocution at power lines, communication towers, and wind turbines: State of the art and state of the science – next steps toward mitigation. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Martin, G.R. and J.M. Shaw. 2010. Bird collisions with power lines: Failing to see the way ahead? *Biological Conservation* 143: 2695–2702.

McCrary, M. D., R. L. McKernan, R. W. Schreiber, W. D. Wagner, and T. C. Sciarrota. 1986. Avian mortality at a solar energy power plant. *J. Field Ornithol.* 57(2): 135-141.

Rusz, P. J., H. H. Prince, R. D. Rusz, and G. A. Dawson. 1986. Bird collisions with transmission lines near power plant cooling pond. *Wildlife Society Bulletin*. 14: 441-444.

Savereno, A. J., L .A. Savereno, R. Boettcher, and S. M. Haig. 1996. Avian behavior and mortality at power lines in coastal South Carolina. *Wildlife Society Bulletin*. 24: 636-648.

Post-construction Avian Mortality Monitoring Report for the Campo Verde Solar Project

Fourth Quarter 2013

Prepared By:

Heritage Environmental Consultants, LLC

1 Introduction

The Campo Verde Solar Project is a solar photovoltaic (PV) energy generating facility (Solar Energy Facility) and an associated electrical transmission line (Gen-Tie Line) in southern Imperial County, California. The solar project is located on private lands and the gen-tie line is located on private and federal lands managed by the Bureau of Land Management (BLM). These are referred to collectively as the "Project."

A Bird and Bat Conservation Strategy (BBCS) was prepared that addresses activities potentially occurring during construction and operation of the Project (Heritage 2013). The BBCS was reviewed and approved by the U.S. Fish and Wildlife Service (FWS), California Department of Fish and Wildlife (CDFW), and BLM. The purpose of the Campo Verde BBCS was to develop and implement a program to identify and avoid risks to avian and bat species that could result from construction and operation of the Project. The goal of this BBCS was to implement a series of best practices, in order to construct and operate the Project to avoid or reduce risk to birds, bats and their habitats.

The post-construction avian mortality monitoring program was set up to comply with the methodology prescribed in the BBCS (Heritage 2013). The methodology is described in Section 6.1 of the BBCS and was approved by the FWS and CDFW. Quarterly reports documenting results of the monitoring program are required for the first year of program, and annually thereafter. Monitoring began in October 2013 just after completion of construction. This report is the first of four quarterly reports.

1.1 Project Description

The general location of the Project is approximately 7 miles southwest of the city of El Centro, Imperial County, California (**Figure 1**). The Project is south of I-8, west of Drew Road, and northeast and south of the Westside Main Canal. The Project consists of two component parts: (i) the Solar Energy Facility and (ii) an approximately 0.9-mile, 230-kilovolt (kV) aboveground, electrical gen-tie line and associated facilities that electrically connects the Solar Energy Facility on private land with the Imperial Valley Substation (IV Substation) located on federal land managed by the BLM.

The Solar Energy Facility is approximately 1,443 acres in size and uses First Solar PV modules that are generally non-reflective and convert sunlight into direct current (DC) electricity. The DC output of multiple rows of PV modules is collected through one or more combiner boxes and directed to an inverter that converts the DC electricity to alternating current (AC) electricity. From the inverter, the generated energy flows to a transformer where it is stepped up to distribution level voltage (approximately 34.5 kV). Multiple transformers are connected in parallel via 34.5 kV lines to the Project substation, where the power is stepped up to 230 kV. This substation is located at the southern end Solar Energy Facility near Liebert Road. The Gen-Tie Line connects the Project substation to the Imperial Valley Substation approximately 0.9 miles to the south.

The Gen-Tie Line uses double-circuit tubular steel monopole structures. Tower structure heights range from 100 to 135 feet. One side of the double-circuit structures currently supports three two- bundle conductors and one shield wire. Typical overall structure widths are approximately 20 feet.

Additional Documentation Attachment to Comment 2-F1

Attachment I-4

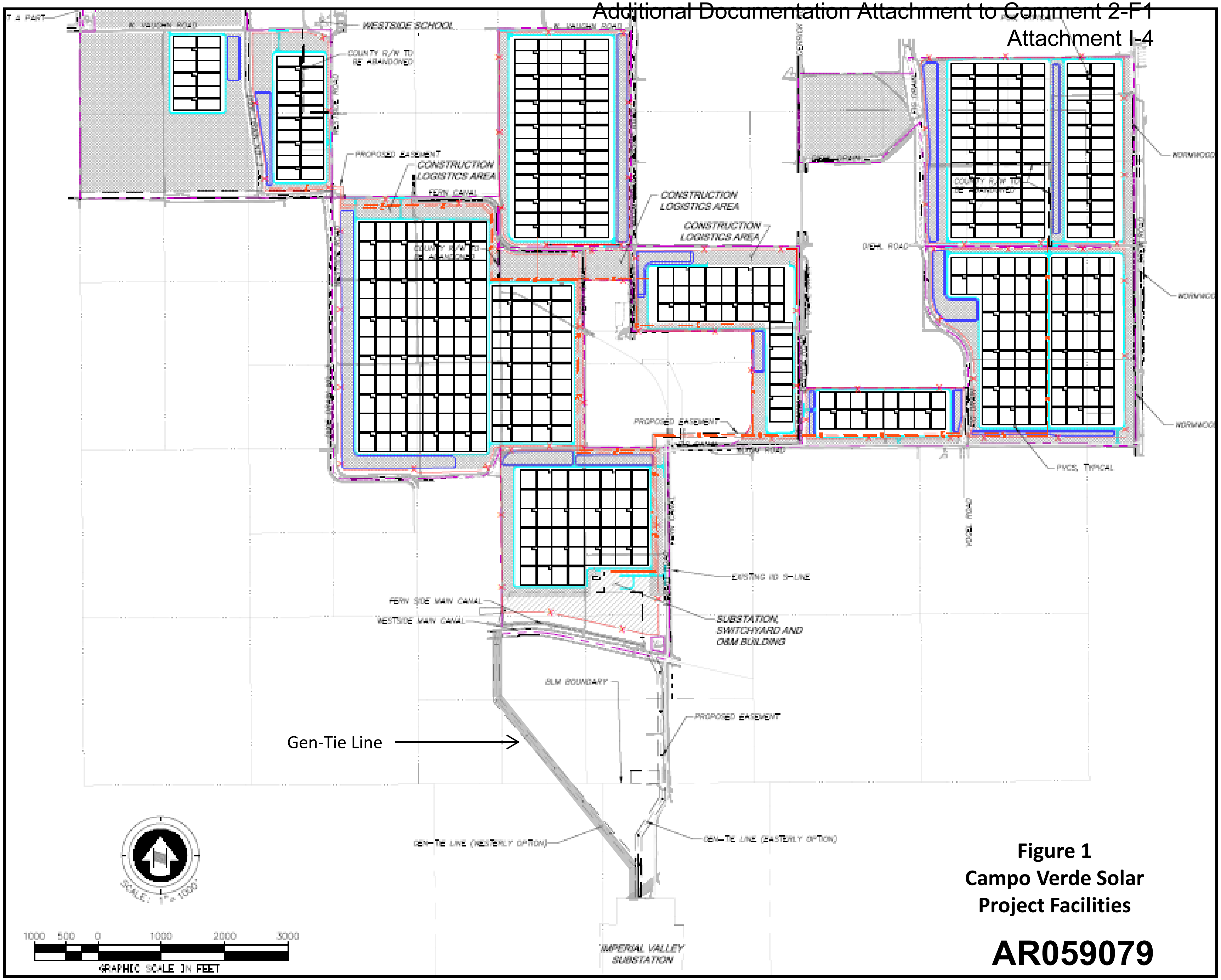


Figure 1
Campo Verde Solar
Project Facilities

2 Methods

Monitoring of the Project was performed in order to document and report avian mortalities and identify areas of concern by tracking both the specific locations where mortalities occur as well as the extent of such mortalities. The monitoring program for the Project is based on the FWS guidance entitled "Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach" (FWS 2012) with modifications, and was approved by FWS.

2.1 Transect Sampling

Sampling transects were established for both the gen-tie line and solar field. For each kilometer of Gen-Tie Line, 300-meter transects were randomly established along the Gen-Tie Line allowing for approximately 30 percent of the Gen-Tie Line to be sampled. Transects were positioned along the centerline of the Gen-Tie Line. For the Campo Verde Solar Energy Facility, transects were also positioned to result in approximately 30-percent coverage of the site with no less than eight transects placed within the solar field itself. Transect selection was systematic randomized. The entire perimeter of the panel arrays was also surveyed during each survey period in addition to the interior transects.

Transects were surveyed for 7 consecutive days each month and each transect was surveyed once daily. Because of the large number of transects, sampling periods were 14-days; the first half of transects were walked for 7- day period and the second half for another 7 day period. One qualified observer walked along the pre-determined transects searching for bird/bat carcasses. When a carcass was observed, a GPS location was recorded at the carcass (for DISTANCE analysis), the species was identified, and information regarding carcass condition per FWS (2012) was recorded using paper datasheets. Once data were collected at a carcass, the observer returned to the pre-determined transect and continued with the survey.

The original protocol stated that each carcass would be marked uniquely and inconspicuously with tape and permanent marker to assess "recapture" rates. However, both the state scientific collection permit (SCP) and the federal special purpose utility permit (SPUT) enabling surveyors to handle carcasses were still being processed during this sampling period so no mark-recapture data was collected. Scavenger removal trials and searcher efficiency trials were also not performed due to the lack of handling permits. Therefore, all estimates presented in this report represent mortality estimates that are uncorrected for observer bias and scavenger removal rates. Future reports will address these biases, once permits are approved by the FWS and CDFW.

2.2 Analysis

Two primary analyses were proposed for mortality estimation. The first analysis used Program DISTANCE to determine the most effective transect width to search for carcasses. Distance models examined a variety of detection functions and used Aikake's Information Criterion (AIC)[1] for model selection.

The second analysis would use Program MARK to estimate total number of mortalities controlling for detection rate, scavenging rate, and proximity to Project components. However, as described above, handling permits have not been approved by either the FWS or CDFW, thus mark-recapture protocols could not be implemented. Future reports will contain a mark-recapture analysis, pending approval of

---

[1] AIC measures the relative quality of a given model by assessing both the model's complexity as well as the model goodness-of-fit to the observed data. Lower AIC values indicate higher quality models. Typically AIC values are compared among several possible models to select the "best" model or models.

handling permits. Alternative analysis packages may be considered (as opposed to Program MARK); see **Section 4.3** for additional discussion of potential statistical analyses.

Project mortality estimates rely on measuring a daily mortality rate that can be used as the basis for all mortality estimates. To calculate the corrected project mortality estimate, we did not count all mortalities observed during day 1 of the 7-day search period under the assumption that the those mortalities represent "bleed through" from the period prior to 24 hours preceding the first search. To accurately generate a rate, all mortalities used for this analysis need to have occurred within the 24 hours preceding discovery. Mortalities observed during the subsequent 6 days were then up-corrected to adjust for time not searched (since the search period captured 6 out of 30 or 31 days each month), producing a time-corrected mortality estimate for each month.

Because taxonomic analyses do not use a rate, but are instead only concerned with the overall breakdown in mortalities, these analyses used all recorded mortality data, including those mortalities observed during day 1 of the 7-day search period. The use of these data from day one assumes that there is not persistence bias for different types of birds. Once scavenger removal trials are approved, this assumption can be tested and analyses will be adjusted if necessary.

3 Results

3.1 Overall Mortalities Observed

Fourth quarter surveys for 2013 were conducted from October 21 – November 3, 2013; November 11-23, 2013; and, December 7-20, 2013. A total of 36 avian mortalities were recorded. Twenty-three (23) of these observed mortalities were recorded as "feather spots" (defined as 10 or more feathers within a 1m^2 area). All feather spots were assumed to be mortalities, though it is unlikely that they all represent a mortality. **Table 1** provides a breakdown of mortalities by sampling period.

Table 1 – Observed Mortalities by Sampling Period

Mortality Type	October (10/21/13 – 11/3/13)	November (11/11/13 – 11/23/13)	December (12/7/13 – 12/20/13)	Q4 2013 TOTAL
Feather Spot Mortalities	6	15	2	23
Non-Feather Spot Mortalities	8	2	3	13
Total Mortalities	*14*	*17*	*5*	*36*

The inclusion of feather spots as observed mortalities is based on standard mortality monitoring protocols, which were largely developed for the wind energy industry. At wind energy facilities, the speed of the spinning blades can result in mortalities that leave very little detectible carcass behind, including only feather spots. Inclusion of feather spots as recorded mortalities at these facilities was intended to conservatively include mortalities caused by blade strikes that might otherwise go unrecorded. Potential bias resulting from the inclusion of feather spots in mortality data can arise from feather spots meeting the definition of a mortality (in this case >10 feathers within 1m^2) but not actually resulting from an avian mortality. This bias can lead to overestimates of mortality rates. This bias is problematic in situations where feathers are commonly deposited in non-mortality related events but get included as incidents of avian morality (e.g. in and around common roost or perch sites, near active nests, etc.). Feather spots may also be caused by predation or attempted-predation events within a survey area. In these cases, the mortality is recorded but the causal relation of that mortality to a project may be misrepresented.

A large proportion of mortalities recorded during the 2013 Q4 surveys were detected as feather spots (over 63% overall and over 88% of mortalities recorded in November). It is unclear if some or all of these feather spots can be accurately attributed to project-related causes, or whether they were actual mortalities. Unlike with wind energy facilities, there are not anticipated project-related mortality hazards that could be expected to result in only feather spot remains. Furthermore, during mortality surveys, biologists routinely observed multiple species perching and roosting on the panels, often times depositing large numbers of feathers. Wintering raptors are also common in the agricultural areas of the Imperial Valley and were routinely observed in and around the panel arrays. Thus, normal perching, roosting, predation and scavenging could account for a significant number of the observed feather spots. Conversely, some of the feather spots were identified as species that would not be expected to naturally occur within the panel arrays and were not previously observed in the interior of the agricultural fields during the pre-construction avian surveys (Heritage 2012). For these reasons, all of the following analyses present results that both include and exclude feather spots to present the full range of possible mortalities. Additional recommendations regarding the use of feather spot data in future surveys can be found in **Section 4.3**.

3.2 Effective Transect Width

DISTANCE analyses were performed using the data pooled across the three-month sampling period and **Tables 2 and 3** present the results of the DISTANCE analysis. It is important to note that none of the models fit the data well and model parameters were constrained to obtain monotonicity[2] in several cases. DISTANCE model fitting issues are discussed in greater detail in **Section 4.3**. The a priori[3] estimate of effective transect width was approximately 7.5 meters (this represents the width of two panel rows measured from the bottom of the panel immediately north of the designated transects to the bottom of the second panel to the south of the transect). Generally, the most likely models were consistent with that assumption. Corrections to the methods used to assess perpendicular distance are expected to improve model fit in future analyses and allow for a more accurate assessment of effective transect width (**Section 4.3**).

Table 2 – Distance Analysis Results – without feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*	2	73.19	0.00	0.150	0.031-0.721	6.24
Uniform – Cosine*	1	73.79	0.61	0.065	0.032-0.132	14.34
Uniform – Polynomial	0	74.19	1.00	0.043	0.077-0.305	22.00
Half Normal – Polynomial	1	74.41	1.22	0.064	0.129-0.369	14.76
Half Normal – Hermit*	1	74.41	1.22	0.064	0.129-0.369	14.76

*Some parameters were constrained to obtain monotonicity.

---

[2] DISTANCE analyses rely on the modeling of a detection function. This detection function models the change in probability of detecting a carcass as the distance from the transect increases. This type of modelling relies on the assumption that the detection function is monotonic. Monotonic means that the probability of detection *only* changes in one direction (decreases) with increasing distance from the transect. If the detection probability goes up and down as distance from the transect increases, then the results violate this assumption of monotonicity. Program DISTANCE automatically constrains certain model parameters to obtain monotonicity but the resulting model may have a poor fit to the observed data.

[3] "A priori" hypotheses are those hypothesis developed based on a theoretical and logical understanding of the system in question and not based on empirical results. That is, a priori hypothesis are those generated before any results have been collected.

Table 3 – Distance Analysis Results – with feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width
Hazard – Cosine*	2	196.39	0.00	0.394	0.175-0.885	6.75
Uniform – Cosine*	3	199.21	2.82	0.303	0.182-0.506	8.76
Uniform – Polynomial*	5	202.43	6.04	0.318	0.186-0.543	8.37
Half Normal – Polynomial	1	202.90	6.52	0.216	0.139-0.337	12.28
Half Normal – Hermit	1	202.90	6.52	0.216	0.139-0.337	12.28

*Some parameters were constrained to obtain monotonicity.

3.3 Searcher Bias

As described above, permits allowing observers to handle bird carcasses were not in place during these surveys. As such, no searcher bias estimates were generated and overall mortality estimates were not adjusted to reflect searcher bias.

3.4 Scavenger Removal Bias

As described above, permits allowing observers to handle bird carcasses were not in place during these surveys. As such, no scavenger removal trials were completed and overall mortality estimates were not adjusted to reflect scavenger removal bias.

3.5 Corrected Project Mortality Estimate

Results from surveys conducted each month were used to generate discrete mortality estimates for each month surveyed. Monthly and overall project mortality estimates only used data from search days 2-7 (see **Section 2.2**). Monthly mortality estimates were used in order to detect seasonal variations in mortality rates. Also, data are presented to reflect estimates with and without feather spots as discussed earlier. For the remainder of this section, mortality values are presented as “number of mortalities excluding feather spots”/”number of mortalities inclusive of feather spots”.

While results of the DISTANCE analyses were less than conclusive, they were at least consistent with the a priori assumption of a minimum 7.5 meter effective transect width. Transect layout, in consideration of this effective transect width, was designed to sample 30% of the overall PV array area. The time-corrected mortality estimates for each month were again up-corrected to account for the area not surveyed. Since no searcher efficiency or scavenger removal bias corrections were performed, this time- and area-corrected mortality estimate represents the overall monthly project mortality estimate. Mortality estimates were rounded to the nearest whole number. **Table 4** summarizes the corrected mortality estimates by month.

3.5.1 October Mortalities

A total of 6/11 mortalities were detected during days 2-7 of the October surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in October) and area surveyed, the overall monthly project mortality estimate for October was 103/189.

3.5.2 November Mortalities

A total of 2/9 mortalities were detected during days 2-7 of the November surveys. Correcting for time (the 6 day survey period represents approximately 20% of the total days in November) and area surveyed, the overall monthly project mortality estimate for November was 33/150.

3.5.3 December Mortalities

A total of 3/5 mortalities were detected during days 2-7 of the December surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in December) and area surveyed, the overall monthly project mortality estimate for December was 52/86.

3.5.4 Fourth Quarter 2013 Corrected Mortality Estimates

After applying time and area corrections to the mortality counts for each month the overall project mortality estimate for the fourth quarter of 2013 is 188/426 birds.

Table 4 – Corrected Mortalities by Month

	October		November		December		Q4 Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 2-7)	6	11	2	9	3	5	11	25
Corrected Mortality Estimate	103	189	33	150	52	86	188	426

3.6 Taxonomic Composition of Observed Mortalities

The following analyses use all observed mortalities including those detected on search day 1 since the taxonomic composition is not a rate-dependent analysis (see **Section 3.2**).

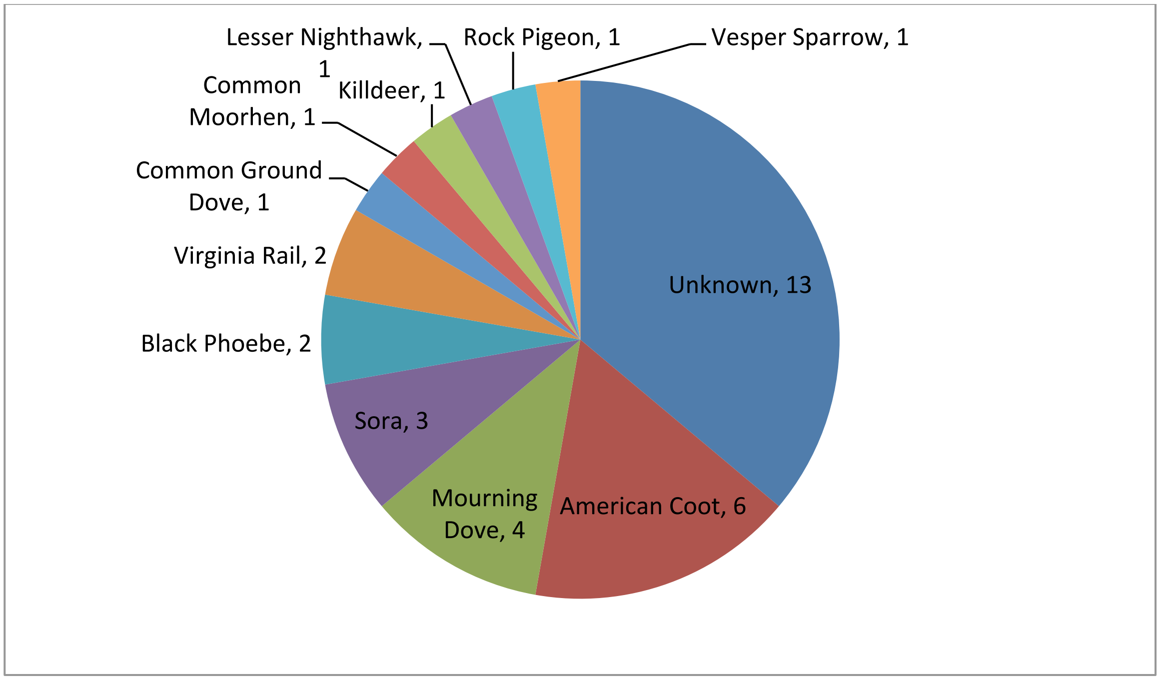
Table 5 – Raw Mortalities by Month (includes data from all search days)

	October		November		December		Q4 Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 1-7)	8	14	2	17	3	5	13	36

3.6.1 Mortalities Including Feather Spots

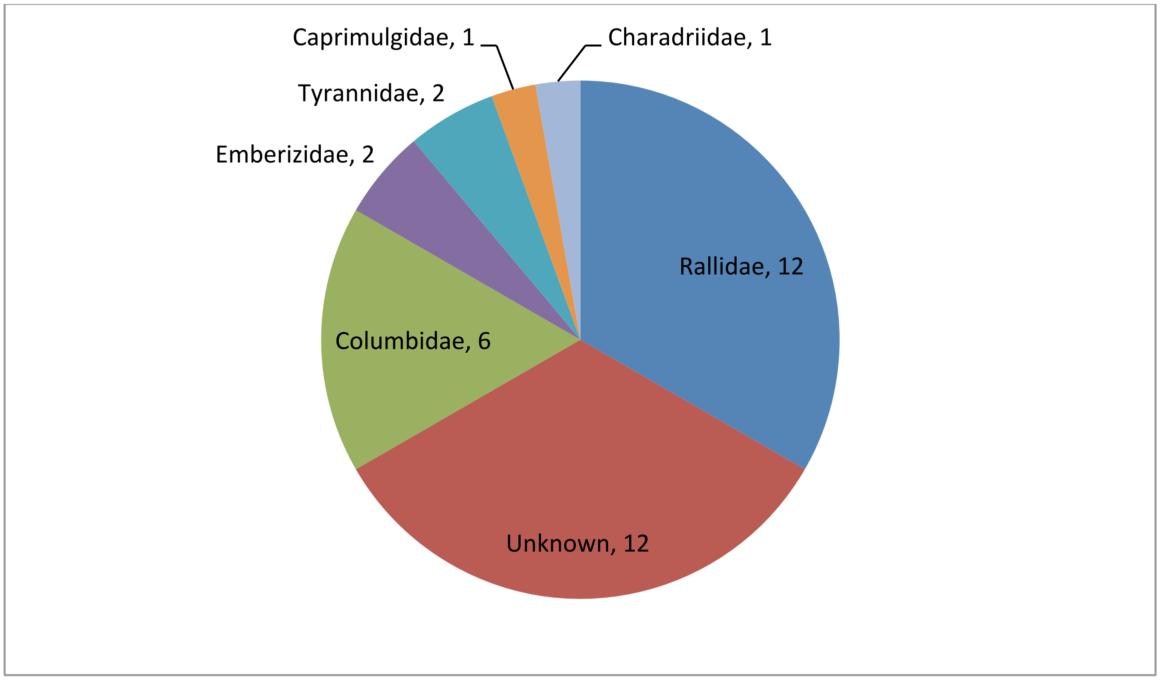
A total of 36 mortalities were observed when feather spots were included in the data set. Thirteen (13) of these mortalities (36%) could not be identified to species. Of the 23 carcasses that could be identified to species, the most commonly observed species were American Coot (*Fulica Americana*; 6 mortalities; 26% of mortalities identified to species level), Mourning Dove (*Zenaida macroura*; 4 mortalities; 18% of mortalities identified to species level), and Sora (*Porzana Carolina*; 3 mortalities; 13% of mortalities identified to species level). **Figure 2** presents the breakdown of observed mortalities by species.

Figure 2 – Mortalities by Species (includes feather spots)



Twenty-four (24) of the 36 observed mortalities could be identified to the family level. Of these 24 mortalities, the families Rallidae (12 mortalities; 50% of mortalities identified to family level), Columbidae (6 mortalities; 25% of mortalities identified to family level), and Emberizidae (2 mortalities; 9% of mortalities identified to family level) were the most commonly observed mortalities. **Figure 3** presents the breakdown of observed mortalities by family.

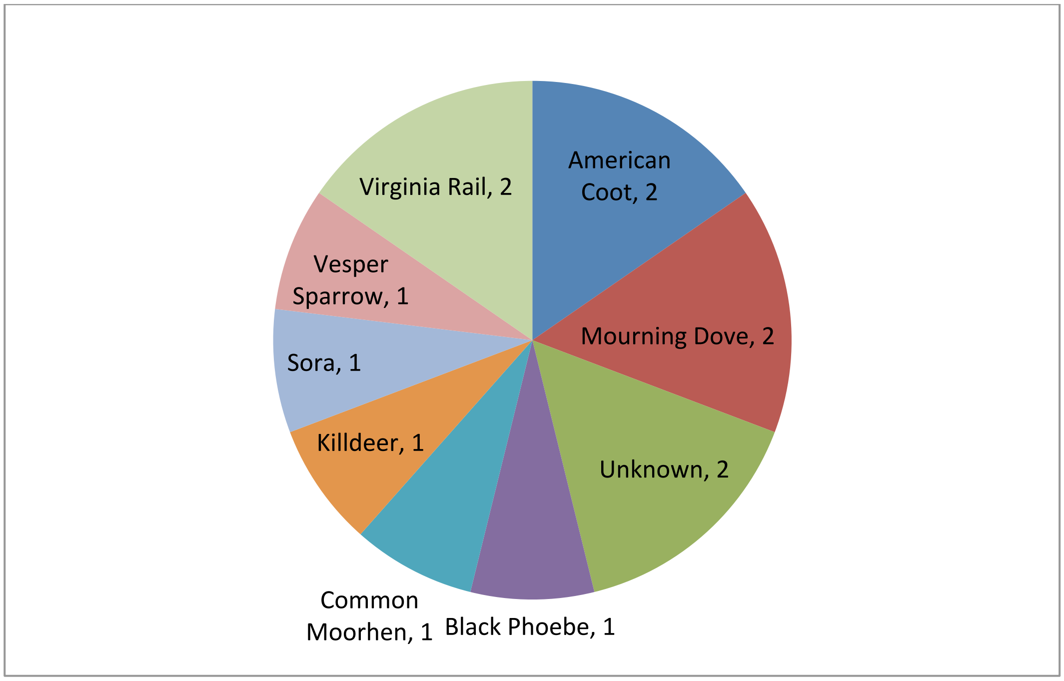
Figure 3 – Mortalities by Family (includes feather spots)



3.6.2 Mortalities Excluding Feather Spots

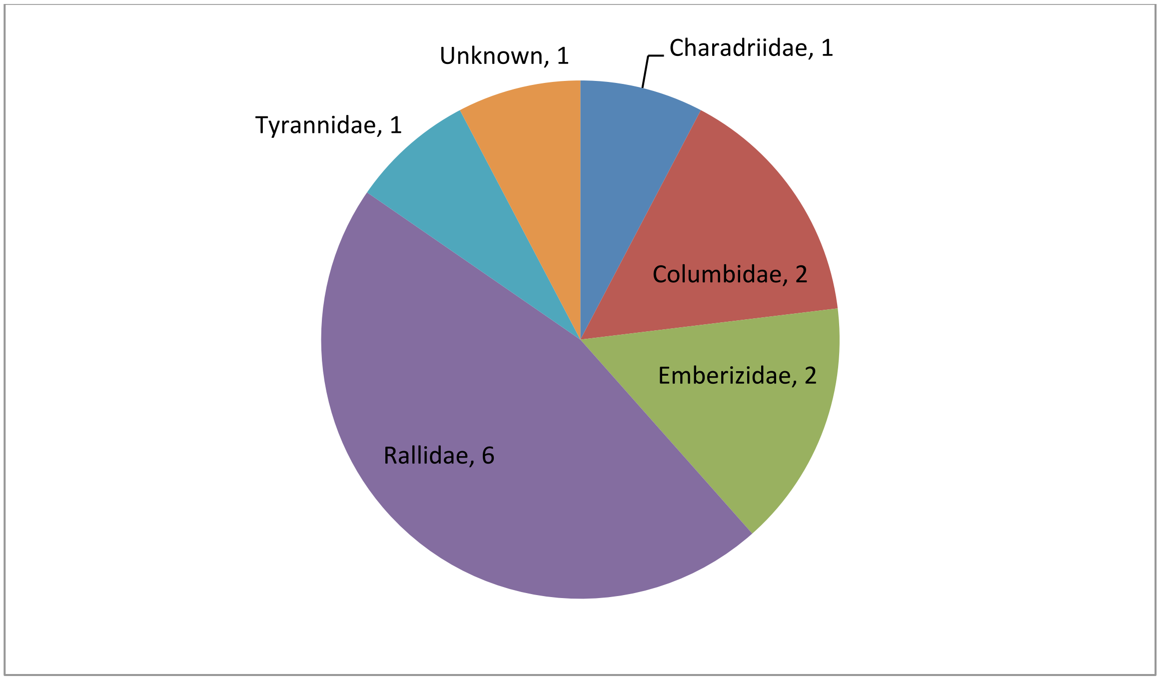
A total of 13 mortalities were observed when feather spots were excluded from the data set. Two (2) of these mortalities (15%) could not be identified to species. Of the 11 carcasses that could be identified to species, the most commonly observed species were American Coot (2 mortalities; 18% of mortalities identified to species level), Mourning Dove (2 mortalities; 18% of mortalities identified to species level), and Virginia Rail (*Rallus limicola*; 2 mortalities; 18% of mortalities identified to species). **Figure 4** presents the breakdown of observed mortalities by species.

Figure 4 - Mortalities by Species (excludes feather spots)



Twelve (12) of the 13 observed mortalities could be identified to the family level. As with the dataset that included feather spots, of these 12 mortalities, the families Rallidae (6 mortalities; 50% of mortalities identified to family level), Columbidae (2 mortalities; 17% of mortalities identified to family level), and Emberizidae (2 mortalities; 17% of mortalities identified to family level) were the most commonly observed mortalities. **Figure 5** presents the breakdown of observed mortalities by family.

Figure 5 – Mortalities by Family (excludes feather spots)



4 Discussion

4.1 Mortality Estimates

Searcher efficiency and scavenger removal trials can only result in up-correcting results (since searchers cannot detect >100% of carcasses and scavengers do not deposit carcasses within a survey area). Because searcher efficiency and scavenger removal trials were not performed during the fourth quarter surveys, the degree of underestimation is unknown. As soon as the Campo Verde Project receives a SPUT permit from FWS and a SCP from CDFW, searcher efficiency and scavenger removal trials will begin. There are no published reports or peer-reviewed articles documenting systematic mortality surveys at a solar photovoltaic facility to compare to the Campo Verde Project.

4.2 Seasonal Variations

A large proportion of the fourth quarter 2013 mortalities were observed in October (55% excluding feather spots; 44% including feather spots). Mortality rates appeared to decline with time. December only accounted for 28% of mortalities (excluding feather spots; 20% when feather spots were included).

4.3 Recommended Methodological Changes

The following changes are recommended to improve survey efficiency and accuracy as well as to improve data collection and analysis.

1. Direct Measurement of Perpendicular Distance – Per the FWS protocol (FWS 2012), a geographic information system was used to measure the perpendicular distance a carcass was located from a transect line. Given the relatively small effective transect width (~7.5m) compared to typical GPS accuracy (~3m), we feel that this method is unlikely to be the most accurate. For subsequent surveys we propose directly measuring the perpendicular distance in the field. The errors in measurement are suspected to have contributed to the lack of monotonicity in the model results.
2. Searcher Efficiency and Scavenger Removal Bias – The results presented in this report are uncorrected for searcher efficiency and scavenger removal. Searcher efficiency at this site is likely very high (near 100%) given the level ground and almost entirely unvegetated environment. As such, the searcher efficiency bias is unlikely to have resulted in a significant underestimate of mortality. However, scavenger removal rates are unknown and could be a source of bias. Numerous potential avian and mammalian scavengers are known to occur in and around the project site. Until scavenger removal trials are performed, the magnitude of this source of bias is unknown. As soon as state and federal permits are approved, these trials will be initiated.
3. Alternative Statistical Analysis Packages – Since the publication of the project BBCS (Heritage 2013), a potentially more robust mortality estimation program has been released for use with the statistical analysis software Program R, called facilityCMR. This program offers several potential advantages over the Warren-Hicks Estimator including analyzing covariance between searcher efficiency and scavenger removal rates and allowing for analysis of carcass condition. We propose using the facilityCMR software in future analyses, as soon as searcher efficiency and scavenger removal trials are permitted. This would be used in lieu of the Warren-Hicks Estimator and Program MARK and better reflects current FWS guidance on mortality studies at solar facilities.
4. Feather Spots – As described in **Section 3.1**, feather spots were problematic in that it is unclear if all feather spots can accurately be attributed to an avian mortality. It is presumed that some proportion of feather spots were the result of avian mortality potentially attributable to project operations or infrastructure; but this proportion is unknown. During collection of data in the fourth quarter 2013, a strict definition of a feather spot mortality was used (≥10 feathers within a $1m^2$ area). We propose giving observers greater discretion in determining whether observed

feathers should be recorded as a likely mortality. This would result in the exclusion of some feather spots where only a few feathers are present with no other evidence of mortality (flesh associated with the feathers, large groups of remiges, feathers from a species not commonly observed in the panel arrays, large numbers of feathers in a concentrated area). With greater discretion, observers would still record feather spot mortalities but could exclude those cases just barely meeting the minimum criteria but not showing any other evidence that an avian mortality has occurred. In cases of any uncertainty, observers would record feather spots as mortalities in order to generate conservative estimates of mortality.

5 Literature Cited

APLIC (Avian Power Line Interaction Committee). 2006. Suggested practices for avian protection on power lines: The state of the art in 2006. Washington, D.C. and Sacramento, CA: Edison Electric Institute, Avian Power Line Interaction Committee, and California Energy Commission.

California Energy Commission (CEC). 2002. *A Roadmap for PIER Research on Avian Collisions with Power Lines in California*. California Energy Commission Staff Report. December, 2002.

Drewitt, A. L., and R. H. W. Langston. 2006. Assessing the impacts of wind farms on birds. *Ibis.* 148:29-42.

FWS. 2012. Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach. December, 2012. 23pp.

Heritage Environmental Consultants, LLC (Heritage). 2012. Campo Verde Solar Energy Project Avian Survey Report. May 2012. 11 pp.

Heritage. 2013. Campo Verde Solar Project Bird and Bat Conservation Strategy. February, 2013. 185pp.

Hovarth, G., M. Blahò, A. Egri, G. Kriska, I. Seres, and B. Robertson. 2010. Reducing the maladaptive attractiveness of solar panels to polarotactic insects. *Conservation Biol.* 24(6): 1644-1653.

Ironwood Consulting, Inc. 2014. 2013 Annual Report for Biological Resources Monitoring, First Solar Desert Sunlight Project, Riverside County, BLM Case File Number CACA-48629, Biological Opinion# FWS-ERIV-08B0789-11F0041, 1 January – 31 December 2013. 188pp.

Janss, G. F. E. 2000. Avian mortality from power lines: A morphologic approach of a species-specific mortality. *Biological Conservation* 95: 353-359.

Manville II, A. M. 2005. Bird strikes and electrocution at power lines, communication towers, and wind turbines: State of the art and state of the science – next steps toward mitigation. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Martin, G.R. and J.M. Shaw. 2010. Bird collisions with power lines: Failing to see the way ahead? *Biological Conservation* 143: 2695–2702.

McCrary, M. D., R. L. McKernan, R. W. Schreiber, W. D. Wagner, and T. C. Sciarrota. 1986. Avian mortality at a solar energy power plant. *J. Field Ornithol.* 57(2): 135-141.

Rusz, P. J., H. H. Prince, R. D. Rusz, and G. A. Dawson. 1986. Bird collisions with transmission lines near power plant cooling pond. *Wildlife Society Bulletin*. 14: 441-444.

Savereno, A. J., L .A. Savereno, R. Boettcher, and S. M. Haig. 1996. Avian behavior and mortality at power lines in coastal South Carolina. *Wildlife Society Bulletin*. 24: 636-648.

Additional Documentation Attachment to Comment 2-F1
Attachment I-4

Post-construction Avian Mortality Monitoring Report Centinela Solar Energy Project

First Quarterly Report (August-September-October 2014)

Prepared By:

Heritage Environmental Consultants, LLC

Table of Contents

1 Introduction

The Centinela Solar Energy (CSE) Project is a solar photovoltaic (PV) energy generating facility (Solar Energy Facility) located on private lands in southern Imperial County, California.

A Bird and Bat Conservation Strategy (BBCS) was prepared that addresses activities potentially occurring during construction and operation of the Project (Heritage 2012). The BBCS was reviewed and approved by the U.S. Fish and Wildlife Service (FWS), California Department of Fish and Wildlife (CDFW), and the Bureau of Land Management (BLM). The purpose of the Campo Verde BBCS was to develop and implement a program to identify and avoid risks to avian and bat species that could result from construction and operation of the Project. The goal of this BBCS was to implement a series of best practices, in order to construct and operate the Project to avoid or reduce risk to birds, bats and their habitats.

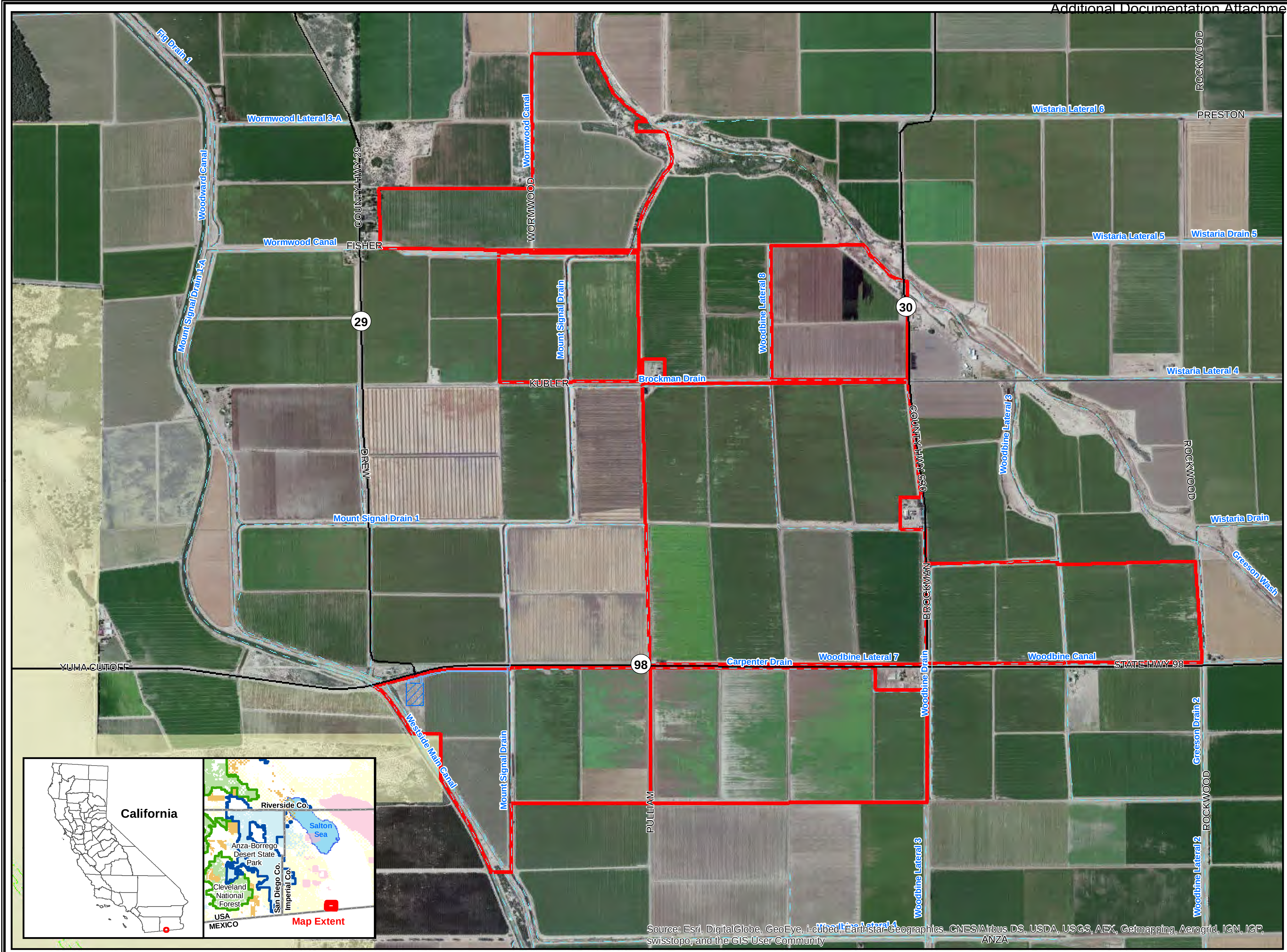
The post-construction avian mortality monitoring program was set up to comply with the methodology prescribed in the BBCS (Heritage 2012). The methodology is described in Section 6.1 of the BBCS and was approved by the FWS and CDFW. Monitoring began in August 2014 just after completion of construction. Monitoring is required for one year following construction. Construction was completed at the end of July 2014. Four quarterly reports documenting results of the monitoring program are required. This report is the first of four quarterly reports.

1.1 Project Description

The CSE Facility (**Figure 1**) is comprised of approximately 2,067 acres of private land, of which approximately 1,861 acres were formerly in active agricultural production. The generation capacity of the CSE Facility is a nominal 275 megawatts alternating current. The CSE Facility uses solar photovoltaic (PV) technology and electronic DC-to-AC power conditioning equipment (inverters) to produce three-phase, 60 Hz, utility-grade electric power directly from sunlight. The PV modules are mounted on racks supported by steel support structures that are anchored or driven into the ground. The PV module racks are a single-axis-tracking system aligned on a north-south axis and that tracks the sun from east to west. The CSE Facility substation is in the southern portion of the CSE Facility site, immediately south of SR 98, approximately mid-way between Pulliam Road and Brockman Road. The purpose of the CSE Facility substation is to aggregate the AC collector lines and increase the voltage of the electricity to 230-kV for connection with the electric grid. The substation includes transformers, medium-voltage and high-voltage circuit breakers, capacitor banks electrical bus work, meters, disconnect switches and an electrical control house. To protect against over-voltages caused by lightning strikes, lightning arresters, overhead shield wires, and lightning masts are installed in the substation.

Centinela Solar Energy, LLC

Figure 1
Project Location



Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Legend

—	Major Road
- -	Stream, Major Canal and/or Irrigation Canal
- -	County Boundary
▨	Ring Bus Switchyard
🟥	CSE Facility Parcel
🟦	Major Water Body
🟩	Cleveland National Forest Congressional Boundary
🟦	State Park Boundary

Jurisdictional Land Ownership

🟨	Bureau of Land Management Land
🟩	U.S. Forest Service Land
🟪	Department of Defense Land
🟦	State Land
🟧	Indian Land

0 0.5
Miles

State Plane Coordinate System
California Zone 6, NAD 83
Lambert Conformal Conic Projection
1983 North American Datum
Linear Unit: Foot US

11-25-14

2 Methods

Monitoring of the project was performed in order to document and report avian mortalities and identify areas of concern by tracking both the specific locations where mortalities occur as well as the extent of such mortalities. The monitoring program for the Project is based on the FWS guidance entitled "Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach" (FWS 2012) with modifications, and was approved by FWS.

2.1 Transect Sampling

Sampling transects were established for the entire solar field and positioned to result in approximately 10-percent coverage of the site with no less than eight transects placed within the solar field itself. Transect selection was systematic randomized. The entire perimeter of the panel arrays was also surveyed during each survey period in addition to the interior transects.

Transects were surveyed for 7 consecutive days each month and each transect was surveyed once daily. One qualified observer walked along the pre-determined transects searching for bird/bat carcasses. When a carcass was observed, a GPS location was recorded at the carcass, the species was identified, the perpendicular distance from the transect to the carcass was measured, and information regarding carcass condition per FWS (2012) was recorded using paper datasheets. Once data were collected at a carcass, the observer returned to the pre-determined transect and continued with the survey.

The original protocol stated that each carcass would be marked uniquely and inconspicuously with tape and permanent marker to assess "recapture" rates. However, both the state scientific collection permit (SCP) and the federal special purpose utility permit (SPUT) enabling surveyors to handle carcasses were still being processed during this sampling period so no mark-recapture data was collected. Scavenger removal trials and searcher efficiency trials were also not performed due to the lack of handling permits. Therefore, all estimates presented in this report represent mortality estimates that are uncorrected for observer bias and scavenger removal rates. Future reports will address these biases, once permits are approved by the FWS and CDFW.

2.2 Analysis

Two primary analyses were proposed for mortality estimation. The first analysis used Program DISTANCE to determine the most effective transect width to search for carcasses. Distance models examined a variety of detection functions and used Aikake's Information Criterion (AIC)[1] for model selection. Models were run using both no truncation as well as 5% upper truncation to remove outliers. Specific model components are discussed in **Section 3.2**.

The second analysis would use Program MARK to estimate total number of mortalities controlling for detection rate, scavenging rate, and proximity to Project components. However, as described above, handling permits have not been approved by either the FWS or CDFW. Thus, mark-recapture protocols could not be implemented. Future reports will contain a mark-recapture analysis, pending approval of handling permits. Alternative analysis packages may be considered (as opposed to Program MARK); see **Section 4.4** for additional discussion of potential statistical analyses.

Project mortality estimates rely on measuring a daily mortality rate that can be used as the basis for all mortality estimates. To calculate the corrected project mortality estimate, we did not count all mortalities observed during day 1 of the 7-day search period under the assumption that the those mortalities represent "bleed through" from the period prior to 24 hours preceding the first search. To accurately generate a rate, all mortalities used for this analysis need to have occurred within the 24 hours preceding discovery. Mortalities observed during the subsequent 6 days were then up-corrected to adjust for time not searched

---

[1] AIC measures the relative quality of a given model by assessing both the model's complexity as well as the model goodness-of-fit to the observed data. Lower AIC values indicate higher quality models. Typically AIC values are compared among several possible models to select the "best" model or models.

(since the search period captured 6 out of 28, 30 or 31 days each month), producing a time-corrected mortality estimate for each month.

Because taxonomic analyses do not use a rate, but are instead only concerned with the overall breakdown in mortalities, these analyses used all recorded mortality data, including those mortalities observed during day 1 of the 7-day search period. The use of these data from day one assumes that there is not persistence bias for different taxa of birds. Once scavenger removal trials are approved, this assumption can be tested and analyses will be adjusted if necessary.

3 Results

3.1 Overall Mortalities Observed

The first three months of surveys for 2014 were conducted from August 23-29, 2014; September 21-27, 2014; and, October 19-25, 2014. A total of 21 avian mortalities were recorded. Eight (8) of these observed mortalities were recorded as "feather spots". **Table 1** provides a breakdown of mortalities by sampling period.

Table 1 – Observed Mortalities by Sampling Period

Mortality Type	August (8/23/14 – 8/29/14)	September (9/21/14 – 9/27/14)	October (10/19/14 – 10/25/14)	Aug.-Oct. 2014 TOTAL
Feather Spot Mortalities	0	2	6	8
Non-Feather Spot Mortalities	6	1	6	13
Total Mortalities	*6*	*3*	*12*	*21*

The inclusion of feather spots as observed mortalities is based on standard mortality monitoring protocols, which were largely developed for the wind energy industry. At wind energy facilities, the speed of the spinning blades can result in mortalities that leave very little detectible carcass behind, including only feather spots. Inclusion of feather spots as recorded mortalities at these facilities was intended to conservatively include mortalities caused by blade strikes that might otherwise go unrecorded. Potential bias resulting from the inclusion of feather spots in mortality data can arise from feather spots meeting the definition of a mortality but not actually resulting from an avian mortality. This bias can lead to overestimates of mortality rates. This bias is problematic in situations where feathers are commonly deposited in non-mortality related events but get included as incidents of avian morality (e.g. in and around common roost or perch sites, near active nests, etc.). Feather spots may also be caused by predation or attempted-predation events within a survey area. Observers used discretion when encountering feather spots to help mitigate this bias. Feather spots that strongly indicated a deposition of feathers that was unrelated to an avian mortality or injury were excluded from the database; in instances where observers were uncertain, the feathers spots were recorded as mortalities in order to be conservative. All of the following analyses present results that both include and exclude feather spots to present the full range of possible mortalities.

3.2 Effective Transect Width

DISTANCE analyses were performed using the data pooled across the three-month sampling period and **Tables 2-5** present the results of the DISTANCE analysis. It is important to note several models had errors likely arising from small sample sizes. These errors included model parameters being constrained to obtain monotonicity[2], parameters at lower bounds[3] and highly correlated parameters. Models were run that included and excluded feather spot as well as models that truncated the data and models that employed no truncation.

---

[2] DISTANCE analyses rely on the modeling of a detection function. This detection function models the change in probability of detecting a carcass as the distance from the transect increases. This type of modelling relies on the assumption that the detection function is monotonic. Monotonic means that the probability of detection *only* changes in one direction (decreases) with increasing distance from the transect. If the detection probability goes up and down as distance from the transect increases, then the results violate this assumption of monotonicity. Program DISTANCE automatically constrains certain model parameters to obtain monotonicity but the resulting model may have a poor fit to the observed data.

[3] Similar error to footnote 2.

The a priori[4] estimate of effective transect width was approximately 8.4 meters (this represents the width of two panel rows measured from the pier of the panel immediately east of the designated transects to the pier of the second panel to the west of the transect). Generally, the most likely models were consistent with or exceeded that assumption. Sample sizes were small for all models run this quarter and model results should be used with some caution. Many of the errors encountered are likely the result of small sample sizes.

Table 2 – Distance Analysis Results – includes feather spots; no truncation

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Uniform – Cosine*	2	138.56	0.00	0.103	0.056-0.189	14.92
Half-Normal – Hermite**	1	140.02	1.46	0.089	0.053-0.151	17.18
Half-Normal – Polynomial	1	140.02	1.46	0.089	0.053-0.151	17.18
Uniform – Polynomial*	3	140.76	2.20	0.100	0.056-0.178	15.33
Hazard - Cosine	--	--	--	--	--	--

*Some parameters were constrained to obtain monotonicity.
**Some parameters are very highly correlated.
***Parameters at lower bounds – model could not run.

Table 3 – Distance Analysis Results – includes feather spots; 5% upper truncation

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Uniform – Cosine*	2	126.68	0.00	0.114	0.061-0.210	12.85
Half-Normal – Hermite**	1	127.29	0.61	0.100	0.058-0.172	14.62
Half-Normal – Polynomial	1	127.29	0.61	0.100	0.058-0.172	14.62
Uniform – Polynomial*	2	128.71	2.03	0.092	0.052-0.163	15.85
Hazard – Cosine***	--	--	--	--	--	--

*Some parameters were constrained to obtain monotonicity.
**Some parameters are very highly correlated.
***Parameters at lower bounds – model could not run.

---

[4] "A priori" hypotheses are those hypothesis developed based on a theoretical and logical understanding of the system in question and not based on empirical results. That is, a priori hypothesis are those generated before any results have been collected.

Table 4 – Distance Analysis Results – excludes feather spots; no truncation

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*	2	90.98	0.00	0.137	0.036-0.522	7.47
Uniform – Cosine**	1	91.80	0.91	0.059	0.032-0.108	17.34
Half Normal – Hermite***	1	92.40	1.52	0.060	0.032-0.112	17.03
Half Normal – Polynomial	1	92.40	1.52	0.060	0.032-0.112	17.03
Uniform – Polynomial**	2	93.59	2.70	0.060	0.030-0.118	17.09

*Some parameters at lower bounds.
**Some parameters were constrained to obtain monotonicity.
.

Table 5 – Distance Analysis Results – excludes feather spots; 5% upper truncation

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*	2	79.96	0.00	0.136	0.035-0.527	6.95
Uniform – Cosine**	1	80.02	0.06	0.067	0.036-0.128	14.08
Half Normal – Hermite***	1	80.61	0.66	0.067	0.035-0.130	14.11
Half Normal – Polynomial	1	80.61	0.66	0.067	0.035-0.130	14.11
Uniform – Polynomial	0	81.64	1.68	0.041	0.024-0.071	23.10

*Some parameters at lower bounds.
**Some parameters were constrained to obtain monotonicity.
*** Some parameters are very highly correlated

3.3 Searcher Bias

As described above, permits allowing observers to handle bird carcasses had not been issued at the time of these surveys. As such, no searcher bias estimates were generated and overall mortality estimates were not adjusted to reflect searcher bias.

3.4 Scavenger Removal Bias

As described above, permits allowing observers to handle bird carcasses had not been issued at the time of these surveys. As such, no scavenger removal trials were completed and overall mortality estimates were not adjusted to reflect scavenger removal bias.

3.5 Corrected Project Mortality Estimate

Results from surveys conducted each month were used to generate discrete mortality estimates for each month surveyed. Monthly and overall project mortality estimates only used data from search days 2-7 (see **Section 2.2**). Monthly mortality estimates were used in order to detect seasonal variations in mortality rates. Also, data are presented to reflect estimates with and without feather spots, as discussed earlier. For the remainder of this section, mortality values are presented as "number of mortalities excluding feather spots"/"number of mortalities inclusive of feather spots".

While results of the DISTANCE analyses were less than conclusive, they were at least consistent with the a priori assumption of a minimum 8.4-meter effective transect width. Transect layout, in consideration of this assumed effective transect width, was designed to sample 10% of the overall PV array area. The time-corrected mortality estimates for each month were again up-corrected to account for the area not surveyed. Since no searcher efficiency or scavenger removal bias corrections were performed, this time- and area-corrected mortality estimate represents the overall monthly project mortality estimate. Mortality estimates were rounded to the nearest whole number. **Table 6** summarizes the corrected mortality estimates by month.

3.5.1 August Mortalities

A total of 6/6 mortalities were detected during days 2-7 of the August surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in August) and area surveyed, the overall monthly project mortality estimate for August was 310/310.

3.5.2 September Mortalities

A total of 0/0 mortalities were detected during days 2-7 of the September surveys. Therefore, the overall monthly project mortality estimate for September was 0/0.

3.5.3 October Mortalities

A total of 3/7 mortalities were detected during days 2-7 of the October surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in October) and area surveyed, the overall monthly project mortality estimate for June was 155/362.

3.5.4 August - October 2014 Corrected Mortality Estimates

After applying time and area corrections to the mortality counts for each month the overall project mortality estimate for the period August to October of 2014 is 465/672.

Table 6 – Corrected Mortalities by Month

	August		September		October		Aug.-Oct. Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 2-7)	6	6	0	0	3	7	9	13
Corrected Mortality Estimate	310	310	0	0	155	362	465	672

3.6 Taxonomic Composition of Observed Mortalities

The following analyses use all observed mortalities including those detected on search day 1 since the taxonomic composition is not a rate-dependent analysis (see **Section 2.2**).

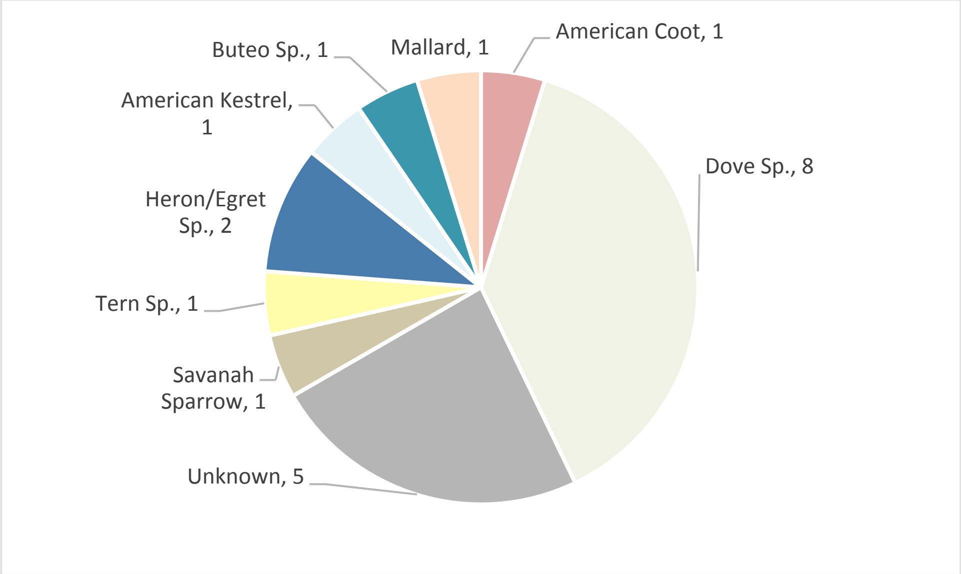
Table 7 – Raw Mortalities by Month (includes data from all search days)

	August		September		October		Aug.-Oct. Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 1-7)	6	6	1	3	6	12	13	21

3.6.1 Mortalities Including Feather Spots

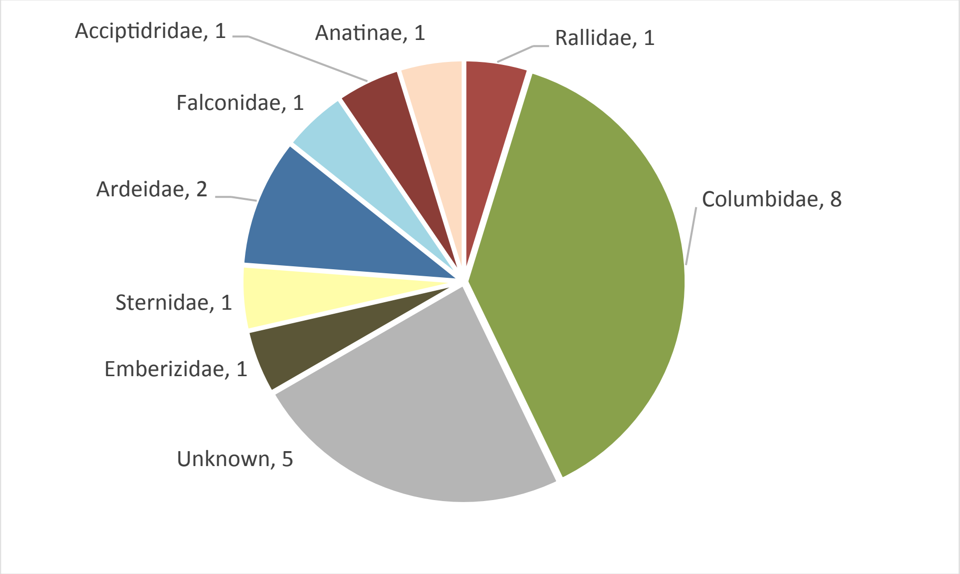
A total of 21 mortalities were observed when feather spots were included in the data set. Eleven (11) of these mortalities (52%) could not be identified to species. The 10 carcasses that could be identified to species each represents a unique species – no single species was more common than any others. **Figure 2** presents the breakdown of observed mortalities by species.

Figure 2 – Mortalities by Species (includes feather spots)



Sixteen (16) of the 21 observed mortalities could be identified to the family level. Of these 16 mortalities, the families Columbidae (8 mortalities; 50% of mortalities identified to family level) and Ardeidae (2 mortalities; 13% of mortalities identified to family level) were the most commonly observed mortalities. **Figure 3** presents the breakdown of observed mortalities by family.

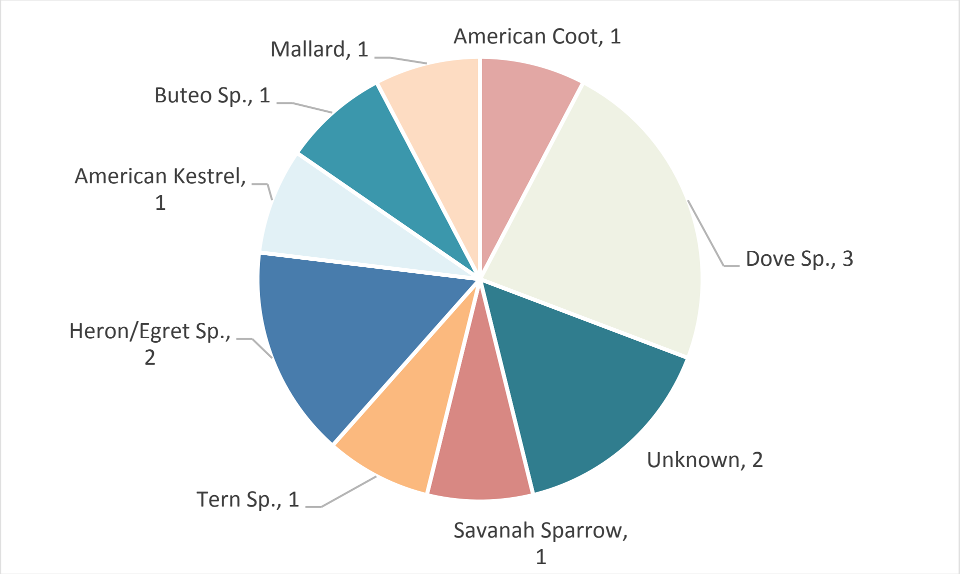
Figure 3 – Mortalities by Family (includes feather spots)



3.6.2 Mortalities Excluding Feather Spots

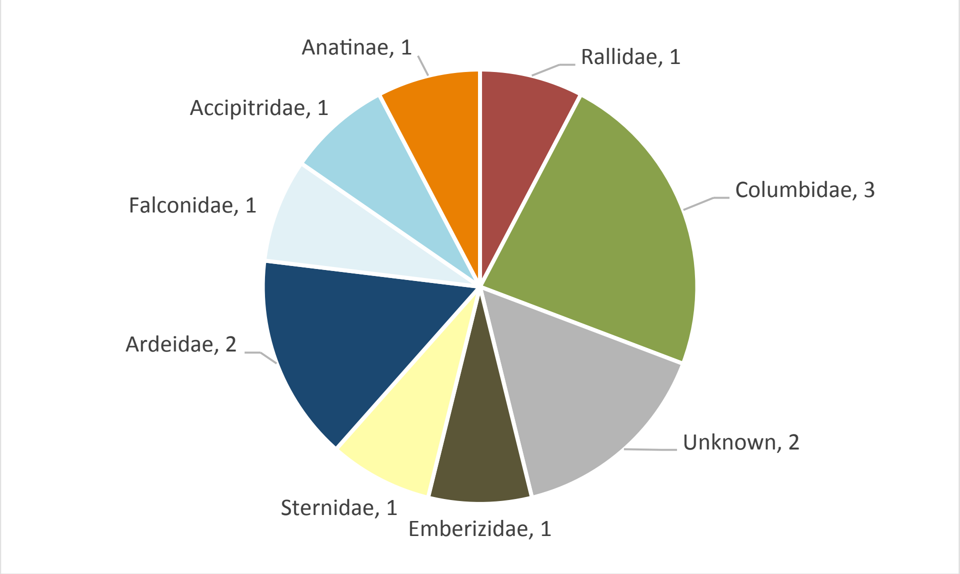
A total of 13 mortalities were observed when feather spots were excluded from the data set. Five (5) of these mortalities (38%) could be identified to species. The 8 carcasses that could be identified to species each represents a unique species – no single species was more common than any others. **Figure 4** presents the breakdown of observed mortalities by species.

Figure 4 - Mortalities by Species (excludes feather spots)



Eleven (11) of the 13 observed mortalities could be identified to the family level. Of these mortalities, the families Columbidae (3 mortalities; 27% of mortalities identified to family level) and Ardeidae (2 mortalities; 18% of mortalities identified to family level) were the most commonly observed. **Figure 5** presents the breakdown of observed mortalities by family.

Figure 5 – Mortalities by Family (excludes feather spots)



4 Discussion

4.1 Mortality Estimates

Searcher efficiency and scavenger removal trials can only result in up-correcting results (since searchers cannot detect >100% of carcasses and scavengers are unlikely to deposit carcasses within a survey area). Because searcher efficiency and scavenger removal trials were not performed during the second quarter surveys, the degree of underestimation is unknown. As soon as the Centinela Solar Energy Project receives a SPUT permit from FWS and a SCP from CDFW, searcher efficiency and scavenger removal trials will begin.

4.2 Seasonal Variations

There was strong variation in estimated mortality rates from month to month. The September estimated mortality rate was 0, whereas August and October estimated mortality rates were significantly higher (310/310 and 155/362, respectively). It should be noted that the sample size of observed mortalities was low this quarter (especially relative to the magnitude of the correction factors), making these types of analyses difficult to achieve high confidence levels.

4.3 Recommended Methodological Changes

The following changes are recommended to improve survey efficiency and accuracy as well as to improve data collection and analysis.

1. Searcher Efficiency and Scavenger Removal Bias – The results presented in this report are uncorrected for searcher efficiency and scavenger removal. Searcher efficiency at this site is likely very high (near 100%) given the level ground and almost entirely unvegetated environment. As such, the searcher efficiency bias is unlikely to have resulted in a significant underestimate of mortality. However, scavenger removal rates are unknown and could be a source of bias. Numerous potential avian and mammalian scavengers are known to occur in and around the project site. Until scavenger removal trials are performed, the magnitude of this source of bias is unknown. As soon as state and federal permits are approved, these trials will be initiated.
2. Alternative Statistical Analysis Packages – Since the publication of the project BBCS (Heritage 2012), a potentially more robust mortality estimation program has been released for use with the statistical analysis software Program R, called *facilityCMR*. This program offers several potential advantages over the Warren-Hicks Estimator including analyzing covariance between searcher efficiency and scavenger removal rates and allowing for analysis of carcass condition. We propose using the *facilityCMR* software in future analyses, as soon as searcher efficiency and scavenger removal trials are permitted. This would be used in lieu of the Warren-Hicks Estimator and Program MARK and better reflects current FWS guidance on mortality studies at solar facilities.

5 Literature Cited

APLIC (Avian Power Line Interaction Committee). 2006. Suggested practices for avian protection on power lines: The state of the art in 2006. Washington, D.C. and Sacramento, CA: Edison Electric Institute, Avian Power Line Interaction Committee, and California Energy Commission.

California Energy Commission (CEC). 2002. *A Roadmap for PIER Research on Avian Collisions with Power Lines in California*. California Energy Commission Staff Report. December, 2002.

Drewitt, A. L., and R. H. W. Langston. 2006. Assessing the impacts of wind farms on birds. *Ibis.* 148:29-42.

FWS. 2012. Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach. December, 2012. 23pp.

Heritage. 2012. Centinela Solar Energy Project Bird and Bat Conservation Strategy. March, 2012. 150pp.

Hovarth, G., M. Blahò, A. Egri, G. Kriska, I. Seres, and B. Robertson. 2010. Reducing the maladaptive attractiveness of solar panels to polarotactic insects. *Conservation Biol.* 24(6): 1644-1653.

Janss, G. F. E. 2000. Avian mortality from power lines: A morphologic approach of a species-specific mortality. *Biological Conservation* 95: 353-359.

Manville II, A. M. 2005. Bird strikes and electrocution at power lines, communication towers, and wind turbines: State of the art and state of the science – next steps toward mitigation. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Martin, G.R. and J.M. Shaw. 2010. Bird collisions with power lines: Failing to see the way ahead? *Biological Conservation* 143: 2695–2702.

McCrary, M. D., R. L. McKernan, R. W. Schreiber, W. D. Wagner, and T. C. Sciarrota. 1986. Avian mortality at a solar energy power plant. *J. Field Ornithol.* 57(2): 135-141.

Rusz, P. J., H. H. Prince, R. D. Rusz, and G. A. Dawson. 1986. Bird collisions with transmission lines near power plant cooling pond. *Wildlife Society Bulletin*. 14: 441-444.

Savereno, A. J., L .A. Savereno, R. Boettcher, and S. M. Haig. 1996. Avian behavior and mortality at power lines in coastal South Carolina. *Wildlife Society Bulletin*. 24: 636-648.

Post-construction Avian Mortality Monitoring Report
Centinela Solar Energy Project

Third Quarterly Report (February-March-April, 2015)

Prepared By:

Heritage Environmental Consultants, LLC

Table of Contents

1 Introduction

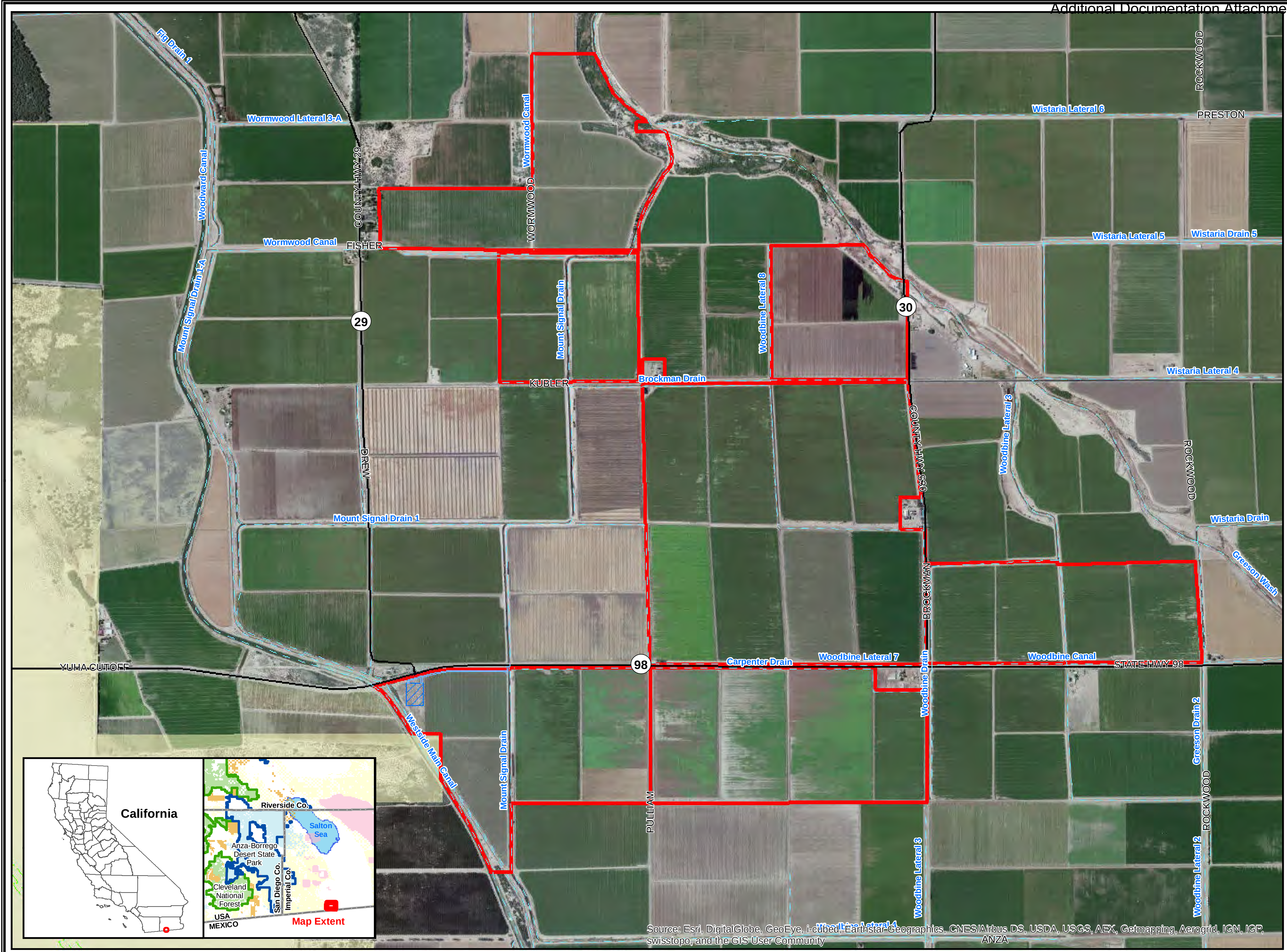
The Centinela Solar Energy (CSE) Project is a solar photovoltaic (PV) energy generating facility (Solar Energy Facility) located on private lands in southern Imperial County, California.

A Bird and Bat Conservation Strategy (BBCS) was prepared that addresses activities potentially occurring during construction and operation of the Project (Heritage 2012). The BBCS was reviewed and approved by the U.S. Fish and Wildlife Service (FWS), California Department of Fish and Wildlife (CDFW), and the Bureau of Land Management (BLM). The purpose of the Centinela BBCS was to develop and implement a program to identify and avoid risks to avian and bat species that could result from construction and operation of the Project. The goal of this BBCS was to implement a series of best practices, in order to construct and operate the Project to avoid or reduce risk to birds, bats and their habitats.

The post-construction avian mortality monitoring program was set up to comply with the methodology prescribed in the BBCS (Heritage 2012). The methodology is described in Section 6.1 of the BBCS and was approved by the FWS and CDFW. Monitoring began in August 2014 just after completion of construction. Monitoring is required for one year following construction. Construction was completed at the end of July 2014. Four quarterly reports documenting results of the monitoring program are required. This report is the third of four quarterly reports.

1.1 Project Description

The CSE Facility (**Figure 1**) is comprised of approximately 2,067 acres of private land, of which approximately 1,861 acres were formerly in active agricultural production. The generation capacity of the CSE Facility is a nominal 275 megawatts alternating current. The CSE Facility uses solar photovoltaic (PV) technology and electronic DC-to-AC power conditioning equipment (inverters) to produce three-phase, 60 Hz, utility-grade electric power directly from sunlight. The PV modules are mounted on racks supported by steel support structures that are anchored or driven into the ground. The PV module racks are a single-axis-tracking system aligned on a north-south axis and that tracks the sun from east to west. The CSE Facility substation is in the southern portion of the CSE Facility site, immediately south of SR 98, approximately mid-way between Pulliam Road and Brockman Road. The purpose of the CSE Facility substation is to aggregate the AC collector lines and increase the voltage of the electricity to 230-kV for connection with the electric grid. The substation includes transformers, medium-voltage and high-voltage circuit breakers, capacitor banks electrical bus work, meters, disconnect switches and an electrical control house. To protect against over-voltages caused by lightning strikes, lightning arresters, overhead shield wires, and lightning masts are installed in the substation.



Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

ANZA

Centinela Solar Energy, LLC

Figure 1
Project Location

Legend

- Major Road
- Stream, Major Canal and/or Irrigation Canal
- County Boundary
- ▨ Ring Bus Switchyard
- 🟥 CSE Facility Parcel
- 🟦 Major Water Body
- 🟩 Cleveland National Forest Congressional Boundary
- 🟦 State Park Boundary

Jurisdictional Land Ownership

- 🟨 Bureau of Land Management Land
- 🟩 U.S. Forest Service Land
- 🟪 Department of Defense Land
- 🟦 State Land
- 🟧 Indian Land

0 0.5
Miles

State Plane Coordinate System
California Zone 6, NAD 83
Lambert Conformal Conic Projection
1983 North American Datum
Linear Unit: Foot US

11-25-14

2 Methods

Monitoring of the project was performed in order to document and report avian mortalities and identify areas of concern by tracking both the specific locations where mortalities occur as well as the extent of such mortalities. The monitoring program for the Project is based on the FWS guidance entitled "Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach" (FWS 2012) with modifications, and was approved by FWS.

2.1 Transect Sampling

Sampling transects were established for the entire solar field and positioned to result in approximately 10-percent coverage of the site with no less than eight transects placed within the solar field itself. Transect selection was systematic randomized. The entire perimeter of the panel arrays was also surveyed during each survey period in addition to the interior transects.

Transects were surveyed for 7 consecutive days each month and each transect was surveyed once daily. One qualified observer walked along the pre-determined transects searching for bird/bat carcasses. When a carcass was observed, a GPS location was recorded at the carcass, the species was identified, the perpendicular distance from the transect to the carcass was measured, and information regarding carcass condition per FWS (2012) was recorded using paper datasheets. Once data were collected at a carcass, the observer returned to the pre-determined transect and continued with the survey.

The original protocol stated that each carcass would be marked uniquely and inconspicuously with tape and permanent marker to assess "recapture" rates. However, both the state scientific collection permit (SCP) and the federal special purpose utility permit (SPUT) enabling surveyors to handle carcasses were still being processed during this sampling period so no mark-recapture data was collected. Scavenger removal trials and searcher efficiency trials were also not performed due to the lack of handling permits. Therefore, all estimates presented in this report represent mortality estimates that are uncorrected for observer bias and scavenger removal rates. Future reports will address these biases, once permits are approved by the FWS and CDFW.

2.2 Analysis

Two primary analyses were proposed for mortality estimation. The first analysis used Program DISTANCE to determine the most effective transect width to search for carcasses. Distance models examined a variety of detection functions and used Aikake's Information Criterion (AIC)[1] for model selection. Models were run using both no truncation as well as 5% upper truncation to remove outliers. Specific model components are discussed in **Section 3.2**.

The second analysis would use Program MARK to estimate total number of mortalities controlling for detection rate, scavenging rate, and proximity to Project components. However, as described above, handling permits have not been approved by either the FWS or CDFW. Thus, mark-recapture protocols could not be implemented. Future reports will contain a mark-recapture analysis, pending approval of handling permits. Alternative analysis packages may be considered (as opposed to Program MARK); see **Section 4.4** for additional discussion of potential statistical analyses.

Project mortality estimates rely on measuring a daily mortality rate that can be used as the basis for all mortality estimates. To calculate the corrected project mortality estimate, we did not count all mortalities observed during day 1 of the 7-day search period under the assumption that some of those mortalities represent "bleed through" from the period prior to 24 hours preceding the first search. To accurately generate a rate, all mortalities used for this analysis need to have occurred within the 24 hours preceding discovery. Mortalities observed during the subsequent 6 days were then up-corrected to adjust for time

---

[1] AIC measures the relative quality of a given model by assessing both the model's complexity as well as the model goodness-of-fit to the observed data. Lower AIC values indicate higher quality models. Typically AIC values are compared among several possible models to select the "best" model or models.

not searched (since the search period captured 6 out of 28, 30 or 31 days each month), producing a time-corrected mortality estimate for each month.

Because taxonomic analyses do not use a rate, but are instead only concerned with the overall breakdown in mortalities, these analyses used all recorded mortality data, including those mortalities observed during day 1 of the 7-day search period. The use of these data from day one assumes that there is not persistence bias for different taxa of birds. Once scavenger removal trials are approved, this assumption can be tested and analyses will be adjusted if necessary.

3 Results

3.1 Overall Mortalities Observed

The three months of surveys were conducted from February 18-24, 2015; March 18-24, 2015; and, April 22-28, 2015. A total of 13 avian mortalities were recorded. Five (5) of these observed mortalities were recorded as "feather spots". **Table 1** provides a breakdown of mortalities by sampling period.

Table 1 – Observed Mortalities by Sampling Period

Mortality Type	February (2/18/15 – 2/24/15)	March (2/18/15 – 2/24/15)	April (4/22/15 – 4/28/15)	Feb.-Apr. 2015 TOTAL
Feather Spot Mortalities	1	1	3	5
Non-Feather Spot Mortalities	3	2	3	8
Total Mortalities	*4*	*3*	*6*	*13*

The inclusion of feather spots as observed mortalities is based on standard mortality monitoring protocols, which were largely developed for the wind energy industry. At wind energy facilities, the speed of the spinning blades can result in mortalities that leave very little detectible carcass behind, including only feather spots. Inclusion of feather spots as recorded mortalities at these facilities was intended to conservatively include mortalities caused by blade strikes that might otherwise go unrecorded. Potential bias resulting from the inclusion of feather spots in mortality data can arise from feather spots meeting the definition of a mortality but not actually resulting from an avian mortality. This bias can lead to overestimates of mortality rates. This bias is problematic in situations where feathers are commonly deposited in non-mortality related events but get included as incidents of avian morality (e.g. in and around common roost or perch sites, near active nests, etc.). Feather spots may also be caused by predation or attempted-predation events within a survey area. Observers used discretion when encountering feather spots to help mitigate this bias. Feather spots that strongly indicated a deposition of feathers that was unrelated to an avian mortality or injury were excluded from the database; in instances where observers were uncertain, the feathers spots were recorded as mortalities in order to be conservative. All of the following analyses present results that both include and exclude feather spots to present the full range of possible mortalities.

3.2 Effective Transect Width

DISTANCE analyses were performed using the data pooled across the three-month sampling period and **Tables 2-5** present the results of the DISTANCE analysis. It is important to note several models had errors likely arising from small sample sizes. These errors included model parameters being constrained to obtain monotonicity[2], parameters at lower bounds[3] and highly correlated parameters. Models were run that included and excluded feather spot as well as models that truncated the data and models that employed no truncation.

---

[2] DISTANCE analyses rely on the modeling of a detection function. This detection function models the change in probability of detecting a carcass as the distance from the transect increases. This type of modelling relies on the assumption that the detection function is monotonic. Monotonic means that the probability of detection *only* changes in one direction (decreases) with increasing distance from the transect. If the detection probability goes up and down as distance from the transect increases, then the results violate this assumption of monotonicity. Program DISTANCE automatically constrains certain model parameters to obtain monotonicity but the resulting model may have a poor fit to the observed data.

[3] Similar error to footnote 2.

The a priori[4] estimate of effective transect width was approximately 8.4 meters (this represents the width of two panel rows measured from the pier of the panel immediately east of the designated transects to the pier of the second panel to the west of the transect). Generally, the most likely models were consistent with or exceeded that assumption. Sample sizes were small for all models run this quarter and model results should be used with caution. Many of the errors encountered are likely the result of very small sample sizes.

Table 2 – Distance Analysis Results – includes feather spots; no truncation

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*	2	85.28	0.00	0.000	0.000-0.001	4.27
Uniform – Cosine**	2	90.60	5.32	0.000	0.000-0.000	17.23
Half-Normal – Hermite***	1	91.32	6.04	0.000	0.000-0.000	20.45
Half-Normal – Polynomial	1	91.32	6.04	0.000	0.000-0.000	20.45
Uniform – Polynomial**	2	92.54	7.26	0.000	0.000-0.000	21.33

*Parameters at lower bounds.
**Some parameters were constrained to obtain monotonicity.
***Some parameters are very highly correlated.

Table 3 – Distance Analysis Results – includes feather spots; 5% upper truncation

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*	2	73.83	0.00	0.000	0.000-0.001	3.82
Uniform – Cosine	1	78.51	4.68	0.000	0.000-0.000	15.86
Half-Normal – Hermite**	1	78.51	4.68	0.000	0.000-0.000	15.86
Half-Normal – Polynomial	1	78.51	4.68	0.000	0.000-0.000	15.86
Uniform – Polynomial***	2	79.66	5.83	0.000	0.000-0.000	16.47

*Parameters at lower bounds.
**Some parameters are very highly correlated.
***Some parameters were constrained to obtain monotonicity.

---

[4] "A priori" hypotheses are those hypothesis developed based on a theoretical and logical understanding of the system in question and not based on empirical results. That is, a priori hypothesis are those generated before any results have been collected.

Table 4 – Distance Analysis Results – excludes feather spots; no truncation

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*, **	2	56.55	0.00	0.000	0.000-0.001	4.76
Uniform – Polynomial**	0	57.64	1.10	0.000	0.000-0.000	36.70
Uniform – Cosine**	0	57.64	1.10	0.000	0.000-0.000	36.70
Half-Normal – Hermite**, ***	1	59.19	2.64	0.000	0.000-0.000	28.50
Half Normal – Polynomial**	1	59.19	2.64	0.000	0.000-0.000	28.50

*Some parameters at lower bounds.
**Very small sample size.
***Some parameters are very highly correlated.

Table 5 – Distance Analysis Results – excludes feather spots; 5% upper truncation

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*, **	2	56.55	0.00	0.000	0.000-0.001	4.76
Uniform – Polynomial**	0	57.64	1.10	0.000	0.000-0.000	36.70
Uniform – Cosine**	0	57.64	1.10	0.000	0.000-0.000	36.70
Half-Normal – Hermite**, ***	1	59.19	2.64	0.000	0.000-0.000	28.50
Half Normal – Polynomial**	1	59.19	2.64	0.000	0.000-0.000	28.50

*Some parameters at lower bounds.
**Very small sample size.
***Some parameters are very highly correlated.

3.3 Searcher Bias

As described above, permits allowing observers to handle bird carcasses had not been issued at the time of these surveys. As such, no searcher bias estimates were generated and overall mortality estimates were not adjusted to reflect searcher bias.

3.4 Scavenger Removal Bias

As described above, permits allowing observers to handle bird carcasses had not been issued at the time of these surveys. As such, no scavenger removal trials were completed and overall mortality estimates were not adjusted to reflect scavenger removal bias.

3.5 Corrected Project Mortality Estimate

Results from surveys conducted each month were used to generate discrete mortality estimates for each month surveyed. Monthly and overall project mortality estimates only used data from search days 2-7 (see **Section 2.2**). Monthly mortality estimates were used in order to detect seasonal variations in mortality rates. Also, data are presented to reflect estimates with and without feather spots, as discussed earlier. For the remainder of this section, mortality values are presented as "number of mortalities excluding feather spots"/"number of mortalities inclusive of feather spots".

While results of the DISTANCE analyses were less than conclusive, they were at least consistent with the a priori assumption of a minimum 8.4-meter effective transect width. Transect layout, in consideration of this assumed effective transect width, was designed to sample 10% of the overall PV array area. The time-corrected mortality estimates for each month were again up-corrected to account for the area not surveyed. Since no searcher efficiency or scavenger removal bias corrections were performed, this time- and area-corrected mortality estimate represents the overall monthly project mortality estimate. Mortality estimates were rounded to the nearest whole number. **Table 6** summarizes the corrected mortality estimates by month.

3.5.1 February Mortalities

A total of 1/1 mortalities were detected during days 2-7 of the February surveys. Correcting for time (the 6 day survey period represents approximately 21% of the total days in February) and area surveyed, the overall monthly project mortality estimate for February was 47/47.

3.5.2 March Mortalities

A total of 1/1 mortalities were detected during days 2-7 of the March surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in March) and area surveyed, the overall monthly project mortality estimate for March was 52/52.

3.5.3 April Mortalities

A total of 2/4 mortalities were detected during days 2-7 of the April surveys. Correcting for time (the 6 day survey period represents approximately 20% of the total days in April) and area surveyed, the overall monthly project mortality estimate for January was 100/200.

3.5.4 February – April 2015 Corrected Mortality Estimates

After applying time and area corrections to the mortality counts for each month the overall project mortality estimate for the period February to January of 2015 is 198/298.

Table 6 – Corrected Mortalities by Month

	November		December		January		Nov-Jan. Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 2-7)	1	1	1	1	2	4	4	6
Corrected Mortality Estimate	47	47	52	52	100	200	198	298

3.6 Taxonomic Composition of Observed Mortalities

The following analyses use all observed mortalities including those detected on search day 1 since the taxonomic composition is not a rate-dependent analysis (see **Section 2.2**).

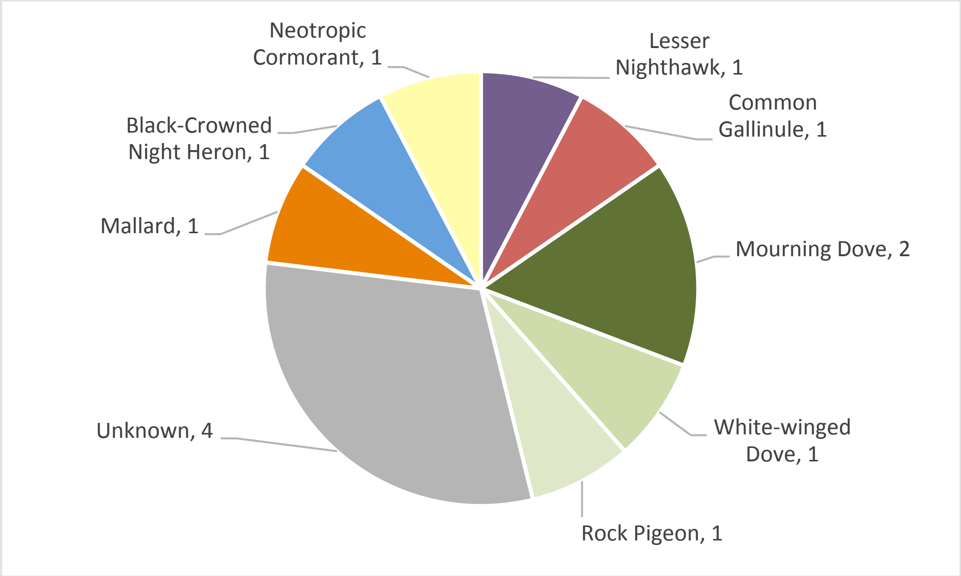
Table 7 – Raw Mortalities by Month (includes data from all search days)

	February		March		April		Feb.-Apr. Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 1-7)	3	4	2	3	3	6	8	13

3.6.1 Mortalities Including Feather Spots

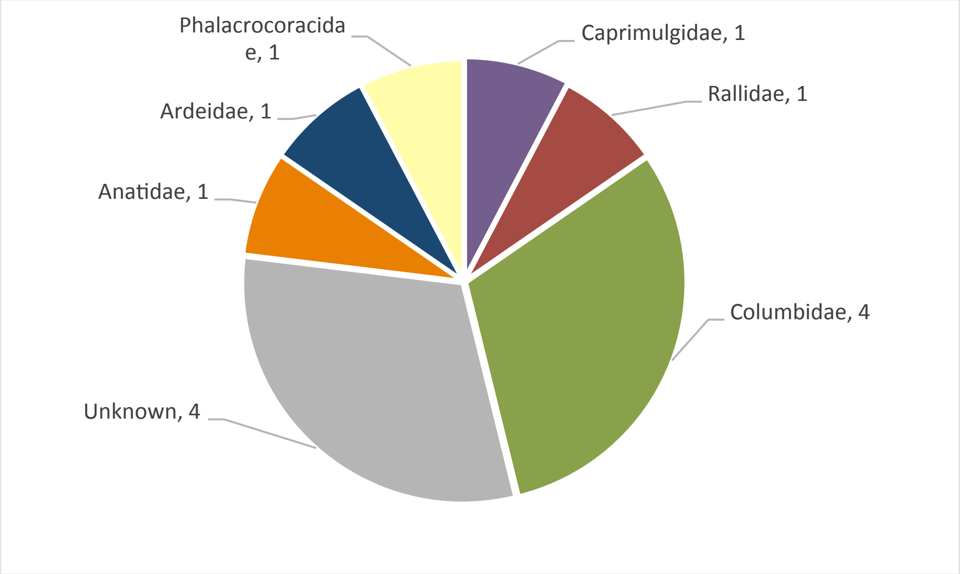
A total of 13 mortalities were observed when feather spots were included in the data set. Four (4) of these mortalities (31%) could not be identified to species. Of the 9 carcasses that could be identified to species, the most commonly observed species was Mourning Dove (*Zenaida macroura*; 2 mortalities; 22% of mortalities identified to species); all other mortalities represented unique species. **Figure 2** presents the breakdown of observed mortalities by species.

Figure 2 – Mortalities by Species (includes feather spots)



Nine (9) of the 13 observed mortalities could be identified to the family level. Of these 9 mortalities, the family Columbidae (4 mortalities; 44% of mortalities identified to family level) was the most commonly observed mortalities. **Figure 3** presents the breakdown of observed mortalities by family.

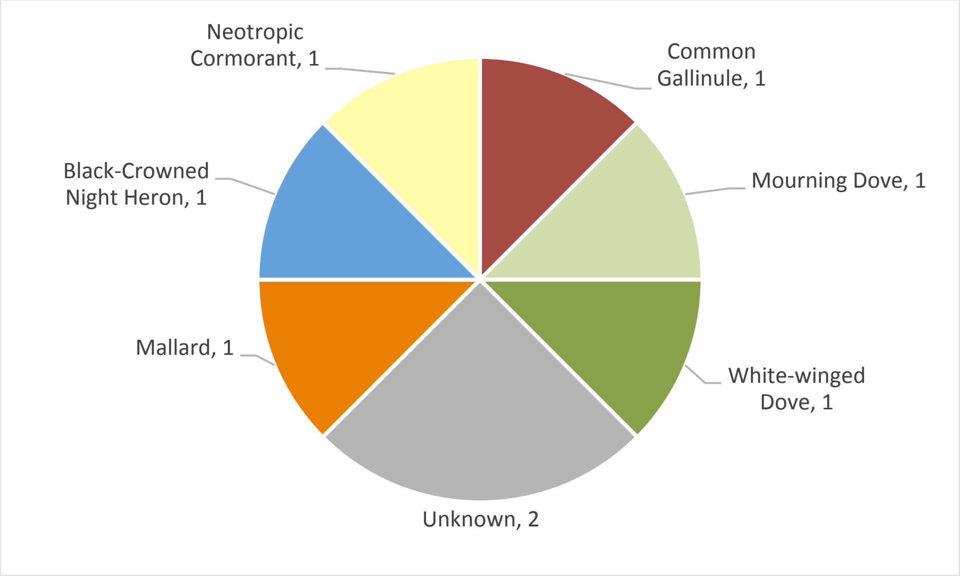
Figure 3 – Mortalities by Family (includes feather spots)



3.6.2 Mortalities Excluding Feather Spots

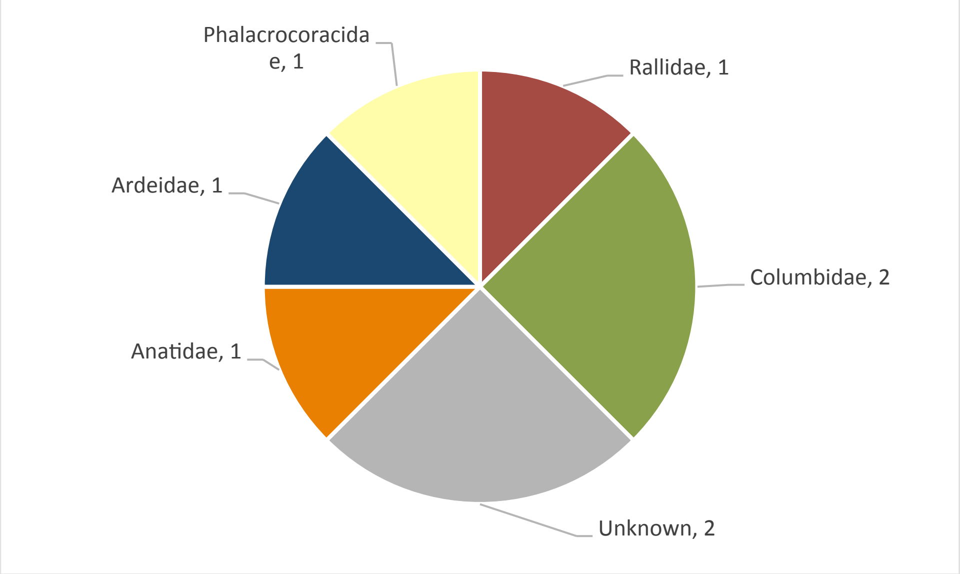
A total of eight (8) mortalities were observed when feather spots were excluded from the data set. Six (6) of these mortalities (75%) could be identified to species. Each of the 6 carcasses that could be identified to species represented the only mortality recorded for that species. **Figure 4** presents the breakdown of observed mortalities by species.

Figure 4 - Mortalities by Species (excludes feather spots)



Six (6) of the 8 observed mortalities could be identified to the family level. Of these mortalities, the family Columbidae (2 mortalities; 25% of mortalities identified to family level) was the most commonly observed. **Figure 5** presents the breakdown of observed mortalities by family.

Figure 5 – Mortalities by Family (excludes feather spots)



4 Discussion

4.1 Mortality Estimates

Searcher efficiency and scavenger removal trials can only result in up-correcting results (since searchers cannot detect >100% of carcasses and scavengers are unlikely to deposit carcasses within a survey area). Because searcher efficiency and scavenger removal trials were not performed during the second quarter surveys, the degree of underestimation is unknown. As soon as the Centinela Solar Energy Project receives a SPUT permit from FWS and a SCP from CDFW, searcher efficiency and scavenger removal trials will begin.

4.2 Seasonal Variations

There was some variation in estimated mortality rates from month to month, especially within the dataset excluding feather-spot mortalities. The February and March estimated mortality rates were 47/47 and 52/52, respectively; whereas the April estimated mortality rate was appreciably higher (100/200). It should be noted that the sample size of observed mortalities was fairly low this quarter (especially relative to the magnitude of the correction factors), making these types of analyses difficult to achieve with high confidence levels.

4.3 Recommended Methodological Changes

The following changes are recommended to improve survey efficiency and accuracy as well as to improve data collection and analysis.

1. Searcher Efficiency and Scavenger Removal Bias – The results presented in this report are uncorrected for searcher efficiency and scavenger removal. Searcher efficiency at this site is likely very high (near 100%) given the level ground and almost entirely unvegetated environment. As such, the searcher efficiency bias is unlikely to have resulted in a significant underestimate of mortality. However, scavenger removal rates are unknown and could be a source of bias. Numerous potential avian and mammalian scavengers are known to occur in and around the project site. Until scavenger removal trials are performed, the magnitude of this source of bias is unknown. As soon as state and federal permits are approved, these trials will be initiated.
2. Alternative Statistical Analysis Packages – Since the publication of the project BBCS (Heritage 2012), a potentially more robust mortality estimation program has been released for use with the statistical analysis software Program R, called *facilityCMR*. This program offers several potential advantages over the Warren-Hicks Estimator including analyzing covariance between searcher efficiency and scavenger removal rates and allowing for analysis of carcass condition. We propose using the *facilityCMR* software in future analyses, as soon as searcher efficiency and scavenger removal trials are permitted. This would be used in lieu of the Warren-Hicks Estimator and Program MARK and better reflects current FWS guidance on mortality studies at solar facilities.

5 Literature Cited

APLIC (Avian Power Line Interaction Committee). 2006. Suggested practices for avian protection on power lines: The state of the art in 2006. Washington, D.C. and Sacramento, CA: Edison Electric Institute, Avian Power Line Interaction Committee, and California Energy Commission.

California Energy Commission (CEC). 2002. *A Roadmap for PIER Research on Avian Collisions with Power Lines in California*. California Energy Commission Staff Report. December, 2002.

Drewitt, A. L., and R. H. W. Langston. 2006. Assessing the impacts of wind farms on birds. *Ibis.* 148:29-42.

FWS. 2012. Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach. December, 2012. 23pp.

Heritage. 2012. Centinela Solar Energy Project Bird and Bat Conservation Strategy. March, 2012. 150pp.

Hovarth, G., M. Blahò, A. Egri, G. Kriska, I. Seres, and B. Robertson. 2010. Reducing the maladaptive attractiveness of solar panels to polarotactic insects. *Conservation Biol.* 24(6): 1644-1653.

Janss, G. F. E. 2000. Avian mortality from power lines: A morphologic approach of a species-specific mortality. *Biological Conservation* 95: 353-359.

Manville II, A. M. 2005. Bird strikes and electrocution at power lines, communication towers, and wind turbines: State of the art and state of the science – next steps toward mitigation. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Martin, G.R. and J.M. Shaw. 2010. Bird collisions with power lines: Failing to see the way ahead? *Biological Conservation* 143: 2695–2702.

McCrary, M. D., R. L. McKernan, R. W. Schreiber, W. D. Wagner, and T. C. Sciarrota. 1986. Avian mortality at a solar energy power plant. *J. Field Ornithol.* 57(2): 135-141.

Rusz, P. J., H. H. Prince, R. D. Rusz, and G. A. Dawson. 1986. Bird collisions with transmission lines near power plant cooling pond. *Wildlife Society Bulletin*. 14: 441-444.

Savereno, A. J., L .A. Savereno, R. Boettcher, and S. M. Haig. 1996. Avian behavior and mortality at power lines in coastal South Carolina. *Wildlife Society Bulletin*. 24: 636-648.

Post-construction Avian Mortality Monitoring Report Centinela Solar Energy Project

---

Second Quarterly Report (November-December 2014,-January 2015)

Prepared By:

Heritage Environmental Consultants, LLC

Table of Contents

1 Introduction

The Centinela Solar Energy (CSE) Project is a solar photovoltaic (PV) energy generating facility (Solar Energy Facility) located on private lands in southern Imperial County, California.

A Bird and Bat Conservation Strategy (BBCS) was prepared that addresses activities potentially occurring during construction and operation of the Project (Heritage 2012). The BBCS was reviewed and approved by the U.S. Fish and Wildlife Service (FWS), California Department of Fish and Wildlife (CDFW), and the Bureau of Land Management (BLM). The purpose of the Centinela BBCS was to develop and implement a program to identify and avoid risks to avian and bat species that could result from construction and operation of the Project. The goal of this BBCS was to implement a series of best practices, in order to construct and operate the Project to avoid or reduce risk to birds, bats and their habitats.

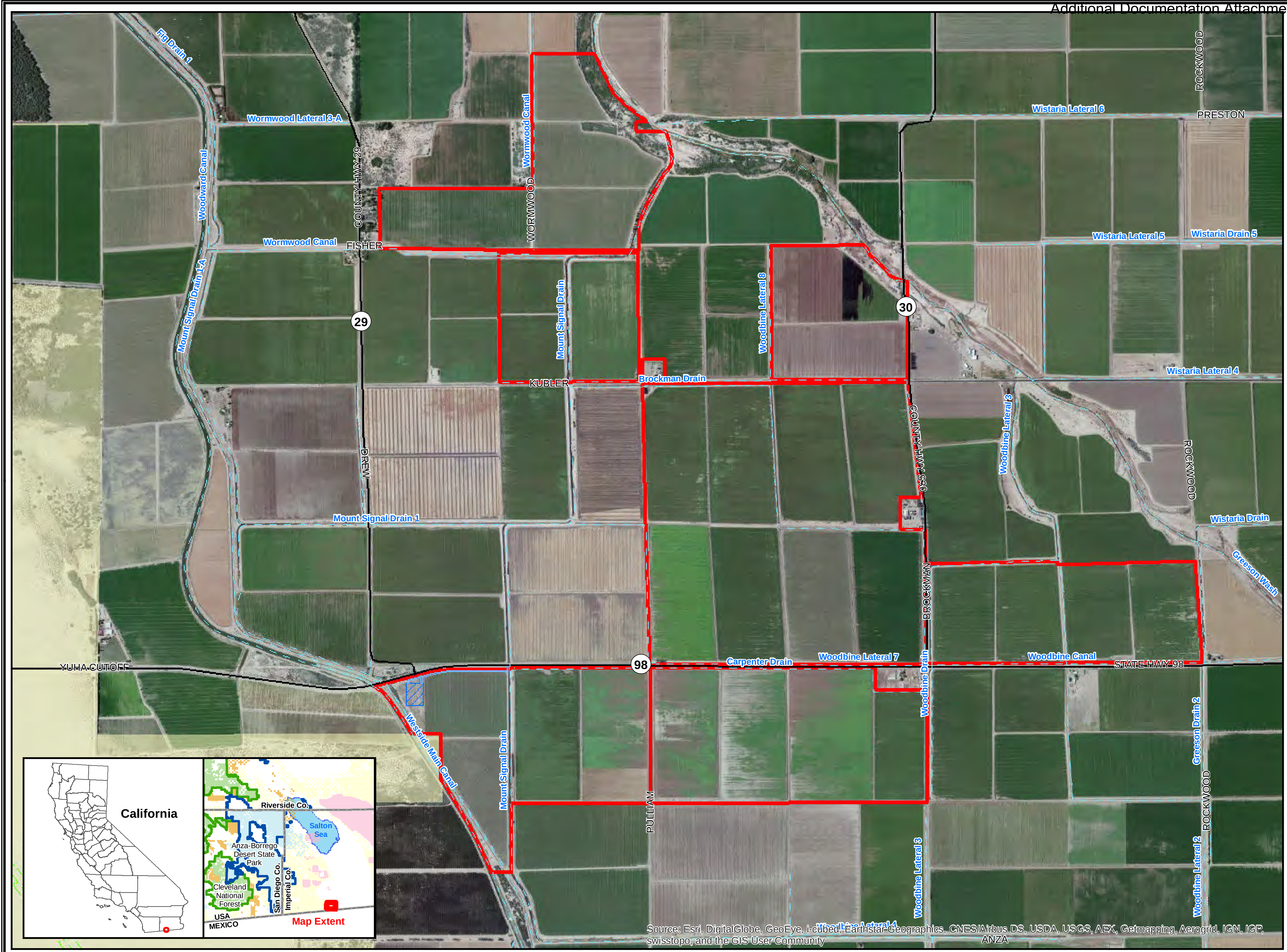
The post-construction avian mortality monitoring program was set up to comply with the methodology prescribed in the BBCS (Heritage 2012). The methodology is described in Section 6.1 of the BBCS and was approved by the FWS and CDFW. Monitoring began in August 2014 just after completion of construction. Monitoring is required for one year following construction. Construction was completed at the end of July 2014. Four quarterly reports documenting results of the monitoring program are required. This report is the second of four quarterly reports.

1.1 Project Description

The CSE Facility (**Figure 1**) is comprised of approximately 2,067 acres of private land, of which approximately 1,861 acres were formerly in active agricultural production. The generation capacity of the CSE Facility is a nominal 275 megawatts alternating current. The CSE Facility uses solar photovoltaic (PV) technology and electronic DC-to-AC power conditioning equipment (inverters) to produce three-phase, 60 Hz, utility-grade electric power directly from sunlight. The PV modules are mounted on racks supported by steel support structures that are anchored or driven into the ground. The PV module racks are a single-axis-tracking system aligned on a north-south axis and that tracks the sun from east to west. The CSE Facility substation is in the southern portion of the CSE Facility site, immediately south of SR 98, approximately mid-way between Pulliam Road and Brockman Road. The purpose of the CSE Facility substation is to aggregate the AC collector lines and increase the voltage of the electricity to 230-kV for connection with the electric grid. The substation includes transformers, medium-voltage and high-voltage circuit breakers, capacitor banks electrical bus work, meters, disconnect switches and an electrical control house. To protect against over-voltages caused by lightning strikes, lightning arresters, overhead shield wires, and lightning masts are installed in the substation.

Centinela Solar Energy, LLC

Figure 1
Project Location



Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Legend

— Major Road
- - Stream, Major Canal and/or Irrigation Canal
- - County Boundary
▨ Ring Bus Switchyard
□ CSE Facility Parcel
🟦 Major Water Body
□ Cleveland National Forest Congressional Boundary
□ State Park Boundary

Jurisdictional Land Ownership

🟨 Bureau of Land Management Land
🟩 U.S. Forest Service Land
🟪 Department of Defense Land
🟦 State Land
🟧 Indian Land

0 0.5
Miles

State Plane Coordinate System
California Zone 6, NAD 83
Lambert Conformal Conic Projection
1983 North American Datum
Linear Unit: Foot US

11-25-14

2 Methods

Monitoring of the project was performed in order to document and report avian mortalities and identify areas of concern by tracking both the specific locations where mortalities occur as well as the extent of such mortalities. The monitoring program for the Project is based on the FWS guidance entitled "Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach" (FWS 2012) with modifications, and was approved by FWS.

2.1 Transect Sampling

Sampling transects were established for the entire solar field and positioned to result in approximately 10-percent coverage of the site with no less than eight transects placed within the solar field itself. Transect selection was systematic randomized. The entire perimeter of the panel arrays was also surveyed during each survey period in addition to the interior transects.

Transects were surveyed for 7 consecutive days each month and each transect was surveyed once daily. One qualified observer walked along the pre-determined transects searching for bird/bat carcasses. When a carcass was observed, a GPS location was recorded at the carcass, the species was identified, the perpendicular distance from the transect to the carcass was measured, and information regarding carcass condition per FWS (2012) was recorded using paper datasheets. Once data were collected at a carcass, the observer returned to the pre-determined transect and continued with the survey.

The original protocol stated that each carcass would be marked uniquely and inconspicuously with tape and permanent marker to assess "recapture" rates. However, both the state scientific collection permit (SCP) and the federal special purpose utility permit (SPUT) enabling surveyors to handle carcasses were still being processed during this sampling period so no mark-recapture data was collected. Scavenger removal trials and searcher efficiency trials were also not performed due to the lack of handling permits. Therefore, all estimates presented in this report represent mortality estimates that are uncorrected for observer bias and scavenger removal rates. Future reports will address these biases, once permits are approved by the FWS and CDFW.

2.2 Analysis

Two primary analyses were proposed for mortality estimation. The first analysis used Program DISTANCE to determine the most effective transect width to search for carcasses. Distance models examined a variety of detection functions and used Aikake's Information Criterion (AIC)[1] for model selection. Models were run using both no truncation as well as 5% upper truncation to remove outliers. Specific model components are discussed in **Section 3.2**.

The second analysis would use Program MARK to estimate total number of mortalities controlling for detection rate, scavenging rate, and proximity to Project components. However, as described above, handling permits have not been approved by either the FWS or CDFW. Thus, mark-recapture protocols could not be implemented. Future reports will contain a mark-recapture analysis, pending approval of handling permits. Alternative analysis packages may be considered (as opposed to Program MARK); see **Section 4.4** for additional discussion of potential statistical analyses.

Project mortality estimates rely on measuring a daily mortality rate that can be used as the basis for all mortality estimates. To calculate the corrected project mortality estimate, we did not count all mortalities observed during day 1 of the 7-day search period under the assumption that the those mortalities represent "bleed through" from the period prior to 24 hours preceding the first search. To accurately generate a rate, all mortalities used for this analysis need to have occurred within the 24 hours preceding discovery. Mortalities observed during the subsequent 6 days were then up-corrected to adjust for time not searched

---

[1] AIC measures the relative quality of a given model by assessing both the model's complexity as well as the model goodness-of-fit to the observed data. Lower AIC values indicate higher quality models. Typically AIC values are compared among several possible models to select the "best" model or models.

(since the search period captured 6 out of 28, 30 or 31 days each month), producing a time-corrected mortality estimate for each month.

Because taxonomic analyses do not use a rate, but are instead only concerned with the overall breakdown in mortalities, these analyses used all recorded mortality data, including those mortalities observed during day 1 of the 7-day search period. The use of these data from day one assumes that there is not persistence bias for different taxa of birds. Once scavenger removal trials are approved, this assumption can be tested and analyses will be adjusted if necessary.

3 Results

3.1 Overall Mortalities Observed

The three months of surveys were conducted from November 19-25, 2014; December 16-22, 2014; and, January 20-26, 2015. A total of 26 avian mortalities were recorded. Nineteen (19) of these observed mortalities were recorded as "feather spots". **Table 1** provides a breakdown of mortalities by sampling period.

Table 1 – Observed Mortalities by Sampling Period

Mortality Type	November (11/19/14 – 11/25/14)	December (12/16/14 – 12/22/14)	January (1/20/15 – 1/26/15)	Nov.-Jan. 2014/2015 TOTAL
Feather Spot Mortalities	3	6	10	19
Non-Feather Spot Mortalities	5	0	3	8
Total Mortalities	*8*	*6*	*13*	*27*

The inclusion of feather spots as observed mortalities is based on standard mortality monitoring protocols, which were largely developed for the wind energy industry. At wind energy facilities, the speed of the spinning blades can result in mortalities that leave very little detectible carcass behind, including only feather spots. Inclusion of feather spots as recorded mortalities at these facilities was intended to conservatively include mortalities caused by blade strikes that might otherwise go unrecorded. Potential bias resulting from the inclusion of feather spots in mortality data can arise from feather spots meeting the definition of a mortality but not actually resulting from an avian mortality. This bias can lead to overestimates of mortality rates. This bias is problematic in situations where feathers are commonly deposited in non-mortality related events but get included as incidents of avian morality (e.g. in and around common roost or perch sites, near active nests, etc.). Feather spots may also be caused by predation or attempted-predation events within a survey area. Observers used discretion when encountering feather spots to help mitigate this bias. Feather spots that strongly indicated a deposition of feathers that was unrelated to an avian mortality or injury were excluded from the database; in instances where observers were uncertain, the feathers spots were recorded as mortalities in order to be conservative. All of the following analyses present results that both include and exclude feather spots to present the full range of possible mortalities.

3.2 Effective Transect Width

DISTANCE analyses were performed using the data pooled across the three-month sampling period and **Tables 2-5** present the results of the DISTANCE analysis. It is important to note several models had errors likely arising from small sample sizes. These errors included model parameters being constrained to obtain monotonicity[2], parameters at lower bounds[3] and highly correlated parameters. Models were run that included and excluded feather spot as well as models that truncated the data and models that employed no truncation.

---

[2] DISTANCE analyses rely on the modeling of a detection function. This detection function models the change in probability of detecting a carcass as the distance from the transect increases. This type of modelling relies on the assumption that the detection function is monotonic. Monotonic means that the probability of detection *only* changes in one direction (decreases) with increasing distance from the transect. If the detection probability goes up and down as distance from the transect increases, then the results violate this assumption of monotonicity. Program DISTANCE automatically constrains certain model parameters to obtain monotonicity but the resulting model may have a poor fit to the observed data.

[3] Similar error to footnote 2.

The a priori[4] estimate of effective transect width was approximately 8.4 meters (this represents the width of two panel rows measured from the pier of the panel immediately east of the designated transects to the pier of the second panel to the west of the transect). Generally, the most likely models were consistent with or exceeded that assumption. Sample sizes were small for all models run this quarter and model results should be used with some caution. Many of the errors encountered are likely the result of small sample sizes.

Table 2 – Distance Analysis Results – includes feather spots; no truncation

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Half-Normal – Polynomial	1	142.98	0.00	0.000	0.000-0.000	10.67
Half-Normal – Hermite*	1	142.98	0.00	0.000	0.000-0.000	10.67
Hazard – Cosine**	2	144.08	1.10	0.000	0.000-0.000	6.17
Uniform – Cosine***	3	163.35	20.37	0.000	0.000-0.000	12.86
Uniform – Polynomial*,***,****	4	165.80	22.82	0.000	0.000-0.000	13.99

*Some parameters are very highly correlated.
**Parameters at lower bounds.
***Some parameters were constrained to obtain monotonicity.
****Convergence failure.

Table 3 – Distance Analysis Results – includes feather spots; 5% upper truncation

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Uniform – Cosine	1	142.60	0.00	0.000	0.000-0.000	11.49
Half-Normal – Polynomial	1	142.98	0.39	0.000	0.000-0.000	10.67
Half-Normal – Hermite*	1	142.98	0.39	0.000	0.000-0.000	10.67
Uniform – Polynomial**	2	143.53	0.93	0.000	0.000-0.000	11.10
Hazard – Cosine***	2	144.08	1.48	0.000	0.000-0.001	6.17

*Some parameters are very highly correlated.
**Some parameters were constrained to obtain monotonicity.
***Parameters at lower bounds.

---

[4] "A priori" hypotheses are those hypothesis developed based on a theoretical and logical understanding of the system in question and not based on empirical results. That is, a priori hypothesis are those generated before any results have been collected.

Table 4 – Distance Analysis Results – excludes feather spots; no truncation

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*, **, ***	2	50.88	0.00	0.000	0.000-0.001	6.59
Uniform – Cosine**, ***	2	51.66	0.77	0.000	0.000-0.000	19.54
Half Normal – Polynomial***	1	52.61	1.72	0.000	0.000-0.000	24.24
Half-normal – Hermite***, ****	1	52.61	1.72	0.000	0.000-0.000	24.24
Uniform – Polynomial***	0	53.17	2.28	0.00	0.00-0.00	44.60

*Some parameters at lower bounds.
**Some parameters were constrained to obtain monotonicity.
***Very small sample size.
****Some parameters are very highly correlated.

Table 5 – Distance Analysis Results – excludes feather spots; 5% upper truncation

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*, **, ***	2	50.88	0.00	0.000	0.000-0.001	6.59
Uniform – Cosine*, **,	2	51.66	0.77	0.000	0.000-0.000	19.54
Half Normal – Polynomial***	1	52.61	1.72	0.000	0.000-0.000	24.24
Half-normal – Hermite***, ****	1	52.61	1.72	0.000	0.000-0.000	24.24
Uniform – Polynomial***	0	53.17	2.28	0.00	0.00-0.00	44.60

*Some parameters at lower bounds.
**Some parameters were constrained to obtain monotonicity.
***Very small sample size
****Some parameters are very highly correlated

3.3 Searcher Bias

As described above, permits allowing observers to handle bird carcasses had not been issued at the time of these surveys. As such, no searcher bias estimates were generated and overall mortality estimates were not adjusted to reflect searcher bias.

3.4 Scavenger Removal Bias

As described above, permits allowing observers to handle bird carcasses had not been issued at the time of these surveys. As such, no scavenger removal trials were completed and overall mortality estimates were not adjusted to reflect scavenger removal bias.

3.5 Corrected Project Mortality Estimate

Results from surveys conducted each month were used to generate discrete mortality estimates for each month surveyed. Monthly and overall project mortality estimates only used data from search days 2-7 (see **Section 2.2**). Monthly mortality estimates were used in order to detect seasonal variations in mortality rates. Also, data are presented to reflect estimates with and without feather spots, as discussed earlier. For the remainder of this section, mortality values are presented as “number of mortalities excluding feather spots”/“number of mortalities inclusive of feather spots”.

While results of the DISTANCE analyses were less than conclusive, they were at least consistent with the a priori assumption of a minimum 8.4-meter effective transect width. Transect layout, in consideration of this assumed effective transect width, was designed to sample 10% of the overall PV array area. The time-corrected mortality estimates for each month were again up-corrected to account for the area not surveyed. Since no searcher efficiency or scavenger removal bias corrections were performed, this time- and area-corrected mortality estimate represents the overall monthly project mortality estimate. Mortality estimates were rounded to the nearest whole number. **Table 6** summarizes the corrected mortality estimates by month.

3.5.1 November Mortalities

A total of 4/6 mortalities were detected during days 2-7 of the November surveys. Correcting for time (the 6 day survey period represents approximately 20% of the total days in November) and area surveyed, the overall monthly project mortality estimate for November was 200/300.

3.5.2 December Mortalities

A total of 0/4 mortalities were detected during days 2-7 of the December surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in December) and area surveyed, the overall monthly project mortality estimate for December was 0/207.

3.5.3 January Mortalities

A total of 2/8 mortalities were detected during days 2-7 of the January surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in January) and area surveyed, the overall monthly project mortality estimate for January was 103/413.

3.5.4 November 2014 –January 2015 Corrected Mortality Estimates

After applying time and area corrections to the mortality counts for each month the overall project mortality estimate for the period November of 2014 to January of 2015 is 303/920.

Table 6 – Corrected Mortalities by Month

	November		December		January		Nov-Jan. Totals	
	Exc. Feather Spots	**Inc. Feather Spots**	**Exc. Feather Spots**	**Inc. Feather Spots**	**Exc. Feather Spots**	**Inc. Feather Spots**	**Exc. Feather Spots**	**Inc. Feather Spots**
Raw Mortality Count (days 2-7)	4	6	0	4	2	7	5	17
Corrected Mortality Estimate	200	300	0	207	103	413	303	920

3.6 Taxonomic Composition of Observed Mortalities

The following analyses use all observed mortalities including those detected on search day 1 since the taxonomic composition is not a rate-dependent analysis (see **Section 2.2**).

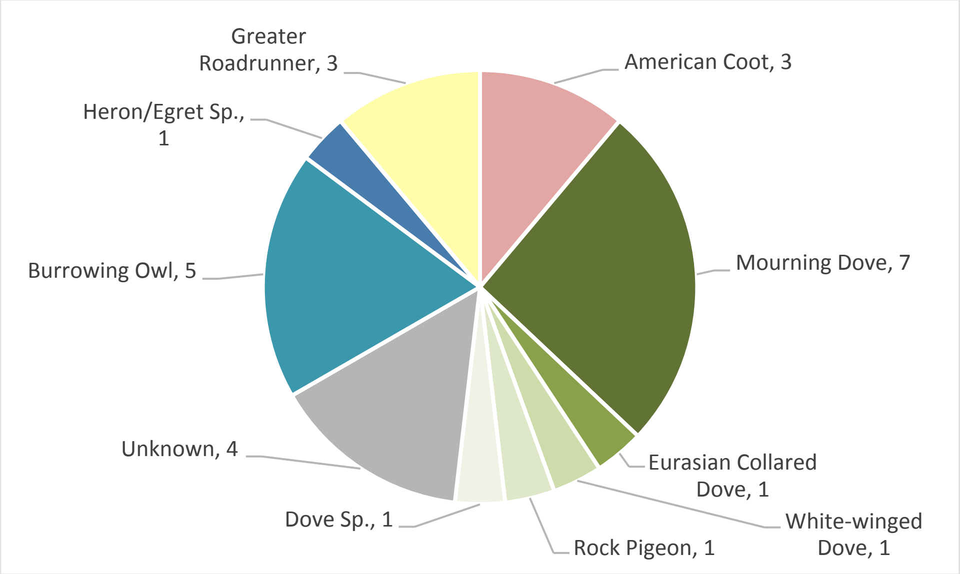
Table 7 – Raw Mortalities by Month (includes data from all search days)

	November		December		January		Nov-Jan. Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 1-7)	5	8	0	6	3	12	8	27

3.6.1 Mortalities Including Feather Spots

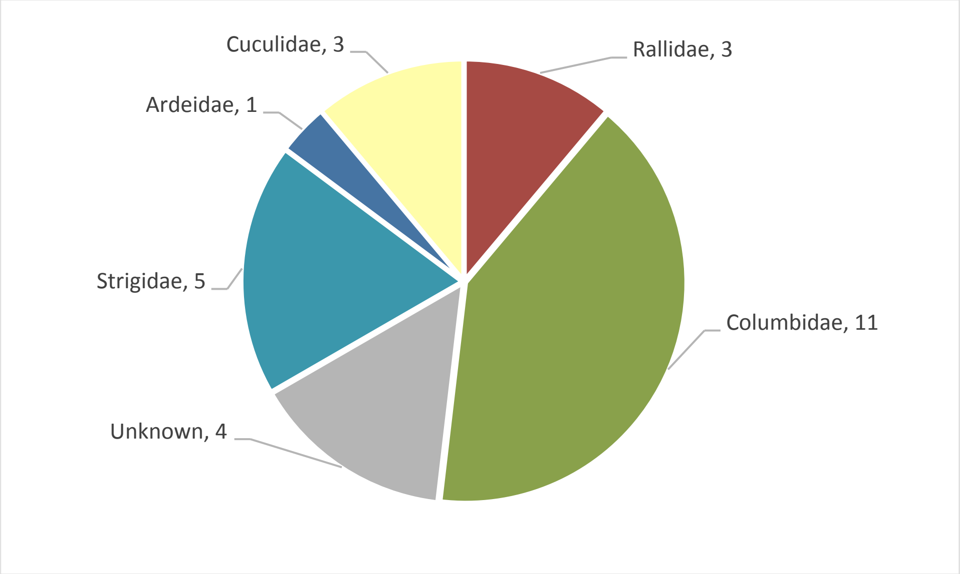
A total of 27 mortalities were observed when feather spots were included in the data set. Four (4) of these mortalities (15%) could not be identified to species. Of the 23 carcasses that could be identified to species, the most commonly observed species were Mourning Dove (*Zenaida macroura*; 7 mortalities; 30% of mortalities identified to species) and Burrowing Owl (*Athene cunicularia*; 5 mortalities; 22% of mortalities identified to species). **Figure 2** presents the breakdown of observed mortalities by species.

Figure 2 – Mortalities by Species (includes feather spots)



Twenty-three (23) of the 27 observed mortalities could be identified to the family level. Of these 23 mortalities, the families Columbidae (11 mortalities; 48% of mortalities identified to family level) and Strigidae (5 mortalities; 22% of mortalities identified to family level) were the most commonly observed mortalities. **Figure 3** presents the breakdown of observed mortalities by family.

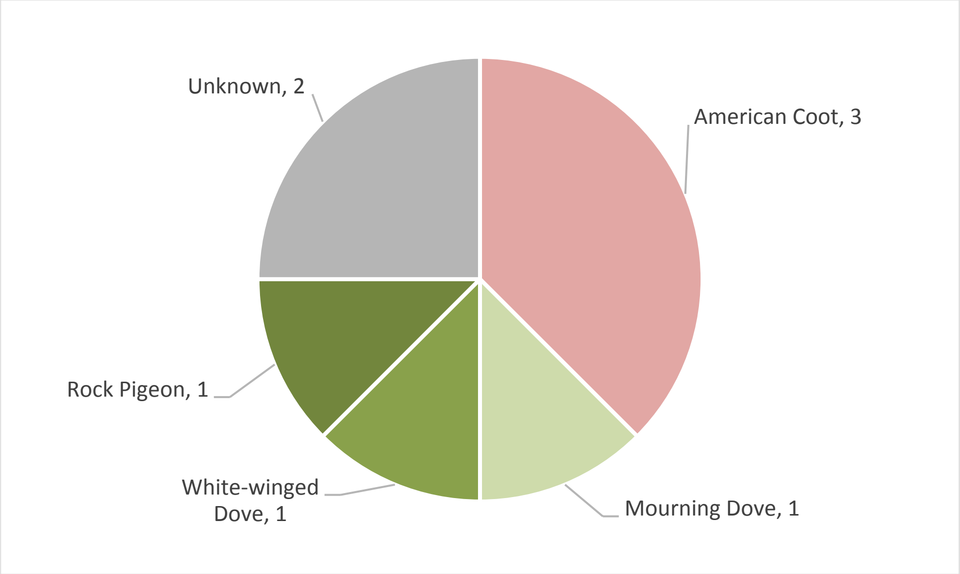
Figure 3 – Mortalities by Family (includes feather spots)



3.6.2 Mortalities Excluding Feather Spots

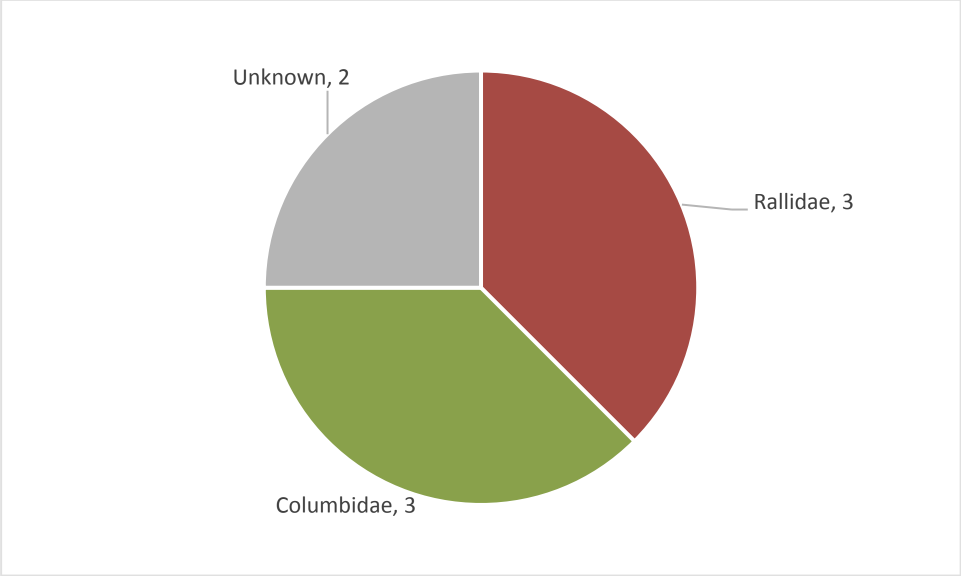
A total of eight (8) mortalities were observed when feather spots were excluded from the data set. Six (6) of these mortalities (75%) could be identified to species. Of the 6 carcasses that could be identified to species, American Coot (*Fulica Americana*; 3 mortalities; 50% of the mortalities identified to species) was the most commonly observed. **Figure 4** presents the breakdown of observed mortalities by species.

Figure 4 - Mortalities by Species (excludes feather spots)



Six (6) of the 8 observed mortalities could be identified to the family level. Of these mortalities, the families Columbidae (3 mortalities; 50% of mortalities identified to family level) and Rallidae (3 mortalities; 50% of mortalities identified to family level) were the most commonly observed. **Figure 5** presents the breakdown of observed mortalities by family.

Figure 5 – Mortalities by Family (excludes feather spots)



4 Discussion

4.1 Mortality Estimates

Searcher efficiency and scavenger removal trials can only result in up-correcting results (since searchers cannot detect >100% of carcasses and scavengers are unlikely to deposit carcasses within a survey area). Because searcher efficiency and scavenger removal trials were not performed during the second quarter surveys, the degree of underestimation is unknown. As soon as the Centinela Solar Energy Project receives a SPUT permit from FWS and a SCP from CDFW, searcher efficiency and scavenger removal trials will begin.

4.2 Seasonal Variations

There was some variation in estimated mortality rates from month to month, especially within the dataset excluding feather-spot mortalities. The December estimated mortality rate was 0/207, whereas November and January estimated mortality rates were appreciably higher (200/300 and 103/413, respectively). It should be noted that the sample size of observed mortalities was fairly low this quarter (especially relative to the magnitude of the correction factors), making these types of analyses difficult to achieve with high confidence levels.

4.3 Recommended Methodological Changes

The following changes are recommended to improve survey efficiency and accuracy as well as to improve data collection and analysis.

1. Searcher Efficiency and Scavenger Removal Bias – The results presented in this report are uncorrected for searcher efficiency and scavenger removal. Searcher efficiency at this site is likely very high (near 100%) given the level ground and almost entirely unvegetated environment. As such, the searcher efficiency bias is unlikely to have resulted in a significant underestimate of mortality. However, scavenger removal rates are unknown and could be a source of bias. Numerous potential avian and mammalian scavengers are known to occur in and around the project site. Until scavenger removal trials are performed, the magnitude of this source of bias is unknown. As soon as state and federal permits are approved, these trials will be initiated.
2. Alternative Statistical Analysis Packages – Since the publication of the project BBCS (Heritage 2012), a potentially more robust mortality estimation program has been released for use with the statistical analysis software Program R, called *facilityCMR*. This program offers several potential advantages over the Warren-Hicks Estimator including analyzing covariance between searcher efficiency and scavenger removal rates and allowing for analysis of carcass condition. We propose using the *facilityCMR* software in future analyses, as soon as searcher efficiency and scavenger removal trials are permitted. This would be used in lieu of the Warren-Hicks Estimator and Program MARK and better reflects current FWS guidance on mortality studies at solar facilities.

5 Literature Cited

APLIC (Avian Power Line Interaction Committee). 2006. Suggested practices for avian protection on power lines: The state of the art in 2006. Washington, D.C. and Sacramento, CA: Edison Electric Institute, Avian Power Line Interaction Committee, and California Energy Commission.

California Energy Commission (CEC). 2002. *A Roadmap for PIER Research on Avian Collisions with Power Lines in California*. California Energy Commission Staff Report. December, 2002.

Drewitt, A. L., and R. H. W. Langston. 2006. Assessing the impacts of wind farms on birds. *Ibis.* 148:29-42.

FWS. 2012. Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach. December, 2012. 23pp.

Heritage. 2012. Centinela Solar Energy Project Bird and Bat Conservation Strategy. March, 2012. 150pp.

Hovarth, G., M. Blahò, A. Egri, G. Kriska, I. Seres, and B. Robertson. 2010. Reducing the maladaptive attractiveness of solar panels to polarotactic insects. *Conservation Biol.* 24(6): 1644-1653.

Janss, G. F. E. 2000. Avian mortality from power lines: A morphologic approach of a species-specific mortality. *Biological Conservation* 95: 353-359.

Manville II, A. M. 2005. Bird strikes and electrocution at power lines, communication towers, and wind turbines: State of the art and state of the science – next steps toward mitigation. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Martin, G.R. and J.M. Shaw. 2010. Bird collisions with power lines: Failing to see the way ahead? *Biological Conservation* 143: 2695–2702.

McCrary, M. D., R. L. McKernan, R. W. Schreiber, W. D. Wagner, and T. C. Sciarrota. 1986. Avian mortality at a solar energy power plant. *J. Field Ornithol.* 57(2): 135-141.

Rusz, P. J., H. H. Prince, R. D. Rusz, and G. A. Dawson. 1986. Bird collisions with transmission lines near power plant cooling pond. *Wildlife Society Bulletin*. 14: 441-444.

Savereno, A. J., L .A. Savereno, R. Boettcher, and S. M. Haig. 1996. Avian behavior and mortality at power lines in coastal South Carolina. *Wildlife Society Bulletin*. 24: 636-648.

Post-construction Avian Mortality Monitoring Report
Campo Verde Solar Project

Third Quarter 2014 (July, August, September)

and

Year 1 Annual Report (October 2013 – September 2014)

Prepared By:

Heritage Environmental Consultants, LLC

December 2014

Table of Contents

1 Introduction

The Campo Verde Solar Project is a solar photovoltaic (PV) energy generating facility (Solar Energy Facility) and an associated electrical transmission line (Gen-Tie Line) in southern Imperial County, California. The solar project is located on private lands and the gen-tie line is located on private and federal lands managed by the Bureau of Land Management (BLM). These are referred to collectively as the "project."

A Bird and Bat Conservation Strategy (BBCS) was prepared that addresses activities potentially occurring during construction and operation of the project (Heritage 2013). The BBCS was reviewed and approved by the U.S. Fish and Wildlife Service (FWS), California Department of Fish and Wildlife (CDFW), and BLM. The purpose of the Campo Verde BBCS was to develop and implement a program to identify and avoid risks to avian and bat species that could result from construction and operation of the project. The goal of this BBCS was to implement a series of best practices, in order to construct and operate the project to avoid or reduce risk to birds, bats and their habitats.

The post-construction avian mortality monitoring program was set up to comply with the methodology prescribed in the BBCS (Heritage 2013). The methodology is described in Section 6.1 of the BBCS and was approved by the FWS and CDFW. Quarterly reports documenting results of the monitoring program are required for the first year of program, and annually thereafter. Monitoring began in October 2013 just after completion of construction. This report is the fourth of four quarterly reports for the first survey year and also provides a summary of the entire first year's results. Periodic reporting will shift to annual (rather than quarterly) after this report.

1.1 Project Description

The general location of the project is approximately 7 miles southwest of the city of El Centro, Imperial County, California (**Figure 1**). The project is south of I-8, west of Drew Road, and northeast and south of the Westside Main Canal. The Project consists of two component parts: (i) the Solar Energy Facility and (ii) an approximately 0.9-mile, 230-kilovolt (kV) aboveground, electrical gen-tie line and associated facilities that electrically connects the Solar Energy Facility on private land with the Imperial Valley Substation (IV Substation) located on federal land managed by the BLM.

The Solar Energy Facility is approximately 1,443 acres in size and uses First Solar PV modules that are generally non-reflective and convert sunlight into direct current (DC) electricity. The DC output of multiple rows of PV modules is collected through one or more combiner boxes and directed to an inverter that converts the DC electricity to alternating current (AC) electricity. From the inverter, the generated energy flows to a transformer where it is stepped up to distribution level voltage (approximately 34.5 kV). Multiple transformers are connected in parallel via 34.5 kV lines to the project substation, where the power is stepped up to 230 kV. This substation is located at the southern end of the Solar Energy Facility near Liebert Road. The Gen-Tie Line connects the project substation to the Imperial Valley Substation approximately 0.9 miles to the south.

The Gen-Tie Line uses double-circuit tubular steel monopole structures. Tower structure heights range from 100 to 135 feet. One side of the double-circuit structures currently supports three two- bundle conductors and one shield wire. Typical overall structure widths are approximately 20 feet.

Additional Documentation Attachment to Comment 2-F1
Attachment I-4

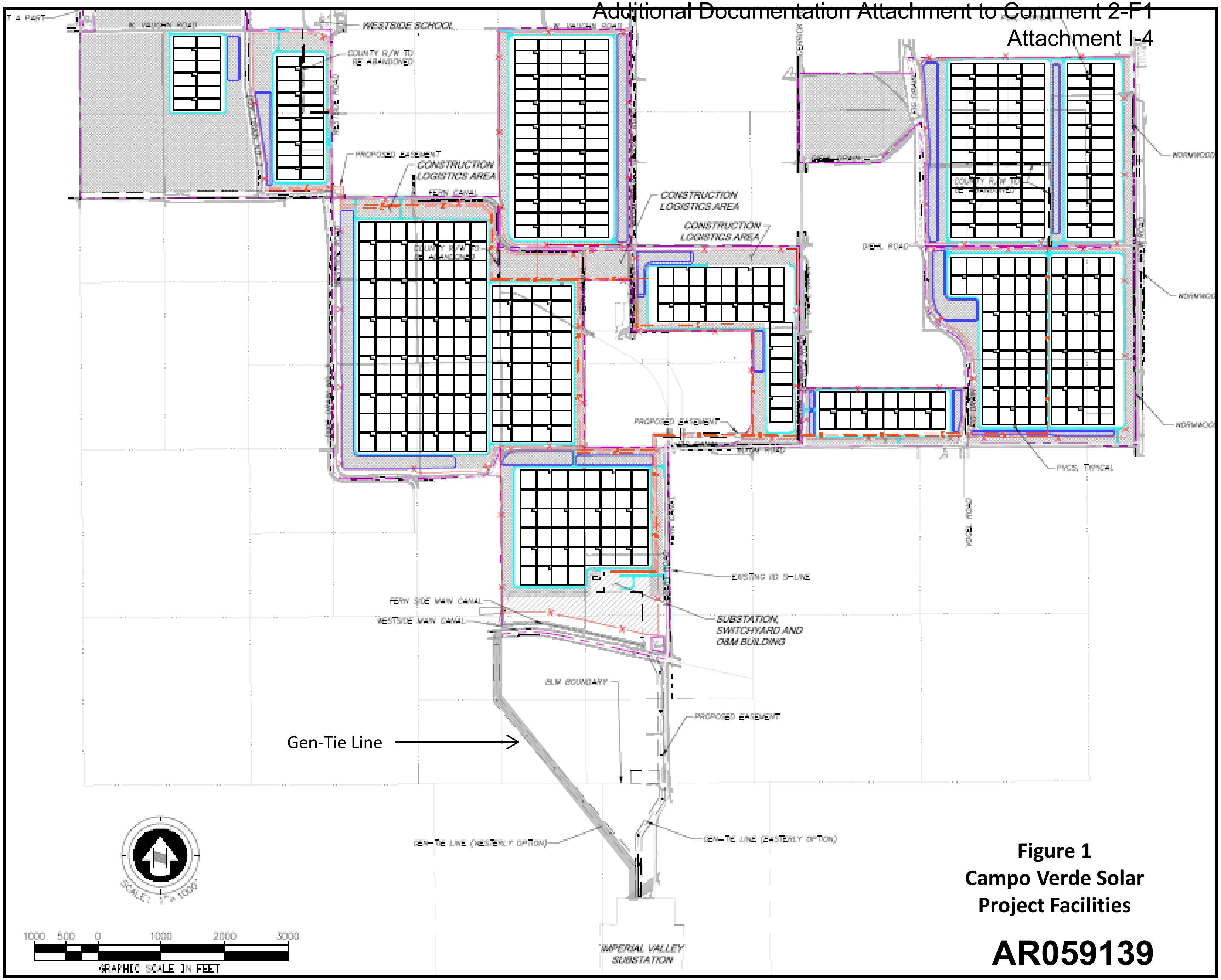


Figure 1
Campo Verde Solar
Project Facilities

2 Methods

Monitoring of the project was performed in order to document and report avian mortalities and identify areas of concern by tracking both the specific locations where mortalities occur as well as the extent of such mortalities. The monitoring program for the project is based on the FWS guidance entitled "Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach" (FWS 2012) with modifications, and was approved by FWS.

2.1 Transect Sampling

Sampling transects were established for both the gen-tie line and solar field. For each kilometer of Gen-Tie Line, 300-meter transects were randomly established along the Gen-Tie Line allowing for approximately 30-percent of the Gen-Tie Line to be sampled. Transects were positioned along the centerline of the Gen-Tie Line. For the Campo Verde Solar Energy Facility, transects were also positioned to result in approximately 30-percent coverage of the site with no less than eight transects placed within the solar field itself. Transect selection was systematic randomized. The entire perimeter of the panel arrays was also surveyed during each survey period in addition to the interior transects.

Transects were surveyed for 7 consecutive days each month and each transect was surveyed once daily. Because of the large number of transects, sampling periods were 14-days; the first half of transects were walked for 7-day period and the second half for another 7-day period. One qualified observer walked along the pre-determined transects searching for bird/bat carcasses. When a carcass was observed, a GPS location was recorded at the carcass, the species was identified, the perpendicular distance from the transect to the carcass was measured, and information regarding carcass condition per FWS (2012) was recorded using paper datasheets. Once data were collected at a carcass, the observer returned to the pre-determined transect and continued with the survey.

The original protocol stated that each carcass would be marked uniquely and inconspicuously with tape and permanent marker to assess "recapture" rates. The federal special purpose utility permit (SPUT) was received in September of 2014 while the state scientific collection permit (SCP) enabling surveyors to handle carcasses was issued in November of 2014. The mark-recapture data, scavenger removal trials, and searcher efficiency trials will commence during the Q1 monitoring period. Therefore, all estimates presented in this report represent mortality estimates that are uncorrected for observer bias and scavenger removal rates. Future reports will address these biases.

2.2 Analysis

Two primary analyses were proposed for mortality estimation. The first analysis used Program DISTANCE to determine the most effective transect width to search for carcasses. Distance models examined a variety of detection functions and used Aikake's Information Criterion (AIC)[1] for model selection. DISTANCE modeling was run using both a 5% upper truncation to remove outliers and without any truncation. Specific model components are discussed in **Section 3.2**.

The second analysis would use Program MARK to estimate total number of mortalities controlling for detection rate, scavenging rate, and proximity to Project components. The mark-recapture protocols were not implemented during this mortality estimation, but will be implemented during future analyses and presented in future reports. Alternative analysis packages may be considered (as opposed to Program MARK); see **Section 4.3** for additional discussion of potential statistical analyses.

Project mortality estimates rely on measuring a daily mortality rate that can be used as the basis for all mortality estimates. To calculate the corrected project mortality estimate, we did not count all mortalities

---

[1] AIC measures the relative quality of a given model by assessing both the model's complexity as well as the model goodness-of-fit to the observed data. Lower AIC values indicate higher quality models. Typically AIC values are compared among several possible models to select the "best" model or models.

observed during day 1 of the 7-day search period under the assumption that the those mortalities represent "bleed through" from the period prior to 24 hours preceding the first search. To accurately generate a rate, all mortalities used for this analysis need to have occurred within the 24 hours preceding discovery. Mortalities observed during the subsequent 6 days were then up-corrected to adjust for time not searched (since the search period captured 6 out of 28, 30 or 31 days each month), producing a time-corrected mortality estimate for each month.

Because taxonomic analyses do not use a rate, but are instead only concerned with the overall breakdown in mortalities, these analyses used all recorded mortality data, including those mortalities observed during day 1 of the 7-day search period. The use of these data from day one assumes that there is not persistence bias for different taxa of birds. Once scavenger removal trials are approved, this assumption can be tested and analyses will be adjusted if necessary.

3 Results

This report presents the results of the Q3 2014 surveys separately from the summary of Year 1 results. **Section 3.1** presents the results from Q3 only since these results have not yet been documented in a report. **Section 3.2** summarizes the entire first year of monitoring and includes data from October 2013 through September 2014.

3.1 Q3 2014 Results

3.1.1 Overall Mortalities Observed

Third quarter surveys for 2014 were conducted from July 12-25, 2014; August 9-22, 2014; and, September 6-19, 2014. A total of 30 avian mortalities were recorded. Four (4) of these observed mortalities were recorded as "feather spots". **Table 1** provides a breakdown of mortalities by sampling period.

Table 1 – Observed Mortalities by Sampling Period

Mortality Type	July (7/12/14 – 7/25/14)	August (8/9/14 – 8/22/14)	September (9/6/14 – 9/19/14)	Q3 2014 TOTAL
Non- Feather Spot Mortalities	7	9	10	26
Feather Spot Mortalities	0	3	1	4
Total Mortalities	*7*	*12*	*11*	*30*

The inclusion of feather spots as observed mortalities is based on standard mortality monitoring protocols, which were largely developed for the wind energy industry. At wind energy facilities, the speed of the spinning blades can result in mortalities that leave very little detectible carcass behind, including only feather spots. Inclusion of feather spots as recorded mortalities at these facilities was intended to conservatively include mortalities caused by blade strikes that might otherwise go unrecorded. Potential bias resulting from the inclusion of feather spots in mortality data can arise from feather spots meeting the definition of a mortality but not actually resulting from an avian mortality. This bias can lead to overestimates of mortality rates. This bias is problematic in situations where feathers are commonly deposited in non-mortality related events but get included as incidents of avian morality (e.g. in and around common roost or perch sites, near active nests, etc.). Feather spots may also be caused by predation or attempted-predation events within a survey area. Based on the large proportion of feather spots observed during the Q4 2013 and Q1 2014 surveys (63% and 41%, respectively), observers used greater discretion when encountering feather spots to help mitigate this bias. Feather spots that strongly indicated a deposition of feathers that was unrelated to an avian mortality or injury were excluded from the database; in instances where observers were uncertain, the feathers spots were recorded as mortalities in order to be conservative. All of the following analyses present results that both include and exclude feather spots to present the full range of possible mortalities.

A single Mexican free-tailed bat (*Tadarida brasiliensis*) carcass was found on August 9 underneath a solar panel. Due to differences in detection probabilities between mammals and birds, this mortality is not included in summary statistics included later in this report.

3.1.2 Effective Transect Width

DISTANCE analyses were performed using the data pooled across the three-month sampling period and **Table 2** presents the results of the DISTANCE analysis run using no truncation. It is important to note that none of the models fit the data well. In addition to parameters being constrained to obtain monotonicity[2], other modelling issues, including high levels of correlation and invalid variance estimates were present in several models[3]. The uniform – polynomial model was not able to run as a result of these problems. A second DISTANCE analysis was completed using 5% upper truncation (**Table 3**). Overall model performance using this truncation was slightly better but still did not result in reliable models. Model parameters were highly correlated in the half-normal – hermite model and parameters were at lower bounds in the hazard – cosine model[4]. Overall sample sizes were very small during Q3 of 2014 (n=17), which is likely the primary factor limiting the reliability of the DISTANCE analysis.

Table 2 – Distance Analysis Results with no truncation– includes feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*	2	181.40	0.00	0.00	0.00-0.00	8.16
Half-Normal – Polynomial*	5	225.84	72.12	0.00	0.00-0.00	10.27
Half-Normal – Hermite	1	253.53	72.12	0.00	0.00-0.00	40.13
Uniform-Cosine	1	277.40	96.00	0.00	0.00-0.00	87.54
Uniform-Polynomial*, **, ***	--	--	--	--	--	--

*Some parameters were constrained to obtain monotonicity.
**Some parameters are very highly correlated
***Invalid variance, model could not run.

Table 3 – Distance Analysis Results with 5% upper truncation – includes feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Uniform – Polynomial	0	131.46	0.00	0.00	0.00-0.00	10.46
Uniform – Cosine	0	131.46	0.00	0.00	0.00-0.00	10.46
Half-Normal – Hermite*	1	131.91	0.45	0.00	0.00-0.00	8.14
Half-Normal – Polynomial	1	131.91	0.45	0.00	0.00-0.00	8.14

---

[2] DISTANCE analyses rely on the modeling of a detection function. This detection function models the change in probability of detecting a carcass as the distance from the transect increases. This type of modelling relies on the assumption that the detection function is monotonic. Monotonic means that the probability of detection *only* changes in one direction (decreases) with increasing distance from the transect. If the detection probability goes up and down as distance from the transect increases, then the results violate this assumption of monotonicity. Program DISTANCE automatically constrains certain model parameters to obtain monotonicity but the resulting model may have a poor fit to the observed data.

[3] These are other constraints placed on the model in order to ensure that the model definitions meet basic assumptions. These errors indicate that data input into the models does not reliable meet the assumptions of DISTANCE analysis and interpretation of these results should use caution.

[4] This issue is the similar to parameter constraints to obtain monotonicity. In this case, the parameters are not at the point of requiring constraint to maintain assumptions but are at the limit of what can be tolerated while still maintaining monotonicity.

Hazard – Cosine**	2	133.45	1.99	0.00	0.00-0.00	7.09

*Some parameters are very highly correlated
**Some parameters are at lower bound.

The a priori[5] estimate of effective transect width was approximately 7.5 meters (this represents the width of two panel rows measured from the bottom of the panel immediately north of the designated transects to the bottom of the second panel to the south of the transect). Generally, the most likely models were consistent with or exceeded that assumption. Sample sizes were small for all models run this quarter and model results should be used with a high degree of caution (e.g. note that modeled density was rounded to 0.00 for all model definitions as a results of low sample sizes and unreliable model results).

3.1.3 Searcher Bias

No searcher bias estimates were generated and overall mortality estimates were not adjusted to reflect searcher bias within this report.

3.1.4 Scavenger Removal Bias

No scavenger removal trials were completed and overall mortality estimates were not adjusted to reflect scavenger removal bias within this report.

3.1.5 Corrected Project Mortality Estimate

Results from surveys conducted each month were used to generate discrete mortality estimates for each month surveyed. Monthly and overall project mortality estimates only used data from search days 2-7 (see **Section 2.2**). Monthly mortality estimates were used in order to detect seasonal variations in mortality rates. Also, data are presented to reflect estimates with and without feather spots, as discussed earlier. For the remainder of this section, mortality values are presented as "number of mortalities excluding feather spots"/"number of mortalities inclusive of feather spots".

While results of the DISTANCE analyses were less than conclusive, they were at least consistent with the a priori assumption of a minimum 7.5-meter effective transect width. Past quarterly DISTANCE analyses for this study have also supported the validity of the 7.5-meter transect. Transect layout, in consideration of this assumed effective transect width, was designed to sample 30% of the overall PV array area. The time-corrected mortality estimates for each month were again up-corrected to account for the area not surveyed. Since no searcher efficiency or scavenger removal bias corrections were performed, this time- and area-corrected mortality estimate represents the overall monthly project mortality estimate. Mortality estimates were rounded to the nearest whole number. **Table 4** summarizes the corrected mortality estimates by month.

3.1.5.1 July Mortalities

A total of 3/3 mortalities were detected during days 2-7 of the July surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in July) and area surveyed, the overall monthly project mortality estimate for July was 52/52 mortalities.

3.1.5.2 August Mortalities

A total of 7/8 mortalities were detected during days 2-7 of the August surveys. Correcting for time (the 6 day survey period represents approximately 19% of the total days in August) and area surveyed, the overall monthly project mortality estimate for August was 36/41 mortalities.

---

[5] "A priori" hypotheses are those hypothesis developed based on a theoretical and logical understanding of the system in question and not based on empirical results. That is, a priori hypothesis are those generated before any results have been collected.

3.1.5.3 September Mortalities

A total of 5/6 mortalities were detected during days 2-7 of the September surveys. Correcting for time (the 6 day survey period represents approximately 20% of the total days in September) and area surveyed, the overall monthly project mortality estimate for September was 83/100.

3.1.5.4 Third Quarter 2014 Corrected Mortality Estimates

After applying time and area corrections to the mortality counts for each month the overall project mortality estimate for the third quarter of 2014 is 256/289 birds.

Table 4 – Corrected Mortalities by Month

	July		August		September		Q3 Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 2-7)	3	3	7	8	5	6	15	17
Corrected Mortality Estimate	52	52	121	138	83	100	256	289

3.1.6 Taxonomic Composition of Observed Mortalities

The following analyses use all observed mortalities including those detected on search day 1 since the taxonomic composition is not a rate-dependent analysis (see **Section 2.2**).

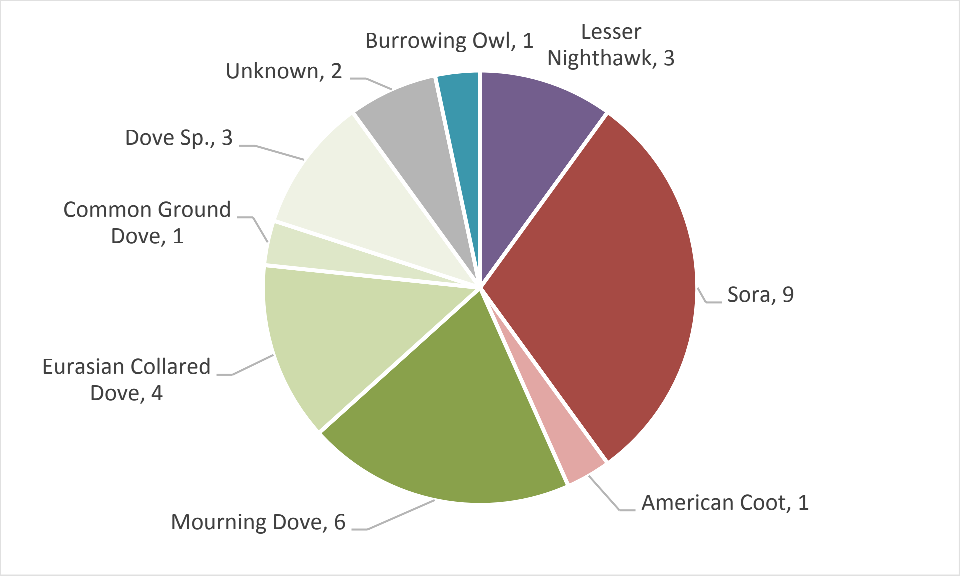
Table 5 – Raw Mortalities by Month (includes data from all search days)

	July		August		September		Q3 Totals	
	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots	Exc. Feather Spots	Inc. Feather Spots
Raw Mortality Count (days 1-7)	7	7	9	12	10	11	26	30

3.1.6.1 Mortalities Including Feather Spots

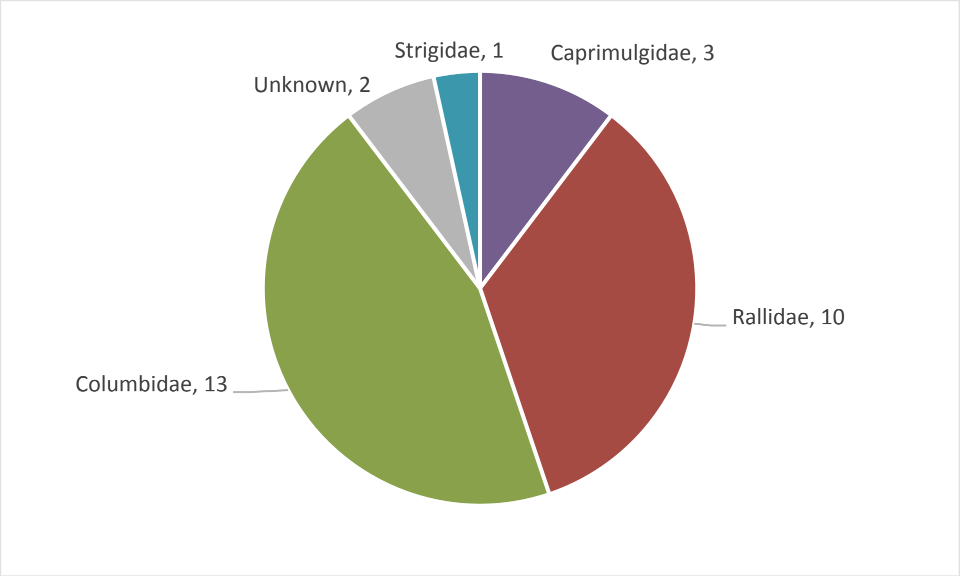
A total of 30 mortalities were observed when feather spots were included in the data set. Five (5) of these mortalities (17%) could not be identified to species. Of the 25 carcasses that could be identified to species, the most commonly observed species were Sora (*Porzana Carolina*; 9 mortalities; 36% of mortalities identified to species level), Mourning Dove (*Zenaida macroura*; 6 mortalities; 24% of mortalities identified to species level), and Eurasian Collard Dove (*Streptopelia decaocto*; 4 mortalities; 16% of mortalities identified to species level). **Figure 2** presents the breakdown of observed mortalities by species.

Figure 2 – Mortalities by Species (includes feather spots)



Twenty-eight (28) of the 30 observed mortalities could be identified to the family level. Of these 28 mortalities, the families Columbidae (14 mortalities; 50% of mortalities identified to family level) and Rallidae (10 mortalities; 36% of mortalities identified to family level) were the most commonly observed mortalities. **Figure 3** presents the breakdown of observed mortalities by family.

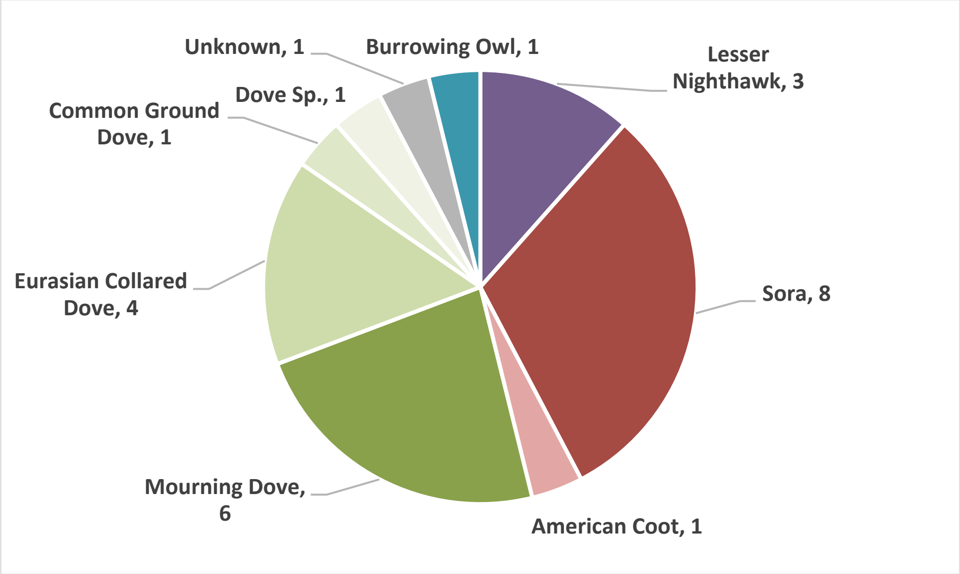
Figure 3 – Mortalities by Family (includes feather spots)



3.1.6.2 Mortalities Excluding Feather Spots

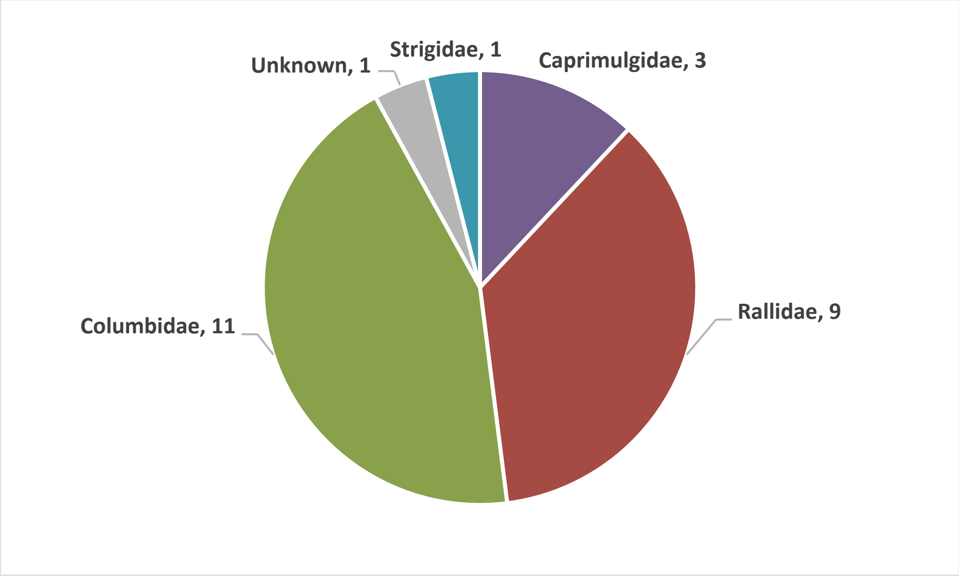
A total of 26 mortalities were observed when feather spots were excluded from the data set. Twenty-four (24) of these mortalities (92%) could be identified to species. Of these 24 carcasses, the most commonly observed species were Sora (8 mortalities; 33% of mortalities identified to species), Mourning Dove (6 mortalities; 25% of mortalities identified to species), and Eurasian Collared Dove (4 mortalities; 17% of mortalities identified to species). **Figure 4** presents the breakdown of observed mortalities by species.

Figure 4 - Mortalities by Species (excludes feather spots)



Twenty-five (25) of the 26 observed mortalities (96%) could be identified to the family level. Of these 25 mortalities, the families Columbidae (12 mortalities; 48% of mortalities identified to species level) and Rallidae (9 mortalities; 36% of mortalities identified to family level) were the most commonly observed. **Figure 5** presents the breakdown of observed mortalities by family.

Figure 5 – Mortalities by Family (excludes feather spots)



3.2 Annual Results Summary (October 2013 – September 2014)

3.2.1 Overall Mortalities Observed

A total of 93 avian mortalities were recorded during the first year of surveys. Thirty-nine (39) of these observed mortalities were recorded as “feather spots”. **Table 6** provides a breakdown of mortalities by sampling period. As discussed in **Section 3.1.1**, all of the following analyses present results that both include and exclude feather spots to present the full range of possible mortalities.

Table 6 – Observed Mortalities by Sampling Period

Mort. Type	Q4 2013			Q1 2014			Q2 2014			Q3 2014			*Total*
	Oct. 2013	Nov. 2013	Dec. 2013	Jan. 2014	Feb. 2014	Mar. 2014	Apr. 2014	May 2014	Jun. 2014	Jul. 2014	Aug. 2014	Sep. 2014	
Feather Spot Mort.	6	15	2	8	1	0	2	0	1	0	3	1	*39*
Non-Feather Spot Mort.	8	2	3	2	2	4	2	1	4	7	9	10	*34*
Total Mort.	*14*	*17*	*5*	*10*	*3*	*4*	*4*	*1*	*5*	*7*	*12*	*11*	*93*

3.2.1 Effective Transect Width

DISTANCE analyses were performed using the data pooled across the twelve-month sampling period. Analyses were run that both included and excluded feather spots as were analyses that both truncated the upper 5% of the data and left the data untruncated. **Tables 7-10** presents the results of the DISTANCE analyses run. It is important to note that none of the models fit the data well. Multiple errors occurred due to parameters being constrained to obtain monotonicity and some parameters exhibiting high correlation. Overall sample sizes were very small relative to the area sampled during the first year of surveys, which is likely the primary factor limiting the reliability of the DISTANCE analysis.

Table 7 – Distance Analysis Results with no truncation– includes feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine	2	614.11	0.00	0.001	0.001-0.002	9.30
Half-Normal – Hermite*, **	3	693.11	78.99	0.001	0.001-0.001	17.06
Half-Normal – Polynomial*	3	694.64	80.53	0.001	0.000-0.001	19.61
Uniform-Polynomial*	2	778.69	164.57	0.00	0.00-0.00	56.18
Uniform-Cosine*, **	1	843.58	229.47	0.00	0.00-0.00	85.55

*Some parameters were constrained to obtain monotonicity.
**Some parameters are very highly correlated

Table 8 – Distance Analysis Results with 5% upper truncation – includes feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard-Cosine*	3	524.73	0.00	0.001	0.001-0.002	8.86
Uniform – Cosine*	4	526.72	1.99	0.001	0.001-0.002	9.27
Uniform-Polynomial*	5	529.56	4.83	0.001	0.001-0.002	9.93
Half-Normal – Polynomial*	3	532.73	8.00	0.001	0.001-0.001	10.40
Half-Normal – Hermite**	1	553.66	28.94	0.001	0.001-0.001	14.07

*Some parameters were constrained to obtain monotonicity.
**Some parameters are very highly correlated

Table 9 – Distance Analysis Results with no truncation – excludes feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard-Cosine*	2	371.65	0.00	0.001	0.000-0.001	11.12
Half-Normal – Polynomial*, **	3	429.39	57.73	0.00	0.00-0.00	32.05
Uniform – Cosine*, **	3	446.12	74.47	0.00	0.00-0.00	47.24
Half-Normal – Hermite**	1	446.74	75.08	0.00	0.00-0.00	37.26
Uniform – Polynomial*	1	489.59	117.94	0.00	0.00-0.00	59.84

*Some parameters were constrained to obtain monotonicity.
**Some parameters are very highly correlated

Table 10 – Distance Analysis Results with 5% upper truncation – excludes feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard-Cosine*	3	315.34	0.00	0.001	0.000-0.001	10.57
Uniform – Cosine*	4	316.82	1.48	0.001	0.000-0.001	9.73
Half-Normal – Polynomial*	3	317.27	1.93	0.001	0.000-0.001	10.87
Uniform – Polynomial*	5	319.86	4.52	0.001	0.000-0.001	10.67
Half-Normal – Hermite**	1	326.15	10.81	0.00	0.000-0.001	14.71

*Some parameters were constrained to obtain monotonicity.
**Some parameters are very highly correlated

The a priori estimate of effective transect width was approximately 7.5 meters (this represents the width of two panel rows measured from the bottom of the panel immediately north of the designated transects to the bottom of the second panel to the south of the transect). Generally, the most likely models were consistent with or exceeded that assumption. Sample sizes were small for all models run this quarter and model results should be used with a high degree of caution (e.g. note that modeled density was rounded to 0.00 or 0.001 for all model definitions as a results of low sample sizes and unreliable model results).

3.2.2 Searcher Bias

No searcher bias estimates were generated and overall mortality estimates were not adjusted to reflect searcher bias within this annual report.

3.2.3 Scavenger Removal Bias

No scavenger removal trials were completed and overall mortality estimates were not adjusted to reflect scavenger removal bias during the surveys completed during Q4 of 2013 through Q3 of 2014.

3.2.1 Corrected Project Mortality Estimate

Results from surveys conducted each month were used to generate discrete mortality estimates for each month surveyed. Monthly and overall project mortality estimates only used data from search days 2-7 (see **Section 2.2**). Monthly mortality estimates were used in order to detect seasonal variations in mortality rates. Also, data are presented to reflect estimates with and without feather spots, as discussed earlier. For the remainder of this section, mortality values are presented as “number of mortalities excluding feather spots”/“number of mortalities inclusive of feather spots”.

While results of the DISTANCE analyses were less than conclusive, they were at least consistent with the a priori assumption of a minimum 7.5-meter effective transect width. Transect layout, in consideration of this assumed effective transect width, was designed to sample 30% of the overall PV array area. The time-corrected mortality estimates for each month were again up-corrected to account for the area not surveyed. Since no searcher efficiency or scavenger removal bias corrections were performed, this time- and area-corrected mortality estimate represents the overall monthly project mortality estimate. Mortality estimates were rounded to the nearest whole number. **Table 11** summarizes the corrected mortality estimates by month. **Figure 6** shows the trend of corrected mortality estimates over the course of the year’s surveys.

Table 11 – Corrected project mortality by month

	Q4 2013			Q1 2014			Q2 2014			Q3 2014			Annual Totals
	Oct. 2013	Nov. 2013	Dec. 2013	Jan. 2014	Feb. 2014	Mar. 2104	Apr. 2014	May 2014	Jun. 2014	Jul. 2014	Aug. 2014	Sep. 2014	
Raw Mortality Count (days 2-7)	6/11	2/9	3/5	0/5	1/2	1/1	1/3	1/1	3/3	3/3	7/8	5/6	33/57
Corrected Mortality Estimate	103/189	33/150	52/86	0/86	16/31	17/17	17/50	17/17	50/50	52/52	121/138	83/100	561/966

*Values reported as “excluding feather spots”/”including feather spots”

J. Field Ornithol., 57(2):135–141

AVIAN MORTALITY AT A SOLAR ENERGY POWER PLANT

By Michael D. McCrary, Robert L. McKernan,
Ralph W. Schreiber, William D. Wagner,
and Terry C. Sciarrotta

In 1979, the United States Department of Energy, in conjunction with the Southern California Edison Company (SCE) and the Los Angeles Department of Water and Power, initiated the construction of Solar One, the world's largest solar energy power plant (Fig. 1). Until the construction of Solar One, the use of the sun's energy to produce electrical power had not been attempted on this scale, and the environmental hazards of operation of a solar power plant were unknown. In this paper we report on bird mortality at Solar One.

STUDY AREA AND METHODS

Solar One is a 10 megawatt, central receiver solar power plant consisting of a 32-ha field of 1818, 6.9 × 6.9 m mirrors (heliostats) which concentrate sunlight on a centrally located, tower-mounted boiler, 86 m in height (Fig. 1). The reflective surface area of each heliostat is approximately 40 m^2, and the total for all heliostats is approximately 72,500 m^2. When not directed at the tower during morning startup, testing, and maintenance, some or all of the heliostats are focused on standby points, four small areas (approximate diameter = 5 m) of sky around the tower at a height of 80 m. Temperatures within the standby points vary with the number of heliostats focused on them and the reflectivity of an object placed within them, but the temperature can be high enough to burn feathers and small insects.

Solar One is located in the Mojave Desert, 4 km east of Daggett, San Bernardino County, California (34°52′N, 116°51′W). The dominant desert plant community in this area is creosote bush (*Larrea divaricata*) scrub, although abandoned and active agricultural fields (alfalfa) and extensive (53 ha) evaporation ponds (Fig. 1) are adjacent to Solar One.

We visited Solar One approximately once per week (2–3 days per visit) on 6 occasions from 3 May through 8 June 1982 and on 34 occasions from 16 September 1982 through May 1983. During each visit 1–2 observers searched the facility for any evidence of bird mortality. Although searches were not conducted in a fixed pattern, the entire facility was covered during each visit. Bird carcasses were readily found because of the sparse vegetation and level ground of Solar One. Experiments involving the placement of 19 bird carcasses of various species within and just outside (<200 m) the fenced facility were conducted in May and September 1982 to measure the rate of bird carcass removal by scavengers. These carcasses were checked periodically until removed by scavengers or decomposed.

FIGURE 1. Aerial view of Solar One: (A) heliostat field, (B) central receiver tower, (C) evaporation ponds. Tower height = 86 m, diameter of field = 765 m.

To determine the impact of bird mortality on local populations, 1–2 observers conducted surveys of relative avian abundance within an area of approximately 150 ha surrounding Solar One, concentrating on the facility grounds (32 ha), evaporation ponds, and agricultural fields. These surveys were conducted on at least 2 d per visit for 3–4 h/d.

RESULTS

Solar One related animal mortality.—During approximately 40 wks of study, we documented 70 bird fatalities involving 26 species at Solar One (Table 1). The mean rate of mortality between visits was 1.7 birds ± 1.8 SD (n = 40, range 0–7). Results of the scavenger bias experiments indicate that from 10–30% of carcasses were removed between searches, thus, the actual rate of mortality may have been from 1.9–2.2 birds. Two causes of avian mortality were identified at Solar One, colliding with structures and burning from standby points.

The most frequent form of avian mortality was from collisions with Solar One structures. We documented 57 (81%) bird deaths (20 species) from collisions (Table 1). In most cases the cause of death was determined by the presence of broken bones (usually mandibles or wings) found through external examination. From the location of birds in relation to structures, most (>75%) died from colliding with the mirrored heliostats, although a dead Blue-winged Teal (*Anas discors*) with a broken wing was found on a platform of the receiver tower. On one occasion

Additional Documentation Attachment to Comment 2-F1
Attachment I-4

TABLE 1. Avian mortality from burning and collisions at Solar One, 1982–1983.

Burn fatalities		Collision fatalities	
Species	Number of individuals	Species	Number of individuals
Vaux's Swift (*Chaetura vauxi*)	1	Eared Grebe (*Podiceps nigricollis*)	11
White-throated Swift (*Aeronautes saxatalis*)	2	Blue-winged Teal (*Anas discors*)	1
Hummingbird sp.	3	American Kestrel (*Falco sparverius*)	1
Cliff Swallow (*Hirundo pyrrhonota*)	2	American Coot (*Fulica americana*)	2
Barn Swallow (*Hirundo rustica*)	1	Black-necked Stilt (*Himantopus mexicanus*)	2
Barn Swallow (*Hirundo rustica*)	1	Sandpiper sp.	1
Yellow-rumped Warbler (*Dendroica coronata*)	1	Red-necked Phalarope (*Phalaropus lobatus*)	1
Wilson's Warbler (*Wilsonia pusilla*)	1	Bonaparte's Gull (*Larus philadelphia*)	1
Sparrow sp.	1	Mourning Dove (*Zenaida macroura*)	6
		Hummingbird sp.	1
		Horned Lark (*Eremophila alpestris*)	3
		European Starling (*Sturnus vulgaris*)	4
		Yellow-rumped Warbler (*Dendroica coronata*)	1
		MacGillivray's Warbler (*Oporornis tolmiei*)	1
		Savannah Sparrow (*Passerculus sandwichensis*)	3
		White-crowned Sparrow (*Zonotrichia leucophrys*)	2
		Dark-eyed Junco (*Junco hyemalis*)	1
		Red-winged Blackbird (*Agelaius phoeniceus*)	3
		Western Meadowlark (*Sturnella neglecta*)	1
		Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*)	2
		Brewer's Blackbird (*Euphagas cyanocephalus*)	5
		House Finch (*Carpodacus mexicanus*)	4
Total	13	Total	57

in May 1982 a Solar One employee observed 4 Mourning Doves (*Zenaida macroura*) die in a collision with a single heliostat.

Thirteen (19%) birds (7 species) died from burning in the standby points (Table 1). Although we never observed a bird fly through one of the standby points, the heavily singed flight and contour feathers indicated that the birds burned to death (Fig. 2). Six (46%) of these fatalities involved aerial foragers (swifts and swallows) which are apparently more susceptible to this form of mortality because of their feeding behavior. Three of these aerial foragers died during a 2-wk period in May 1982, corresponding with the presence of the highest numbers of swifts and swallows observed (>500 per d), and an extensive period of heliostat testing when the occurrence and intensity of standby points was probably greater than at other times.

Relative avian abundance.—During 102 d from May–June 1982 (18 d) and September 1982–May 1983 (84 d), we recorded 107 bird species (daily mean = 16.7 ± 6.1 SD, n = 102) in the immediate area (150 ha) of Solar One. The mean daily count for individuals was 314 ± 203 SD (range 148–1040). Most avian species recorded at Solar One were migrants and only 15 species are year-round residents, with Horned Larks (*Eremophila alpestris*), European Starlings (*Sturnus vulgaris*), and House Finches (*Carpodacus mexicanus*) the most common breeding birds.

Of the habitats surveyed in this study, the evaporation ponds were the most heavily used by birds. Seventy percent of all species were recorded at least once at the ponds, and 45% were recorded only at the ponds; the majority of daily counts recorded mostly waterbirds.

DISCUSSION

Creosote bush scrub, which characterizes much of the undisturbed portions of the Mojave Desert near Solar One, is usually only sparsely inhabited by birds. The avian community of similar habitat in Arizona is usually less than 20 species (Tomoff, Ecology 55:396–403, 1974). However, we recorded 107 species in the vicinity of Solar One, 15 of which breed in the area. The special attraction of Solar One to birds is most likely related to the presence of a large, man-made water impoundment and irrigated agricultural fields, both of which produce an abundance of insects. Naturally occurring open water sources in the Mojave Desert are rare and usually ephemeral, while the man-made ponds near Solar One are permanent.

The most frequent form of avian mortality at Solar One during this study was from collisions with structures, primarily heliostats. Avian collisions are an inevitable by-product of almost all man-made structures (see Avery et al., FWS/OBS-80/54, 1980). Reflective surfaces are especially prone to collisions (Klem, Ph.D. thesis, Southern Illinois Univ., Carbondale, 1979), and it is not surprising that collisions with mirrored heliostats occur on a somewhat regular basis considering the reflective surface area of Solar One.

A form of avian mortality unique to solar central receiver power plants is burning in standby points. Death after being burned was infrequent in occurrence at Solar One, being in part a function of the frequent absence and variable intensity of standby points and the number of aerial foragers (swifts and swallows) in the airspace over Solar One.

Additional Documentation Attachment to Comment 2-F1
Attachment I-4

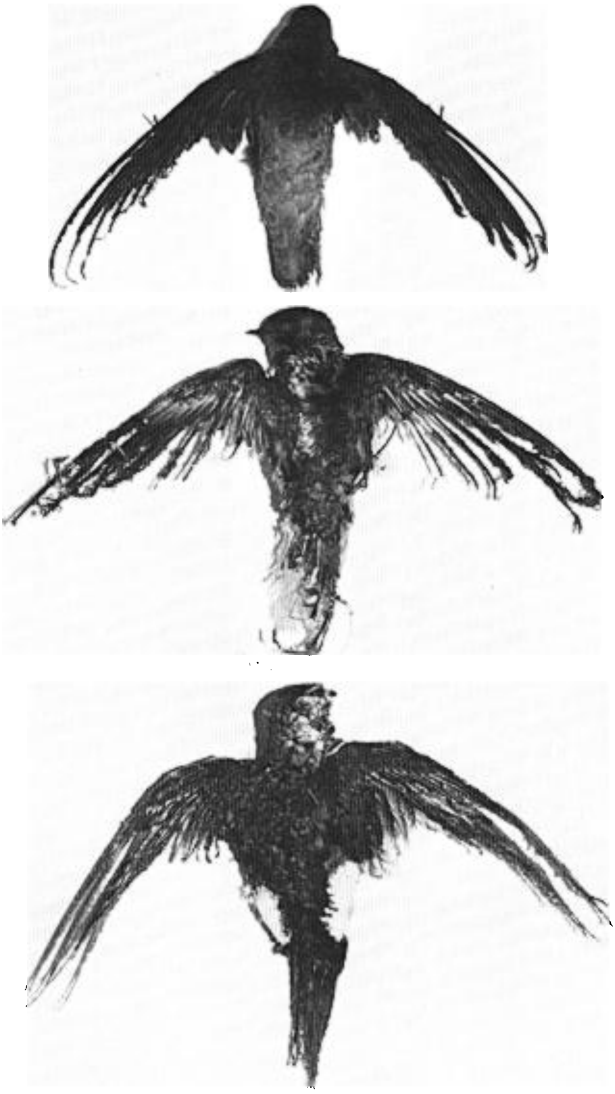


FIGURE 2. Three birds burned in standby points at Solar One. Top to bottom: Vaux's Swift (*Chaetura vauxi*), Barn Swallow (*Hirundo rustica*), and White-throated Swift (*Aeronautes saxatalis*). Note the heavily singed rectrices and remiges especially in the Barn Swallow.

Considering all known avian fatalities (70 birds) at Solar One during this study the impact of the facility on birds after construction appears minimal. Comparing the estimated rate of mortality (1.9–2.2 birds per wk) and mean relative avian abundance (314 birds per count) recorded in the vicinity of Solar One, only 0.6–0.7% of the local population present at any given time may have been affected during this study. The effect on the total population using the region in a year is obviously much less, but is unestimatable.

The results of this study suggest that, to reduce their impact on birds, future solar central receiver power plants in the Mojave Desert and other areas should not be sited in close proximity to open water or agricultural fields. The variety of species involved in avian mortality at Solar One indicates that caution should be taken when siting a solar power plant near populations of rare, threatened, or endangered species. If possible, the occurrence and intensity of standby points should be kept to a minimum. Since Solar One is only a 10 megawatt pilot facility, future projects designed to produce hundreds of megawatts will require several thousand heliostats and much taller receiver towers. The greater magnitude of these facilities may produce non-linear increases in the rate of avian mortality when compared to Solar One and extrapolations from this study should be made with caution. The removal of large tracts of desert from biological production for solar power generation and the ecological effects caused thereby should also be of concern.

SUMMARY

We studied avian mortality at an operating solar central receiver power plant in the Mojave Desert of southern California. During 40 wks of study we documented the deaths of 70 birds (26 species). The estimated mortality rate was 1.9–2.2 birds per week. Fifty-seven (81%) birds of 20 species died from collisions with Solar One structures, mainly the mirrored surfaces of heliostats. Thirteen (19%) birds (7 species) died from burns received by flying through standby points. The impact of this mortality on the local bird population is considered minimal (0.6–0.7% per wk).

ACKNOWLEDGMENTS

We thank J. Reeves (Research and Development, Southern California Edison Co.), P. Skvarna (SCE Site Manager of Solar One), D. Elliott (U.S. Department of Energy Project Director), and all other Solar One personnel for their valuable assistance on this project. P. Flanagan and G. Sawyer provided assistance in the field, and C. Barrows, P. Bloom, E. H. Burtt, Jr., J. Gore, and D. Klem provided editorial comments on the manuscript. This project was financially supported by a contract from the Southern California Edison Company to the Los Angeles County Museum of Natural History Foundation.

Los Angeles County Museum of Natural History, Section of Ornithology, 900 Exposition Blvd., Los Angeles, California 90007 (MDM, RLM, RWS, WDW); *Southern California Edison Company, Research and Development, P.O. Box 800, Rosemead, California 91770* (TCS). Received 1 Oct. 1985; accepted 24 Jan. 1986.

Calvert, A. M., C. A. Bishop, R. D. Elliot, E. A. Krebs, T. M. Kydd, C. S. Machtans, and G. J. Robertson. 2013. A synthesis of human-related avian mortality in Canada. *Avian Conservation and Ecology* **8**(2): 11.
http://dx.doi.org/10.5751/ACE-00581-080211

AVIAN CONSERVATION & ECOLOGY

Synthesis, part of a Special Feature on Quantifying Human-related Mortality of Birds in Canada

A Synthesis of Human-related Avian Mortality in Canada

Synthèse des sources de mortalité aviaire d’origine anthropique au Canada

Anna M. Calvert, *Christine A. Bishop*[1], *Richard D. Elliot*[1], *Elizabeth A. Krebs*[1], *Tyler M. Kydd*[2], *Craig S. Machtans*[2] *and Gregory J. Robertson*[1]

ABSTRACT. Many human activities in Canada kill wild birds, yet the relative magnitude of mortality from different sources and the consequent effects on bird populations have not been systematically evaluated. We synthesize recent estimates of avian mortality in Canada from a range of industrial and other human activities, to provide context for the estimates from individual sources presented in this special feature. We assessed the geographic, seasonal, and taxonomic variation in the magnitude of national-scale mortality and in population-level effects on species or groups across Canada, by combining these estimates into a stochastic model of stage-specific mortality. The range of estimates of avian mortality from each source covers several orders of magnitude, and, numerically, landbirds were the most affected group. In total, we estimate that approximately 269 million birds and 2 million nests are destroyed annually in Canada, the equivalent of over 186 million breeding individuals. Combined, cat predation and collisions with windows, vehicles, and transmission lines caused > 95% of all mortality; the highest industrial causes of mortality were the electrical power and agriculture sectors. Other mortality sources such as fisheries bycatch can have important local or species-specific impacts, but are relatively small at a national scale. Mortality rates differed across species and families within major bird groups, highlighting that mortality is not simply proportional to abundance. We also found that mortality is not evenly spread across the country; the largest mortality sources are coincident with human population distribution, while industrial sources are concentrated in southern Ontario, Alberta, and southwestern British Columbia. Many species are therefore likely to be vulnerable to cumulative effects of multiple human-related impacts. This assessment also confirms the high uncertainty in estimating human-related avian mortality in terms of species involved, potential for population-level effects, and the cumulative effects of mortality across the landscape. Effort is still required to improve these estimates, and to guide conservation efforts to minimize direct mortality caused by human activities on Canada’s wild bird populations. As avian mortality represents only a portion of the overall impact to avifauna, indirect effects such as habitat fragmentation and alteration, site avoidance, disturbance, and related issues must also be carefully considered.

RÉSUMÉ. Au Canada, de nombreuses activités d’origine anthropique entraînent la mort d’oiseaux sauvages, mais l’ampleur relative de la mortalité selon les diverses sources et leurs conséquences sur les populations d’oiseaux n’ont pas été évaluées systématiquement. Nous avons compilé des estimations récentes de mortalité aviaire au Canada causée par des activités industrielles et d’autres origines anthropiques afin de mettre en contexte les estimations calculées pour chacune des sources de mortalité présentées dans ce numéro spécial. Nous avons évalué la variation géographique, saisonnière et taxinomique de l’ampleur de la mortalité à l’échelle nationale, de même que les effets sur les populations d’espèces ou de groupes dans l’ensemble du Canada. Nous avons ensuite combiné ces estimations dans un modèle stochastique de mortalité spécifique au stade de vie. L’étendue des estimations de la mortalité par les diverses sources couvre plusieurs ordres de grandeur et les oiseaux terrestres sont le groupe le plus affecté en termes de nombre. Dans l’ensemble, nous avons estimé qu’approximativement 276 millions d’oiseaux et 2 millions de nids sont détruits chaque année au Canada, soit l’équivalent de plus de 188 millions d’individus nicheurs. La prédation par les chats et les collisions mortelles avec les fenêtres, les véhicules et les lignes de transmission ont été collectivement responsables de > 95 % de la mortalité; les sources industrielles de mortalité les plus importantes ont été les secteurs de la production d’énergie et de l’agriculture. Par ailleurs, les sources de mortalité comme les prises accidentelles par les pêcheries peuvent avoir d’importants impacts locaux ou propres à une espèce, mais ces impacts sont relativement faibles à l’échelle nationale. Les taux de mortalité variaient selon les espèces et les familles au sein des principaux groupes d’oiseaux, soulignant le fait que la mortalité n’est pas simplement proportionnelle à l’abondance. Nous avons aussi constaté que la mortalité n’est pas uniforme dans l’ensemble du pays : les sources de mortalité les plus importantes coïncident avec les foyers de population

---

[1]Environment Canada, Wildlife Research Division, Wildlife and Landscape Science Directorate, [2]Environment Canada, Canadian Wildlife Service

SCO - SOC

Sponsored by the Society of Canadian Ornithologists and *Bird Studies Canada*

Parrainée par la Société des ornithologistes du Canada et Études d’oiseaux Canada

BIRD STUDIES CANADA ÉTUDES D’OISEAUX

humaine, alors que les sources industrielles sont concentrées dans le sud de l'Ontario, en Alberta et dans le sud-ouest de la Colombie-Britannique. De nombreuses espèces sont donc vraisemblablement vulnérables aux effets cumulatifs des multiples impacts de sources anthropiques. Notre évaluation confirme aussi les grandes incertitudes liées à l'estimation de la mortalité aviaire d'origine anthropique en matière d'espèces touchées, d'effets potentiels sur le plan des populations et d'effets cumulatifs de la mortalité à l'échelle du paysage. Les efforts doivent être poursuivis afin d'améliorer ces estimations et d'orienter les actions de conservation pour minimiser la mortalité directe causée par les activités d'origine anthropique sur les populations aviaires du Canada. Puisque la mortalité aviaire ne représente qu'une partie de l'ensemble des impacts sur l'avifaune, les effets indirects – tels que la fragmentation et la perturbation d'habitats, l'évitement de sites précis, le dérangement et autres enjeux connexes – doivent également être considérés attentivement.

Key Words: *bird mortality; cats; collisions; human impacts; incidental take; industry; population effects*

INTRODUCTION

Several billion birds from over 400 species breed each year in Canada (Blancher 2002), in a wide variety of habitats. Landbirds, i.e., songbirds, raptors, upland gamebirds, represent most of the birds in Canada and tend to have large and widespread populations. Aquatic birds, such as waterfowl, seabirds, shorebirds, and inland waterbirds, occupy freshwater and marine habitats across the country. Birds occupy diverse niches across Canada that overlap substantially with human activities, and so are vulnerable to a large range of human-related stressors. The recent *State of Canada's Birds* report (NABCI-Canada 2012) highlighted conservation efforts that have contributed to increases in waterfowl and raptor populations, but shorebirds, grassland birds, and aerial insectivores have experienced rapid declines, some of which are attributed to human-driven habitat change and mortality across North America over the past 40 years (NABCI-Canada 2012).

Direct mortality resulting from human activities may have important consequences, particularly when it is additive to natural mortality, i.e. if individuals killed would have otherwise survived (Anderson and Burnham 1976). Agricultural practices, for example, have been identified as a factor in declines of Northern Pintail (*Anas acuta*; Miller and Duncan 1999, Prairie Habitat Joint Venture 2008) and Bobolink (*Dolichonyx oryzivorus*; COSEWIC 2010) as well as U.S. grassland birds (Mineau and Whiteside 2013), while reduced juvenile survivorship and population declines of urban songbirds have been linked to predation by cats (Crooks and Soulé 1999, Balogh et al. 2011). Quantification of the magnitude of human-related avian mortality, and its population-level effects on Canada's birds, is essential for directing management and conservation actions and for prioritizing future research directions (Loss et al. 2012); especially when considered in conjunction with indirect stressors such as habitat alteration and climate change.

Preventing and minimizing human-related mortality to birds, their nests, and eggs is widely supported by environmental legislation in Canada. Federal and provincial governments are responsible for the protection, conservation, and management of birds under the federal Migratory Birds Convention Act (S.C. 1994, c. 22), the federal Species at Risk Act (S.C. 2002, c. 29) and various provincial wildlife Acts. These laws generally prohibit the destruction of nests and eggs, and the "take" or killing of individual birds. Permitting systems exist to manage direct mortality due to hunting or while preventing damage and danger to the public, but provisions or systems to authorize inadvertent destruction of nests or birds as a consequence of anthropogenic activities, often called 'incidental take,' are applicable only to limited species or circumstances. Activities that may destroy nests or birds are currently managed through compliance promotion and by providing relevant information, e.g., timing of breeding seasons, key migration periods and pathways, to industrial sectors. This information allows the development and adoption of measures that minimize the risk of inadvertent destruction of nests and eggs, or killing of individuals.

Some sources of human-related avian mortality are well-quantified, such as the regulated sport harvest of game birds, but the magnitudes of most sources are imprecise or unknown. In particular, those affecting a few birds at a time, e.g., cat predation or building collisions, may often be overlooked because their local effects are rarely extrapolated nationally. Therefore, the number of birds killed annually in Canada as a result of human activities is poorly known, as are any resulting effects on populations. Despite limitations imposed by small-scale studies, nonrandom sampling designs, and an absence of experimental controls (Loss et al. 2012), preliminary estimates of human-related bird mortality at national- or continental-level scales can be highly informative. For instance, mortality from collisions with communication towers results in a total annual kill across the U.S. and Canada of about 6.8 million birds (Longcore et al. 2012), include disproportionately large impacts on certain species, many of conservation concern (Longcore et al. 2013). These studies can further highlight the susceptibility of particular bird groups to certain mortality sources, such as the vulnerability of long-distance or nocturnal migrants to collisions with towers and buildings (Klem 2009, Manville 2009, Arnold and Zink 2011) or of auks to bycatch in gill nets (Piatt et al. 1984).

The papers presented in this special feature of *Avian Conservation and Ecology* reflect the current scientific understanding of the magnitude of human-related bird mortality in Canada, based on data collected from a variety of industrial and other activities. Each paper reports an estimate of the total annual loss of birds, nests, or eggs, and considers the likelihood of population-level effects on species in Canada. In this synthesis, we compare the relative contribution of each source of mortality, including several estimates that are unpublished or were published recently elsewhere, and consider the implications of the total kill from all sources. Specifically, this synthesis aims to (i) identify, quantify, and compare sources of human-related avian mortality in Canada, (ii) explicitly model the sources of uncertainty in the mortality estimates, (iii) identify the remaining gaps in the current knowledge of threats to Canadian bird populations, and (iv) thereby help to prioritize research, policy, management, and conservation actions aimed at understanding and reducing human-related bird mortality in Canada.

METHODS

Sources of mortality

We synthesized estimates of the magnitude of human-related avian mortality in Canada from major industrial sectors and nonindustrial or public activities that we believe kill substantial numbers of birds. Initial estimates were developed in a series of reports prepared for Environment Canada. Nine of these are found in this special feature, namely mortality caused by: collisions with vehicles (Bishop and Brogan 2013), cats (Blancher 2013), marine industries, i.e., offshore oil and gas, commercial fisheries (Ellis et al. 2013), commercial forestry (Hobson et al. 2013), collisions with windows in buildings (Machtans et al. 2013), collisions with power transmission lines (Rioux et al. 2013), mechanical agricultural activities such as haying or mowing, cultivation, and harvest (Tews et al. 2013), terrestrial oil and gas (Van Wilgenburg et al. 2013), and wind power (Zimmerling et al. 2013). Estimates from communication towers appear elsewhere (Longcore et al. 2012). Reports on several other anthropogenic activities with more limited data are cited here as unpublished works (roadside maintenance: D. Abraham, D. Pickard, and C. Wedeles, *unpublished manuscript*; agricultural pesticides: P. Mineau, *unpublished manuscript*; mining: J. Williams, *unpublished manuscript*; electrical and hydro power generation: J.-P. L. Savard and S. Rioux, *unpublished manuscript*; Appendix 1). Unless otherwise specified, the information for each source presented in this synthesis is drawn directly from these papers and reports.

Published mortality estimates for three other activities are also presented for comparison. Sport-hunting totals for migratory game birds in Canada from years 2000-2011 were obtained from the National Harvest Survey data base (http://www.cws-scf.ec.gc.ca/harvest-prises/def_e.cfm). Data on total annual harvest of nonmigratory game birds, mainly Galliformes, were obtained from provincial and territorial government web sites and representatives. We also include an estimate of seabird mortality from chronic ship-source oil pollution in the northwest Atlantic from the late 1990s (Wiese and Robertson 2004).

We were unable to include several additional sources of human-related mortality that may be important to Canadian bird populations. A recent assessment of livestock impacts (B. Bleho, N. Koper, and C. S. Machtans, *unpublished manuscript*) found both positive effects of vegetation management and negative effects of trampling on bird nests, estimating a loss of ~1.5% of nests at a local scale, but is not included here because it did not quantify total mortality. We also did not calculate mortality and nest destruction from forest harvesting on private lands. Canada's National Forestry Database (http://nfdp.ccfm.org) indicates that private land harvest accounts for ~19% of the total annual volume of wood harvested from all lands in Canada, but we did not assess whether harvest timing or bird densities were similar to those calculated for commercial harvest. We found little published information on the magnitude of avian mortality in Canada from aircraft-strikes, and impacts from large-scale tailings ponds remain uncertain (Timoney and Ronconi 2010), although the number of birds killed annually by these sources is expected to be small. Recent evidence also indicates potentially important population-level effects of rodenticides on birds of prey (Thomas et al. 2011), but this source of mortality was not considered here. Effects of the aquaculture industry were initially assessed because entanglements with exclusion nets or nets associated with farms are potential sources of mortality (Price and Nickum 1995). However, this mortality source has not been documented in Canada, and the consensus was that aquaculture currently causes very limited direct bird mortality. Information on indirect impacts of aquaculture development on marine bird populations is also limited, and shellfish aquaculture may sometimes benefit certain waterfowl species (Zydelis et al. 2006, 2009). As a result, aquaculture is not considered further. Finally, we do not include estimates of bird bycatch in freshwater fisheries although the documentation of large kills suggests this is an important information gap (e.g., Ellarson 1956).

Comparing mortality estimates between sources

Human activities can affect birds at different stages of their annual cycles. Activities that alter habitat during the breeding season, such as forestry and agricultural mowing, tend to destroy nests, eggs and young. Many other sources cause direct mortality of breeding adults, subadults, and juvenile birds, such as fishing or collisions with cars or buildings. We present total mortality estimates by the life stage where it occurs, to highlight differences among sources.

We used the methodology of Hobson et al. (2013) and Van Wilgenburg et al. (2013) to develop a stochastic simulation model that expresses stage-specific losses as an equivalent loss of potential adult breeders. This enabled a comparison of the effects of mortality affecting species at different life stages. In addition to allowing comparison of mortality across sources, this model explicitly quantified and combined the various sources of uncertainty in current mortality estimates. An advantage of this modeling approach is that it allowed us to combine data with various measures of central tendency and spread (means, medians, min-max ranges, confidence limits). These modeled values were also used to assess population-level effects of mortality.

The stochastic model controlled both for effects at differing life stages and for variation in life history strategies by converting all individuals to the potential breeding adult stage. However, we were unable to control for variation in time needed to reach those stages because longer lived and low-fecundity species take longer to reach breeding age, making populations slower to recover from perturbations. Our analysis also did not assess the effects of activities reducing future productivity through habitat loss or alteration, e.g., unreclaimed oil and gas clearings in forest, which may be a significant consequence of some of the industrial activities considered here. Our analysis does enable direct comparisons of mortality across various sources, which should be most reliable when focused on comparisons of sources that affect groups of species with similar life history characteristics. Most importantly, these comparisons of numbers killed do not take into account differences in population sizes of species, or species groups.

Stochastic model to derive estimate of potential adult breeders killed

Converting estimates of stage-specific losses to potential adult breeders using the stochastic model involved the following steps. First, we compiled estimates of stage-specific mortality (nest, egg/nestling, or independent bird) for each mortality source, including any information on age-composition (for independent birds killed) and species-group composition of the kill (see Appendix 2 for details). Additional author feedback was sought for some sources, especially regarding estimates of approximate species-group or age composition of the kill.

Next, unless exact values were available, probability distributions were assigned to all values for stage-specific kill totals, age-ratios, and species-group composition (see Appendix 2, Table A2.1). Kill totals from individual papers generally included some measure of central tendency (mean, median, or midpoint) and data spread (confidence interval or min-max range) that were converted to values required to model a log-normal distribution (mean μ and standard deviation σ). We modeled kill estimates as log-normal distributions because these estimates were all based on some multiplicative extrapolation. Age-ratios were modeled in various ways; draws from a binomial distribution were used when proportions were reasonably well known, beta distributions were used when estimated variances in proportions were available, and uniform distributions were used when only minimum and maximum values were reported. Similar distributions were used for species-group proportions, except that multinomial distributions were used when more than two species-groups were affected. For sport harvest of migratory birds, detailed data on age-ratios of the kill were available for ducks, geese, and shorebirds (snipe and woodcock), and age-ratio data for snipe and woodcock were applied to other species (doves, pigeons, rails, and cranes). Age-ratios were not needed for the harvest for upland nonmigratory game birds (Galliformes), because juvenile and adult nonbreeding season survivorship probabilities are comparable for these birds. Age at first breeding was assumed to be the second year of life for all species groups except seabirds, which were assumed to breed in their fifth year.

Demographic rates, with associated measures of data spread where available, were collated for each species group; these included clutch size, nest success, hatchability (or hatch success), survival of young to fledging, overwinter survivorship of juveniles, and adult survivorship. Note that in some instances only the product of several parameters was available, e.g., a general productivity value that equaled clutch size × hatching success × survival of hatchlings to fledgling (see Appendix 2, Table A2.2). For landbirds, except nonmigratory game birds, we used the values already collated in Hobson et al. (2013), with adult survival rates obtained from Johnston et al. (1997). All other demographic rates were obtained from literature values for species considered representative of each species group (Appendix 2, Table A2.2). For shorebirds, we chose values from two larger bodied upland nesting species, as these species are more likely to be affected by the mortality sources considered, i.e., mowing and collisions, compared to smaller Arctic-breeding migrants. When a particular value was not available, notably overwinter survival of hatch-year birds (S_o), this value was estimated using the other vital rates available, assuming a stable population ($S_o = (1- S_a)/F$), where S_a is adult survival and F is fecundity (number of independent young produced). A variety of distributions was used to model these vital rates. For instance, beta distributions were used for well-estimated parameters, draws from uniform distributions were used when uncertainty was high and only minimum and maximum values were available, and random draws from a collection of rates were used for landbirds and shorebirds where a number of estimates were available. See Appendix 2 for additional details on vital rates used for each species group.

Finally, these values and distributions were used to estimate the equivalent number of potential adult breeders that would be removed from the population, based on the stage-specific kill estimates. For example, for an activity that kills eggs and nestlings at the start of the breeding season, draws from the distribution of total kill of eggs for a given species group were multiplied by draws for estimates of nest success, hatch success, survival of young to fledging, and overwinter survival for that species group. Models were run 100,000 times, and various descriptive statistics of the resulting distributions were extracted. We present medians with 90% intervals, to allow direct comparison of the numbers presented for forestry (Hobson et al. 2013) and terrestrial oil and gas (Van Wilgenburg et al. 2013). Note that no conversion was necessary for these two sectors because the authors directly converted their estimates of nest losses to the equivalent loss of potential adult breeders.

Extent, scale, and scope of mortality

We tabulated the season when most human-related mortality occurs (spring, breeding, fall, winter) in Canada for each of the main groups (landbirds, seabirds, shorebirds, waterbirds, waterfowl) to better understand the timing and extent of mortality across Canadian bird populations. We assigned a qualitative score of ‘no/little known effect,’ ‘some effect,’ or ‘large effect’ to each source/group/season combination, based on the information in each paper or report and feedback from their authors. Generally, a ‘large effect’ score was assigned when a particular species group was clearly identified as being frequently killed during a given season, whereas ‘some effect’ was assigned to species groups and seasons that were peripherally affected. Note that factors that kill birds while they are outside of Canada, including human-caused mortality to migrants, were not included in this assessment.

To quantify the relative population impact of differing sources of human-related mortality (hereafter ‘population-level impacts’), we compared the estimated mortality to the total abundance of individual populations, species, or families where data were available at that resolution; in some cases, mortality data were not available below the level of broad taxonomic group. For wind power, marine industries, oil and gas, agriculture, and roadside maintenance, we present population-level impacts that were directly calculated by the paper or report authors; for building collisions, we calculated family-level impacts by combining kill data provided by authors with current estimates of family-level abundance in Canada (Blancher 2002; P. Blancher *unpublished data*). For all these estimates, total kill of nests/eggs/nestlings was converted to the equivalent mortality of potential breeding adults, as described above, to enable comparability among sources of mortality; see Appendix 3 for full details on population-level kill and abundance. Note that although population-level impact estimates provide examples of the relative importance of particular mortality sources, these populations do not represent a random sample of all population-level impacts because they may have been highlighted by authors for different reasons, e.g., those considered particularly at risk, those representative of most birds affected, or those with the best available data on population size. We considered reference levels of 10%, 1%, and 0.1% to be informative. Individual sectors near or above 10% could likely translate to detectable negative population effects. Population proportions of 1% are considered nationally significant from the perspective of management of protected areas (e.g., RAMSAR criteria). We are not aware of documented population effects for rates of mortality below 0.1% from individual sources.

Spatial assessment of mortality risk

A spatial representation of cumulative human-related mortality in Canada was created for a subset of sectors. Applicable or proxy spatial information was available for the following eight sources of terrestrial-based mortality: cats, bird-window collisions, bird-vehicle collisions, bird-communication tower collisions, agriculture (haying and crops), commercial forestry, oil and gas, and wind turbines. All data were summarized and displayed on a 50 × 50 km tile grid covering Canada. This grid-level balanced the goal of providing interpretable images against the false precision of mapping data that usually had low spatial resolution or concordance with specific processes causing mortality, e.g., we know precisely where all paved roads are, but not where bird-vehicle collisions occur on those roads. All data sources and detailed procedures used to derive the maps are provided in Appendix 4.

We began by taking the proportion of activity in a 50 × 50 km tile grid across areas of resolution defined by the original research paper, e.g., provincially for forestry; by turbine for wind facilities; and by applicable portions of Bird Conservation Regions for agriculture. The total mortality estimate for each tile was then calculated by multiplying the proportion of activity in each tile by the original mortality estimate (number of wind turbines, km^2 of oil and gas activity, etc.). The completed tiles from the eight sources were overlaid and summed to compute the total mortality estimate per tile.

The final map was colored using 10 classes calculated by the Jenks classifier (Jenks 1967) in ArcGIS 10 and output in raster format. We applied a low-pass filter to the raster output using a 5 × 5 tile kernel size (Jensen 2005). We caution that the map represents an index of probable mortality across key sources, and is only an approximation. Accurately mapping mortality would require spatially explicit information on bird density, specific details on how and when each sector interacts with birds in each tile, and a variety of covariates that are not available nationally or may not be understood, e.g., why does mortality at tall buildings apparently differ appreciably among cities (Machtans et al. 2013)?

RESULTS

Total mortality estimates

Mortality estimates from each human-related source ranged from a few thousand to tens or hundreds of millions of birds.

In Canada, all combined sources of human-related mortality destroyed an average of ~2 million nests and killed ~269 million birds per year, or the equivalent of ~186 million potential adult breeders each year (Fig. 1). Cats and collisions with structures were the largest causes of human-related bird mortality in Canada: cumulatively, the top five sources of mortality, i.e., predation by feral and pet cats, and collisions with road vehicles, houses, and transmission lines, represented more than 95% of the individuals killed across all human-related sources. Because each of these top-ranking mortality sources are widespread, they may represent relatively small numbers at the local scale, but sum to very high levels of mortality when extrapolated across Canada. In contrast, some other mortality sources do not occur uniformly across the country, e.g., terrestrial oil and gas, fisheries, or are from industries located at relatively few scattered locations, e.g. wind power, and thus have relatively modest national-level kill totals, despite measurable localized effects.

The nine largest sources of anthropogenic mortality all killed mobile individual birds, including adult, subadult, and juvenile birds, although over a million nests and eggs are destroyed annually by forestry and agriculture, respectively (Fig. 1A). Fig. 1A and Table 1 show the total number killed by each source, identifying the life stage at which most mortality occurs, i.e., nest destruction, mortality of eggs or nestlings, or loss of independent mobile individuals. Mortality occurring at two stages, i.e., loss of eggs and mobile individuals through road maintenance, is shown as two points for that source. Note that although most estimates were made at a national level, for example, by extrapolating from local-scale estimates across the country, a few were only made at smaller scales (indicated as hollow symbols in Fig. 1): the agricultural haying and road maintenance estimates each represent impacts on just five and six focal species, respectively, and the hydro reservoir estimate was made for Quebec only. Total Canada-wide cross-taxa mortality caused by these activities is therefore likely to be appreciably higher than the values presented here.

The relative ranking of mortality sources was similar for the stage-specific and converted values (Figs. 1A, 1B), particularly for the largest sources of mortality. However, for human activities that destroy eggs and nests, the equivalent potential adult breeder total was considerably reduced, and thus the relative ranking of these sources somewhat altered, because many of the eggs or young killed by these sources would have not been expected to survive to adulthood otherwise (Fig 1B).

Converted estimates pooled across related activities provided broad estimates for the main sources of human-caused mortality (Fig 1C). These pooled sectors were cats (feral and pet), transportation (vehicle-collisions, road maintenance, and chronic ship-source oil), buildings (collisions with all three types), electrical power (transmission-line collisions, hydro reservoirs, electrocutions, transmission-line maintenance, and wind energy), harvest (migratory and nonmigratory game birds), agriculture (haying and pesticides), fisheries (all gear types), oil and gas (all terrestrial and marine sources), and mining (pits/quarries and metals/minerals); the original single-source values for forestry and communication towers are also shown. Nonindustrial activities (cats, transportation, and buildings) still represented the greatest overall sources of mortality, while electrical power and agriculture represented the largest industrial sources of mortality, with an annual kill of over 18 million and over 2 million potentially breeding birds, respectively. At the other end of the spectrum, the fisheries, oil and gas, and mining industries each killed the equivalent of fewer than 25,000 breeders annually (Fig. 1C). Note that within sectors, some sources of mortality were relatively low, e.g., electrocutions in the electrical power sector, while others dominated the overall sectoral kill, e.g., transmission line collisions.

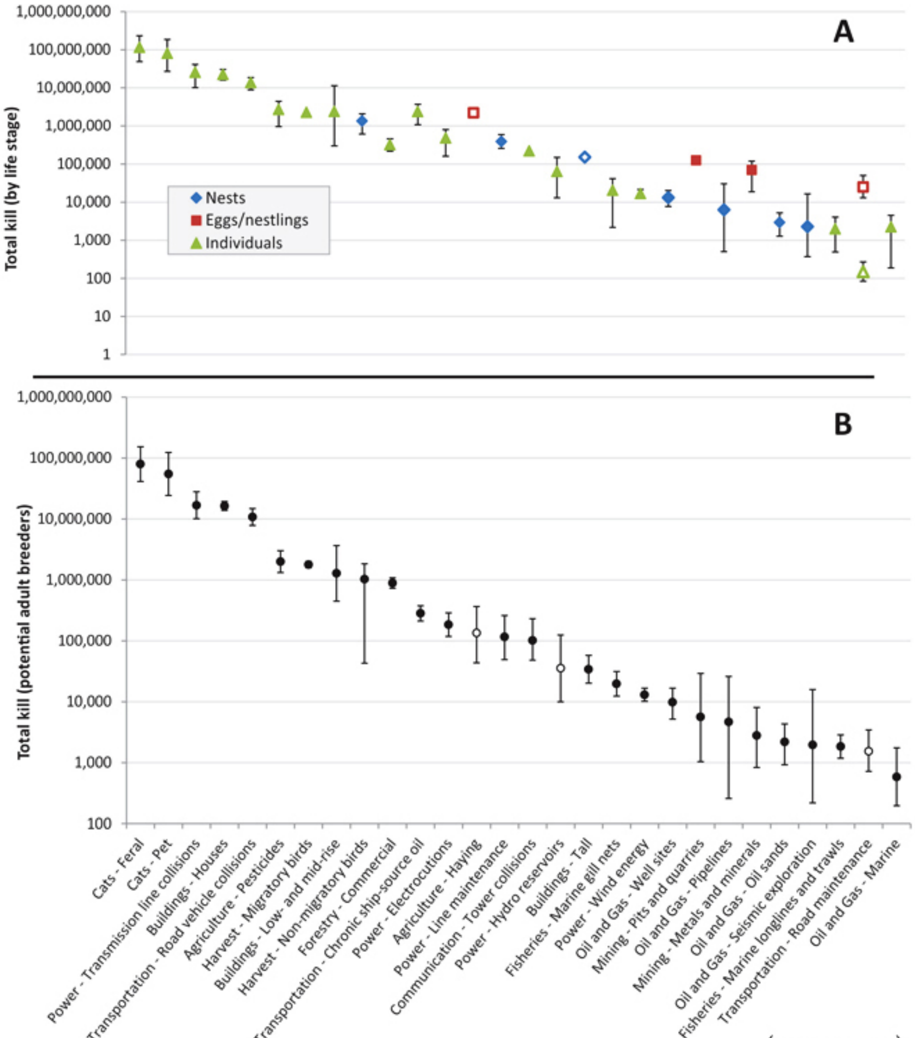
Evaluating potential population effects: seasonal and taxonomic distribution of mortality

The distribution of anthropogenic mortality among bird groups and across seasons for each mortality source showed that landbirds as a group were affected by the widest range of human activities (Table 2). These impacts occurred primarily during the breeding seasons, as expected, because many species overwinter outside of Canada. Shorebirds and waterfowl also faced many potential threats at their nesting sites, and birds across all groups confronted a range of human-caused mortality during spring and fall migration, particularly from collisions with cars, buildings, power-lines, and transmission structures.

Landbirds make up the majority of all Canadian breeding birds, and they constituted most of the estimated total mortality among the five species groups when expressed in common units of potential adult breeders (Table 3). In total, we estimated that 89% of all birds killed annually by human activities are landbirds; 6% are waterfowl, and the remaining 5% includes waterbirds, shorebirds, and seabirds. The majority of mortality occurred through direct kill of mobile individuals (74%; mostly cats, but see Table 2 for categories of impact type), with 25% of mortality caused by collisions. The destruction of nests represented less than 1% of overall estimated impact when converted to potential adult breeders.

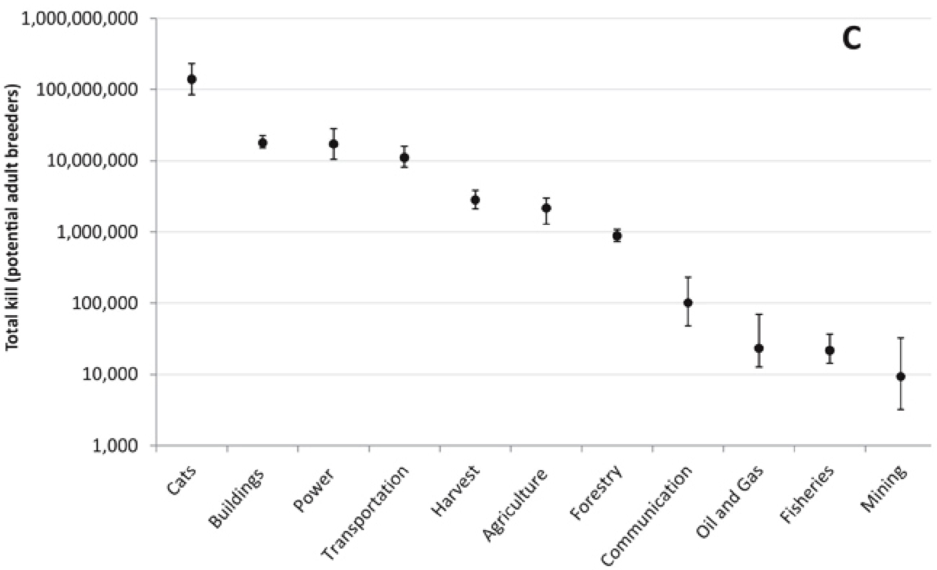
Although overall national-scale mortality estimates illustrated the magnitude of bird mortality across Canada, some human-related activities had disproportionately large effects on particular species or populations, with the potential for population-level impacts at a regional or national level (Fig. 2; see Appendix 3 for full details). For example, marine fisheries bycatch had one of the lowest total mortality estimates nation-wide, but may annually kill a relatively large

Fig. 1. Annual mortality of Canadian birds due to human activities (log-scale). Panel A shows stage-specific estimates for each activity, according to whether entire nests, single eggs/nestlings, or mobile individuals were killed, as in original papers and reports. Values include both means and medians, and error bars represent both confidence limits (90% or 95%) and maximum/minimum ranges, as originally presented. Panel B shows converted mortality estimates for each activity (median with 90% confidence limits), where stage-specific kill totals have been converted to the equivalent number of potential adult breeders based on a stochastic model incorporating species-composition and demography. Hollow symbols indicate mortality only estimated for part of Canada or for a limited number of species, and thus where total Canada-wide cross-taxa mortality is likely much higher than these estimates. Panel C shows these same converted estimates (median with 90% confidence limits), pooled across related activities (cats: feral and pet; transportation: vehicle-collisions, road maintenance, and chronic ship-source oil; buildings: collisions with all 3 types; power: transmission-line collisions, hydro reservoirs, electrocutions, transmission-line maintenance, and wind energy; agriculture: haying and pesticides; harvest: migratory and nonmigratory birds; fisheries: all gear types; oil and gas: all terrestrial and marine sources; mining: both pits/quarries and metals/minerals), as well as the original single-source values for forestry and communication towers. Values in all panels are ranked in descending order according to the converted kill totals. See text and Appendix 2 for citations of papers and reports used as data sources.



(*cont'd next page*)

Figure 1 continued.



proportion of Canadian populations of a few species, e.g., Black-footed Albatross *Phoebastria nigripes*: 4% of the entire Canadian population, or Common Eiders *Somateria mollissima*: 7% of the Nova Scotia breeding population (Fig. 2). Mortality from building collisions also nonrandomly impacted landbirds. Overall, tall buildings killed less than 0.01% of total abundance of any landbird family, whereas between 2-5% of nuthatches, chickadees, and pigeons may have been killed at houses (see Bayne et al. 2012 for proportions of house-collision kills by family, which we used in Appendix 3 and Fig. 2). Although this simple comparison does not capture the complexity of potential population effects, it confirms that national mortality totals alone do not reflect the ecological importance of human-related activities for most species and that mortality is not simply proportional to abundance (see also Longcore et al. 2013).

We did not directly assess the impacts of sport harvest on populations of game birds because ongoing assessments exist elsewhere (e.g. Williams and Johnson 1995, Nichols et al. 2007), and extensive programs are in place throughout North America that ensure that any population-level effects of regulated harvests are sustainable in the long term (e.g., Runge et al. 2009). These impacts would likely have dominated Fig. 2, because sport-harvest was clearly important as a human-related source of mortality in Canada for waterfowl and an important factor for some other bird groups (Table 3).

Spatial distribution of mortality risk and potential cumulative effects

Human-related mortality from terrestrial sources was not uniformly distributed across Canada (Fig. 3A) because areas of higher mortality corresponded with areas of high human population and high human activity. Peak mortality for all sources combined was highest in southern Ontario and Quebec, around the five major prairie cities, and in southwestern British Columbia. In addition to having high human populations, and correspondingly large numbers of cats, buildings, and roads, numerous industries overlap with these areas. Overall, very little avian mortality from the sources that we mapped currently occurs in the northern part of many provinces and in the territories.

The distribution of mortality when excluding the three largest sources (cats, buildings, roads) was spread more evenly across southern Canada (Fig. 3B), partly reflecting broad areas of forest harvesting and the diffuse distribution of communication towers across this area. Southern Alberta and southeastern Ontario appeared to be areas for potential additive effects of multiple industries. The high values in the Maritimes were partially attributable to forestry, whereas those in the lower mainland of British Columbia primarily reflect the high number of hay farms. Individual, unsmoothed maps for each mortality source are provided in Appendix 4.

In contrast to most impacts of clearing activities (Fig. 3B), collision-based sources of mortality impacted some species more than others, and thus potential cumulative effects were harder to assess spatially. Based on available data, we found indications that different types of collisions appeared to affect different groups of landbirds. At the family level, warblers dominated birds killed in communication tower collisions (15 of the most abundant 20 species recorded, Longcore et al. 2013) whereas a wider variety of species dominated tall

Table 1. Life stage-specific (nests, eggs/ nestlings, or independent individuals) mortality estimates of human-related avian mortality in Canada derived directly from published papers and unpublished reports. These values are illustrated in Fig. 1A, and served as the basis for the stochastic model conversion to an equivalent number of potential adult breeders; mortality sources are listed in descending order of converted kill totals. Characteristics of the estimate are indicated in the last column, i.e., whether central values were mean, median, or midpoint of a range, and whether lower/upper values represent a confidence interval (CI) or a range. Note that the estimates for forestry and terrestrial oil and gas shown here represent the estimated number of nests destroyed.

	Nests			Eggs or Nestlings			Individuals			Values
Source	Lower	Central	Upper	Lower	Central	Upper	Lower	Central	Upper	Estimated
Cats - Feral							49,000,000	116,000,000	232,000,000	median, 95% CI
Cats - Domestic							27,000,000	80,000,000	186,000,000	median, 95% CI
Power - Transmission line collisions							10,100,000	25,600,000	41,200,000	mean, 95% CI
Buildings - Houses							15,800,000	22,400,000	30,500,000	mean, range
Transportation - Road vehicle collisions							8,914,341	13,810,906	18,707,470	mean, 95% CI
Agriculture - Pesticides							960,011	2,695,415	4,430,819	midpoint, range
Harvest - Migratory birds								2,279,655		mean
Buildings - Low- and midrise							300,000	2,400,000	11,400,000	mean, range
Harvest - Nonmigratory birds							1,076,810	2,389,124	3,701,438	mean, 95% CI
Forestry - Commercial	615,959	1,351,340	2,086,720							midpoint, range
Transportation - Chronic ship-source oil							217,800	321,900	458,600	mean, 95% CI
Power - Electrocutions							160,836	481,399	801,962	midpoint, range
Agriculture - Haying					2,209,400					mean
Power - Line maintenance	258,849	388,274	592,418							midpoint, range
Communication - Tower collisions								220,649		mean
Power - Hydro reservoirs		152,162								mean
Buildings - Tall							13,000	64,000	149,000	mean, range
Fisheries - Marine gill nets							2185	20,612	41,528	mean, range
Power - Wind energy							13,330	16,700	21,600	mean, 95% CI
Oil and Gas - Well sites	7688	13,182	20,249							median, 90% CI
Mining - Pits and quarries					125,529					mean
Oil and Gas - Pipelines	503	6314	30,234							median, 90% CI
Mining - Metals and minerals				18,653	69,211	119,768				midpoint, range
Oil and Gas - Oil sands	1281	2939	5236							median, 90% CI
Oil and Gas - Seismic exploration	374	2280	16,438							median, range
Fisheries - Marine longlines and trawls							494	1,999	4058	mean, range
Transportation - Road maintenance				13,086	25,149	50,294	84	149	270	median, range
Oil and Gas - Marine							188	2244	4494	median, range
TOTAL		1,916,491			2,429,289			268,704,752		

Fig. 2. Proportion of population affected by anthropogenic mortality on Canadian birds, by species group (panel A) and by mortality source (panel B), for populations where data were available at sufficient resolution. Estimated annual kill for a given species, population, or family (converted to potential adult breeders) is plotted against the estimated Canadian abundance for that group, to show the estimated proportion of the total population killed by each activity. The three diagonal lines represent a mortality rate of 10%, 1%, and 0.1% for visual reference and are explained in more detail in the text. Details of mortality and abundance totals, as well as the identity of the species/population/family represented by each data point, are provided in Appendix 3. Game bird harvests are not included in this figure because they would dominate the figure and this source of mortality is regulated.

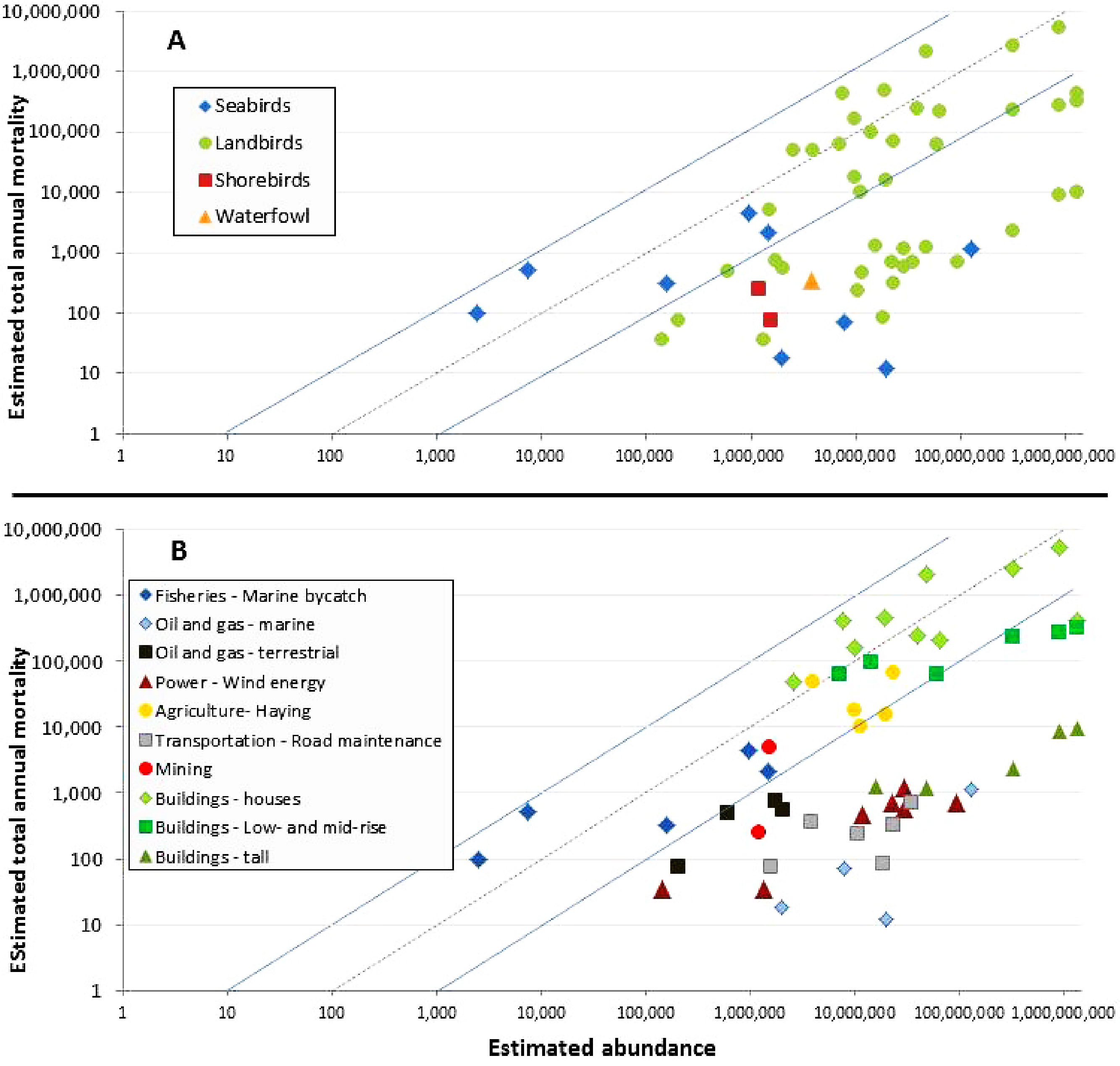


Fig. 3. Approximated distribution of total bird mortality estimates in Canada from eight terrestrial sources (cats, building collisions, vehicle collisions, agriculture, forestry, terrestrial oil and gas, communication towers, and wind turbines). Panel A is the sum of all eight sources, while panel B excludes the first three in the above list. These maps present the probability of mortality based on the distribution of each source in Canada. The hotspot on Montreal is because a single tile of our grid overlapped that city perfectly, while, for example, Toronto was centered at the intersection of 4 tiles. Unsmoothed maps for each mortality source and all mapping methods are provided in Appendix 4.

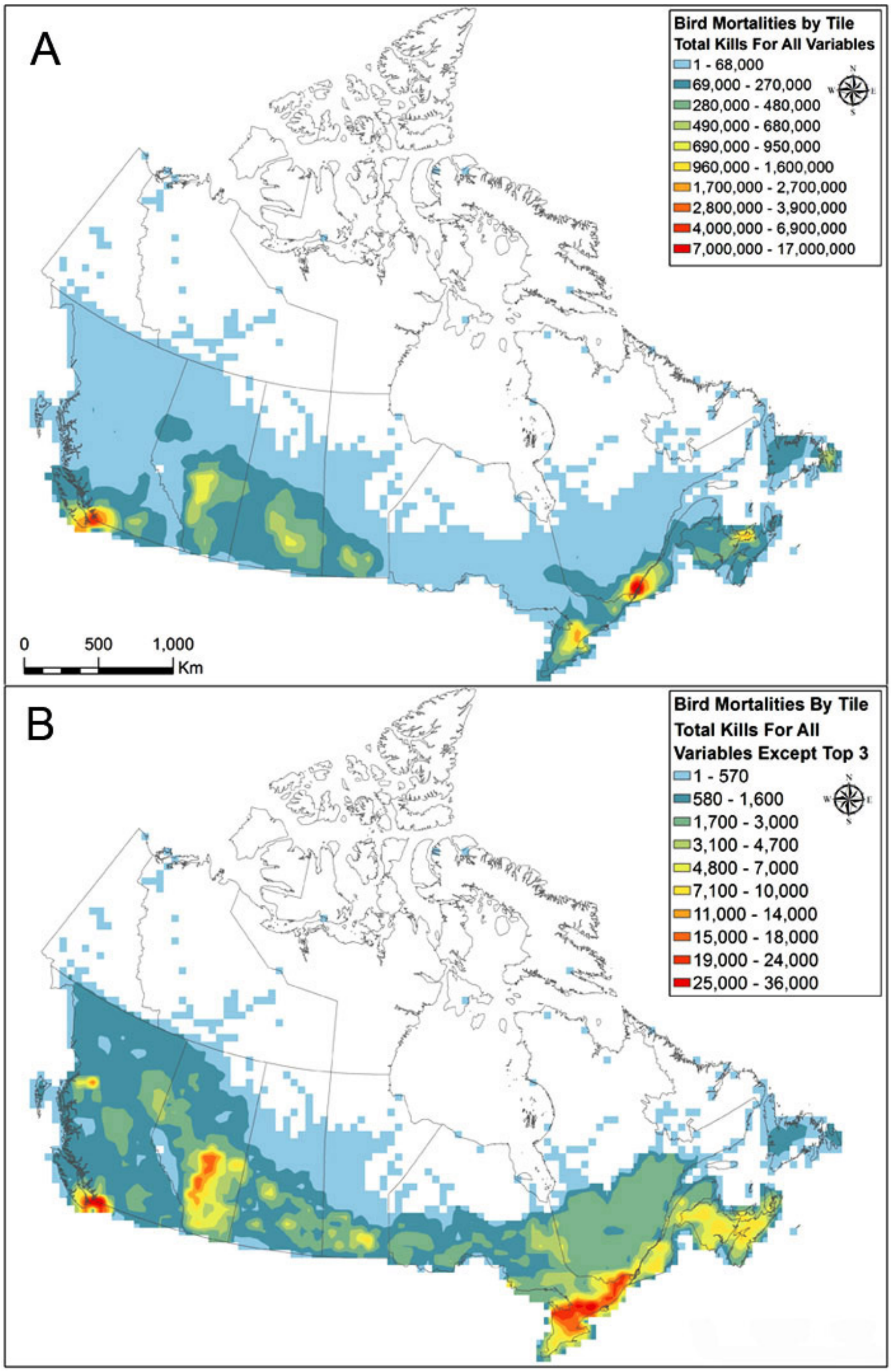


Table 2. Seasonal and species-group breakdown for each source of human-related avian mortality in Canada: o little or no known effect, + some effect, including effects anticipated but not quantified [highlighted yellow], ++ large effect [highlighted orange], na not applicable. Within the effect-type categories (collisions, direct kill, or nest destruction), mortality sources are ordered in descending order of converted kill totals, as presented in Fig. 1B. Comparisons should be made within source rows, rather than within columns because the level of effect was evaluated qualitatively among seasons and species-groups within each source, and is not intended to reflect differences in magnitude among sources. Note that ‘winter’ refers only to impacts on birds while wintering in Canada.

		LANDBIRDS				SEABIRDS				SHOREBIRDS				WATERBIRDS				WATERFOWL			
Primary type of impact	Source	S-PR	B-RE	F-ALL	WIN	S-PR	B-RE	F-ALL	WIN	S-PR	B-RE	F-ALL	WIN	S-PR	B-RE	F-ALL	WIN	S-PR	B-RE	F-ALL	WIN
Collisions	Transportation - Road vehicle collisions	+	++	+	+	o	o	o	o	+	+	+	o	+	+	+	o	+	+	+	o
	Buildings – Houses	++	++	++	+	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Power - Transmission line collisions	+	+	+	+	o	o	o	o	++	++	++	+	+	+	+	+	++	+	++	+
	Buildings - Low- and mid-rise	++	++	++	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Power – Electrocutions	+	+	+	+	o	o	o	o	+	o	+	o	+	o	+	o	o	o	o	o
	Communication - Tower collisions	++	+	++	+	o	o	o	o	+	o	+	o	+	o	+	o	+	o	+	o
	Buildings – Tall	++	o	++	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Power - Wind energy	+	++	+	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Direct kill	Cats (feral and domestic)	++	++	++	++	o	o	o	o	o	+	o	o	o	+	o	o	o	+	o	o
	Agriculture – Pesticides	+	++	+	o	o	o	o	o	+	+	+	o	+	+	+	o	+	+	+	o
	Harvest - Migratory game birds	o	o	o	o	o	o	+	+	o	o	+	+	o	o	+	+	+	o	++	+
	Harvest - Non-migratory game birds	o	o	++	+	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Transportation - Chronic ship-source oil	o	o	o	o	o	o	o	++	o	o	o	o	o	o	o	o	o	o	o	o
	Fisheries - Marine gillnets	o	o	o	o	o	++	+	o	o	o	o	o	o	o	o	o	o	+	o	o
	Fisheries - Marine longlines and trawls	o	o	o	o	o	+	+	o	o	o	o	o	o	o	o	o	o	o	o	o
	Oil and Gas - Marine[†]	o	o	o	o	+	+	+	+	o	o	o	o	o	o	o	o	o	o	o	o
Nest destruction	Agriculture – Haying and mowing	na	++	na	na	na	o	na	na	na	o	na	na	na	o	na	na	na	++	na	na
	Forestry – Commercial	na	++	na	na	na	o	na	na	na	+	na	na	na	o	na	na	na	+	na	na
	Power - Line maintenance	na	++	na	na	na	o	na	na	na	++	na	na	na	++	na	na	na	++	na	na
	Power - Hydro reservoirs	na	++	na	na	na	o	na	na	na	++	na	na	na	++	na	na	na	++	na	na
	Oil and Gas - Terrestrial (all)	na	++	na	na	na	o	na	na	na	+	na	na	na	o	na	na	na	+	na	na
	Mining (all)	na	++	na	na	na	o	na	na	na	+	na	na	na	o	na	na	na	+	na	na
	Transportation - Road maintenance[‡]	na	++	na	na	na	o	na	na	na	+	na	na	na	o	na	na	na	++	na	na

[†] mortality from both direct kill and collisions;
[‡] mortality from both nest destruction and direct kill

building collisions (only 6 of the top 20 were warblers, Machtans et al. 2013). At the species level, the top five species killed in tall building collisions in southern Ontario (based on the Toronto Fatal Light Awareness Program, www.flap.org) were Golden-crowned Kinglet (*Regulus satrapa*), White-throated Sparrow (*Zonotrichia albicollis*), Ruby-crowned Kinglet (*Regulus calendula*), Dark-eyed Junco (*Junco hyemalis*), and Ovenbird (*Seiurus aurocapilla*), together comprising 42% of mortalities. In contrast, the top five species killed in communication tower collisions in the Bird Conservation Region, which includes Toronto (Longcore et al. 2013), were Ovenbird, Ruby-crowned Kinglet, Blackpoll Warbler (*Setophaga striata*), Red-eyed Vireo (*Vireo olivaceus*), and Common Yellowthroat (*Geothlypis trichas*), together comprising 44% of mortalities. Species reported killed most often at wind-turbines only showed some overlap with these other collision-sources, with the top five being Horned Lark (*Eremophila alpestris*), Golden-crowned Kinglet, Red-eyed Vireo, European Starling (*Sturnus vulgaris*), and Tree Swallow (*Tachycineta bicolor*; Zimmerling et al. 2013). Only 80% of birds killed at wind turbines were passerines, proportionately much lower than at communication towers (97% passerines, Longcore et al. 2013) or in collisions with windows of tall buildings (90% passerines, Machtans et al. 2013). Much better species-level data are required concerning cat kills and window collisions at homes, as well as from the range of other human activities for which population-level data are not yet available, to better understand the most significant population impacts and to identify additive or cumulative impacts. Even the species comparisons above should be taken with caution because the spatial scale of the data sources differ across each study.

Table 3. Median annual estimates of human-related mortality in Canada across the five major species groups, based on a stochastic model that converted stage-specific mortality to potential adult breeders, ranked in descending order according to total estimated mortality across all bird groups. Note that species-group totals do not sum exactly to the ‘all birds’ value because uncertainty in species composition was explicitly modeled and the “all birds” value was modeled independently of each species group’s total. See text and Appendix 2 for details of the stochastic model conversions. In cases where mortality was not fully extrapolated to all regions and taxa, e.g., where it was only estimated for a given region or set of focal species, the taxonomic or regional scope of the estimate is indicated; impacts estimated Canada-wide and across taxa are indicated as ‘all’ in the Scope column.

SOURCE	SCOPE	LANDBIRDS	SEABIRDS	SHOREBIRDS	WATERBIRDS	WATERFOWL	ALL BIRDS
Cats - Feral	All	78,600,000			293,400	380,500	79,600,000
Cats - Domestic	All	54,150,000			199,300	258,300	54,880,000
Power - Transmission line collisions	All	574,700		2,548,000	5,170,000	8,459,000	16,810,000
Buildings - Houses	All	16,390,000					16,390,000
Transportation - Road vehicle collisions	All	8,743,000		197,000	187,200	218,500	9,814,000
Agriculture - Pesticides	All	1,898,000		19,230	19,430	19,130	1,998,000
Harvest - Migratory game birds	All	235	55,520	24,770	8773	1,691,000	1,786,000
Buildings - Low- and mid-rise	All	1,132,000		26,310	23,870	32,190	1,283,000
Harvest - Non-migratory game birds	All	1,031,000					1,031,000
Forestry - Commercial	Landbirds	887,835					887,835
Transportation - Chronic ship-source oil	All		282,700				282,700
Power - Electrocutions	All	178,200		1715	1854	2275	184,300
Agriculture – Haying and mowing	5 species	135,400					135,400
Power - Line maintenance	All	70,140		4474		33,030	116,000
Communication - Tower collisions	All	101,500		965	1050	1278	101,500
Power - Hydro reservoirs	Québec	31,260		490	1571	158	35,770
Buildings - Tall	All	32,000		388	339	501	34,130
Fisheries - Marine gill nets	All		19,790				19,790
Power - Wind energy	All	13,060					13,060
Oil and Gas - Well sites	Landbirds	9815					9815
Mining - Pits and quarries	All	5169		39	168		5637
Oil and Gas - Pipelines	Landbirds	4687					4687
Mining - Metals and minerals	All	2798					2798
Oil and Gas - Oil sands	Landbirds	2193					2193
Oil and Gas - Seismic exploration	Landbirds	1966					1966
Fisheries - Marine longlines and trawls	All		1843				1843
Transportation - Road maintenance	6 species	1103		71		324	1545
Oil and Gas - Marine	All		584				584
TOTAL		163,980,226	360,437	2,848,252	5,931,455	11,124,386	186,429,553

DISCUSSION

Interpreting mortality estimates

Human-related activities inadvertently kill hundreds of millions of birds and destroy millions of nests in Canada every year, with landbirds most affected. Birds are primarily affected during the breeding season, although collisions occur year round. Landbirds were subject to the largest diversity of impacts, suggesting that they may be most vulnerable to additive effects across sources and seasons. Many of these human-related activities also pose a threat to migrants when outside of Canada, mortality that has not been quantified here, and thus the cumulative year-round population-level effects will be higher for species that migrate outside Canada. For instance, in the United States a median estimate of 2.4 billion birds are killed annually by cats (Loss et al. 2013), and a substantial proportion of these birds will have been produced in Canada. In the context of severe population declines already observed for many groups (e.g. long-distance migrants: BirdLife International 2008; grassland breeders, shorebirds, aerial insectivores: NABCI-Canada 2012), human-related activities create additional population pressures for many of Canada’s birds.

The estimated number of potential breeders killed annually by specific sectors or sources differs by several orders of magnitude, ranging from fewer than one thousand for routine marine oil and gas activities, to tens of millions for collisions with vehicles, transmission lines, and houses, and over 140 million for cat kills. Most of these activities are known to effect birds at a local scale, although extrapolation to the national level has highlighted the magnitude and potential significance of several widespread impacts, such as cats and building collisions. For other activities, a national scale perspective may lead to important local-scale mortality being overlooked, e.g., regionally concentrated fisheries bycatch. Our geographical assessment revealed the highest cumulative risk to birds in regions of high human population density and related road networks. Southern Alberta and Ontario also stood out as areas with potentially high cumulative effects because of a convergence of several human activities in addition to the top three sources, whereas other high risk locations were generally attributable to single mortality sources.

Although these estimates provide new insight into the relative significance of different industrial and other human-related activities to wild birds in Canada, the precision of our review is limited by the availability of relevant information from Canada. The wide confidence ranges around the converted estimates explicitly indicate the considerable uncertainty in our present knowledge of the magnitude of source-specific mortality, so these should be viewed as preliminary estimates pending further refinement, additional research, and increased monitoring and assessment.

Uncertainties and caveats

Accurate estimation of the magnitude of bird mortality from industrial and other human-related activities is compromised by the need to estimate large-scale national impacts by extrapolating from small studies, often with limited data. Wherever possible, authors directly accounted for known sources of bias, such as variability in detection and scavenging of bird carcasses (e.g., road vehicles: Bishop and Brogan 2013; building collisions: Machtans et al. 2013; wind power: Zimmerman et al. 2013; transmission line collisions: Rioux et al. 2013). Some explicitly assessed the sensitivity of mortality estimates to key parameters such as the number of unowned cats in Canada (Blancher 2013), or the timing of agricultural or oil and gas activities in relation to breeding seasons (Tews et al. 2013, Van Wilgenburg et al. 2013). Overall, we consider that the estimates presented in this issue are likely to be precise to within an order of magnitude, particularly because actual levels of mortality from each source will likely vary significantly from one year to the next.

Some important sources of estimation bias still remain. For instance, the scale of available data may sometimes be mismatched to the scale of human-related activities. The harvest volume from commercial forestry activities is typically reported provincially and not by area cut, while the density of nesting birds is inferred from extrapolating local-scale point-counts to Bird Conservation Regions, which do not align with provincial boundaries (Hobson et al. 2013). Additionally, specific Canadian data for predation rates by cats, pesticide use, and mortality from power generation were also lacking (Blancher 2013; Appendix 1), so the estimates presented here are derived in part using data from other countries or continents. Extrapolations for marine oil and gas were based on untested assumptions, with few data available to inform these estimates (Ellis et al. 2013).

Estimates of effects from most sources could be improved by a better understanding of the seasonal distribution of mortality. For instance, the proportion of industrial activities that occur within the breeding season had to be approximated for several sources (e.g., forestry: Hobson et al. 2013; oil and gas: Van Wilgenburg et al. 2013). Species-composition of the kill is also poorly known for many human activities (e.g., vehicle collisions: Bishop and Brogan 2013; transmission line collisions: Rioux et al. 2013), limiting our ability to evaluate potential population-level impacts. Finally, most analyses presented here were designed to estimate direct annual kill of individual birds or destruction of nests. Estimates for most mortality sources that also involve significant clearing or alteration of habitat do not reflect the total long-term impact of the activity on bird populations because most analyses did not account for additional long-term impacts, e.g., via habitat change (Wells et al. 2008) or related one-time mortality events, e.g., destruction of nests during initial construction of transmission lines (Rioux et al. 2013).

The stochastic simulation model addressed some of these biases, so that the distributions of potential adult breeder mortality are more likely to reflect the actual impacts of estimated mortality. The confidence limits around median estimates reflect the remaining uncertainty in the input values; for instance, the magnitude of mortality caused by fisheries bycatch or wind power is known with greater precision than that caused by mining activities or terrestrial oil and gas. These estimates all assume that most mortality estimated here is additive to natural mortality, so density-dependence was not incorporated into these conversions. The stochastic simulation model did make some simplifying assumptions, such as assigning age of first breeding to the second year of life for all but the seabirds, which would overestimate the number of potential breeders when breeding begins later, and by using nest success estimates that assume that nests were destroyed at the beginning of nesting, which would underestimate the number of potential breeders if nest destruction occurred later in the season. An important potential bias of the modeling process was the use of representative vital rates from only a few species, except the landbirds. In the future, more detailed estimates of species-specific kills could be incorporated with models using their species-specific vital rates to properly assess the effects of any particular mortality source. Finally, there are some considerations that the conversion to potential adult breeders could not incorporate. Long-lived, low-fecundity species take longer to recover from population perturbations, and mortality for these species is more likely to be additive than for shorter lived high-fecundity species. Additionally, long-lived, low-fecundity species tend to have much smaller population sizes, so a greater portion of the population is removed with each potential adult killed.

The risk mapping also relied on some important assumptions, specifically that mortality from each source was spread across the landscape in proportion to its existing spatial intensity. This is certainly not the case; forestry companies do not harvest equally across their tenure area and not every communication tower or wind turbine kills the average number of birds. However, adopting this assumption was necessary to create a first order spatial representation of the distribution of avian mortality risk across Canada.

The values considered here represent the current best estimates of source-specific annual bird mortality for Canada across all species groups and age classes, although a few sectoral mortality estimates must be considered to be quite preliminary, and there is some inherent uncertainty in all estimates. Moreover, because the magnitude of the estimates is likely to be fairly accurate, with true mortality levels contained within the estimation range, the relative ranking of mortality sources is unlikely to change substantially with improved precision.

CONCLUSIONS AND IMPLICATIONS

From a conservation perspective, it is now important to develop a more complete understanding of the population level effects of human-related avian mortality within and across sectors, at relevant spatial scales. Sources such as window strikes at houses cause high levels of mortality nation-wide, but this mortality is not spread equally across different species or families. Longcore et al. (2013) found similarly variable population impacts of communication tower collisions. Marine fisheries bycatch was not among the highest-ranking sources of mortality nation-wide, yet it kills disproportionately high numbers of birds from particular regional populations. Our assessment did not consider the fact that certain populations or species may still manifest a population-level consequence through additive effects of several mortality sources, even though each source individually would not be expected to show such an effect. Understanding these cumulative effects will not be possible until species-specific kill rates are available for all sectors. In the interim, those habitats or areas of the country where many sectors operate together are places where these multiple stressors have the potential to combine and create such a cumulative impact.

This synthesis and accompanying papers focus primarily on direct mortality of birds and destruction of nests resulting from human activities, but do not consider the potential longer term effects on birds from habitat changes. Wind turbines, for example, cause mortality by nest-destruction during construction as well as through collision mortality during operation. Indeed, recent evidence suggests that initial construction may sometimes pose a greater overall threat to birds (Pearce-Higgins et al. 2012). Commercial forestry, terrestrial oil and gas, and mining are further examples of activities where there may be significant longer term or broader scale effects of habitat modification that are not addressed here. Furthermore, mortality rates may change in the future for industries undergoing rapid rates of development, such as wind facilities, which are predicted to expand ten-fold in Canada over the next 10-15 years (CanWEA 2013). Human activities currently contributing relatively little to total mortality may therefore present a greater risk in years to come.

The complex relationships among all ecological factors regulating avian populations, and particularly migratory birds, require consideration of factors operating at points throughout the entire life cycle (Faaborg et al. 2010). For example, if wintering habitat conditions are not limiting, human-related mortality may be additive. However, if wintering habitat becomes limiting, human-related mortality may shift to being compensatory and its influence on population regulation may change. Improved understanding of species composition of mortality events, the magnitude of mortality of migrants south of Canada, and survival estimates at each life stage will be required to effectively model the demography of affected populations, particularly if bird conservation objectives include maintaining source-specific mortality from human-related causes below certain levels (e.g., McGowan and Ryan 2009, Runge et al. 2009, Dillingham and Fletcher 2011).

Insight into the relative magnitude of different human-related sources of mortality provides a valuable tool for guiding management, and affords additional perspectives for prioritizing conservation and research initiatives for Canada’s birds. We propose four key areas for future research or management. First, to enable more precise analyses and impact modeling, we recommend additional Canadian research into the magnitude of bird effects for data-poor sectors, e.g., pesticides, and the species likely affected, and into particular aspects of mortality, e.g., species composition and seasonal timing of the kill. Second, our results highlight the value of increased efforts to minimize impacts of widespread and generalized low-intensity human-related activities that create nationally high levels of mortality but could be mitigated at local scales, e.g., cats and buildings. Such investments could include local approaches using outreach and other available conservation tools. Third, we recommend specifically targeting those mortality sources identified as having population-level effects at regional or national levels for priority conservation action. Finally, we encourage further assessments that integrate the effects on populations across multiple sectors to truly understand the impacts of all mortality sources on priority species. Such mitigation efforts can reduce human-related impacts on birds if appropriately directed (as shown by e.g., Nocera et al. 2005, 2007: changing the timing of agricultural activities to reduce impacts on grassland breeders; Gehring et al. 2009: changing lights on communication towers to reduce collision mortality; and Løkkeborg 2011: modifying fishing gear to reduce bycatch of seabirds.

Given that the relative ranking of mortality sources considered here is unlikely to change substantially even with increased precision, an immediate focus should consider mitigation of those mortality sources with the highest magnitudes at the national level, e.g., cats and collisions. At the same time, scientists should try to identify and better understand potential population-level impacts on populations or species, at appropriate geographical scales. Effective application of these findings to the conservation of Canadian birds will require constructive collaboration among the public and various levels of government, nongovernmental organizations, and industries within Canada. This assessment should help target these initiatives appropriately to improve the population and conservation status of birds within Canada, as well as the continental conservation status for migratory species.

Responses to this article can be read online at:
http://www.ace-eco.org/issues/responses.php/581

Acknowledgments:

This research was instigated and funded by Environment Canada. Thank you to Amos Chow for assistance in compiling some of the mapping data, to Beau MacDonald for providing quality-controlled communication tower data, to Alyssa Serena for compiling provincial game-bird harvest numbers, to Steve Van Wilgenburg and Keith Hobson for providing their landbird demographic rates, and to Peter Blancher for unpublished family-level abundance estimates. Finally, we thank the authors of all the papers and reports cited here on individual sources of human-related avian mortality for their feedback and clarification of their mortality estimates.

LITERATURE CITED

Anderson, D. R., and K. P. Burnham. 1976. *Population ecology of the mallard IV: the effect of exploitation on survival.* Publication 128. U.S. Department of the Interior, U.S. Geological Survey, Reston, Virginia, USA.

Arnold, T. W., and R. M. Zink. 2011. Collision mortality has no discernible effect on population trends of North American birds. *PLoS ONE* 6(9):e24708. http://dx.doi.org/10.1371/journal.pone.0024708

Balogh, A. L., T. B. Ryder, and P. P. Marra. 2011. Population demography of Gray Catbirds in the suburban matrix: sources, sinks and domestic cats. *Journal of Ornithology* 152:717-726. http://dx.doi.org/10.1007/s10336-011-0648-7

Bayne, E. M., C. A. Scobie, and M. Rawson-Clark. 2012. Factors influencing the annual risk of bird-window collisions at residential structures in Alberta, Canada. *Wildlife Research* 39(7):583-592.

BirdLife International. 2008. *State of the world's birds: indicators for our changing world*. BirdLife International, Cambridge, UK.

Bishop, C. A., and J. M. Brogan. 2013. Estimates of avian mortality attributed to vehicle collisions in Canada. *Avian Conservation and Ecology* 8(2): 2. http://dx.doi.org/10.5751/ACE-00604-080202

Blancher, P. J. 2002. *Importance of breeding birds exported from Canada – information on landbirds and shorebirds.* Unpublished report to the North American Bird Conservation Initiative Canada National Council. Ottawa, Ontario, Canada.

Blancher, P. J. 2013. Estimated number of birds killed by house cats (*Felis catus*) in Canada. *Avian Conservation and Ecology* 8(2): 3. http://dx.doi.org/10.5751/ACE-00557-080203

Canadian Wind Energy Association (CanWEA). 2013. *Powering Canada' future.* CanWEA, Ottawa, Ontario, Canada. [online] URL: http://www.canwea.ca/pdf/Canada%20Current%20Installed%20Capacity_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2010. *COSEWIC assessment and status report on the Bobolink* Dolichonyx oryzivorus *in Canada*. COSEWIC, Ottawa, Ontario, Canada. [online] URL: http://registrelep-sararegistry.gc.ca/default.asp?lang=En&n=7019552A-1

Crooks, K. R., and M. E. Soulé. 1999. Mesopredator release and avifaunal extinctions in a fragmented system. *Nature* 400:563-566. http://dx.doi.org/10.1038/23028

Dillingham, P. W., and D. Fletcher. 2011. Potential biological removal of albatrosses and petrels with minimal demographic information. *Biological Conservation* 144:1885-1894. http://dx.doi.org/10.1016/j.biocon.2011.04.014

Ellarson, R. S. 1956. *A study of the Old-squaw Duck on Lake Michigan*. Dissertation. University of Wisconsin, Madison, Wisconsin, USA.

Ellis, J. I., S. I. Wilhelm, A. Hedd, G. S. Fraser, G. J. Robertson, J.-F. Rail, M. Fowler, and K. H. Morgan. 2013. Mortality of migratory birds from marine commercial fisheries and offshore oil and gas production in Canada. *Avian Conservation and Ecology* 8(2): 4. http://dx.doi.org/10.5751/ACE-00589-080204

Faaborg, J., R. T. Holmes, A. D. Anders, K. L. Bildstein, K. M. Dugger, S. A. Gauthreaux Jr., P. Heglund, K. A. Hobson, A. E. Jahn, D. H. Johnson, S. C. Latta, D. J. Levey, P. P. Marra, C. L. Merkord, E. Nol, S. I. Rothstein, T. W. Sherry, T. S. Sillett, F. R. Thomson III, and N. Warnock. 2010. Recent advances in understanding migration systems of New World land birds. *Ecological Monographs* 80:3-48. http://dx.doi.org/10.1890/09-0395.1

Gehring, J., P. Kerlinger, and A. M. Manville II. 2009. Communication towers, lights, and birds: successful methods of reducing the frequency of avian collisions. *Ecological Applications* 19:505-514. http://dx.doi.org/10.1890/07-1708.1

Hobson, K. A., A. G. Wilson, S. L. Van Wilgenburg, and E. M. Bayne. 2013. An estimate of nest loss in Canada due to industrial forestry operations. *Avian Conservation and Ecology* 8(2): 5. http://dx.doi.org/10.5751/ACE-00583-080205

Jenks, G. F. 1967. The data model concept in statistical mapping. *International Yearbook of Cartography* 7:186–190.

Jensen, J. R. 2005. *Introductory digital image processing: a remote sensing perspective*. Third edition. Pearson Prentice Hall, Upper Saddle River, New Jersey, USA.

Johnston, J. P., W. J. Peach, R. D. Gregory, and S. A. White. 1997. Survival rates of tropical and temperate passerines: a Trinidadian perspective. *American Naturalist* 150:771-789. http://dx.doi.org/10.1086/286093

Klem, D., Jr. 2009. Preventing bird-window collisions. *Wilson Journal of Ornithology* 121:314-321. http://dx.doi.org/10.1676/08-118.1

Løkkeborg, S. 2011. Best practices to mitigate seabird bycatch in longline, trawl and gillnet fisheries-efficiency and practical applicability. *Marine Ecology Progress Series* 435:285-303. http://dx.doi.org/10.3354/meps09227

Longcore, T., C. Rich, P. Mineau, B. MacDonald, D. G. Bert, L. M. Sullivan, E. Mutrie, S. A. Gauthreaux Jr., M. L. Avery, R. L. Crawford, A. M. Manville II, E. R. Travis, and D. Drake. 2012. An estimate of avian mortality at communication towers in the United States and Canada. *PLoS ONE* 7(4): e34025. http://dx.doi.org/10.1371/journal.pone.0034025

Longcore, T., C. Rich, P. Mineau, B. MacDonald, D. G. Bert, L. M. Sullivan, E. Mutrie, S. A. Gauthreaux Jr., M. L. Avery, R. L. Crawford, A. M. Manville II, E. R. Travis, and D. Drake. 2013. Avian mortality at communication towers in the United States and Canada: which species, how many, and where? *Biological Conservation* 158:410-419. http://dx.doi.org/10.1016/j.biocon.2012.09.019

Loss, S. R., T. Will, and P. P. Marra. 2012. Direct human-caused mortality of birds: improving quantification of magnitude and assessment of population impact. *Frontiers in Ecology and the Environment* 10:357–364. http://dx.doi.org/10.1890/110251

Loss, S. R., T. Will, and P. P. Marra. 2013. The impact of free-ranging domestic cats on wildlife of the United States. *Nature Communications* 4:1396. http://dx.doi.org/10.1038/ncomms2380

Machtans, C. S., C. H. R. Wedeles, and E. M. Bayne. 2013. A first estimate for Canada of the number of birds killed by colliding with building windows. *Avian Conservation and Ecology* 8(2): 6. http://dx.doi.org/10.5751/ACE-00568-080206

Manville, A. M., II. 2009. Towers, turbines, power lines, and buildings – steps being taken by the U.S. Fish and Wildlife Service to avoid or minimize take of migratory birds at these structures. Pages 262-272 *in* T. D. Rich, C. Arizmendi, D. W. Demarest, and C. Thompson, editors. *Tundra to tropics: connecting birds, habitats, and people*. Proceedings of the 4th International Partners in Flight Conference, Partners in Flight, McAllen, Texas, USA.

McGowan, C. P., and M. R. Ryan. 2009. A quantitative framework to evaluate incidental take and endangered species population viability. *Biological Conservation* 142:3128-3136. http://dx.doi.org/10.1016/j.biocon.2009.08.012

Miller, M. R., and D. C. Duncan. 1999. The northern pintail in North America: status and conservation needs of a struggling population. *Wildlife Society Bulletin* 27:788-800.

Mineau, P., and M. Whiteside. 2013. Pesticide acute toxicity is a better correlate of U.S. grassland bird declines than agricultural intensification. *PLoS ONE* 8(2):e57457. http://dx.doi.org/10.1371/journal.pone.0057457

Nichols, J. D., M. C. Runge, F. A. Johnson, and B. K. Williams. 2007. Adaptive harvest management of North American waterfowl populations: a brief history and future prospects. *Journal of Ornithology* 148(Suppl. 2):S343-S349. http://dx.doi.org/10.1007/s10336-007-0256-8

Nocera, J. J., G. Forbes, and G. R. Milton. 2007. Habitat relationships of three grassland breeding bird species: broadscale comparisons and hayfield management implications. *Avian Conservation and Ecology* 2(1): 7. [online] URL: http://www.ace-eco.org/vol2/iss1/art7/

Nocera, J. J., G. J. Parsons, G. R. Milton, and A. H. Fredeen. 2005. Compatibility of delayed cutting regime with bird breeding and hay nutritional quality. *Agriculture, Ecosystems & Environment* 107:245-253. http://dx.doi.org/10.1016/j.agee.2004.11.001

North American Bird Conservation Initiative Canada (NABCI-Canada). 2012. *The state of Canada's birds, 2012.* Environment Canada, Gatineau, Quebec, Canada.

Pearce-Higgins, J. W., L. Stephen, A. Douse, and R. H. W. Langston. 2012. Greater impacts of wind farms on bird populations during construction than subsequent operation: results of a multi-site and multi-species analysis. *Journal of Applied Ecology* 49:386-394. http://dx.doi.org/10.1111/j.1365-2664.2012.02110.x

Piatt, J. F., D. N. Nettleship, and W. T. Threlfall. 1984. Net mortality of Common Murres *Uria aalge* and Atlantic Puffins *Fratercula acrtica* in Newfoundland, 1951-1981. Pages 196-206 *in* D. N. Nettleship, G. Sanger, and P. F. Springer, editors. *Marine birds: their feeding ecology and commercial fisheries relationships*. Special publication. Canadian Wildlife Service, Ottawa, Ontario, Canada.

Price, I. M., and J. G. Nickum. 1995. Aquaculture and birds: the context for controversy. *Colonial Waterbirds* 18 (Special Publication):33-45. http://dx.doi.org/10.2307/1521522

Prairie Habitat Joint Venture. 2008. *Prairie Habitat Joint Venture Implementation Plan 2007 - 2012*. Report of the Prairie Habitat Joint Venture. Environment Canada, Edmonton, Alberta, Canada.

Rioux, S., J.-P. L. Savard, and A. A. Gerick. 2013. Avian mortalities due to transmission line collisions: a review of current estimates and field methods with an emphasis on applications to the Canadian electric network. *Avian Conservation and Ecology* 8(2): 7. http://dx.doi.org/10.5751/ACE-00614-080207

Runge, M. C., J. R. Sauer, M. L. Avery, B. F. Blackwell, and M. D. Koneff. 2009. Assessing allowable take of migratory birds. *Journal of Wildlife Management* 73:556-565. http://dx.doi.org/10.2193/2008-090

Tews, J., D. G. Bert, and P. Mineau. 2013. Estimated mortality of selected migratory bird species from mowing and other mechanical operations in Canadian agriculture. *Avian Conservation and Ecology* 8(2): 8. http://dx.doi.org/10.5751/ACE-00559-080208

Thomas, P. J., P. Mineau, R. F. Shore, L. Champoux, P. A. Martin, L. K. Wilson, G. Fitzgerald, and J. E. Elliott. 2011. Second generation anticoagulant rodenticides in predatory birds: probabilities characterisation of toxic liver concentrations and implications for predatory bird populations in Canada. *Environment International* 37:914-920. http://dx.doi.org/10.1016/j.envint.2011.03.010

Timoney, K. P, and R. A. Ronconi. 2010. Annual bird mortality in the bitumen tailings ponds in northeastern Alberta, Canada. *Wilson Journal of Ornithology* 122:569-576. http://dx.doi.org/10.1676/09-181.1

Van Wilgenburg, S. L., K. A. Hobson, E. M. Bayne, and N. Koper. 2013. Estimated avian nest loss associated with oil and gas exploration and extraction in the Western Canadian Sedimentary Basin. *Avian Conservation and Ecology* 8(2): 9. http://dx.doi.org/10.5751/ACE-00585-080209

Wells, J., S. Casey-Lefkowitz, G. Chavarria, and S. Dyer. 2008. *Danger in the nursery: impacts on birds of tar sands oil development in Canada's boreal forest.* Natural Resources Defense Council, New York, NY, USA.

Wiese, F. K., and G. J. Robertson. 2004. Assessing seabird mortality from chronic oil discharges at sea. *Journal of Wildlife Management* 68:627-638. http://dx.doi.org/10.2193/0022-541X(2004)068[0627:ASMFCO]2.0.CO;2

Williams, B. K., and F. A. Johnson. 1995. Adaptive management and the regulation of waterfowl harvests. *Wildlife Society Bulletin* 23:430-436.

Zimmerling, J. R., A. Pomeroy, M. d'Entremont, and C. M. Francis. 2013. Canadian estimate of bird mortality due to collisions and direct habitat loss associated with wind turbine developments. *Avian Conservation and Ecology* 8(2): 10. http://dx.doi.org/10.5751/ACE-00609-080210

Zydelis, R., D. Esler, M. Kirk, and W. S. Boyd. 2009. Effects of off-bottom shellfish aquaculture on winter habitat use by molluscivorous sea ducks. *Aquatic Conservation: Marine and Freshwater Ecosystems* 19:34-42. http://dx.doi.org/10.1002/aqc.977

Zydelis, R., D. Esler, W. S. Boyd, D. L. Lacroix, and M. Kirk. 2006. Habitat use by wintering Surf and White-winged Scoters: effects of environmental attributes and shellfish aquaculture. *Journal of Wildlife Management* 70:1754-1762. http://dx.doi.org/10.2193/0022-541X(2006)70[1754:HUBWSA]2.0.CO;2

Appendix 1: Unpublished reports on sources of mortality cited in the text.

The following reports are not peer reviewed and should not be cited as such. The authors of the main paper for which these materials form a supplementary appendix make no expression on the validity of individual portions of or computations in the papers aside from what was extracted for use with noted caveats in the main paper.

Avian Incidental Take due to Roadside Maintenance Operations in Canada

Prepared by
ESSA Technologies Ltd.
and
Arbor Vitae Environmental Services Ltd.

for
Environment Canada

June 2010

Suggested Citation: **Abraham, D., D. Pickard and C. Wedeles.** 2010. Avian Incidental Take due to Roadside Maintenance Operations in Canada. Report Prepared by ESSA Technologies Ltd. and Arbor Vitae Environmental Services Ltd. for Environment Canada. 31 pp. + appendices

Table of Contents

List of Tables

1 EXECUTIVE SUMMARY

ArborVitae Environmental Services Ltd. and ESSA Technologies Ltd. generated preliminary estimates of the magnitude of avian incidental take due to roadside maintenance operations across Canada. Eighteen roadside nesting species, all protected under the Migratory Birds Convention Act, were identified through the literature and expert advice. To model the impacts on these species, this study took a focal-species approach, in which estimates of incidental take were modeled for 6 focal species and then extrapolated to 12 other species which had similar ecologies. The estimates of take for the focal species were based on:

- their nesting ecology (i.e. nesting dates, number of eggs laid, incubation periods) and range in Canada;
- preferred nesting habitats relative to the availability of the habitats along roadsides; and
- the amount of road and maintenance activities conducted in each province.

We used a modeling approach which integrated the information above with assumed and calculated distributions of nesting period, road maintenance schedules, egg laying, etc.

Estimates of take were made for these species using a combination of modeling and extrapolation. Incidental take ranged from 7 (Lark Sparrow) to 820,000 (American Robin) individuals per year across Canada. We estimate that approximately 861,000 nestlings, eggs, and adults (only waterfowl adults are susceptible to incidental take) are killed by incidental take per year. However, this analysis, although very detailed, is subject to a number of caveats which suggest that the results should be interpreted with considerable caution.

There are no published criteria for what constitutes biologically significant levels of incidental take for bird populations. However, a widely accepted criterion for identifying key habitat sites for population conservation may serve as a suitable surrogate. Sites believed to support at least 1% of a Canadian population are considered to be key habitat sites, and their loss would potentially have a significant detrimental impact on the total population. By extension, losses to incidental take of 1% or more of a species Canadian population could be considered biologically significant (C. Machtans, pers. com.).

As a proportion of total Canadian populations, take was estimated to be less than 1% for all species, ranging from 0.0057% (Clay-colored Sparrow) to 0.5880% (American Robin). According to the 1% criterion, incidental take due to roadside maintenance operations is not a biologically significant mortality factor in Canada.

2 INTRODUCTION

The inadvertent destruction of birds and/or their nests and young occurs in Canada during otherwise legitimate operations in a variety of sectors, including forestry, mining, agriculture, electrical generation and transmission, fishing, structures, roadside maintenance and road construction. Such "incidental take" is an important factor in bird conservation and management, and Environment Canada has identified a need to better understand the magnitude and significance of the issue.

The objective of this project was to generate defensible species specific estimates of the number of birds killed annually due to roadside maintenance activities in Canada, by province/territory, e.g., for every hectare of roadside affected by mowing and/or brushing, an average of X number of individuals of species Y are killed each year. Only bird species that breed in Canada and are covered under the *Migratory Birds Convention Act* (MBCA) were included; species not protected by the MBCA include raptors, corvids, blackbirds, gallinaceous birds, and some others not explicitly mentioned in the *Act*. The temporal scope of the project was the breeding season, so winter maintenance activities such as snow management were excluded. Roadside maintenance activities in Canada include mowing, brushing (shrub cutting), and tree trimming. Some jurisdictions also use herbicides (e.g., Newfoundland/Labrador) to control vegetation, but this type of impact falls under the category of substances harmful to birds (as regulated by S5.1 of the MBCA), and was beyond the scope of the project. All roads for which roadside vegetation is managed by mechanical means were included in the analysis. Long-term resource roads that provide access to the back country were included, but short-term resource roads were out of scope.

This report documents a research and modeling effort to estimate the magnitude of avian mortality due to roadside maintenance activities, such as mowing and shrub brushing, across Canada. Roadside vegetation is managed for a variety of reasons, including safety (Forman et al. 2003; Jacobson 2005), aesthetics (Jacobson 2005), the control of invasive plant species, and in preparation for snow removal. Mowing-related avian mortality in roadside habitats is understood by many researchers to occur (e.g., Forman et al. 2003; Maguire 2007), but few studies have attempted to quantify it, and none have attempted to quantify it on a national scale. Even comprehensive reviews on the short- and long-term ecological effects of roads do not cover mortality from mowing equipment (Spellerberg 1998; Trombulak and Frissell 2000; Forman et al. 2003). In agricultural areas, bird use of strip-cover habitats such as road rights-of-way, fencerows, farmstead shelterbelts and grassed waterways can be high (Best et al. 1995). Such habitats provide nest sites, particularly shrubs and trees that are usually not available in the surrounding landscape. For bird species associated with roadside habitats, incidental take by mowing and other right-of-way maintenance operations may be a significant source of mortality.

A thorough literature review, combined with information from experts in the growing field of road ecology (see Appendix A), showed that data related to avian mortality due to roadside maintenance activities are virtually nonexistent. In North Dakota, Cook and Daggett (1995) reported "major losses" of birds to road right-of-way mowing; this loss includes ducks (34% of roadside duck nests have not hatched by the time the mowing occurs) and fledgling birds that could not escape the mowers. The same study estimated that 4,500 ducks are killed annually in the Prairie Pothole Region of North Dakota, but it isn't clear if this mortality is mowing-related or due to vehicle strikes. In a study in Iowa, roadside mowing destroyed only 2 of 98 nests in 34 roadside plots that covered 10.2 hectares (Camp and Best 1994); predation was the major mortality factor. In Illinois, 13 of 91 ring-necked pheasant roadside nests were destroyed by mowing (Joselyn et al. 1968). A California study reported the inadvertent destruction of 4 burrowing owl nests on an 800 m stretch of road due to roadside maintenance activities; 3 adult owls were also killed (Catlin and Rosenberg 2006). In a Danish study, roadside mowing was confirmed responsible for the loss of 1 of 3 skylark nests over a 4.7 km stretch of roadway (Laursen 1981). In Oregon, two maintenance workers estimated they killed between 400 and 600 birds during early July mowing operations (Braun et al. 1978, in Dale 1993). Jackson and Jackson (2000) characterized some gravel roadsides as ecological sinks for killdeer due to the negative impacts of pesticides and "destruction of eggs and chicks"; it isn't clear, however, if this destruction was due to roadside maintenance or to some other form of road-related activity. In other published studies, mortality due to roadside mowing is implied by results that show lower productivity following mowing (Dale et al. 1997), higher nesting success where mowing was delayed (e.g., Oetting and Cassel 1971; Dale 1993; Leif 2004), or higher nest densities in unmowed vs. mowed roadside (Berner 1984:32 *in* MDNR 2005). In many instances, maintenance-related mortality is understood to occur, but no empirical evidence is provided (e.g., Farris et al. 1977; Camp and Best 1994; Jacobson 2005; Belanger et al. 2006; Maguire 2007).

3 METHODS

Given the nearly total absence of empirical data about bird mortality as a result of roadside maintenance operations, we chose a modelling approach to estimate incidental take (Appendix B). To do this, we needed to: 1) derive a list of bird species likely to nest in roadside habitats; 2) gather breeding and nest density information for those species; and 3) obtain information about the area disturbed by maintenance activities in each province and territory.

3.1 Deriving a List of Roadside nesting Birds

A search of the literature established that no recognized "roadside nesting guild" of birds exists in published works, including Forman et al. (2003). We used a combination of expert opinion and literature to build a list of species likely to nest in road rights-of-way across Canada. As noted earlier, only species covered by the MBCA were considered for inclusion, which explains the otherwise noteworthy absence from the list of species like red-winged blackbird and ring-necked pheasant. The species on the list were then grouped according to general habitat requirements based on the literature listed in Table 1. For each group, a single focal species was selected to represent the group's risk of exposure to mortality from mowing and brushing operations. This approach was adapted from the approach taken by Tews et al. (2009) for the incidental take analysis of the agriculture sector.

The list of roadside nesting birds (Table 1), with habitat groupings and focal species, was then reviewed by grassland bird experts from Environment Canada (K. Lindsay, B.Dale) and revised accordingly.

Table 1: List of roadside nesting bird species, organized into groups according to general habitat characteristics. Focal species for each group are indicted in bold text.

General Habitat Characteristics	Nest Elevation	Species	Source
bare ground or sparse, low vegetation	ground	**Killdeer**	Oetting and Cassel 1971; Peck and James 1983; Best et al. 1995
denser, taller vegetation	elevated	American Goldfinch	Peck and James 1987; McGraw and Middleton 2009
denser, taller vegetation	ground	Eastern Meadowlark	Hergenrader 1962; Peck and James 1987; Warner 1992; Best et al. 1995; Leif 2004; MDNR 2005; Shochat et al. 2005
denser, taller vegetation	ground	**Savannah Sparrow**	Peck and James 1987; Best et al. 1995; MDNR 2005; Wheelwright and Rising 2008; Brenda Dale, pers. com.
denser, taller vegetation	ground	Western Meadowlark	Hergenrader 1962; Warner 1992; Camp and Best 1994; Best et al. 1995; Leif 2004; MDNR 2005
open shrub/tree; woodland edges	ground and elevated	Mourning Dove	Hergenrader 1962; Oetting and Cassel 1971; Leif 2004
open shrub-tree; woodland edges	ground and elevated	**Song Sparrow**	Peck and James 1987; Warner 1992; Camp and Best 1994; Best et al. 1995
open shrub/tree; woodland edges	elevated	Indigo Bunting	Peck and James 1987; Payne 2006
grass-shrub mix	ground and elevated	**Clay-colored Sparrow**	Brenda Dale, pers. com.
grass-shrub mix	elevated	American Robin	Best et al. 1995

grass-shrub mix	ground	Vesper Sparrow	Peck and James 1987; Warner 1992; Camp and Best 1994; Best et al. 1995; Brenda Dale, pers. com.
grass-shrub mix	ground	Lark Sparrow	Peck and James 1987
grassy fields; meadows	ground	American Black Duck	Peck and James 1983
grassy fields; meadows	ground	Blue-winged Teal	Peck and James 1983
grassy fields; meadows	ground	Gadwall	Peck and James 1983
grassy fields; meadows	ground	Mallard	Peck and James 1983
grassy fields; meadows	ground	Northern Pintail	Peck and James 1983
grassy fields; meadows	ground	Northern Shoveler	Peck and James 1983

3.2 GATHERING BREEDING AND NEST DENSITY INFORMATION

In order to model the number of individual birds (adults, eggs and nestlings) that are killed annually by roadside mowing and brushing operations, we needed to assemble breeding and nest density information for each of the focal species on the bird list (Table 2).

Table 2: Model parameter input information for birds.

Parameter	Description
egg dates	the earliest and latest dates on which viable eggs have been recorded in nests (Peck and James 1987:2)
incubation time	average # days from date of last egg laid to hatch
nestling time	average # days in nest after hatching
temporal distribution of egg-laying	use start date regression model to determine proportion of nests initiated by date (as per Tews et al. 2009)
temporal distribution of fledging	assumed to be the same as distribution of egg-laying, i.e., fixed number of days for incubation and nestling time
clutch size	average number of eggs per nest
nest densities	average # nests per hectare, in each of 4 general habitat types

The assumptions inherent in the parameter definitions in Table 2 are:

- 1 brood per pair and no re-nesting (as per Tews et al. 2009); most of the focal species on the list of roadside birds are known or suspected to be capable of raising second broods (killdeer, savannah sparrow, song sparrow, vesper sparrow) (Peck and James 1987), but further research is needed to gather the information necessary to incorporate this factor into the calculations of take
- 100% of eggs laid are fertile and represent a bird for the purposes of incidental take
- hatching success is 100%, i.e., the number of fledglings equals the number of eggs
- the nestlings of altricial species stay in or near the nest until fledged, and are therefore vulnerable to mowing/brushing equipment for the entire nestling period; the nestlings of killdeer (the only precocial species on the list) are led away from the nest by their parents within 2 days of hatching (Davis 1943 *in* Ankney 1985), travelling long distances (greater than 100 m) to brood rearing habitats (Powell 1993), at which time they are no longer vulnerable to mowing/brushing equipment

Natural mortality was not deducted from our estimates (pers. comm. C. Machtans and B. Dale, Environment Canada). The consensus was that a nestling killed by a mower constitutes incidental take no matter if that nestling would have later died of other anthropogenic or non-anthropogenic causes. These assumptions will therefore generate a maximum estimate of incidental take.

To maximize efficiency, we used the breeding information compiled by Tews et al. (2009)[1] whenever possible, i.e., for focal species that were common to both projects. For other focal species, we used Peck and James (1983, 1987) and the Birds of North America online as resources.

To determine estimates for nest densities by habitat type, we used the Canadian Breeding Bird Census (CBBC) database (see Kennedy et al. 1999) which reports adult densities (birds/km^2) derived from "spot- or territory-mapping" censuses from 640 sites spread across 76 of Canada's 194 ecoregions (Figure 1) (Blancher 2002).

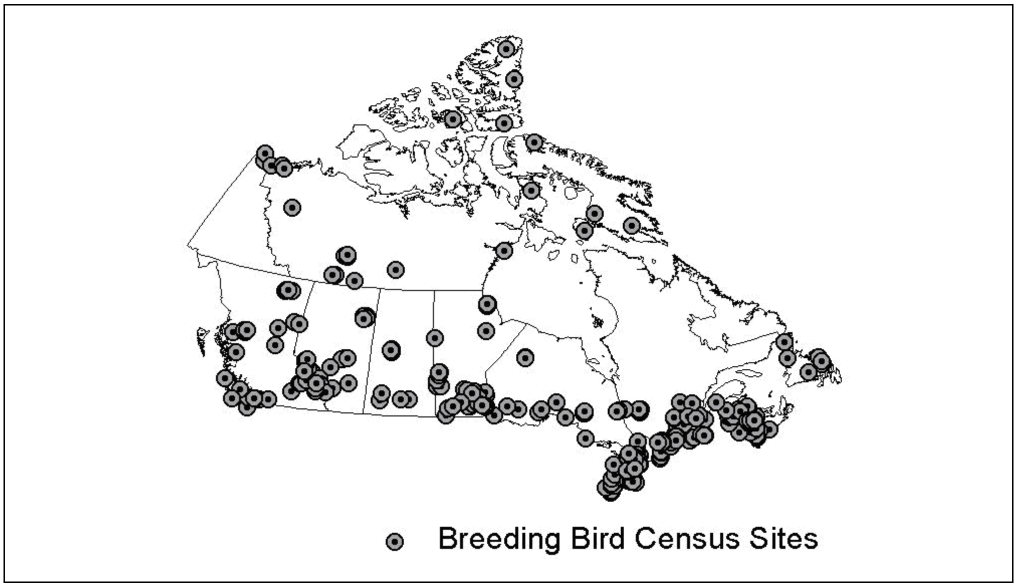


Figure 1. Canadian Breeding Bird Census sites (from Blancher 2002).

For each of our focal species, we mapped the habitats in the CBBC to 4 general habitat types – Forest, Shrubland, Grassland And Wetland. For example, "grazed pasture" and "clover-alfalfa-timothy field" both mapped to Grassland, whereas "old field with hedgerows" and "tall bottomland willow stand" both mapped to Shrubland. This both simplified and standardized the relevant habitats, and made them compatible with the Land Cover classes available to us for the GIS analysis (see Table 5, below). For provinces/territories within a species range that had no density estimates in the CBBC, we used densities from the nearest neighbouring province/territory for which there were data. Where multiple values were available, we used the mean value. The strength of the CBBC is that it provides habitat-specific density estimates by species and by province/territory; its weaknesses are: 1) older data; 2) low sample sizes, precluding fine resolution analysis; and 3) non-random sampling sites, which make it unclear to what extent densities are representative of areas not sampled (Blancher 2002). Additionally,

---

[1] We are indebted to Pierre Mineau, Environment Canada (Ottawa) for access to these data.

the CBBC under-represents the boreal and taiga regions of Canada (see Figure 1, above), and there are no census data for the province of Prince Edward Island.

The bird breeding and density inputs used in the simulation model are shown in Appendix C. Further research and analysis could be done to refine these density estimates (e.g., using the approach taken by Blancher (2002)), including incorporation of data from the Northwest Territories / Nunavut Bird Checklist Survey, and data for Prince Edward Island. Density values can easily be updated in the model if/when better information becomes available.

Accounting for Habitat Quality

Bird species that occur in roadside habitats tend to be similar to those of the adjacent habitat (Meunier et al. 1999; Belanger et al. 2006). However, road rights-of-way are probably not preferred habitat for any of the species that nest there, except possibly killdeer (Jackson and Jackson 2000). In a study in southern Quebec, species richness and bird abundance were both greater in the adjacent habitats than in the road rights-of-way (Belanger et al. 2006). Given that roadside nesting species tend to be open country birds, roads that run through closed forest habitat probably have fewer breeding birds using the roadside than those running through open habitat. Exceptions to this general rule are probably habitat generalists (e.g., song sparrow) and species that use woodland edges such as Mourning Dove and Indigo Bunting. In an attempt to address this issue, we decided to incorporate habitat quality into the analysis. For each focal species, we categorized roadside habitat as either moderate or poor quality, based on the surrounding habitat type and the habitat preferences of each species. Sources for species habitat information were Peck and James (1983, 1987), Birds of North America online, and the CBBC database (Kennedy et al. 1999). Each category was then assigned a multiplier so we could discount nest density values to account for the habitat quality factor. The multipliers we used were 0.5 for moderate quality habitat and 0.1 for poor quality habitat. For example, if the density of savannah sparrow nests in preferred habitat was 1 per hectare, then our analysis would use half of that density for roads running through open country and one tenth of that density for roads running through forests. These multiplier values should be considered placeholders; an attempt to validate/revise them with research and expert opinion still needs to be made.

Additionally, we have allowed for some variation in roadside habitat type in our analysis. For example, a road running through open country might have a right-of-way composed mostly of grasses and herbs, whereas a road running through a forest may tend to have more of a woody component.

The combinations of habitat type and quality used for each focal species are listed in Table 3.

Table 3. Combinations of habitat type and quality for each focal species. Surrounding Habitat is the habitat through which the roadside runs, and Right-of-Way Habitat is the habitat assumed to be available to nesting birds along the roadside. Habitat Quality Multipliers are used in the analysis to discount nest densities in non-preferred habitats.

Killdeer

Surrounding Habitat	Right-of-Way Habitat (Habitat Quality)	Habitat Quality Multipliers
Forest	50% grass (poor), 50% shrub (poor)	0.1, 0.1
Grassland	100% grass (moderate)	no discount
Shrubland	50% grass (moderate), 50% shrub (moderate)	no discount
Wetland	50% grass (moderate), 50% wetland (moderate)	no discount

Savannah Sparrow

Surrounding Habitat	Habitat of Road Right-of-Way (Habitat Quality)	Habitat Quality Multipliers
Forest	50% grass (poor), 50% shrub (poor)	0.1, 0.1
Grassland	100% grass (moderate)	0.5
Shrubland	50% grass (moderate), 50% shrub (poor)	0.5, 0.1
Wetland	50% grass (moderate), 50% wetland (poor)	0.5, 0.1

Song Sparrow

Surrounding Habitat	Habitat of Road Right-of-Way (Habitat Quality)	Habitat Quality Multipliers
Forest	50% grass (moderate), 50% shrub (moderate)	0.5, 0.5
Grassland	100% grass (poor)	0.1
Shrubland	50% grass (moderate), 50% shrub (moderate)	0.5, 0.5
Wetland	50% grass (poor), 50% wetland (poor)	0.1, 0.1

Clay-Colored Sparrow

Surrounding Habitat	Habitat of Road Right-of-Way (Habitat Quality)	Habitat Quality Multipliers
Forest	50% grass (poor), 50% shrub (poor)	0.1, 0.1
Grassland	100% grass (poor)	0.1
Shrubland	50% grass (moderate), 50% shrub (moderate)	0.5, 0.5
Wetland	50% grass (poor), 50% wetland (poor)	0.1, 0.1

Vesper Sparrow

Surrounding Habitat	Habitat of Road Right-of-Way (Habitat Quality)	Habitat Quality Multipliers
Forest	50% grass (poor), 50% shrub (poor)	0.1, 0.1
Grassland	100% grass (moderate)	0.5
Shrubland	50% grass (moderate), 50% shrub (moderate)	0.5, 0.5
Wetland	50% grass (poor), 50% wetland (poor)	0.1, 0.1

Mallard

Surrounding Habitat	Habitat of Road Right-of-Way (Habitat Quality)	Habitat Quality Multipliers
Forest	50% grass (poor), 50% shrub (poor)	0.1, 0.1
Grassland	100% grass (moderate)	0.5
Shrubland	50% grass (moderate), 50% shrub (moderate)	0.5, 0.5
Wetland	50% grass (moderate), 50% wetland (moderate)	0.5, 0.5

3.3 OBTAINING INFORMATION ABOUT AREA DISTURBED

The task of estimating area disturbed by mowing and/or brushing required a number of inputs. These included:

- total number of kilometers of roads by province/territory
- total number of kilometers of roads within the breeding ranges of each focal species in each province/territory
- total number of kilometers of roads in each of 4 general land cover types (forest, grassland, shrubland, wetland) within the breeding range of each focal species – for determining how to apply the habitat quality multipliers to nest density values
- total number of hectares mowed and/or brushed in each province/territory
- timing information for the disturbance

GIS Analysis
A GIS analysis was needed to obtain the required information about the extent of roads in each province and habitat type, and within each focal species breeding range.

The first step in this process was identifying an efficient, electronic source for the extent of Canada's road network. This source was the National Road Network of Canada (NRNC), available free of charge via the GeoBase web portal. The NRNC is the responsibility of Natural Resources Canada, and contains current, accurate geospatial data about Canada's roads. The NRNC is maintained under a federal-provincial-territorial-municipal agreement, and updates occur at least once per year.

The NRNC GIS layer included some road classes that were unlikely to result in incidental take for various reasons, and these were excluded from the analysis. The excluded road classes were: 1) winter roads; 2) local streets and back alleyways; and 3) rapid transit lanes for buses. Winter roads were excluded because the winter season is out of scope for our estimate of take. For the other excluded classes, we felt that their rights-of-way would either be too regularly maintained to be viable habitat for nesting birds (e.g., weekly mowing of rights-of-way by private property owners as in a subdivision), or they would be sidewalks (e.g., urban areas). The road classes that we did include in the analysis are listed in Table 4 - these are the roads that we considered likely to be maintained by government resources.

Table 4. Road classes included in the GIS analysis for kilometers of road in each province/territory.

Code	Road Class	Description
1	Freeway	An unimpeded, high speed controlled access thoroughfare for through traffic with typically no at grade intersections, usually with no property access or direct access and which is accessed by a Ramp. Pedestrians prohibited.
2	Expressway / Highway	A high-speed thoroughfare with a combination of controlled access intersections at any grade.
3	Arterial	A major thoroughfare with medium to large traffic capacity.
4	Collector	A minor thoroughfare mainly used to access properties and to feed traffic with right of way.
9	Ramp	A system of interconnecting roadways providing for the controlled movement between two or more roadways.
10	Resource / Recreation	A narrow passage whose primary function is to provide access for resource extraction and may also serve in providing public access to the backcountry.
12	Service Lane	A stretch of road permitting vehicles to come to a stop along a Freeway or Highway. Scale, service lane, emergency lane, lookout and rest area.

Habitat types for all of Canada were also available from the GeoBase web portal, in the form of 250 separate land cover shapefiles. This land cover information comes from Landsat 5 and Landsat 7 ortho-images produced by the Canadian Forest Service (CFS) for the forested areas, by Agriculture and Agri-Food Canada (AAFC) for the agricultural areas, and by the Canadian Centre of Remote Sensing (CCRS) for the northern territories. The land cover classification system used is a harmonization of existing systems used by these three agencies, and is summarized at http://www.geobase.ca/doc/specs/pdf/GeoBase_LCC2000V_Harmonization_Legend.pdf. The harmonized classification contains 43 land cover types, 10 of which are un-vegetated. From these, we created 4 general habitat types – Forest, Shrubland, Grassland and Wetland – that captured 91% of vegetated land cover classes in Canada (Table 5).

Table 5. General habitat types used in the analysis and the land cover classes that comprise them; these 4 Habitat Types represent 91% of the vegetated land covers classes in Canada.

Habitat Types	Land Cover Classes	Legend Code
Grassland	Herb	100
	Tussock graminoid tundra	101
	Grassland	110
	Cultivated Agricultural Land	121
	Annual Crops	122
	Perennial Crops and Pastures	123
Shrubland	Shrubland	50
	Shrub- Tall	51
	Shrub – Low	52
	Prostrate dwarf shrub	53
	Moist to dry non-tussock graminoid/shrub tundra	103
	Dry graminoid prostrate dwarf shrub	104
Forest	Forest/Trees	200
	Coniferous	210
	Coniferous– Dense	211
	Coniferous – Open	212

Habitat Types	Land Cover Classes	Legend Code
	Coniferous – Sparse	213
	Broadleaf	220
	Broadleaf – Dense	221
	Broadleaf – Open	222
	Broadleaf – Sparse	223
	Mixedwood	230
	Mixedwood – Dense	231
	Mixedwood – Open	232
	Mixedwood – Sparse	233
Wetland	Wetland	80
	Wetland Treed	81
	Wetland Shrub	82
	Wetland Herb	83
	Wet Sedge	102

The final input for the GIS analysis was information about the breeding ranges of each focal species on the list from NatureServe 3.0 (http://www.natureserve.org/getData/birdMaps.jsp).

The total number of kilometers of maintained road (filtered as described above) in each province/territory is shown in Table 6.

Table 6. The extent of roads in Canada, by province and territory.

Province/Territory	Total Maintenance[1] Road Length (km)	Total Road Length (km)
BC	32,669	77,248
Yukon	3,660	6,043
NW Territories	2,773	5,358
Alberta	221,211	231,567
Saskatchewan	239,662	250,455
Manitoba	78,610	87,864
Ontario	99,591	234,769
Quebec	113,965	146,586
New Brunswick	26,731	31,740
Nova Scotia	21,741	45,707
PEI	3,500	6,708
Newfoundland/Labrador	16,143	19,632
Nunavut	405	916
Total	860,661	1,144,596

[1] Maintenance road length reflects the exclusion of urban and suburban roads.

The unfiltered total extent of roads in Canada, based on the NRNC data, is approximately 1.1 M km. This agrees reasonably well with Forman et al. (2003:38), who reported a total of 902,000 km of 2-lane equivalent roadway in Canada for the year 2000. Of these, 574,000 km are unpaved, 312,000 km are paved, and 16,000 km are freeways. The process of filtering out the surburban/urban and rapid transit road classes has reduced total road extent for each province and territory; in some cases, the reduction is quite substantial (e.g. road length in Ontario was reduced from 235,000 to 99,000 km). This may not be an unreasonable result, given the extensive road networks in the many cities and towns of southern Ontario. Additionally, our filtering resulted in a total maintenance road length for British Columbia that was surprisingly small (<33,000 km). However, contacts at the British Columbia Ministry of Transportation, verified this value as reasonable since they maintain about 47,000 km of roads including some suburban/urban.

The number of kilometers of maintenance road (filtered as described above) within each focal species breeding range is shown in Table 7.

Table 7. Number of kilometers of road (filtered) within the breeding range for 6 focal species.

	Kilometers of Road within Range					
	KILL	**SASP**	**SOSP**	**CCSP**	**VESP**	**MALL**
BC	16,996	17,361	17,667	6,760	10,519	17,667
Yukon	756	2,436	702	0	0	2,436
NW Territories	307	337	264	253	0	339
Alberta	183,870	183,870	183,870	183,870	183,804	183,870
Saskatchewan	210,538	210,538	210,538	210,508	209,059	210,538
Manitoba	47,392	47,392	47,392	47,081	45,847	47,359
Ontario	66,759	66,769	66,759	53,240	63,503	66,759
Quebec	63,500	74,158	63,333	13,610	50,024	70,320
New Brunswick	16,693	16,724	16,724	0	10,463	16,611
Nova Scotia	8,079	15,411	15,411	0	8,957	12,567
PEI	2,764	2,764	2,764	0	2,764	0
Newfoundland/Labrador	0	9,714	1,401	0	0	0
Nunavut	0	31	0	0	0	0

Researching Area Disturbed

Information about area disturbed was collected from provincial and territorial transportation ministries (contacts are provided in Appendix A); these agencies managed most of the road kilometers in the country. Some jurisdictions did not provide data, so it was necessary to generate estimates for them based on information obtained from the responding jurisdictions. For each province/territory that provided disturbance data, we calculated the proportion of total roadside hectares that were mowed or brushed. We then averaged the proportion maintained for the responding provinces/territories, and applied this proportion to the total roadside hectares for all non-respondent jurisdictions to derive an estimate of area maintained for them. In terms of the timing of maintenance operations for non-respondent jurisdictions, we assumed an even distribution of effort between June and August inclusive, unless information obtained from interviews with transportation contacts indicated otherwise.

The road maintenance inputs used in the simulation model are shown in Appendix C. These values can easily be updated in the model if/when better quality data become available.

3.4 CALCULATING INCIDENTAL TAKE

Disturbance data were expressed as total area by province/territory (analysis region). Area disturbed within each region for each focal species was derived by overlaying the digital road data with the digital bird distribution data. This approach assumes an even distribution of area disturbed across all roads within each province/territory.

The mortality rate for eggs and nestlings exposed to maintenance operations was assumed to be 100% for all focal species; adult mortality was assumed to be 0% for all focal species except waterfowl (after Tews et al. 2009). A literature review provided in Tews et al. (2009) noted that some proportion of nesting adults of most waterfowl species are subject to mortality from mowing. We have used a mortality rate of 23.5% (i.e. 23.5 adults killed per 100 nests destroyed), consistent with Tews.

For each focal species (except mallard), the total number of birds killed by maintenance operations was calculated by multiplying the number of eggs/nestlings present on a given day (after adjustments for habitat quality) by the number of hectares disturbed on the same day and then summing these results across all days within the breeding range and within each province/territory. For mallards, the number of adults killed, based on nest density, was tallied separately from the number of eggs/nestlings affected.

For each focal species, we calculated the proportion of birds killed relative to published estimates of total population size for each province/territory. Population estimates were obtained from the Partners in Flight/Breeding Bird Survey online database (http://rmbo.org/pif_db/laped) (see Blancher et al. 2007) for the landbirds (savannah sparrow, song sparrow, clay-colored sparrow and vesper sparrow) and from Blancher (2002) for killdeer. For Mallards, population estimates were obtained for the Prairie Provinces from provincial North American Waterfowl Management Plan (NAWMP) implementation plans prepared under the Prairie Habitat Joint Venture (PHJV) (Manitoba Implementation Plan Committee 2008, Saskatchewan NAWMP Technical Committee 2008, Alberta NAWMP Partnership Management Committee 2008). Data used were the 2007 10-year average breeding population for the area covered by the PHJV for each province. Comparable data were not available for other provinces. For Ontario, Quebec and the Maritime provinces, data were provided by the Canadian Wildlife Service (J. Hughes pers. comm.) based on stratified surveys from areal and ground reconnaissance last completed in 2005. Data for British Columbia and the territories could not be obtained. These proportions were used to calculate incidental take for all non-focal roadside species (as per Tews et al. 2009). For example, if an average of 0.1% of savannah sparrows in Ontario were calculated to be lost to roadside maintenance operations, we applied the same percent loss to the non-focal members of the group in that province. This approach assumes that take for non-focal species is proportionately similar to take for focal species.

4 RESULTS

We calculated that approximately 494,000 to 1.525 million birds are killed annually (median value approx. 861,000) by maintenance operations. Most (95%) of these are American robins (but see discussion in Section 5 explaining the calculated robin mortality). On a proportional basis, incidental take was less than 1% of the total population for all focal species[2] at the national scale.

For the 6 focal species, the estimated number of birds (adults, eggs and nestlings) lost each year in Canada as a result of roadside maintenance activities is presented for each province/territory in Table 8, and for all of Canada in Table 9. Of the focal species, the highest level of calculated take is for savannah sparrow (approx. 9,300), and the least for clay-coloured sparrow (approx. 1,090). No obvious trends are apparent, as levels of take are largely a function of the nest densities in the various provinces, affinity for roadside habitat, and nesting ecology (i.e. dates of egg-laying, incubation times, etc.) as described in Section 3.4 and in considerable detail in Appendix B.

Estimates extrapolated to the non-focal roadside nesting species are provided in Table 10. Totals are summarised in Table 11. For the non-focal species the highest level of estimate mortality is, for American robin, and the least for lark sparrow (median value 7).

Table 8. Incidental take for 6 focal species by province/territory. Mortality = number of birds (adults, nestlings, eggs) killed by maintenance operations. POP= population estimates- from Partners in Flight Landbird Database for all birds except mallards; for mallards population estimates were taken from the Habitat Joint Ventures as explained in text. %Pop = the percent of the population killed, and is used for calculation of incidental take of non-focal species in each group. The median (50%), and the 50th percentile and the 95% percentile interval from 1000 simulations are reported, where LB (lower bound) = 2.5 percentile and UB (upper bound) = 97.5 percentile. For all species except mallard, mortality is eggs and nestlings only; for mallards mortality of adults is indicated separately from mortality of eggs and nestlings.

Species	**Prov/Terr**	**Mortality (percentiles)**			**POP**	**%Pop (Mortality/POP*100)**		
		50%	LB = 2.5%	UB= 97.5%		Estimate	**LB**	**UB**
Killdeer [1]	AB	27	20	38				
	BC	7	5	10				
	MB	129	106	160				
	NB	0	0	0				
	NL	0	0	0				
	NS	0	0	0				
	NU [2]	0	0	0				
	NWT	0	0	0				
	ON	580	341	989				
	PEI	0	0	0				
	QC	0	0	0				
	SK	1283	803	2019				
	YT	0	0	0				
Total		2026	1275	3216				
Savannah Sparrow	AB	1296	555	2854	8,000,000	0.01620	0.00694	0.03568
	BC	25	13	48	3,000,000	0.00083	0.00043	0.00160
	MB	1982	810	4605	7,000,000	0.02831	0.01157	0.06579

---

[2] Because we used proportion of the total population that was taken for focal species to estimate take for non-focal species, we can't make any statements about the proportional take for non-focal species.

Species	**Prov/Terr**	**Mortality (percentiles)**			**POP**	**%Pop (Mortality/POP*100)**		
		50%	LB = 2.5%	UB= 97.5%		Estimate	**LB**	**UB**
	NB	0	0	0	200,000	0	0	0
	NL	0	0	0	1,300,000	0	0	0
	NS [2]	2	1	4	190,000	0.00105	0.00053	0.00211
	NU [2]	0	0	0				
	NWT	7	4	13	300,000	0.00233	0.00133	0.00433
	ON	2566	1176	6324	6,000,000	0.04277	0.01960	0.10540
	PEI	0	0	0	80,000	0	0	0
	QC	2173	1028	4789	3,000,000	0.07243	0.03427	0.15963
	SK	1248	758	1989	6,000,000	0.02080	0.01263	0.03315
	YT	7	4	14	700,000	0.00100	0.00057	0.00200
Total		9306	4349	20640				
Song Sparrow	AB	77	50	121	4,000,000	0.00193	0.00125	0.00303
	BC	50	15	162	3,000,000	0.00167	0.00050	0.00540
	MB	415	257	656	3,000,000	0.01383	0.00857	0.02187
	NB	0	0	0	690,000	0	0	0
	NL	0	0	0	60,000	0	0	0
	NS	41	23	74	1,000,000	0.00410	0.00230	0.00740
	NU [2]	0	0	0				
	NWT	0	0	0	40,000	0	0	0
	ON	2033	800	5016	4,000,000	0.05083	0.02000	0.12540
	PEI	3	2	4	170,000	0	0	0
	QC	63	47	82	4,000,000	0.00158	0.00118	0.00205
	SK	1493	902	2355	4,000,000	0.03733	0.02255	0.05888
	YT	0	0	0	70,000	0.00000	0.00000	0.00000
Total		4175	2096	8470				
Clay-colored Sparrow	AB	492	161	1543	7,000,000	0.00703	0.00230	0.02204
	BC	147	50	400	1,600,000	0.00919	0.00313	0.02500
	MB	99	48	200	2,700,000	0.00367	0.00178	0.00741
	NB	0	0	0	-			
	NL	0	0	0	-			
	NS	0	0	0	-			
	NU [2]	0	0	0				
	NWT	0	0	0	600,000	0	0	0
	ON	151	88	265	60,000	0.25167	0.14667	0.44167
	PEI	0	0	0	-			
	QC	104	60	178	3,000	3.46667	2.00000	5.93333
	SK	95	55	171	7,000,000	0.00136	0.00079	0.00244
	YT	0	0	0	19,000	0.00000	0.00000	0.00000
Total		1088	462	2757				
Vesper Sparrow	AB	296	156	492	3,000,000	0.00987	0.00520	0.01640
	BC	0	0	0	1,300,000	0	0	0
	MB	0	0	0	1,100,000	0	0	0
	NB	0	0	0	500	0	0	0
	NL	0	0	0	-			
	NS	0	0	0	1,400	0	0	0
	NU [2]	0	0	0				
	NWT	0	0	0	-			
	ON	779	447	1388	170,000	0.45824	0.26294	0.81647
	PEI	0	0	0	700	0	0	0
	QC	407	244	670	120,000	0.33917	0.20333	0.55833
	SK	1571	958	2647	5,000,000	0.03142	0.01916	0.05294
	YT	0	0	0	-			
Total		3053	1805	5197				
Mallard[3] Eggs and Nestlings	AB	1346	608	3014	1,200,000	0.11217	.0.5067	0.25117
	BC	9	7	11				
	MB	805	535	1237	445,000	0.18090	0.12022	0.27780
	NB	23	13	38	5,000	0.46000	0.26000	0.76000

Species	Prov/Terr	Mortality (percentiles)			POP	%Pop (Mortality/POP*100)		
		50%	LB = 2.5%	UB= 97.5%		Estimate	LB	UB
	NL	0	0	0	0	0	0	0
	NS	44	24	78	4,000	1.1000	0.6000	1.95000
	NU	0	0	0				
	NWT	2	1	3				
	ON	805	446	1526	320,000	0.25156	0.13937	0.47688
	PEI	0	0	0	3,000	0	0	0
	QC	759	418	1325	93,600	0.81090	0.44659	1.41560
	SK	1707	1046	2780	2,000,000	0.08535	0.05230	0.13900
	YT	1	1	2				
Total		5501	3099	10014				
Mallard Adults	AB	36	16	82	1,200,000	0.003	0.00133	0.00683
	BC	0	0	0				
	MB	22	14	33	445,000	0.00494	0.00315	0.00741
	NB	1	0	1	5,000	0.02000	0	0.02000
	NL	0	0	0	0	0	0	0
	NS	1	1	1	4,000	0.02500	0.025000	0.05000
	NU	0	0	0				
	NWT	0	0	0				
	ON	22	12	41	320,000	0.00688	0.00375	0.01281
	PEI	0	0	0	3,000	0	0	0
	QC	21	12	36	93,600	0.02244	0.01282	0.38462
	SK	46	29	75	2,000,000	0.00230	0.00145	0.00375
	YT	0	0	0				
Total		151	85	273				
Focal Species Total		**25,298**	**13,170**	**50,564**				

[1] Because killdeer is the only member of its group, there is no need to calculate a value for %Pop to use in calculating the incidental take of non-focal species in the same group.

[2] Population estimates from Partners in Flight combine Nunavut and the Northwest Territories, so estimates of incidental take for these two territories have been combined in order to calculate %Pop.

[3] Mallard population estimates were not available for BC, Nunavut, NWT and Yukon.

Table 9. Incident take for 6 focal species for all of Canada. Total Take = number of birds killed annually in Canada. %Tot = percent of the total annual take. Median, lower bound (LB=2.5 percentile) and upper bound (UB= 97.5 percentile) values are reported.

	Total Take (%Tot)		
	Median	LB	UB
Killdeer	2,026 (8.1)	1,275 (9.7)	3,216 (6.4)
Savannah Sparrow	9,306 (36.7)	4,349 (33.0)	20,640 (40.8)
Song Sparrow	4,175 (16.5)	2,096 (15.9)	8,470 (16.8)
Clay-colored Sparrow	1,088 (4.3)	462 (3.5)	2,757 (5.4)
Vesper Sparrow	3,053 (12.1)	1,805 (13.7)	5,197 (10.3)
Mallard (eggs/nestlings)	5,501(21.7)	3,099(23.5)	10,014(19.8)
Mallard (adults)	149(0.6)	84(0.6)	270(0.5)
Total	25,298 (100)	13,170 (100)	50,564 (100)

Table 10. Incidental take for 12 non-focal species by province/territory. %Pop focal = the percent of the focal species population killed (from Table 8). Pop Est - population estimates. Estimated take (Mortality) = Number of birds (adults, nestlings, eggs) killed by maintenance operations, calculated as proportion lost (%Pop focal/100) multiplied by the population size of the non-focal species. LB = lower bound on the estimate; UB = upper bound on the estimate. For example: for American Goldfinch in Alberta, we estimate (0.0162/100)*840,000=136.08 birds as the median take. Note that separate estimates are provided for waterfowl eggs and nestlings, and adults.

			%Pop focal				Estimated take (Mortality) Non-focal species		
Non-focal Species	Focal species	Region	Median	LB	UB	Pop. Est.	Median	LB	UB
American Goldfinch	Savannah Sparrow	AB	0.0162	0.00694	0.03568	840,000	136	58	300
		BC	0.00083	0.00043	0.0016	400,000	3	2	6
		MB	0.02831	0.01157	0.06579	1,000,000	283	116	658
		NB	0	0	0	300,000	0	0	0
		NL	0	0	0	40,000	0	0	0
		NS	0.00105	0.00053	0.00211	500,000	5	3	11
		NU				-			
		NWT	0.00233	0.00133	0.00433	-			
		ON	0.04277	0.0196	0.1054	1,700,000	727	333	1792
		PEI	0	0	0	30,000	0	0	0
		QC	0.07243	0.03427	0.15963	1,800,000	1304	617	2873
		SK	0.0208	0.01263	0.03315	1,800,000	374	227	596.7
		YT	0.001	0.00057	0.002	-			
Total							2,832	1,356	5,640
Eastern Meadowlark	Savannah Sparrow								
		AB	0.0162	0.00694	0.03568	-			
		BC	0.00083	0.00043	0.0016	-			
		MB	0.02831	0.01157	0.06579	-			
		NB	0	0	0	300	0	0	0
		NL	0	0	0	-			
		NS	0.00105	0.00053	0.00211	-			
		NU				-			
		NWT	0.00233	0.00133	0.00433	-			
		ON	0.04277	0.0196	0.1054	200,000	86	39	211
		PEI	0	0	0	-			
		QC	0.07243	0.03427	0.15963	60,000	43	21	96
		SK	0.0208	0.01263	0.03315	-			
		YT	0.001	0.00057	0.002	-			
Total							129	60	307
Western Meadowlark	Savannah Sparrow								
		AB	0.0162	0.00694	0.03568	810,000	131	56	289

		%Pop focal					Estimated take (Mortality) Non-focal species		
Non-focal Species	Focal species	Region	Median	LB	UB	Pop. Est.	Median	LB	UB
		BC	0.00083	0.00043	0.0016	300,000	2	1	5
		MB	0.02831	0.01157	0.06579	380,000	108	44	250
		NB	0	0	0	-			
		NL	0	0	0	-			
		NS	0.00105	0.00053	0.00211	-			
		NU				-			
		NWT	0.00233	0.00133	0.00433	-			
		ON	0.04277	0.0196	0.1054	6,000	3	1	6
		PEI	0	0	0	-			
		QC	0.07243	0.03427	0.15963	-			
		SK	0.0208	0.01263	0.03315	1,100,000	229	139	365
		YT	0.001	0.00057	0.002	-			
Total							473	241	915
Mourning Dove	Song Sparrow	AB	0.00193	0.00125	0.00303	220,000	4	3	7
		BC	0.00167	0.0005	0.0054	180,000	3	1	10
		MB	0.01383	0.00857	0.02187	1,200,000	166	103	262
		NB	0	0	0	140,000	0	0	0
		NL	0	0	0	400	0	0	0
		NS	0.0041	0.0023	0.0074	80,000	3	2	6
		NU				-			
		NWT	0	0	0	-			
		ON	0.05083	0.02	0.1254	1,200,000	610	240	1505
		PEI	0	0	0	5,000	0	0	0
		QC	0.00158	0.00118	0.00205	590,000	9	7	12
		SK	0.03733	0.02255	0.05888	1,700,000	635	383	1001
		YT	0	0	0	-			
Total							1,430	739	2,803
Indigo Bunting	Song Sparrow	AB	0.00193	0.00125	0.00303	-			
		BC	0.00167	0.0005	0.0054	-			
		MB	0.01383	0.00857	0.02187	14,000	2	1	3
		NB	0	0	0	-			
		NL	0	0	0	-			
		NS	0.0041	0.0023	0.0074	-			
		NU				-			
		NWT	0	0	0	-			
		ON	0.05083	0.02	0.1254	350,000	178	70	439
		PEI	0	0	0	-			
		QC	0.00158	0.00118	0.00205	90,000	1	1	2
		SK	0.03733	0.02255	0.05888	-			
		YT	0	0	0	-			
Total							181	72	444

			%Pop focal				Estimated take (Mortality) Non-focal species		
Non-focal Species	Focal species	Region	Median	LB	UB	Pop. Est.	Median	LB	UB
American Robin	Clay-Colored Sparrow	AB	0.00703	0.0023	0.02204	12000000	844	276	2645
		BC	0.00919	0.00313	0.025	30000000	2757	939	7500
		MB	0.00367	0.00178	0.00741	9000000	330	160	667
		NB	0.467[1]	0.269	0.804	3000000	14010	8070	24120
		NL	0.467[1]	0.269	0.804	9000000	42030	24210	72360
		NS	0.467[1]	0.269	0.804	3000000	14010	8070	24120
		NU	0	0	0	18000000	0	0	0
		NWT	0	0	0		0	0	0
		ON	0.25167	0.14667	0.44167	20000000	50334	29334	88334
		PEI	0.467[1]	0.269	0.804	400000	1868	1076	3216
		QC	3.46667	2	5.93333	20000000	693334	400000	1186660
		SK	0.00136	0.00079	0.00244	7000000	95	55	171
		YT	0	0	0	8000000	0	0	0
Total							819,612	472,190	1,409,793
Lark Sparrow	Vesper Sparrow	AB	0.00987	0.0052	0.0164	15000	1	1	2
		BC	0	0	0	3000	0	0	0
		MB	0	0	0	6000	0	0	0
		NB	0	0	0	-			
		NL				-			
		NS	0	0	0	-			
		NU				-			
		NWT				-			
		ON	0.45824	0.26294	0.81647	-			
		PEI	0	0	0	-			
		QC	0.33917	0.20333	0.55833	-			
		SK	0.03142	0.01916	0.05294	19,000	6	4	10
		YT				-			
Total							7	5	12
Black Duck eggs and nestlings	Mallard[2] eggs and nestlings	AB	0.11217	.0.05067	0.25117				
		MB	0.18090	0.12022	0.27780				
		NB	0.46000	0.26000	0.76000	74,000	340	192	562
		NL[3]	0.79029	0.43553	1.3752	64,000	506	278	880
		NS	1.10000	0.60000	1.95000	74,000	814	444	1443
		ON	0.25156	0.13938	0.47688	106,400	267	148	51
		PEI[3]	0.79029	0.43553	1.37520	26,000	205	113	358
		QC	0.81089	0.44658	1.41560	329,000	2668	1469	4657
		SK	0.08535	0.05230	0.13900				
Total							4801	2645	7950
Blue-winged teal eggs and nestlings	Mallard eggs and	AB	0.11217	.0.05067	0.25117	650,000	729	329	1632
		MB	0.18090	0.12022	0.27780	349,500	632	420	971

		%Pop focal					Estimated take (Mortality) Non-focal species		
Non-focal Species	Focal species	Region	Median	LB	UB	Pop. Est.	Median	LB	UB
	nestlings	NB	0.46000	0.26000	0.76000				
		NL	0.79029	0.43553	1.3752				
		NS	1.10000	0.60000	1.95000				
		ON	0.25156	0.13938	0.47688	8,200	21	11	39
		PEI	0.79029	0.43553	1.37520				
		QC	0.81089	0.44658	1.41560				
		SK	0.08535	0.05230	0.13900	165,000	141	89	229
Total							1522	847	2871
Gadwall eggs and nestlings	Mallard eggs and nestlings	AB	0.11217	.0.05067	0.25117	210,000	236	106	527
		MB	0.18090	0.12022	0.27780	105,000	190	126	292
		NB	0.46000	0.26000	0.76000				
		NL	0.79029	0.43553	1.3752				
		NS	1.10000	0.60000	1.95000				
		ON	0.25156	0.13938	0.47688				
		PEI	0.79029	0.43553	1.37520				
		QC	0.81089	0.44658	1.41560				
		SK	0.08535	0.05230	0.13900	850,000	725	445	1182
Total							1151	677	2001
Pintail eggs and nestlings	Mallard eggs and nestlings	AB	0.11217	.0.05067	0.25117	250,000	280	127	628
		MB	0.18090	0.12022	0.27780	50,500	91	61	140
		NB	0.46000	0.26000	0.76000				
		NL	0.79029	0.43553	1.3752				
		NS	1.10000	0.60000	1.95000				
		ON	0.25156	0.13938	0.47688				
		PEI	0.79029	0.43553	1.37520				
		QC	0.81089	0.44658	1.41560				
		SK	0.08535	0.05230	0.13900	725,000	618	279	1008
Total							991	567	1176
Shoveler eggs and nestlings	Mallard eggs and nestlings	AB	0.11217	.0.05067	0.25117	500,000	561	253	1256
		MB	0.18090	0.12022	0.27780	445,000	805	535	1236
		NB	0.46000	0.26000	0.76000				
		NL	0.79029	0.43553	1.3752				
		NS	1.10000	0.60000	1.95000				
		ON	0.25156	0.13938	0.47688				
		PEI	0.79029	0.43553	1.37520				
		QC	0.81089	0.44658	1.41560				
		SK	0.08535	0.05230	0.13900	1,100,000	939	575	1529
Total							2,305	1,364	4,021
Black Duck adults	Mallard[2] adults	AB	0.00300	0.00133	0.00683				
		MB	0.00494	0.00315	0.00741				
		NB	0.02000	0	0.02000	74,000	15	0	15
		NL[3]	0.02248	0.01261	0.03615	64,000	14	8	23
		NS	0.02500	0.02500	0.05000	74,000	18	18	37

			%Pop focal				Estimated take (Mortality) Non-focal species		
Non-focal Species	Focal species	Region	Median	LB	UB	Pop. Est.	Median	LB	UB
		ON	0.00688	0.00375	0.01281	106,400	7	4	14
		PEI[3]	0.02248	0.01261	0.03615	26,000	6	3	9
		QC	0.02244	0.01282	0.03862	329,000	74	42	127
		SK	0.00230	0.00145	0.00375				
Total							135	76	225
Blue-winged teal eggs and nestlings	Mallard eggs and nestlings	AB	0.00300	0.00133	0.00683	650,000	20	9	44
		MB	0.00494	0.00315	0.00741	349,500	17	11	26
		NB	0.02000	0	0.02000				
		NL	0.02248	0.01261	0.03615				
		NS	0.02500	0.02500	0.05000				
		ON	0.00688	0.00375	0.01281	8,200	1	0	1
		PEI	0.02248	0.01261	0.03615				
		QC	0.02244	0.01282	0.03862				
		SK	0.00230	0.00145	0.00375	165,000	4	2	6
Total							41	22	76
Gadwall adults	Mallard adults	AB	0.00300	0.00133	0.00683	210,000	6	3	14
		MB	0.00494	0.00315	0.00741	105,000	5	3	8
		NB	0.02000	0	0.02000				
		NL	0.02248	0.01261	0.03615				
		NS	0.02500	0.02500	0.05000				
		ON	0.00688	0.00375	0.01281				
		PEI	0.02248	0.01261	0.03615				
		QC	0.02244	0.01282	0.03862				
		SK	0.00230	0.00145	0.00375	850,000	20	12	32
Total							31	18	54
Pintail adults	Mallard adults	AB	0.00300	0.00133	0.00683	250,000	7	3	17
		MB	0.00494	0.00315	0.00741	50,500	2	2	4
		NB	0.02000	0	0.02000				
		NL	0.02248	0.01261	0.03615				
		NS	0.02500	0.02500	0.05000				
		ON	0.00688	0.00375	0.01281				
		PEI	0.02248	0.01261	0.03615				
		QC	0.02244	0.01282	0.03862				
		SK	0.00230	0.00145	0.00375	725,000	16	10	27
Total							27	10	48
Shoveler adults	Mallard adults	AB	0.00300	0.00133	0.00683	500,000	15	7	34
		MB	0.00494	0.00315	0.00741	445,000	22	14	33
		NB	0.02000	0	0.02000				
		NL	0.02248	0.01261	0.03615				
		NS	0.02500	0.02500	0.05000				
		ON	0.00688	0.00375	0.01281				
		PEI	0.02248	0.01261	0.03615				
		QC	0.02244	0.01282	0.03862				

		%Pop focal					Estimated take (Mortality) Non-focal species		
Non-focal Species	Focal species	Region	Median	LB	UB	Pop. Est.	Median	LB	UB
		SK	0.00230	0.00145	0.00375	1,100,000	25	16	41
Total							62	37	108

Non-focal Species Totals	835,730	480,926	1,438,354

---

[1] Clay-colored Sparrow (CCSP) is the focal species for the group containing American Robin (AMRO). AMRO occurs in the maritime provinces, but CCSP does not. To calculate estimated take values for AMRO in the maritime provinces, we averaged CCSP % take over all provinces/territories in which it occurred, and used these values for AMRO %Pop focal.

2 Population estimates for all waterfowl (Including Mallards) were not available for BC, or any of the Territories. As no estimates of take were possible those jurisdictions are not included in this table.

3 Because no mallard data were available to calculate density information for Newfoundland and PEI (as the provinces are mostly out of the species' range), we used average results for NB, NS, and QC in this calculation of take for black duck

Table 11. Total annual estimated incidental take for 18 bird species affected by roadside maintenance operations across Canada. Species indicated in bold are focal species. Estimates are based on median totals in Table 8 and Table 10.

Common Name	Estimated Take	Total CDN Pop	% Total CDN Pop
Killdeer [1]	2,026	1,613,200	0.1256
Savannah Sparrow	9,306	35,770,000	0.0260
American Goldfinch	2,833	8,410,000	0.0337
Eastern Meadowlark	129	260,300	0.0496
Western Meadowlark	473	2,596,000	0.0182
Song Sparrow	4,175	24,030,000	0.0174
Mourning Dove	1,430	5,315,400	0.0269
Indigo Bunting	181	454,000	0.0399
Clay-colored Sparrow	1,088	18,982,000	0.0057
American Robin	819,612	139,400,000	0.5880
Vesper Sparrow	3,053	10,692,600	0.0286
Lark Sparrow	7	43,000	0.0173
American Black Duck[2,3]	4,935	673,400	0.7328
Blue-winged Teal[2,3]	1,563	1,172,700	0.1333
Gadwall[2,3]	1,182	1,165,000	0.1015
Mallard[2,3]	5,650	3,857,800	0.1465
Northern Pintail[2,3]	1,017	1,025,500	0.0992
Northern Shoveler[2,3]	2,367	1,757,500	0.1347

[1] The estimated total Canadian population size for killdeer is an average of 5 values from Blancher (2002), including one from Morrison et al. (2001).

[2] Data shown for waterfowl is the sum of eggs, nestlings and adults

[3] Data for waterfowl populations was incomplete, see discussion in text.

Table 12. Total annual estimated take (based on median values from Table 8 and Table 10) for 6 focal species and 12 non-focal species.

	Province/Territory												
	AB	BC	MB	NB	NL	NS	NWT &NU	ON	PEI	QC	SK	YT	Total
focal species	3,570	238	3,452	24	0	88	9	6,936	3	3,527	7,443	8	25,298
non-focal spp	2,970	2,765	2,653	14,365	42,550	14,850	0	52,234	2,079	697,433	3,827	0	835,726
Total	6,540	3,003	6,105	14,389	42,550	14,938	9	59,170	2,082	700,960	11,270	8	861,024

5 DISCUSSION

The biological significance of incidental take for bird populations is as yet unknown. Populations of many species are declining, but the role of take in these declines is anything but clear. The impact of take is likely to vary from species to species, and from region to region. Effects may occur locally but not regionally. For sectors in which incidental take kills individuals regardless of condition (e.g., window strikes at structures), the impact on populations may be greater than for factors that cause mortality among weaker individuals (e.g., predation by house cats). Additionally, incidental take that kills adults can be expected to have a greater impact at the population level than where mortality is predominantly juveniles.

For the roads sector, incidental take is an indiscriminant mortality factor, taking individuals regardless of their condition. On the other hand, take is mostly juvenile birds (eggs and nestlings) rather than adults. We estimated mortality of adult waterfowl, based on documented evidence that they are susceptible to take in agricultural mowing. Our calculations suggest than the total amount of adult take is less than 3% of that of the take of eggs and nestlings. As such, in general, this source of incidental take affects recruitment but does not greatly diminish the population of breeding adults. Even so, if recruitment gets reduced to the point where it becomes insufficient to maintain the population over the long term, then incidental take will have created a local population sink.

There are no published criteria for what constitutes biologically significant levels of incidental take for bird populations. However, a widely accepted criterion for identifying key habitat sites for population conservation may serve as a suitable surrogate. Key habitat sites are those that are so important that their loss could have a significant detrimental impact on the total population (Latour et al. 2006). Sites believed to support at least 1% of a Canadian population are considered to be key habitat sites. By extension, losses to incidental take of 1% or more of a species Canadian population could be considered biologically significant (C. Machtans, pers. com.).

At the national scale, our calculations suggest that take approaches 1% only for black ducks (0.73%). For all other species, levels of take are considerably less than 1% (Table 11). The seemingly high proportion of take for black ducks seems to be a function of their high population in Quebec, for which incidental take of mallards (the focal species) was estimated to be high. According to the 1% criterion, incidental take due to roadside maintenance operations is not a biologically significant mortality factor in Canada. In fact, given that most take was for nestlings and eggs, which generally have low survival rates, the impact of this source of take likely very small.

At the provincial scale, clay-colored sparrow was the only focal species that experienced take of 1% or more of its population. Modelling results showed an estimated 2.0 - 5.9% (median 3.5%) of the Quebec population clay-colored sparrows is killed each year by roadside maintenance operations. Two factors contributed to this result. Quebec represents the easternmost limit of clay-colored sparrow breeding range, and the provincial population is small relative to populations in all other provinces and territories in which it occurs. The number of birds lost to incidental take will have a larger proportional impact on small populations than on larger ones, resulting in a relatively high value for Quebec. Additionally, the species range in Quebec covers the road-rich southwestern corner of the province, where over 13,000 km of road intersect with clay-colored sparrow breeding range (see Table 7). If the 1% criterion can also be applied at the provincial scale, then it is likely that maintenance-related incidental take has a biologically significant impact on the clay-colored sparrow population in Quebec. No other focal species experienced take of 1% or more of their provincial population.

Among the non-focal species, the American robin in Quebec experiences the highest total incidental take due to roadside maintenance. Our model estimated that 820,000 eggs and nestlings are destroyed annually in Quebec as a result of roadside maintenance operations. This result is largely an artifact of the way take has been calculated. The focal species for American robin was clay-colored sparrow which experienced particularly high proportional take in Quebec. Applying this high proportional take to the population estimate for robins in Quebec (20,000,000 birds) results in a very large number of birds lost to incidental take. Consequently, Quebec accounts for the bulk (84.6%) of all incidental take of American robins in Canada, and American robin take comprises 95% of the total take for Canada. Even so, this level of take represents only 0.588% of the Canadian population of American robin (139,400,000 birds), so does not exceed the 1% criterion for biological significance.

Maintained road rights-of-way are open habitats. Many of the birds that nest along roadsides are grassland birds. As a group, grassland birds have experienced population declines over the past three decades that far exceed those of any other group of North American birds; loss of grassland habitat on breeding grounds is the most likely cause (Herkert et al. 2003). In areas of intensive agriculture, roadsides may represent an attractive alternative habitat for many open country bird species (Oetting and Cassel 1971; Voorhees and Cassel 1980; Dale 1993; Belanger et al. 2006). On the other hand, the benefits to productivity of this alternative habitat are counter-balanced at least somewhat by the risks associated with it. Not only is there a demonstrable risk of mortality from maintenance operations in roadside habitats, there is also higher mortality from predation in these habitats (Haensly et al. 1987; Camp and Best 1994). Road rights-of-way are linear, and can serve as travel corridors for mammalian predators (Dale 1993). Additionally, productivity can be adversely affected by avian predators, particularly if the right-of-way contains a fenceline (Evans and Wolfe 1967; Meunier et al. 2000). Brood parasitism by the brown-headed cowbird can also be a factor that affects productivity in habitats with a lot of edge, such as a roadside (Herkert et al. 2003).

Despite the risks associated with roadside nesting, there is still tremendous potential for managing roadside habitats to offset productivity losses among grassland and other open country bird species in Canada. Where roadside mowing can be avoided, or delayed until after young-of-the-year have fledged, nesting success will improve (Oetting and Cassel 1971; Berner 1984:32 *in* MDNR 2005; Dale 1993; Cook and Daggett 1995; Leif 2004).

Mitigating Incidental Take

Some provinces have environmental policies in place that prohibit the incidental take of birds (nests, eggs, nestlings) during road maintenance and construction operations. In British Columbia, maintenance specifications state that the contractors must comply with the Province's Environmental Best Practices for Highway Maintenance Activities (BCMTI 2009a: Section 5.10). These standards state that operations must cause "No injury, molestation or destruction of a bird, its eggs, and occupied nest, or the nest of an eagle, Peregrine Falcon, Gyrfalcon, Osprey, heron, or Burrowing Owl, unless the species is listed under Schedule C as exempt from this protection (*Wildlife Act*, Section 34)". Permits must be obtained for any activity that will affect migratory birds. Construction work must comply with federal (including the MBCA), provincial, municipal and local laws to ensure that work does not adversely affect the environment (BCMTI 2009b, Section 165). If clearing must occur during the breeding season for birds, the area is surveyed for active nests before work begins. If active nests are found, clearing is either delayed or a 30 m "no clear" buffer is established to mitigate disturbance

(Angela Buckingham, pers. com.). These requirements are expressly stated in construction contracts.

In Ontario, specific environmental protection requirements are imposed on road maintenance and construction operations by the Ministry of Transportation Ontario (MTO), including the protection of active bird nests (MTO 2006a:11; MTO 2006b:12). Construction contracts contain "Bird Nesting Preventative Measures" requirements (NSP 9051) that state "No work is permitted to proceed that would result in the destruction of active nests (nests with eggs or young birds), or the wounding or killing of birds, of species protected under the *Migratory Birds Convention Act*, 1994 and/or Regulations under that Act". Maintenance operations must comply with Maintenance Special Provision SSP 080S06, which requires operators to conduct a visual inspection for bird nests in all areas of work. If active nests are found, operators must either protect the nest or suspend operations. MTO takes the migratory bird issue "very seriously", and the agency is continually looking for better ways to minimize interference with active nesting (John Small, pers. com.). Because these mitigations are not strictly timing mitigations, i.e., operations occur during the breeding season, our modeling results will probably overestimate incidental take for Ontario's provincially-managed roads by reporting take that may not actually occur.

The Province of Saskatchewan requires that road construction operations comply "with all federal, provincial, municipal and local laws and regulations which seek to ensure that construction work does not adversely affect the environment", including the *Migratory Bird Convention Act* (see http://www.highways.gov.sk.ca/1650/). Timing is not specified in construction contracts, but provisions are included to allow the imposition of timing restrictions and set-backs in the event that a "sensitive species" is encountered on the job site (Nichole Andre, pers. com.). Saskatchewan does not appear to similarly regulate roadside maintenance operations.

In Newfoundland and Labrador, the Environment Assessment process constrains the timing of land clearing for road construction such that it minimizes the disturbance/destruction of bird nests. For example, a recent screening report states that the Department of Transportation and Works (DTW) will conduct a pre-construction survey for migratory birds and nesting locations; nests observed within the work area will be flagged and the vegetation within the immediate surrounding area will remain undisturbed during construction activities (Transport Canada 2009). As a general rule, DTW tries to avoid clearing between April and August (John Morrissey, pers. com.). Roadsides in the province are not mowed.

British Columbia, Ontario, Saskatchewan and Newfoundland/Labrador are the only provinces that offered information about their policies and best practices that mitigate against losses of bird nests during maintenance and construction operations. Other provinces/territories may also follow such procedures, but more research is needed to explore this possibility.

Caveats and Assumptions

There are several caveats which should be taken into account in interpreting this analysis:

- obviously, the approach used is susceptible to anomalous circumstances (such as which exist for clay-coloured sparrow, and American robin);
- the density data used to calibrate the models (from the CBBC) are sparse for many species and habitats, and so may not be accurate in all circumstances;
- waterfowl data were unavailable for British Columbia, and the territories and so estimates of take for ducks are underestimated;

- there are almost certainly species other than those modelled in this paper which nest in roadside habitat, and which are therefore likely susceptible to incidental take. The total estimate of incidental take estimated for this project is likely an underestimate (notwithstanding the odd result for American robin);
- there are several elements of this approach which called for educated judgments to be used (i.e. lumping of habitat types, estimates of the relative value of roadside habitats), and adding further uncertainty to the results.

Next Steps

The results generated here should be viewed as very rough estimates of incidental take. Many assumptions were required for the modeling exercise. Estimates could be improved by:

- deriving better bird density estimates for each province/territory, including incorporation of data from the Northwest Territories / Nunavut Bird Checklist Survey and data for Prince Edward Island
- modelling each of the roadside nesting species in the list separately to improve the integrity of the incidental take estimates; applying the percent take from focal species to non-focal species within the same functional group implicitly assumes that the proportion of the population in roadside vs. non-roadside habitat is the same for both populations; this may be a particularly poor assumption for non-focal species with very large populations (e.g., American robin); in this case, the total available roadside habitat may be too small to realistically hold the same proportion of the total population
- validate/revise habitat quality multipliers with research and expert opinion
- more research into the birds that might be vulnerable to roadside maintenance in the taiga/tundra (gulls/terns, shorebirds, waterfowl)
- more research into the kinds of road maintenance that occur, if any, in Nunavut
- addition of "Arctic" habitat type to represent tundra (it is currently represented as needed in the Grassland, Shrubland and Wetland habitat types)
- more research into accounting for latitudinal differences in initiation dates, clutch size, incubation time, nestling period, fledging dates and nesting density
- research inter-annual variation in nest initiation dates to bound the simulated dates
- incorporate right-of-way width into estimating nest densities (e.g., wide rights-of-way are more likely to support waterfowl)
- more research into maintenance on permanent resource roads; take from this type of road is probably under-represented in our estimates because, at least in some provinces (e.g., Ontario), resource roads are managed by the natural resources ministry rather than by transportation; information about maintenance activities conducted by these agencies needs to be obtained
- gather information from Parks Canada about its maintenance activities in national parks
- improve estimates of area disturbed by maintenance operations by 1) obtaining information from non-respondent provinces and Nunavut, and 2) incorporating information from provinces that responded too late for their input to be used in the analysis and reporting (e.g., Ontario and Saskatchewan municipalities)

6 REFERENCES

Alberta NAWMP Partnership Management Committee. 2008. Alberta NAWMP Implementation Plan 2007-2012. Prairie Habitat Joint Venture. 56 p.

Ankney, C.D. 1985. Habitat selection by roof-nesting killdeer. Journal of Field Ornithology 56(3):284-286

Best, L.B., K.E. Freemark, J.J. Dinsmore and M. Camp. 1995. A Review and Synthesis of Habitat Use by Breeding Birds in Agricultural Landscapes of Iowa. American Midland Naturalist 134(1):1-29

Blancher, P.J. 2002. Importance of breeding birds exported from Canada – Information on landbirds and shorebirds. Environment Canada. 46 pp + appendices.

Blancher, P. J., K. V. Rosenberg, A. O. Panjabi, B. Altman, J. Bart, C. J. Beardmore, G. S. Butcher, D. Demarest, R. Dettmers, E. H. Dunn, W. Easton, W. C. Hunter, E. E. Iñigo-Elias, D. N. Pashley, C. J. Ralph, T. D. Rich, C. M. Rustay, J. M. Ruth, and T. C. Will. 2007. Guide to the Partners in Flight Population Estimates Database. Version: North American Landbird Conservation Plan 2004. Partners in Flight Technical Series No 5.

British Columbia Ministry of Transportation and Infrastructure (BCMTI). 2009a. Environmental Best Practices for Highway Maintenance Activities, January 2009. Edited by Allan D. Planiden and Leonard E. Sielecki. 154 pp.

British Columbia Ministry of Transportation and Infrastructure (BCMTI). 2009b. 2009 Standard Specifications for Highway Construction. Adopted October 1, 2008. Volume 1 of 2. 586 pp.

Casella, G. and R.L. Berger. 2002. Statistical Inference, 2nd Edition. Duxbury, Pacific Grove California, USA.

Catlin, D.H. and D.K. Rosenberg. 2006. Nest destruction associated with mortality and dispersal of Burrowing Owls in the Imperial Valley, California. The Southwestern Naturalist 51(3):406-409

Camp, M. and L.B. Best. 1994. Nest Density and Nesting Success of Birds in Roadsides Adjacent to Rowcrop Fields. American Midland Naturalist 131(2):347-358

Cook, K.E. and P-M. Daggett. 1995. Highway Roadkill, Safety, and Associated Issues of Safety and Impact on Highway Ecotones. Unreviewed report prepared for the Task Force on Natural Resources (A1F52), Transportation Research Board, National Research Council.

Dale, B. 1993. Effects of haying on waterfowl, upland game birds and shorebirds. *In* Proceedings of the Third Prairie Conservation and Endangered Species Workshop, February 1992. Provincial Museum of Alberta Natural History Occasional Paper No. 19:22-26.

Dale, B.C., P.A. Martin, P.S. Taylor. 1997. Effects of Hay Management on Grassland Songbirds in Saskatchewan. Wildlife Society Bulletin 25(3):616-626

Evans, R.D. and C.W. Wolfe. Jr. 1967. Waterfowl production in the rainwater basin area of Nebraska. Wildl. Manage. 31:788-794

Latour, P.B., J. Leger, J.E. Hines, M.L. Mallory, D.L. Mulders, H.G. Gilchrist, P.A. Smith and D.L. Dickson. 2006. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut. Third Edition. Canadian Wildlife Service Occasional Paper, March 2006. Partial copy available online at: http://www.ngps.nt.ca/Upload/Interveners/Environment%20Canada/key_terrestrial_part1_mar06.pdf. Accessed April 22, 2010.

Laursen, K. 1981. Birds on roadside verges and the effect of mowing on frequency and distribution. Biological Conservation 20:59-68

Leif, A. P. 2004. Avian nest densities and success in state highway roadsides in South Dakota. Completion Report 2004-11, South Dakota Department of Game, Fish and Parks, Pierre.

Efron, B. and R.J. Tibshirani. 1994. An Introduction to the Bootstrap. Monographs on Statstics and Applied Probability 57. Chapman & Hall/CRC. Boca Raton, FL.

Farris, A.L., E.D. Klonglan and R.C. Nomsen. 1977. The Ring-necked Pheasant in Iowa. Iowa Conservation Commission, Des Moines.

Forman, R.T., D. Sperling, J.A. Bissonette, A.P. Clevenger, C.D. Cutshall, V.H. Dale, L. Fahrig, R. France, C.R. Goldman, K. Heanue, J.A. Jones, F.J. Swanson, T. Turrentine and T.C. Winter. 2003. Road Ecology Science and Solutions. Island Press, Washington. 481 pp.

Haensly, T.F., J.A. Crawford and S.M. Myers. 1987. Relationships of habitat structure to nest success of Ring-necked Pheasants. J. Wildl. Manage. 51 :421-425

Hergenrader, G.L. 1962. The Incidence of Nest Parasitism by the Brown-Headed Cowbird (*Molothrus ater*) on Roadside Nesting Birds in Nebraska. The Auk 79(1):85-88

Herkert, J.R., D.L. Reinking, D.A. Wiedenfeld, M. Winter, J.L. Zimmerman, W.E. Jensen, E.J. Finck, R.R. Koford, D.H. Wolfe, S.K. Sherrod, M.A. Jenkins, J. Faaborg and S.K. Robinson. 2003. Effects of Prairie Fragmentation on the Nest Success of Breeding Birds in the Mid-continental United States. Conservation Biology 17(2):587–594

Hilborn, R. and M. Mangel. 1997. The ecological detective: confronting models with data. Mongr. Pop. Biol. No. 28. Princeton University Press, Princeton, N.J.

Jackson, B.J. and J.A. Jackson. 2000. Killdeer (*Charadrius vociferus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna.html/species/517

Jacobson, S.L. 2005. Mitigation Measures for Highway-caused Impacts to Birds. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191. pp. 1043-1050

Joselyn. G.B.. J.E. Warnock. and S.L. Etter. 1968. Manipulation of Roadside Cover for Nesting Pheasants--a Preliminary Report. J. Wildl. Manage. 32(2):217-233

Kennedy, J, P. Dilworth-Christie and Erskine. 1999. The Canadian Breeding Bird (Mapping) Census Database. Technical Report Series No. 342, Canadian Wildlife Service, Ottawa, Ontario. Available online at: http://dsp-psd.pwgsc.gc.ca/Collection/CW69-5-342E.pdf.

Maguire, C.C. 2007. Oregon Strategies for Transportation Compliance with the Migratory Bird Treaty Act. UC Davis: Road Ecology Center. Retrieved from: http://escholarship.org/uc/item/0sw2c380

Manitoba Implementation Plan Committee. 2008. Manitoba NAWMP Implementation Plan: 2007-2012. Prairie Habitat Joint Venture. 49 p. + appendices.

McGraw, Kevin J. and Alex L. Middleton. 2009. American Goldfinch (*Carduelis tristis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/080

Ministry of Transportation Ontario (MTO). 2006a. Environmental Protection Requirements for Transportation Planning and Highway Design, Construction, Operation and Maintenance, October 2006. Ministry of Transportation Ontario.

Ministry of Transportation Ontario (MTO). 2006b. Environmental Reference for Highway Design, Section 3.2: Terrestrial Ecosystems, October 2006. Ministry of Transportation Ontario.

Minnesota Department of Natural Resources (MDNR). 2005. Roadside Wildlife Habitat Legislative Report. Report prepared in consultation with Minnesota Department of Transportation. 37 pp. Available online at: http://archive.leg.state.mn.us/docs/2005/mandated/050422.pdf

Meunier, F.D., C. Verheyden and P. Jouventin. 2000. User of roadsides by diurnal raptors in agricultural landscapes. Biological Conservation 92: 291-298

Morrison, R.I.G., R.E. Gill, Jr., B.A. Harrington, S. Skagen, G.W. Page, C.L. Gratto-Trevor and S.M. Haig. 2001. Estimates of shorebird populations in North America. Occasional Paper No. 104, Canadian Wildlife Service, Ottawa, Ontario. 64 pp.

Oetting. R.B. and J.F. Cassel. 1971. Waterfowl Nesting on Interstate Highway Right-of-Way in North Dakota. J. Wildl. Manage. 35(4) :774-781

Peck, G. and R. James. 1983. Breeding birds of Ontario Nidiology and distribution. Volume 1 – Non-passerines. A Life Science Miscellaneous Publication of the Royal Ontario Museum, Toronto. 321 pp.

Peck, G. and R. James. 1987. Breeding birds of Ontario Nidiology and distribution. Volume 2 – Passerines. A Life Science Miscellaneous Publication of the Royal Ontario Museum, Toronto. 387 pp.

Payne, Robert B. 2006. Indigo Bunting (Passerina cyanea), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/004

Powell, A.N. 1993. Brood rearing and chick behavior in killdeer *Charadrius vociferus* and piping plovers *C. melodus*. Wader Study Group Bulletin 71:15-16

Saskatchewan NAWMP Technical Committee. 2008. Saskatchewan NAWMP Implementation Plan 2001-2026. Five Year Plan April 2007 – April 2012. Prairie Habitat Joint Venture. 73 p.

Shochat, E., D.H. Wolfe, M.A. Patten and D.L. Reinking and S.K. Sherrod. 2005. Tallgrass prairie management and bird nest success along roadsides. Biological Conservation 121:399-407

Spellerberg, I.F. 1998. Ecological Effects of Roads and Traffic: A Literature Review. Global Ecology and Biogeography Letters 7(5):317-333

Tews, J., P. Mineau and D.G. Bert. 2009. Avian mortality related to mowing and other mechanical operations in agricultural landscapes. Draft report prepared for Environment Canada, Science and Technology Branch, Ottawa. 41 pp.

Trombulak, S.C. and C.A. Frissell. 2000. Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities. Conservation Biology 14(1):18-19

Voorhees, L.D. and J.F. Cassel. 1980. Highway right-of-way: Mowing versus succession as Related to Duck Nesting. J. Wildl. Manage. 44(1):155-163.

Warner, R.E. 1992. Nest ecology of grassland passerines on road rights-of-way in central Illinois. Biological Conservation 59:1-7

Wheelwright, N. T. and J. D. Rising. 2008. Savannah Sparrow (Passerculus sandwichensis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/045

APPENDIX A: CONTACTS

A total of 32 people were contacted for information during the course of the project, most multiple times.

Contacts were asked for the following information on a provincial/territorial scale:

- what types of roadside maintenance occur in your province/territory?
- how much area (in hectares) is affected by each type of maintenance?
- when does each type of maintenance occur?

The collection of roadside disturbance information began on January 4th, 2010, and attempts to obtain good quality data continued for a full month. Early in the process of collecting these data, it became clear that many jurisdictions did not have ready access to the information we needed. In some cases (e.g., Saskatchewan, Ontario), many kilometers of road are maintained by individual Municipalities and maintenance information is simply not available at a provincial scale; getting it would require contacting many hundreds of people (e.g., there are 444 Municipalities in Ontario alone). For Ontario, the Ontario Good Roads Association agreed to circulate a simple survey to members to collect the information we needed directly from the municipalities that do the maintenance. At the time of writing, 33 responses had been received. Our contact at the Saskatchewan Association of Rural Municipalities also circulated a survey to members, and 18 responses were received. British Columbia also has a tiered road maintenance system, and information from the Districts about their maintenance activities is only available from the individual Districts. In this case, however, the proportion of roads under District management is very small relative to that managed by the Province (Angela Buckingham, pers. com.).

Roadside Disturbance Inquiries

Thirty-two people were contacted across the country, some multiple times, for information about the area of roadside maintained and the area of land cleared for road construction, and the timing of these works. The following table lists those people whose contributions moved our research forward, and summarizes their input.

British Columbia

Dianne Froese, Manager Procurement, Highway Maintenance Contracts Dianne.Froese@gov.bc.ca	roadside maintenance is performed by independent contractors who are paid a fixed price per month, and her office doesn't track their activities; maintenance is done according to general specs, but these don't dictate what time of the year or how much to mow/brush; the Districts oversee maintenance; maintenance operations must comply with all applicable federal, provincial and local laws, including the MBCA; if maintenance is going to impact birds and/or nests, a permit can be obtained from WLAP
Fred Hughes, District Operations Manager - West Kootenay District Fred.C.Hughes@gov.bc.ca	forwarded our request to Brent Bailey for response (see next entry)
Brent Bailey West Kootenay District 250-354-6517	there is no province-wide summary of maintenance operations on roads managed by the Districts; data for provincial roads should be available in an annual summary road maintenance report; contact Monique Meek in Victoria
Monique Meek Monique.Meek@gov.bc.ca	forwarded our request to Angela Buckingham
Angela Buckingham, Chief Environmental Officer, Ministry of Transportation and Infrastructure	agreed to collect the required data (both maintenance and construction); not readily available so will take some time; can only provide information for roads under Provincial management, but these constitute the vast majority of roads in BC; timing windows for maintenance and

Angela.Buckingham@gov.bc.ca	construction, during which operations are prohibited in order to protect nests/eggs/nestlings, vary depending on latitude; to date, have not received land clearing for construction information for BC
Marni Fedoruk, Project Analyst Environment, BC Ministry of Transportation and Infrastructure Marni.Fedoruk@gov.bc.ca	sent details on area maintained for roads managed by the Province; "The timing is impossible for us to track here …"; sent details on timing windows for each region: South Coast March 15 to July 31 (if works are to occur during the critical period, use a nest survey protocol) Southern Interior April 1 to July 31 Northern dates will vary depending on a project's geographic location (e.g., for Omineca in Region 7, the prohibition window is April 30 to August 1; see pg. 6 of http://www.env.gov.bc.ca/wld/documents/bmp/omineca_tw_bmp.pdf)

Alberta

Don Collins, Divisional Coordinator, Alberta Transportation (don.collins@gov.ab.ca	mowing is typically done once or twice per year on high volume highways (i.e., divided highways and busy undivided ones); mowing is done late in the season when the grasses are high; less busy roads (including unpaved ones) are typically not mowed at all; 2 additional contacts have elicited no further response

Saskatchewan

Nichole Andre, Preservation Standards Engineer, Saskatoon Ministry of Highways & Infrastructure nichole.andre@gov.sk.ca)	the Province manages >26,000 km of provincial highways; the rural municipal road system, managed by local governments throughout the province, covers nearly an additional 134,000 km (mostly gravel roads); sent requested information for both maintenance and construction; suggested contacting the Saskatchewan Association of Rural Municipalities for information about rural roads
Dale Harvey, Assistant Executive Director, Saskatchewan Association of Rural Municipalities dharvey@sarm.ca)	information on area maintained and area cleared for construction is not tracked; gave only a general sense of timing; indicated concern about asking SARM members for information about their maintenance activities because municipalities have been frustrated lately by "illogical and unnecessary cost increases and delays due to regulations and processes of Fisheries and Oceans and Navigable Waters."

Manitoba

Kimber Osiowy, Manager of Environmental Services, Manitoba Infrastructure and Transportation Ph: 204 945-2053	forwarded our request to David Block (see next entry)
David Block, Manitoba Infrastructure and Transportation david.block@gov.mb.ca	explained our data requirements on the phone and with a follow-up email (including introductory letter from EC); 2 additional contacts (by email) have not yielded any information from Manitoba

Ontario

John Small, Environmental Planner, Ontario Ministry of Transportation john.small@ontario.ca	Provincial Roads: standards for conducting mowing and vegetation control activities are generally based on the height of the vegetation in relation to visibility/traffic safety, but there is a general Special Provision (SSP 080S06) which applies to all such operations and imposes specific requirements for the monitoring/reporting of bird nesting activity; "MTO takes the migratory bird issue very seriously, and we are always looking for better ways to minimize our interference with active nesting. This week, for example, I was involved in a meeting with a falconer, whose services we are considering to deter swallows from nesting on structures slated for construction activity which would otherwise destroy their nests."
Ontario Good Roads Association Scott Butler, Policy and Research Manager Ph: 905-795-2555 x 24	recommended that we speak to Frank Hull
Ontario Good Roads Association Frank Hull, Manager of Technical Services	no central database of information about road right-of-way maintenance, or of area cleared for road construction; municipalities handle these operations on their own; gave us a contact for Wellington County as a starting point, and offered to provide more names if we decided to do a

frank@ogra.org	sample of the municipalities
Paul Johnson, Operations Manager Wellington County paulj@wellington.ca	offered to circulate a simple survey to OGRA members; did this immediately, and received 20 responses within the first 2 weeks (there are 444 municipalities in Ontario that manage 145,000 km of highway)

Quebec

Yves Bedard Transportation Quebec, Quebec ybedard@mtq.gouv.qc.ca	this person is one of the authors of the Quebec mowing report (Belanger et al. 2006); called (left message) and sent follow-up email detailing our data requirements; received 1 emailed response "I received your request for information and I hope to answer it as soon as possible and in best my knowledge but that will take some time."; followed up again by email, but to date we have received no information for Quebec

New Brunswick

Kevin Maclean, Assistant Director Highway Maintenance and Environment, Transportation Kevin.MACLEAN@gnb.ca	forwarded our request for construction information to Dale Forster, and will try to compile the information we need on maintenance by the middle of next week; to date, we have received no maintenance information for New Brunswick
Dale A. Forster, Director of Construction, New Brunswick Department of Transportation Ph (506) 453-2673, email: dale.forster@gnb.ca	to date, we have received no construction information for New Brunswick

Nova Scotia

Charles MacDonald, Executive Director Maintenance and Operations Department of Transportation and Infrastructure Renewal macdonch@gov.ns.ca	called to say he would collect the information we need, and we sent email with introductory letter; called to follow up and left message; to date, no information has been received for Nova Scotia

Prince Edward Island

Robert MacKinnon, Inventory Control Manager, Highway Maintenance, Transportation and Infrastructure ramackinnon@gov.pe.ca	received required maintenance information, including pictures of the equipment used for mowing and brushing; was directed to Stephen Yeo (Chief Engineer/Director, Capital Projects) for land clearing for construction information
Stephen Yeo, Chief Engineer/Director, Capital Projects, Transportation and Infrastructure Ph (902) 368-5105 sjyeo@gov.pe.ca	called and left message; followed up with detailed email and introductory letter; to date, no construction information has been received for PEI

Newfoundland/Labrador

John Morrissey Transportation and Works morrisseyj@gov.nl.ca	roadsides are not mowed; brushing occurs late in the season (late October through December); clearing for road construction also occurs late October through December, except in Labrador where construction seasons is short; received all required information

Nunavut

John Hawkins, Director of Transportation Policy & Planning Division jhawkins@gov.nu.ca	called and left a message; followed up with detailed email and introductory letter; called again a week later and left another message; to date, no information has been received for Nunavut

Northwest Territories

Kevin McLeod, Director Highways & Marine	forwarded our request to Adnan Aamir (see next entry)

KEVIN_MCLEOD@gov.nt.ca	
Adnan Aamir, Assistant Director Highways Operations, Department of Transportation Adnan_Aamir@gov.nt.ca	received all required information

Yukon Territory

Don Hobbis, Director Transportation Maintenance Branch don.hobbis@gov.yk.ca	received all required maintenance information from Mr. Hobbis' administrative assistant, Sonia Gay (sonia.gay@gov.yk.ca)
Robin Walsh, Director Transportation Engineering robin.walsh@gov.yk.ca	received all required construction information

General Inquiries

A total of 18 people were contacted for information about what studies have already been done on avian mortality as a result of roadside mowing/brushing. The following table lists those people whose contributions moved our research forward, and summarizes their input.

Angela Kociolek, Research Scientist Road Ecology Program Area, Western Transportation Institute Montana State University angela.kociolek@coe.montana.edu	identified Catlin and Rosenberg (2006) as the only attempt she knows to quantify incidental take due to roadside maintenance operations
Mandy Karch, Co-ordinator Ontario Road Ecology Group mkarch@torontozoo.ca	"… the lack of data points to the importance of this type of research"; OREG only has a small set of vehicle strike data
Chris C. Maguire Geo-Environmental Section, Oregon Department of Transportation christine.c.maguire@ODOT.state.or.us	"… ODOT has no data on bird mortality in the right-of-way. We know it exists, but no one has any idea about the magnitude."
Carmelita Nelson, Coordinator Roadsides for Wildlife (Minnesota) Carmelita.nelson@dnr.state.mn.us	the program provides local road authorities with information on state mowing laws with the aim of reducing disturbance of nesting wildlife "There is some research, but not enough"; sent excerpt from a book on ring-necked pheasant (Farris et al. 1977) that includes some roadside density information and a recommendation to not mow, but no data or references for mowing-related mortality; sent excerpt (literature review) from MDNR (2005) (written by Ken Varland)that contains nest success/density information for pheasant, partridge, grouse and waterfowl, but no data or references for mowing-related mortality
Keith Hobson, Research Scientist Environment Canada, Saskatoon Ph: 306-975-4102	author of incidental take report for the forestry sector; called and left message asking if he had calculated species-specific take results and, if so, would he be willing to share them for use in the land clearing for road construction portion of the roads tally; to date, no response has been received
Pierre Mineau, Head EC – Ecopathology, Ottawa Pierre.Mineau@ec.gc.ca	shared background information for Tews et al. (2009) incidental take report for the agriculture sector (related papers, breeding and population data, including regression equations used); had no data or papers on avian mortality due to roadside mowing; suggested I contact Luc Belanger to ask about his recent study of mowing impacts on roadside habitat quality in southern Quebec
Luc Belanger, Manager CWS - Population Conservation, QC Luc.Belanger@ec.gc.ca	one of the authors of recent report of mowing impacts on roadside habitat quality (Belanger et al. 2006); asked if he has any papers or data he'd be willing to share with us about bird mortality related to roadside mowing; Luc responded by forwarding request to one of the other authors (Benoit Jobin) and asking him to respond (see below)
Benoit Jobin, SAR Biologist EC – Ecosystem Conservation, Sainte-Foy	"The project aimed at evaluating bird use of roadside rights-of-way along 3 highway sections in southern Québec. We did not look at the actual effect of mowing on birds. We were looking a the effect on bird use and habitat characteristics of a reduction of the frequency of mowing .."

Benoit.Jobin@ec.gc.ca	nest searches in the roadside habitat found a single nest – mallard
Brenda Dale, Wildlife Population Biologist, EC - Population Assessment Unit, Edmonton Brenda.Dale@EC.gc.ca	sent a large number of papers/reports about various impacts on nesting success (e.g., habitat fragmentation/connectivity, vegetation structure), roadkill, invasive species, effects of haying on habitat quality, effects of roads/trails on bird community structure, and a number of papers to help determine what species nest in roadside habitats; also provided expert opinion and review of draft list of roadside nesting birds
Kathryn Lindsay, Senior Manager EC - Habitat Landscape Conservation & Biodiversity Standards, Gatineau Kathryn.Lindsay@ec.gc.ca	provided input for list of roadside nesting birds (sent Best et al. 1995), and reviewed draft list
Peter Blancher EC – Ottawa Ph: 613-998-7311 peter.blancher@ec.gc.ca	recommended talking to local birders to get information about roadside nesting birds; also recommended Brenda Dale, EC – Edmonton for input; also provided guidance with the use of the Partners in Flight Landbird Population Estimates Database
Don McNicol, Head EC - Population Assessment, Ottawa Ph: 613-949-8266 Don.McNicol@ec.gc.ca	NatureServe web site provides GIS layers for bird breeding ranges http://www.natureserve.org/getData/animalData.jsp
Connie Downes, Landbird Surveys Biologist; EC - Species Abundance and Distribution, Ottawa connie.downes@ec.gc.ca	described Breeding Bird Survey methods, and limitations for use in calculating nest densities; sent an English translation of Executive Summary for Belanger et al. 2006
Becky Stewart, Maritimes Breeding Bird Atlas Coordinator, Sackville bstewart@bsc-eoc.org	requested information about nest density estimates for savannah sparrow and song sparrow as these are not represented in the CBBC (Kennedy et al. 1999); "I'm afraid it hasn't already been summarized--all I can provide you with is the raw data from Nature Counts on our website www.mba-aom.ca"

APPENDIX B: MODELLING APPROACH

Simulation is a popular approach for estimating uncertainty when the theoretical calculations are complex. When the statistic of interest is a function of several other random variables, the variance calculations can be very difficult to solve theoretically. Monte Carlo sampling is one alternative approach for multi-dimensional numerical integration (Efron and Tibshirani 1994), which takes a brute force approach to solving such problems.

Total incidental take resulting from road maintenance activities depends on many variables, and each of these variables has uncertainty. Estimates of total take and associated uncertainty must incorporate the uncertainty in each of the component variables; we used a simulation approach to do this. As with any model, a number of assumptions were made. While no model is perfect, a simulation model is a useful tool for bounding a problem and identifying knowledge gaps. Simply proposing a model often provokes debate and helps to identify new research questions.

We followed the general framework used by Tews et al. (2009) in their assessment of incidental take associated with agricultural activities. Essentially the model compares the date of a disturbance activity to the presence of breeding birds (adults, eggs, hatchlings) within the disturbance area. In a deterministic model, all of the inputs are fixed (i.e., do not include any uncertainty). A stochastic simulation model typically uses a combination of fixed and random variables, but must have at least one random term by definition. In both cases an assumption is made about the value of the input variable and the distribution and the degree of uncertainty. However in the case of the fixed variable we are implicitly assuming that there is no uncertainty. Choosing which variables to fix and which to treat as random is somewhat subjective. However, we followed two general principles: 1) incorporate uncertainty for the terms most likely to affect variability in take; and 2) keep to simple assumptions where limited data were available, rather than trying to assess uncertainty.

The ability to estimate uncertainty is one of the key advantages to using a stochastic simulation model to estimate take. There are several different approaches to estimating uncertainty. First, if the observed results (e.g., 1000 simulation outcomes) are approximately normal or can be transformed so that they are approximately normal, then a traditional normal confidence interval can be calculated. Another approach which requires no assumption about distribution is a percentile interval. If the distribution is normal, the percentile interval will be the same as the normal confidence interval, but if the normal assumption was violated, the percentile interval is more reliable (Efron and Tibshirani, 1994).

Tews et al. (2009) incorporated uncertainty in two variables: 1) a random nest initiation date each year; and 2) a random mowing date. We also chose to include two random variables. Like Tews et al. (2009), we use a random start date for nesting. We considered incorporating uncertainty in the disturbance inputs, but ended up rejecting this idea. The disturbance data we were able to reliably obtain on the scale necessary for a Canada-wide estimate were very coarse – simply a proportion of maintenance effort by month (see Appendix C: Roads). Additionally, the timing of maintenance operations was driven not only by environmental conditions, but also by contracting cycles and contractor availability. Instead, we decided to include uncertainty in the estimate of nest density, as populations are known to fluctuate between years with environmental covariates or population cycles, and our confidence in the density estimates is not perfect (i.e., assuming zero uncertainty is unreasonable). While the various life-history variables of clutch size, sex ratio, nests per female, and egg to fledge timing are likely to vary on a local scale, we did not include uncertainty in these variables because limited data were available and we weren't interested in local scale estimates. For example, if we assume a clutch size of four eggs, but in reality some nests have three and some have five, it won't affect the calculations of take at the regional scale. We are interested in the variability in annual take at the regional scale, not how take varies from one hectare to the next.

Adding Uncertainty

Like Tews et al. (2009), we use a random nest initiation date which is drawn from a uniform (a, b) distribution with the values of parameters a, b defined by the user. Figure 2 shows an example of 1000 draws from a random uniform (91, 105) for killdeer in Ontario.

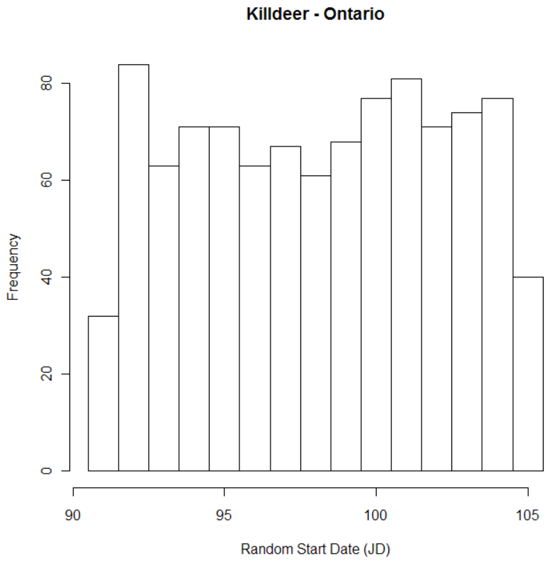


Figure 2: **Example of 1000 random nest start dates drawn from a random uniform (91,105) draws used in the simulation for Ontario killdeer. The lower frequencies at the end point are a consequence of the fact that after we take the random uniform draw, we round to the nearest Julian Day (i.e., integer) and the endpoints (91 & 105) have no probability in the continuous distribution.**

Incorporating uncertainty in the bird densities was more challenging due to the nature and quality of the data. Density estimates were obtained from Kennedy et al. (1999) as birds per km^2 by habitat type. Where data were not available we used densities from the nearest neighbouring province/territory for which there were data. Where multiple values were available, we used the mean value (see Appendix C:Birds). The non-zero estimates vary from 0.1-314 birds/km^2. While count or density data are often approximated by a Poisson distribution, this distribution is sensitive to the units (ha, km^2, 1000km^2). Simulated Poisson data generates integer values so, at lower abundances, it results in many zeros or 1s with nothing in between. This is realistic at the local scale, but is not the scale at which we have set up the simulation. For the purpose of the simulation, the parameter of interest is variation of annual density. A uniform distribution is too simple an assumption for densities, and a normal distribution is not appropriate as it may result in negative densities, especially for the lower density species. Abundance is often well approximated by a log-normal distribution (Hilborn and Mangel 1997). The lognormal distribution has characteristics similar to those of the Poisson distribution, but is continuous. By definition the X=ln(Y) ~ Normal (mu, sigma), if Y~ lognormal (mu, sigma). Where mu, and sigma refer to the mean and standard deviation of X (i.e., the normal distribution). The mean and standard deviation of Y (i.e., the lognormal distribution) are related to but not equal to mu and sigma. For each run of the simulation, we drew from a random lognormal distribution with mu=log(density).

Without better information, we assumed the variability was proportional to the mean and used sigma=0.1*log(density) (i.e., CV of 10% on the log scale). As an example, the user input density for killdeer in shrubland in Ontario was 15.4 birds/km^2. Figure 3a illustrates a realistic distribution for density (e.g., non-negative, skewed to the right), however skewed distributions are more difficult to analyze and so we can transform the data to something familiar (i.e., a normal distribution) as shown in Figure 3b).

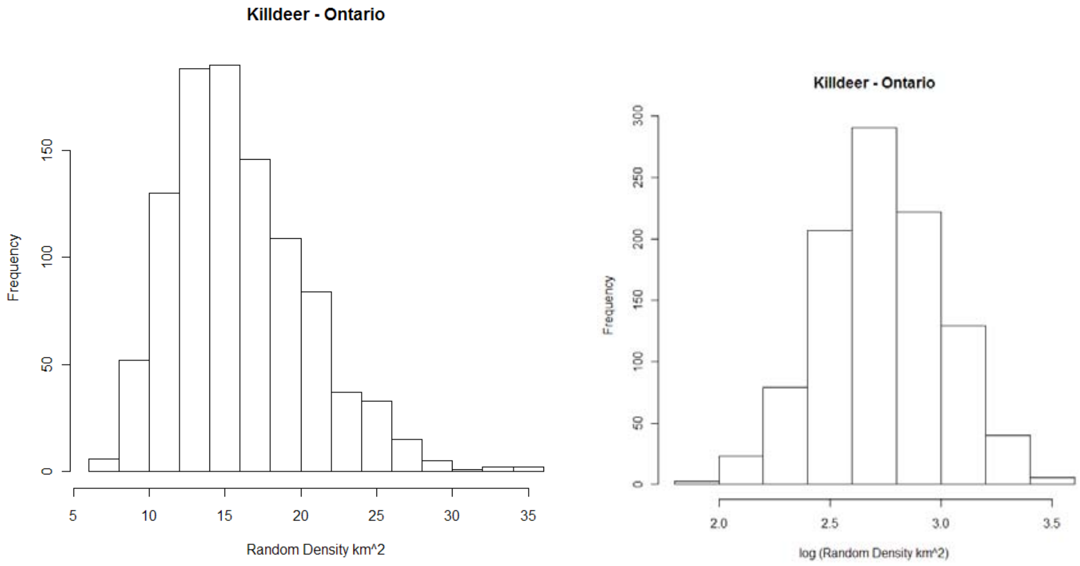


Figure 3: **a) shows 1000 draws from a lognormal distribution with mu=log(15.4) and sigma=.1*log(15.4), notice the median of the distribution = 15.4 and the distribution is skewed; b) shows the same data after taking a natural log transformation, notice the mean of the distribution = log(15.4) and the distribution is no longer skewed.**

Model Structure

The model has an annual time scale, so each run of the simulation estimates the total take for one year. The spatial scale is flexible and depends on the user defined ‘Regions’. For this report, we have treated each Province as a Region, and so the model estimates the annual take for a Province (Region). Estimates are generated separately for every focal species. Separate model inputs are required for every species and region.

The model script was written in several stand alone sections. A simple function (take.fcn) at the heart of the model calculates the annual take for a generic scenario (i.e., any land clearing activity). Several other functions calculate the necessary inputs specific to the ‘road-maintenance’ tally and loop through all scenarios of interest to the road maintenance tally. The advantage of this segmented approach is that the take.fcn function may be used to estimate the annual take for any disturbance activity; it is not just limited to ‘road-maintenance’.

Model Inputs

File name	**Description**

LifeHistoryInputs.csv	For every Species, Region, and Habitat class this file contains: o DensityKm - Density/km^2 of adult birds o ClutchSize - Mean Clutch Size o FirstEggMean – earliest breeding date (in Julian days) o rangeFirstegg – range in dates for the first egg laid o EggWindow – Length of breeding season (days between the first egg laid and the last egg laid) o EggFledge – incubation time + nestling time o P.Female – proportion of females in the population o NumNestFemale – number of nests per female (per year) o B_affected– proportion of eggs/nestlings killed given that they are present when a disturbance occurs o P_affected – proportion of the area that is actually disturbed (not currently in use, but might be useful if different types of disturbance affect areas differently
Disturb-data.csv	For every Region, this file contains: o The breakdown by month for the disturbance (i.e., % by month)
TotalRoadsRegion.csv	For every Region, this file contains: o Total_Roads - The total length of roads in km o Total_Ha_Disturbed - The total area (Ha) affected by road maintenance activity
RoadsBySpecies.csv	For every Species, Region, and Habitat class, this file contains: o Roads – the length of roads (km) in the breeding range intersecting each habitat type
Discount.csv	For every Species and Habitat class (both surrounding area and roadside): o Discount: a multiplier to account for possibility that productivity of roadside habitat may vary and may differ depending on the surrounding habitat

Script Files

Script files are shown in grey headings, with embedded functions listed in the left column and described in the right column.

Bird_functions.r	This file contains several stand-alone functions that are necessary for estimating take.
Egg.density()	Calculates the density of eggs given: adult density, clutch size, proportion of females, nests per female, and a discount value if specified. Each of these variables is user input, but initially we assumed that: the proportion of females = .5 and only 1 nest per female per year.
p.present()	Calculates the proportion of the population of eggs and nestlings are present on a given Julian day given: o Julian day, FirstEgg , EggWindow, EggFledge
Disturbance()	Function that takes in: o a vector (length 12) with the pct area affected by month o h.overlap – total hectares disturbed in the breeding area, o p.affected – set to 1 but was meant to allow for situations where only ½ the roads are mowed each year → outputs a matrix of hectares disturbed by julian day for the entire year
Area()	Calculates the hectares disturbed within each habitat, given:

	o total km of roads in the region o km of road by habitat type, within the breeding range o total hectares disturbed This function translates between the road information in km to area disturbed in hectares. We assume the disturbance is applied equally to all roads. We use the proportion of roads within the breeding area to calculate the hectares disturbed within the breeding area. We assume that the disturbance is applied to each habitat type in the same proportion that we observe roads by habitat type (within the breeding range).
Discount.fcn()	Calculates the hectares disturbed within each habitat sub-category, given: - The hectares disturbed within each habitat type, from Area() - Assumptions about roadside habitat type and quality (Table 3)
Take.fcn()	Requires: egg.density(); p.present () Calculates take for a single year for a specific: species, region, and habitat type inputs: FirstEgg,AdultDens, EggWindow, EggFledge, p.female, NPF, EggsPerNest, Rel.effort, H.overlap (hectares disturbed in breeding range), P.affected, B.affected Outputs: o Calculates take by day and reports total take for the year Note: This function can be run as a stand-alone function for any disturbance type, species, region of interest. It is not restricted to the 'road-maintenance' tally.
Bird_overall_fcn.r	This file contains a single function.
Overall.fcn	Inputs: o Region o Species o n, number of runs o noise (as a percent of the mean on the log scale) This function calculates the annual take for a species and region. Each run represents a new year. Within a year and region we assume the start date and densities are not independent. We use the same start date for all habitat types within a region, species, and year. We let the density change annually, but maintain the same relative density between habitat types. Outputs: o interim results (useful for ground truthing, de-bugging) these results display the hectares disturbed within the breeding area for each sub-category. o Simulation results – each row represents a single year or run. There is a column for each habitat sub-category in case it is of interest to compare among categories. There is also a summary column documenting the annual take across all categories. Finally there are two columns to record the two randomly generated variables: first day & density.

Birds_run.r	The function that actually runs the code & calculates take for several habitat types within a region.
	Steps: 1) set working directory 2) read in input files 3) run overall.fcn for each species and region of interest
Birds_results.r	Summarizes the simulated results: histograms, CI's
	Calculates quantile confidence intervals as well as confidence intervals assuming a log normal distribution. These are then output to a file. Histograms for the simulation results are also stored to a file.

Steps for a single run of the road-maintenance simulation (details in the table above):

1) Pull the relevant inputs (i.e., information for the current species and region) from the input files.
2) Calculate the area in hectares disturbed within each habitat class[3], using the *Area()* function.
3) Calculate the area in hectares disturbed within each habitat sub-category[4] (e.g., forest-grass, forest except grass @ roadside) and look up the associated discount multiplier; an example of interim results is shown in Table 13. Later in the model, the information in this table will be used to discount the densities in each of the habitat class sub-categories and to determine how many eggs/nestlings are present in each habitat type. This table is produced by the *Discount.fcn().*

Table 13: Example of interim results of the *Discount.fcn()* for killdeer in Ontario.

Species	hab.class	new.hab	Discount	Hectares Disturbed	DensityKm	DensityHa
Killdeer	grass	forest.grass	0.1	7364.8	10.16	0.1016
Killdeer	grass	grass.grass	1	16946.9	10.16	0.1016
Killdeer	grass	wetland.grass	1	300.7	10.16	0.1016
Killdeer	shrub	forest.shrub	0.1	7364.8	15.4	0.154
Killdeer	shrub	shrub.shrub	1	261.0	15.4	0.154
Killdeer	wetland	wetland.wetland	1	300.7	14.14	0.1414

4) Look up the relative effort, i.e., the proportion of maintenance that occurs during each month.
5) Randomly select a 'first egg date' from a uniform distribution with user input start and end dates.
6) Pick out the maximum density across habitat types within the species and region.
7) Randomly select an annual estimate of density, from a lognormal distribution based on the maximum density from the previous step (e.g., lognormal(mu=log(max.dens), sigma=.1*log(max.dens)).

---

[3] Habitat class refers to the general habitat class with which the roads intersect as identified from the GIS exercise.

[4] Habitat class sub-category refers to the general habitat class as well as the local roadside habitat. For example: forest-grass: is roadside grassland habitat that is running through a forest, whereas grass-grass: is roadside grassland habitat running through a grassland.

8) We assume that the density in different habitat types within a region are correlated (e.g., in low density years, they are all low density). Calculate the density for the other habitat types so as to maintain the same relative size. In other words, allow density to vary among years, but ensure that within a year the relative density in each habitat is maintained.
9) For each habitat type within the Region, call the generic *take.fcn()* which calculates annual take by habitat sub-category, Region, and species.

Take.fcn(), this generic function can be applied to any disturbance activity:

10) Uses the *disturbance()* function to determine how many hectares are disturbed each day of the year. Assumes that the monthly effort is spread equally among days in the month.
11) Uses *p.present()* to estimate the density of birds vulnerable to destruction each day of the year. We assume the proportion of eggs for the year can be fit by a straight line between the first egg date and the last day an egg is laid (i.e., the proportion = 0 before the first egg is laid, and =1 after the last egg is laid). This differs slightly from Tews et al. (2009) who used a regression model with real data to predict this curve. However, upon review the data were all fit adequately with a simple straight-line model which suggests that a straight-line model is a reasonable assumption to begin with. If data become available to suggest a different shape is more appropriate, it would be easy to update the code accordingly. Once the proportion of eggs by day is determined, the presence of eggs and/or nestlings for each day can be calculated based on the user input egg to fledge timing. It is then a simple matter to check any individual day to see whether or not any eggs or nestlings are available to be harmed. We assumed a fixed egg to fledge time. Although Tews et al. (2009) use a second regression curve to predict fledging behaviour, in all but one case they simply used the exact same fit as for the egg-laying; this is essentially the same as simply using a fixed egg to fledge time as we have done.
12) The number of hectares disturbed each day is then compared with the density of vulnerable birds on the same day. The daily density of vulnerable birds is multiplied by the daily hectares disturbed to estimate the daily take. The take for all days in the year is summed.
13) The annual estimate of take by habitat type, species, and region is saved and a new run begins.
14) The estimates for many runs are then summarized to provide an estimate of the total annual take and associated uncertainty. We report the median along with the 2.5th and 97.5th percentiles (Figure 4).

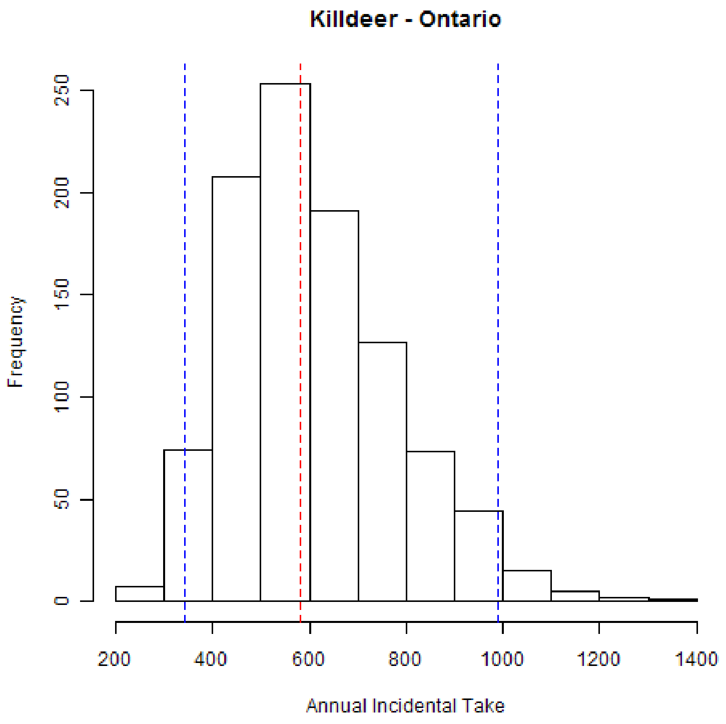


Figure 4: Summary of 1000 outcomes from the simulation model for Ontario killdeer. Each run results in an annual estimate of take. The red line represents the median or the 50th percentile from those 1000 simulations. The blue lines represent the 2.5th and 97.5th percentiles respectively.

Example of model output for killdeer

Estimates are reported by province or territory. In general, the observed results were approximately lognormally distributed, and were transformed to normalize them. Both non-parametric percentile intervals and normal confidence intervals are provided (based on the log transformed results) (Table 14). For this report we have shown the non-parametric results for each Region as they require no assumptions about distribution.

Table 14: Example of model output for killdeer. Both non-parametric percentile intervals and parametric confidence intervals (assuming lognormal distribution) are reported. LB = lower bound; UB = upper bound.

		Median & 95% Percentile intervals			Mean & 95% Confidence Intervals (assuming log(results) ~normal		
Species	Region	Median (50%)	LB (2.5%)	UB (97.5%)	mean	LB	UB
Killdeer	BC	6.9	4.8	9.9	6.9	4.7	10.1
Killdeer	Yukon	0.1	0.0	0.0	0.0	0.0	0.0
Killdeer	NW Territories						
Killdeer	Alberta	27.5	19.8	37.7	27.4	19.8	37.9
Killdeer	Saskatchewan	1282.6	802.7	2019.2	1288.5	810.6	2048.3
Killdeer	Manitoba	129.4	106.2	160.5	129.6	104.9	160.1
Killdeer	Ontario	580.2	341.3	988.9	584.8	339.5	1007.2
Killdeer	Quebec	0.2	0.2	0.2	0.2	0.2	0.2

Killdeer	NB	0.0	0.0	0.0	0.0	0.0	0.0
Killdeer	Nova Scotia	0.0	0.0	0.0	0.0	0.0	0.0
Killdeer	PEI	0.0	0.0	0.0	0.0	0.0	0.0
Killdeer	NL						
Killdeer	Nunavut						

APPENDIX C: MODEL INPUTS

Bird Breeding and Density Inputs

The following table contains the bird breeding and density data used in the simulation model. Density values by habitat type are from Kennedy et al. (1999), and breeding information is from Peck and James (1983, 1987).

Species	Prov.	Nesting Habitat	Birds /km^2	In Range?	Clutch Size	First Egg Egg (Date)	Min Incubation Time (d)	Max Incubation Time (d)	Mean Nestling Period
KILL	BC	F	0	y	4	April 1	24	30	2
KILL	BC	S	3.6	y	4	April 1	24	30	2
KILL	BC	G	0	y	4	April 1	24	30	2
KILL	BC	W	0	y	4	April 1	24	30	2
KILL	AB	F	0	y	4	April 1	24	30	2
KILL	AB	S	3.6	y	4	April 1	24	30	2
KILL	AB	G	0	y	4	April 1	24	30	2
KILL	AB	W	0	y	4	April 1	24	30	2
KILL	SK	F	0	y	4	April 1	24	30	2
KILL	SK	S	0	y	4	April 1	24	30	2
KILL	SK	G	8.73	y	4	April 1	24	30	2
KILL	SK	W	0	y	4	April 1	24	30	2
KILL	MB	F	0	y	4	April 1	24	30	2
KILL	MB	S	0	y	4	April 1	24	30	2
KILL	MB	G	2.85	y	4	April 1	24	30	2
KILL	MB	W	0	y	4	April 1	24	30	2
KILL	ON	F	3.92	y	4	April 1	24	30	2
KILL	ON	S	15.4	y	4	April 1	24	30	2
KILL	ON	G	10.16	y	4	April 1	24	30	2
KILL	ON	W	14.14	y	4	April 1	24	30	2
KILL	QC	F	0	y	4	April 1	24	30	2
KILL	QC	S	0	y	4	April 1	24	30	2
KILL	QC	G	0	y	4	April 1	24	30	2
KILL	QC	W	1	y	4	April 1	24	30	2
KILL	NB	F	0	y	4	April 1	24	30	2
KILL	NB	S	0	y	4	April 1	24	30	2

Species	Prov.	Nesting Habitat	Birds /km^2	In Range?	Clutch Size	First Egg Egg (Date)	Min Incubation Time (d)	Max Incubation Time (d)	Mean Nestling Period
KILL	NB	G	0	y	4	April 1	24	30	2
KILL	NB	W	1.5	y	4	April 1	24	30	2
KILL	NS	F	0	y	4	April 1	24	30	2
KILL	NS	S	0	y	4	April 1	24	30	2
KILL	NS	G	0	y	4	April 1	24	30	2
KILL	NS	W	1.5	y	4	April 1	24	30	2
KILL	PEI	F	0	y	4	April 1	24	30	2
KILL	PEI	S	0	y	4	April 1	24	30	2
KILL	PEI	G	0	y	4	April 1	24	30	2
KILL	PEI	W	1.5	y	4	April 1	24	30	2
KILL	NL	F	0	y	4	April 1	24	30	2
KILL	NL	S	0	y	4	April 1	24	30	2
KILL	NL	G	0	y	4	April 1	24	30	2
KILL	NL	W	1.5	y	4	April 1	24	30	2
KILL	NU	F	0	n	4	April 1	24	30	2
KILL	NU	S	0	n	4	April 1	24	30	2
KILL	NU	G	0	n	4	April 1	24	30	2
KILL	NU	W	0	n	4	April 1	24	30	2
KILL	NT	F	0	y	4	April 1	24	30	2
KILL	NT	S	0	y	4	April 1	24	30	2
KILL	NT	G	0	y	4	April 1	24	30	2
KILL	NT	W	1.5	y	4	April 1	24	30	2
KILL	YT	F	0	y	4	April 1	24	30	2
KILL	YT	S	0	y	4	April 1	24	30	2
KILL	YT	G	0	y	4	April 1	24	30	2
KILL	YT	W	1.5	y	4	April 1	24	30	2
SASP	BC	F	0	y	4	April 27	9	13	9
SASP	BC	S	22.2	y	4	April 27	9	13	9
SASP	BC	G	0	y	4	April 27	9	13	9
SASP	BC	W	0	y	4	April 27	9	13	9
SASP	AB	F	0.1	y	4	April 27	9	13	9
SASP	AB	S	32	y	4	April 27	9	13	9
SASP	AB	G	19.57	y	4	April 27	9	13	9

Species	Prov.	Nesting Habitat	Birds /km^2	In Range?	Clutch Size	First Egg Egg (Date)	Min Incubation Time (d)	Max Incubation Time (d)	Mean Nestling Period
SASP	AB	W	0	y	4	April 27	9	13	9
SASP	SK	F	0	y	4	April 27	9	13	9
SASP	SK	S	0	y	4	April 27	9	13	9
SASP	SK	G	11.43	y	4	April 27	9	13	9
SASP	SK	W	0	y	4	April 27	9	13	9
SASP	MB	F	3.8	y	4	April 27	9	13	9
SASP	MB	S	67.5	y	4	April 27	9	13	9
SASP	MB	G	47.67	y	4	April 27	9	13	9
SASP	MB	W	0	y	4	April 27	9	13	9
SASP	ON	F	43.5	y	4	April 27	9	13	9
SASP	ON	S	45.12	y	4	April 27	9	13	9
SASP	ON	G	75.83	y	4	April 27	9	13	9
SASP	ON	W	0	y	4	April 27	9	13	9
SASP	QC	F	9.14	y	4	April 27	9	13	9
SASP	QC	S	4	y	4	April 27	9	13	9
SASP	QC	G	50	y	4	April 27	9	13	9
SASP	QC	W	0	y	4	April 27	9	13	9
SASP	NB	F	9	y	4	April 27	9	13	9
SASP	NB	S	0	y	4	April 27	9	13	9
SASP	NB	G	0	y	4	April 27	9	13	9
SASP	NB	W	83.33	y	4	April 27	9	13	9
SASP	NS	F	9	y	4	April 27	9	13	9
SASP	NS	S	0	y	4	April 27	9	13	9
SASP	NS	G	0	y	4	April 27	9	13	9
SASP	NS	W	83.33	y	4	April 27	9	13	9
SASP	PEI	F	9	y	4	April 27	9	13	9
SASP	PEI	S	0	y	4	April 27	9	13	9
SASP	PEI	G	0	y	4	April 27	9	13	9
SASP	PEI	W	83.33	y	4	April 27	9	13	9
SASP	NL	F	9	y	4	April 27	9	13	9
SASP	NL	S	0	y	4	April 27	9	13	9
SASP	NL	G	0	y	4	April 27	9	13	9
SASP	NL	W	83.33	y	4	April 27	9	13	9

Species	Prov.	Nesting Habitat	Birds /km^2	In Range?	Clutch Size	First Egg Egg (Date)	Min Incubation Time (d)	Max Incubation Time (d)	Mean Nestling Period
SASP	NU	F	0	y	4	April 27	9	13	9
SASP	NU	S	20	y	4	April 27	9	13	9
SASP	NU	G	8.65	y	4	April 27	9	13	9
SASP	NU	W	0	y	4	April 27	9	13	9
SASP	NT	F	0	y	4	April 27	9	13	9
SASP	NT	S	20	y	4	April 27	9	13	9
SASP	NT	G	8.65	y	4	April 27	9	13	9
SASP	NT	W	0	y	4	April 27	9	13	9
SASP	YT	F	0	y	4	April 27	9	13	9
SASP	YT	S	20	y	4	April 27	9	13	9
SASP	YT	G	8.65	y	4	April 27	9	13	9
SASP	YT	W	0	y	4	April 27	9	13	9
SOSP	BC	F	25.52	y	4	April 17	11	15	10
SOSP	BC	S	19.7	y	4	April 17	11	15	10
SOSP	BC	G	0	y	4	April 17	11	15	10
SOSP	BC	W	314.5	y	4	April 17	11	15	10
SOSP	AB	F	10	y	4	April 17	11	15	10
SOSP	AB	S	8.5	y	4	April 17	11	15	10
SOSP	AB	G	0	y	4	April 17	11	15	10
SOSP	AB	W	4.2	y	4	April 17	11	15	10
SOSP	SK	F	53.35	y	4	April 17	11	15	10
SOSP	SK	S	10	y	4	April 17	11	15	10
SOSP	SK	G	10.5	y	4	April 17	11	15	10
SOSP	SK	W	3.08	y	4	April 17	11	15	10
SOSP	MB	F	53.35	y	4	April 17	11	15	10
SOSP	MB	S	10	y	4	April 17	11	15	10
SOSP	MB	G	10.5	y	4	April 17	11	15	10
SOSP	MB	W	3.08	y	4	April 17	11	15	10
SOSP	ON	F	0	y	4	April 17	11	15	10
SOSP	ON	S	96.47	y	4	April 17	11	15	10
SOSP	ON	G	30.78	y	4	April 17	11	15	10
SOSP	ON	W	43.35	y	4	April 17	11	15	10
SOSP	QC	F	15.44	y	4	April 17	11	15	10

Species	Prov.	Nesting Habitat	Birds /km^2	In Range?	Clutch Size	First Egg Egg (Date)	Min Incubation Time (d)	Max Incubation Time (d)	Mean Nestling Period
SOSP	QC	S	4	y	4	April 17	11	15	10
SOSP	QC	G	0.1	y	4	April 17	11	15	10
SOSP	QC	W	0	y	4	April 17	11	15	10
SOSP	NB	F	37.5	y	4	April 17	11	15	10
SOSP	NB	S	0	y	4	April 17	11	15	10
SOSP	NB	G	0	y	4	April 17	11	15	10
SOSP	NB	W	9.92	y	4	April 17	11	15	10
SOSP	NS	F	33.05	y	4	April 17	11	15	10
SOSP	NS	S	19	y	4	April 17	11	15	10
SOSP	NS	G	0	y	4	April 17	11	15	10
SOSP	NS	W	0	y	4	April 17	11	15	10
SOSP	PEI	F	35.23	y	4	April 17	11	15	10
SOSP	PEI	S	9.5	y	4	April 17	11	15	10
SOSP	PEI	G	0	y	4	April 17	11	15	10
SOSP	PEI	W	4.96	y	4	April 17	11	15	10
SOSP	NL	F	35.23	y	4	April 17	11	15	10
SOSP	NL	S	9.5	y	4	April 17	11	15	10
SOSP	NL	G	0	y	4	April 17	11	15	10
SOSP	NL	W	4.96	y	4	April 17	11	15	10
SOSP	NU	F	0	n					
SOSP	NU	S	0	n					
SOSP	NU	G	0	n					
SOSP	NU	W	0	n					
SOSP	NT	F	0	y	4	April 17	11	15	10
SOSP	NT	S	0	y	4	April 17	11	15	10
SOSP	NT	G	0	y	4	April 17	11	15	10
SOSP	NT	W	10	y	4	April 17	11	15	10
SOSP	YT	F	0	y	4	April 17	11	15	10
SOSP	YT	S	0	y	4	April 17	11	15	10
SOSP	YT	G	0	y	4	April 17	11	15	10
SOSP	YT	W	10	y	4	April 17	11	15	10
CCSP	BC	F	0	y	4	May 17	10	14	9
CCSP	BC	S	204	y	4	May 17	10	14	9

Species	Prov.	Nesting Habitat	Birds /km^2	In Range?	Clutch Size	First Egg Egg (Date)	Min Incubation Time (d)	Max Incubation Time (d)	Mean Nestling Period
CCSP	BC	G	0	y	4	May 17	10	14	9
CCSP	BC	W	0	y	4	May 17	10	14	9
CCSP	AB	F	31.84	y	4	May 17	10	14	9
CCSP	AB	S	25.33	y	4	May 17	10	14	9
CCSP	AB	G	6.96	y	4	May 17	10	14	9
CCSP	AB	W	39.66	y	4	May 17	10	14	9
CCSP	SK	F	26	y	4	May 17	10	14	9
CCSP	SK	S	0	y	4	May 17	10	14	9
CCSP	SK	G	21.42	y	4	May 17	10	14	9
CCSP	SK	W	0	y	4	May 17	10	14	9
CCSP	MB	F	8.94	y	4	May 17	10	14	9
CCSP	MB	S	0	y	4	May 17	10	14	9
CCSP	MB	G	32.33	y	4	May 17	10	14	9
CCSP	MB	W	13	y	4	May 17	10	14	9
CCSP	ON	F	61.2	y	4	May 17	10	14	9
CCSP	ON	S	0	y	4	May 17	10	14	9
CCSP	ON	G	16.33	y	4	May 17	10	14	9
CCSP	ON	W	0	y	4	May 17	10	14	9
CCSP	QC	F	61.2	y	4	May 17	10	14	9
CCSP	QC	S	0	y	4	May 17	10	14	9
CCSP	QC	G	16.33	y	4	May 17	10	14	9
CCSP	QC	W	0	y	4	May 17	10	14	9
CCSP	NB	F	0	n					
CCSP	NB	S	0	n					
CCSP	NB	G	0	n					
CCSP	NB	W	0	n					
CCSP	NS	F	0	n					
CCSP	NS	S	0	n					
CCSP	NS	G	0	n					
CCSP	NS	W	0	n					
CCSP	PEI	F	0	n					
CCSP	PEI	S	0	n					
CCSP	PEI	G	0	n					

Species	Prov.	Nesting Habitat	Birds /km^2	In Range?	Clutch Size	First Egg Egg (Date)	Min Incubation Time (d)	Max Incubation Time (d)	Mean Nestling Period
CCSP	PEI	W	0	n					
CCSP	NL	F	0	n					
CCSP	NL	S	0	n					
CCSP	NL	G	0	n					
CCSP	NL	W	0	n					
CCSP	NU	F	0	n					
CCSP	NU	S	0	n					
CCSP	NU	G	0	n					
CCSP	NU	W	0	n					
CCSP	NT	F	31.84	y	4	May 17	10	14	9
CCSP	NT	S	25.33	y	4	May 17	10	14	9
CCSP	NT	G	6.96	y	4	May 17	10	14	9
CCSP	NT	W	39.66	y	4	May 17	10	14	9
CCSP	YT	F	0	n					
CCSP	YT	S	0	0					
CCSP	YT	G	0	n					
CCSP	YT	W	0	n					
VESP	BC	F	14	y	4	April 23	11	14	9
VESP	BC	S	0	y	4	April 23	11	14	9
VESP	BC	G	0	y	4	April 23	11	14	9
VESP	BC	W	0	y	4	April 23	11	14	9
VESP	AB	F	5	y	4	April 23	11	14	9
VESP	AB	S	0	y	4	April 23	11	14	9
VESP	AB	G	6	y	4	April 23	11	14	9
VESP	AB	W	0	y	4	April 23	11	14	9
VESP	SK	F	0	y	4	April 23	11	14	9
VESP	SK	S	0	y	4	April 23	11	14	9
VESP	SK	G	13.95	y	4	April 23	11	14	9
VESP	SK	W	0	y	4	April 23	11	14	9
VESP	MB	F	17.13	y	4	April 23	11	14	9
VESP	MB	S	0	y	4	April 23	11	14	9
VESP	MB	G	0	y	4	April 23	11	14	9
VESP	MB	W	0	y	4	April 23	11	14	9

Species	Prov.	Nesting Habitat	Birds /km^2	In Range?	Clutch Size	First Egg Egg (Date)	Min Incubation Time (d)	Max Incubation Time (d)	Mean Nestling Period
VESP	ON	F	22.26	y	4	April 23	11	14	9
VESP	ON	S	14.4	y	4	April 23	11	14	9
VESP	ON	G	22.08	y	4	April 23	11	14	9
VESP	ON	W	0	y	4	April 23	11	14	9
VESP	QC	F	10.4	y	4	April 23	11	14	9
VESP	QC	S	0	y	4	April 23	11	14	9
VESP	QC	G	12.36	y	4	April 23	11	14	9
VESP	QC	W	0	y	4	April 23	11	14	9
VESP	NB	F	9	y	4	April 23	11	14	9
VESP	NB	S	0	y	4	April 23	11	14	9
VESP	NB	G	0	y	4	April 23	11	14	9
VESP	NB	W	0	y	4	April 23	11	14	9
VESP	NS	F	9	y	4	April 23	11	14	9
VESP	NS	S	0	y	4	April 23	11	14	9
VESP	NS	G	0	y	4	April 23	11	14	9
VESP	NS	W	0	y	4	April 23	11	14	9
VESP	PEI	F	0	n					
VESP	PEI	S	0	n					
VESP	PEI	G	0	n					
VESP	PEI	W	0	n					
VESP	NL	F	0	n					
VESP	NL	S	0	n					
VESP	NL	G	0	n					
VESP	NL	W	0	n					
VESP	NU	F	0	n					
VESP	NU	S	0	n					
VESP	NU	G	0	n					
VESP	NU	W	0	n					
VESP	NT	F	0	n					
VESP	NT	S	0	n					
VESP	NT	G	0	n					
VESP	NT	W	0	n					
VESP	YT	F	0	n					

Species	Prov.	Nesting Habitat	Birds /km^2	In Range?	Clutch Size	First Egg Egg (Date)	Min Incubation Time (d)	Max Incubation Time (d)	Mean Nestling Period
VESP	YT	S	0	n					
VESP	YT	G	0	n					
VESP	YT	W	0	n					
MALL	BC	F	3.1	y	8.7	April 2	24	31	1
MALL	BC	S	0.1	y	8.7	April 2	24	31	1
MALL	BC	G	1.8	y	8.7	April 2	24	31	1
MALL	BC	W	3.4	y	8.7	April 2	24	31	1
MALL	AB	F	20.8	y	8.7	April 2	24	31	1
MALL	AB	S	5.5	y	8.7	April 2	24	31	1
MALL	AB	G	12.2	y	8.7	April 2	24	31	1
MALL	AB	W	22.6	y	8.7	April 2	24	31	1
MALL	SK	F	10.2	y	8.7	April 2	24	31	1
MALL	SK	S	2.7	y	8.7	April 2	24	31	1
MALL	SK	G	6	y	8.7	April 2	24	31	1
MALL	SK	W	11.1	y	8.7	April 2	24	31	1
MALL	MB	F	17.7	y	8.7	April 2	24	31	1
MALL	MB	S	3.5	y	8.7	April 2	24	31	1
MALL	MB	G	8	y	8.7	April 2	24	31	1
MALL	MB	W	5.1	y	8.7	April 2	24	31	1
MALL	ON	F	18.3	y	8.7	April 2	24	31	1
MALL	ON	S	5	y	8.7	April 2	24	31	1
MALL	ON	G	8.4	y	8.7	April 2	24	31	1
MALL	ON	W	22.6	y	8.7	April 2	24	31	1
MALL	QC	F	12.8	y	8.7	April 2	24	31	1
MALL	QC	S	3.5	y	8.7	April 2	24	31	1
MALL	QC	G	5.9	y	8.7	April 2	24	31	1
MALL	QC	W	15.8	y	8.7	April 2	24	31	1
MALL	NB	F	13.0	y	8.7	April 2	24	31	1
MALL	NB	S	3.5	y	8.7	April 2	24	31	1
MALL	NB	G	5.9	y	8.7	April 2	24	31	1
MALL	NB	W	16.0	y	8.7	April 2	24	31	1
MALL	NS	F	13.0	y	8.7	April 2	24	31	1
MALL	NS	S	3.5	y	8.7	April 2	24	31	1

Species	Prov.	Nesting Habitat	Birds /km^2	In Range?	Clutch Size	First Egg Egg (Date)	Min Incubation Time (d)	Max Incubation Time (d)	Mean Nestling Period
MALL	NS	G	5.9	y	8.7	April 2	24	31	1
MALL	NS	W	16.0	y	8.7	April 2	24	31	1
MALL	PEI	F	13.0	y	8.7	April 2	24	31	1
MALL	PEI	S	3.5	y	8.7	April 2	24	31	1
MALL	PEI	G	5.9	y	8.7	April 2	24	31	1
MALL	PEI	W	16.0	y	8.7	April 2	24	31	1
MALL	NL	F	0	n					
MALL	NL	S	0	n					
MALL	NL	G	0	n					
MALL	NL	W	0	n					
MALL	NU	F	0	n					
MALL	NU	S	0	n					
MALL	NU	G	0	n					
MALL	NU	W	0	n					
MALL	NT	F	4.3	y	8.7	April 2	24	31	1
MALL	NT	S	1.2	y	8.7	April 2	24	31	1
MALL	NT	G	2.0	y	8.7	April 2	24	31	1
MALL	NT	W	5.4	y	8.7	April 2	24	31	1
MALL	YT	F	3.2	y	8.7	April 2	24	31	1
MALL	YT	S	0.9	y	8.7	April 2	24	31	1
MALL	YT	G	1.5	y	8.7	April 2	24	31	1
MALL	YT	W	3.9	y	8.7	April 2	24	31	1

Road Maintenance Inputs

The following table contains the road maintenance data used in the simulation model. Values in square brackets are estimates to represent provinces for which incomplete or no information was provided. Area estimates are based on average proportion maintained for the provinces/territories for which complete data were obtained. Timing estimates assume an even distribution of effort from June through August unless otherwise stated in the **Notes** field.

Maintenance			Timing							
Location	**Activity**	**Area (ha)**	**% April**	**% May**	**% June**	**% July**	**% Aug**	**% Sept**	**% Oct**	**Notes**
British Columbia	provincial - mowing	11,852						50	50	provincial policy requires that works occur outside breeding periods so as not to disturb nests; use a nest survey protocol if works must occur within this period; timing of period shifts with latitude
British Columbia	provincial - brushing	758						[50]	[50]	includes machine and overhead brushing; timing assumed to be the same as provincial mowing
British Columbia	provincial - ditching	194						[50]	[50]	this operation would affect ground-nesters (same as mowing); timing assumed to be the same as provincial mowing
British Columbia	district	[3,246]			[34]	[33]	[33]			no data will be coming for District roads as there is no province-wide summary of their activities; could try MoE for permits (would give some info about timing)
Alberta		[108,685]					[50]	[50]		timing estimated based on input from Don Collins
Saskatchewan	provincial - mowing	4200			25	75				spring shoulder cut
Saskatchewan	provincial - mowing	28900				25	50	25		full right-of-way cut on divided highways (5900 ha) and shoulder cut for remainder (23,000 ha)
Saskatchewan	municipal	[84,651]			10	40		50		timing estimate based on input from Dale Harvey; DH circulated our survey for the RMs, but input wasn't received in time to be included

Maintenance			Timing							
Location	**Activity**	**Area (ha)**	**% April**	**% May**	**% June**	**% July**	**% Aug**	**% Sept**	**% Oct**	**Notes**
Manitoba	mowing	[38,623]			[34]	[33]	[33]			got response too late for inclusion (April 19, 2010), but the area provided in that response (38,000 ha) was very close to the estimate we used in the model; timing information was incomplete ("twice a summer on the PTH network and once in the fall on the PR Network")
Ontario	provincial	8,671	1	3	15	23	21	17	11	provincial policy requires that maintenance not disturb nests; the mitigation is not strictly a timing mitigation
Ontario	municipal placeholder	[40,260]	[1]	[10]	[21]	[21]	[19]	[20]	[8]	survey sent Feb 3; timing based on averages for 25 responses; hectares calculated by subtraction; provincial environmental standards do not apply to the municipalities
Quebec		[55,993]			[34]	[33]	[33]			no response after 2 contacts
New Brunswick	mowing	983			40	40	20			includes shrub & tree cutting
New Brunswick	ditching	72			10	35	35	20		
New Brunswick	NB Power mowing	828	2	2	8	7	13	11	8	NB Power also mows provincial roads; about 70% of the work occurs outside the breeding season; does not include urban mowing
Nova Scotia	mowing	4,450			10	40	40	10		
Prince Edward Island	brushing	465	0	0	16	28	28	28	0	brushing starts in latter half of June, and effort is evenly distributed over the 14 weeks to the end of September; the area brushed is in addition to the area mowed
Prince Edward Island	mowing	3075	0	0	40	0	20	0	40	1025 ha gets cut in latter half of June, and then it all gets cut again in mid-August, and then it all gets cut again in late September or early October for snow management; the first cut will almost certainly result in take, and the third will almost certainly NOT result in take; the second cut will probably result in some take, but only for birds that like short vegetation; have used timing to "discount" the amount of take on the second mowing

Maintenance			Timing							
Location	**Activity**	**Area (ha)**	**% April**	**% May**	**% June**	**% July**	**% Aug**	**% Sept**	**% Oct**	**Notes**
Prince Edward Island	tree trimming	15	0	0	30	0	0	35	35	tree trimming is in addition to area brushed; usually starts in June and they may skip the summer and go back to it in the fall; average 10-15 km per year
Newfoundland & Labrador	mowing	0	0	0	0	0	0	0	0	roadsides are not mowed
Newfoundland & Labrador	brushing	220	0	0	0	0	0	0	50	averaged over the last 4 years; occurs from late October through December
Nunavut		[199]			[34]	[33]	[33]			no response after 2 contacts
Northwest Territories	mowing	2750	0	0	15	30	40	15	0	includes brushing, clearing rights-of-way for highways, airports and some community roads
Northwest Territories	mowing	100	10	10	20	25	25	10	0	includes ditch cleaning, off-takes clearing and culvert repair/replacement
Yukon	mowing & brushing	1220	0	0	0	10	45	35	10	percentages are an estimate based on receipt of invoices

Avian Incidental Take due to Mining Operations in Canada

FINAL REPORT

Prepared by
ArborVitae Environmental Services Ltd.

Prepared for
Environment Canada
Western Arctic Unit, Yellowknife

December 17, 2010

Acknowledgements

The author of this project has benefited from discussions with many people in government and industry. I would like to thank the following for their contributions:

- Moss Giasson, Diane Howe, Angeline Tillmans, Steve Cranbrook, (British Columbia provincial government)
- Gavin Direm (AME BC)
- Teri Muhlbeier (Alberta Sand and Gravel Assn)
- Tim Moulding, Ann Riemer, Gordon Gray, Mike Balfour, Wes Kotyck, Rick Stilling (Saskatchewan government)
- Leslie Hymers (Ontario Mining Assocation)
- Brian Polhill (Ontario government)
- Raymond Bullac (Quebec government)
- Line Rochefort (Laval)
- Michael Cadman, Jean-Pierre Savard (Environment Canada)

Suggested Citation: **Williams, Jeremy.** 2010. Avian Incidental Take due to Mining Operations in Canada. Report Prepared by ArborVitae Environmental Services Ltd. for Environment Canada, Western Arctic Unit, Yellowknife. 32 pp.

Table of Contents

Executive Summary

The incidental take of birds covered by the Migratory Birds Convention Act was estimated for activities undertaken in the mining sector. The scope of the analysis covered most of common mining activities, with the exception of oil sands extraction. The assessment looked at metals and mineral extraction, aggregate mining and quarrying, and peat extraction.

There was virtually no IT identified as being associated with peat extraction because the main activity that has the potential to cause IT – the stripping of the vegetation layer at the beginning of operations – is often done in winter, while the removal of the upper peat layer to expose the mineable peat often takes place in late summer or fall. Once a bog is in production, it is inhospitable for birds and so there is no IT involved.

In the case of metals and mineral extraction, there is a meaningful level of IT. There was a considerable level of uncertainty in the estimates of IT associated with mining, so that high and low estimates were generated. The range of these estimates is very likely to include the actual value, in the opinion of the author. The variables with the greatest uncertainty were:

- The proportion of land clearing that takes place during nesting season; and
- The amount of land cleared annually, which is primarily associated with the expansion of open pit facilities.

There was a considerable variation in the estimate of the mine footprints between B.C. Saskatchewan and Ontario, however the author has considerable confidence in the numbers because all values were derived from data in the case of B.C. and from extensive discussions with government and industry staff in the sector, in the case of Saskatchewan and Ontario. Thus, if the amount of IT is near the upper end of the metal mining estimate, then pits and quarries operations produce roughly the same level of IT as metal mining does. However, the low end estimate of IT associated with metals mining is approximately 15% of the estimated IT associated with pits and quarries.

In the case of pits and quarries, two sources of IT were identified – the clearing of the land to establish or enlarge a pit (vegetation removal and overburden stripping) and the extraction of the material that can cause IT to killdeer and bank swallows. There were some data available which were used to base the estimates of bank swallow mortality on, however the author does not have a great deal of confidence in these data since they are based on a relatively small sample size. Key variables which have a significant amount of uncertainty associated with them include:

- The average number of nests in a colony;
- The number of colonies per pit;
- The percentage of pits that have operations and mortality in them in any given year; and
- Rates of colony destruction.

High and low estimates were not developed because there were data available, however as mentioned above, the author is not highly confident of the precision of the values however he believes they are within reasonable range of true values.

All Mining	Pits & Quarries	High Est Mining	High SUM	Low Est Mining	Low SUM
Nfld, NS, NB, Que & MB	33887	59221	93108	7896	41783
Ontario	49876	25974	75850	3463	53339
Saskatchewan	993	745	1738	186	1179
Alberta	7169	887	8056	221	7390
British Columbia	33604	32453	66057	6722	40326
Territories	0	488	488	165	165
SUM	125529	119768	245297	18653	144182

Table 1. Estimated Incidental Take in Canada due to Aggregate Pit Operations.

Introduction

The inadvertent destruction of birds and/or their nests and young occurs in Canada during otherwise legitimate operations in a variety of sectors, including forestry, mining, agriculture, electrical generation and transmission, fishing, roadside maintenance and road construction. Such "incidental take" is an important factor in bird conservation and management, and Environment Canada has identified a need to better understand the magnitude and significance of the issue.

This report documents a research and modeling effort to estimate the magnitude of avian mortality due to activities associated with mining across Canada, for species that breed in Canada and are covered under the Migratory Birds Convention Act (MBCA). The MBCA does not protect raptors, corvids, blackbirds, or gallinaceous birds, among others not specifically listed in the Convention.

In consultation with the Canadian Wildlife Service (CWS) project authority, the scope for this project has been defined as coverage of mining or extracting from the earth the following materials:

- metallic ore, including precious and industrial metals;
- coal and uranium;
- potash;
- diamonds;
- clay, sand, gravel and aggregates; and
- miscellaneous materials such as salt, gypsum and peat.

Oil sands mining is excluded from this study (it is part of another study in the same series).

The activities associated with mining begin with prospecting, or early stage exploration. This is often done using airborne detectors, however there are still elements of ground-based work involved, especially once a localized area has been identified as being of interest. Once a potential deposit of interest has been identified, the land is claimed or staked and further work is undertaken to determine the location, extent and grade of the deposit. There are many factors that influence the economic attractiveness of a project, and the activities associated with resource delineation and the development of a mine plan may easily take five years or more. If the deposit appears to be physically and economically feasible to extract, and a major facility is required, an environmental assessment (EA) will be undertaken. An EA is also generally required for the major expansion of an existing mine. Once the EA has been successfully completed, the facility is constructed. The nature of the facility depends on the location, characteristics of the deposit and mode of extraction, material being extracted, and such, however access roads and power lines are often constructed, as well as the physical mine site, tailings ponds and on-site processing facilities. The mine footprint is strongly influenced by whether the operation is an open pit mine or whether it is constructed underground, or is a combination of the two approaches.

Incidental take may be associated with all stages of mining, and it will most often be associated with land clearing for roads, drill site, resource sampling, and the construction of the mine site and related infrastructure. We do not here consider incidental caused by collisions with mining vehicles or mine infrastructure; those sources of IT would be considered to fall into other components of IT which have been studied separately.

In the case of aggregate pits (note there are pits for the production of sand, gravel, and aggregate, and quarries for stone – these shall collectively be referred to as aggregate pits), there is also exploratory activity but it is generally more limited and does not involve as much land clearing as in the case of metals and minerals. When a pit or quarry is developed, there is also often no environmental assessment unless it is especially large or in an especially sensitive setting. Aggregate pits are attractive nesting sites for killdeer and bank swallows also may nest in the steep sites of a pit. Therefore, the major activities that could produce incidental take associated with pits and quarries are the land clearing for pit establishment and enlargement, and activities associated with the operation of an existing pit where bank swallows have nested in the face of the pit side and/or killdeer have nested in the pit itself.

In summary, the operations considered in this analysis are:

Metals and Minerals

Activities:	Exploration, deposit appraisal, mine and mine-related infrastructure construction, and mine operation/expansion. Mine-related infrastructure may include access roads, power lines and dams, space for the facilities, and other operations (e.g. a small lake was moved to provide access to the Ekati mine in Northwest Territories). Includes coal, potash, uranium and diamonds as well as base metals and precious metals. Most of the coal, potash, uranium and diamond mines are open pit mines, but there are some that are underground (e.g. Snap Lake – diamonds; Cigar Lake - uranium) a. Similarly, just more than half of the existing and under development metal mines in B.C. are open pit; the remainder are below ground.

Aggregates

Activities:	The activities covered include the removal of the surface vegetation and overburden to start a pit or expand an existing pit and the annual operations in existing pits.

Peat

Activities:	The primary activities of interest are the preparation of the peat bogs for extraction – operations include felling any trees, creating a series of drainage ditches to dry out the peat deposit, and the stripping of the surface vegetation. In recent years, operators have begun to mix the surface vegetation into the peat deposit (excluding trees) rather than remove it. Once the peat deposit has been prepared, the peat is removed gradually over a period of years.

The mining industry, including harvesters of peat and companies that remove sand, stone, and aggregate, are required to rehabilitate spent mines, pits and quarries. There is considerable scrutiny to ensure that rehabilitation is undertaken well, and this will restore habitat to the mine site once the rehabilitation work is established. While many companies do a good job at this, this does not offset the calculation of incidental take in this study, which is concerned with the mortality caused by initial and on-going operations.

Mining operations often take place in very remote areas and mining is often seen as a means for developing or opening up an area. As indicated above, mines have substantial power needs, as well as a need for road and sometimes rail access. As a result, governments may undertake major regional infrastructure projects to support mining. There are currently several such projects being undertaken in Canada by provincial and territorial governments that are designed to provide access and power to remote areas that are known to have major mineral reserves (Canadian Intergovernmental Working Group on the Mining Industry, 2010):

- The extension of Highway 167 in northern Quebec: in its March 2009 budget, the Quebec government announced the $130 million extension of Highway 167 from Chibougamau to the Otish Mountains. The extended highway will facilitate access to projects such as Renard (diamonds), Matoush (uranium), and Macleod Lake (copper-molybdenum).
- The Northwest Transmission Line (NTL) in northwestern British Columbia: on September 16, 2009, the federal government announced a $130 million commitment to help build the 335-km NTL. Part of the remaining $274 million, from a total cost of $404 million, would come from private industry, but the Government of British Columbia, which has committed to build the NTL, would bear the largest costs with a contribution that could reach a reported $250 million. Upon completion, the NTL would improve the economics of a number of significant mining projects in northwestern British Columbia, including Galore Creek, Kerr-Sulphurets-Mitchell, and Schaft Creek.
- The Bathurst Inlet Port and Road (BIPR) project in Nunavut: this proposed deep-water port and permanent all-weather road would foster mineral exploration and production in the Kitikmeot region of Nunavut by reducing transportation costs associated with projects in this area and by lengthening the trucking season. A 50-50 joint venture between Kitikmeot Corporation and Nuna Logistics, the BIPR would be financed through a public-private partnership. Its Environmental Impact Statement is currently on hold with the Nunavut Impact Review Board. Examples of projects that could benefit from the BIPR include Hope Bay (gold); Izok Lake, NICO, Hackett River, and High Lake (all base metals); Gahcho Kue (diamonds); and Thor Lake (REE).

Because these projects are not being undertaken solely to support mining, the incidental take associated with them is considered to come under the powerline and road construction and maintenance categories, and not mining.

Basic Methodology and Analysis

OVERVIEW OF METHODOLOGY

The most widespread cause of incidental take associated with mining is the clearing of land. Because land clearing is essentially the same no matter what metal, mineral, or stone is to be mined, the same basic approach to the calculation of incidental take was followed for all components of mining. In addition, for the activities associated with aggregate pits, there were additional calculations of the within-pit mortality of killdeer and bank swallows.

This section provides an overview of the methodology for calculating the incidental take associated with land clearing for the development or expansion of mines, pits and quarries.

The key data required are:

- Area cleared per year, by broad habitat type and region
- % of area cleared during nesting season
- Density of nesting birds and average clutch size
- % of birds and eggs killed per ha of land cleared during nesting season

Mining activities are undertaken in each province and territory, but the activity is not evenly distributed across the country. In metal and mineral mining, five provinces and territories are dominant. Therefore for each mining sub-sector, detailed analyses were undertaken for the most important jurisdictions, and the results extrapolated to other provinces and territories based on the level of activity in those jurisdictions.

Bird IT mortality was calculated for two general habitat types – grassland/scrubland and forest. No data were found specifying the amount of area cleared by habitat type – while a reasonable estimate of area cleared could be developed from available data, the author used a combination of his knowledge of the country and discussion with experts to estimate the proportion of each habitat type cleared. In addition, mining for metals and diamonds, and related exploration, is being undertaken in Nunavut and Northwest Territories, and a “sub-arctic habitat” IT figure was derived for this segment of the mining sector.

In the case of metal and mineral mines, the basic calculation was to estimate the number of new mines /major mine expansions per province or territory per year, the associated footprint, and the timing of clearing and type of habitat involved. Information on new mine types and locations was readily available, and information on footprint size was obtained from government and industry personnel, and from literature in some cases.

The nature of the mining process is important from the perspective of incidental take, since the area disturbed to create and operate an open pit mine is more extensive than the area requirements for an underground mine. Moreover, in the classic strip-mining process, a strip of land is cleared, the resource excavated, and the process is repeated on successive strips of land. In contrast, the footprint for the latter type of mine is essentially established when the mine starts up, unless a future expansion takes place. Frequently mines start out as open pit operations and then convert to underground mines once the excavation depth exceeds what is feasible to be extracted from an open pit.

Estimating the incidental take associated with exploration was perhaps the most difficult task, in that there was no systematic information available on the amount of area disturbed. Where a deposit is found and there is considerable resource delineation activity, much of this will fall on what turns out to be the mine footprint, should a mine be built. Seasonality also played a major role in the assessment of impacts, as well as discussions with those in the sector regarding the introduction of low impact (and also low cost) methods of exploration.

All aggregate pits, whether they be on public or private land, must be permitted. Most jurisdictions tabulate, or have access to, the area covered by the leases, licences and permits. However, the area covered under any individual authorization is generally larger than the area of the actual pit, and there was much less information available regarding actual pit area. The Ontario Aggregate Resources Corporation (TOARC) was the only source that was located of annual new pit area. In other jurisdictions, an estimate of area cleared per annum was made based on the term of the licence. Some licence types were only valid for pits of a defined size, and where this was so, this information was considered in estimating annual new disturbance area. In general, there was less information about pits on private land, which is unfortunate since that is where the majority of pits are located.

The seasonality of operations is critical – if most land clearing takes place outside of the nesting season, there will be no incidental take, or certainly negligible amounts. There were no published data on this, and it was through discussions with industry and government staff that an estimate was determined. Reasonable data were available regarding average clutch size however little information was available regarding what proportion of the eggs, young and adult birds are killed when land is cleared during nesting season.

There were also some intangible factors that were taken into account as well. Pits on public land are more closely regulated, and can be inspected by government staff from time to time. This created the impression that operators were less likely to cause incidental take of bank swallows in pits on public land. In addition, the Ontario industry members that were contacted were all aware of the Migratory Bird Convention Act and stated that there were best practices to not operate where there were nesting colonies. Provincial government staff were also aware of the MBCA. This created the impression that at least some operators to try to avoid causing incidental take. In contrast, pit operators on private land in Alberta operate with fair less constraint. The Alberta Sand and Gravel Association was unable to collect basic operational information from its own members. In addition, none of the interviewees in the province mentioned the MBCA. This created the strong impression that there was considerable IT associated with the operation of existing pits, and a factor was added to account for this.

The within-pit incidental take of killdeer and bank swallows was based on the number of pit licences and permits (as a proxy for the number of pits), an estimate of the number of nests (killdeer) and colonies (bank swallows) in each pit and the number that are destroyed by regular extraction operations.

Incidental Take Associated with Metals & Minerals

This section covers much of what is considered to be traditional mining, namely the extraction of precious metals such gold and silver, and base metals such as copper, zinc, and nickel. Also included are coal, uranium, potash, and diamonds. There are numerous mines in Canada, and from 2004 onwards there was a tremendous amount of exploration that ended abruptly in 2008 when commodity prices declined sharply, credit became difficult to find, and the world economy went into recession. However, from the initial discovery of a potentially mineable resource, it will take a minimum of 4-6 years to develop an understanding of the nature and grade of the deposit, to formulate a mine plan and assess of the economics of the project. If the project appears to be able to generate a favourable rate of return, permitting may take several more years, since new mines and major mine expansions require environmental assessments. If a mine passes through the EA process, another 2-3 years are generally required to construct the facilities and bring it into production. Thus, mine development is a long-term undertaking, and while recessions can and do derail the process in some cases (especially when the mine developer is a small company), in most instances, once the resource has reached the permitting stage, mine development will proceed regardless of economic fluctuations.

To give the reader an idea of the number of mines, Figure 1 is a map of active mines and development projects in British Columbia, which has traditionally been among the top three mining provinces. As of 2008, there were 10 active metal mines, 9 coal mines and 35 industrial material mines in the province, with 3 metal mines and 1 coal project in an advanced stage. Another 10 metal mines, 7 coal mines and two industrial mineral quarries were in the EA process, and there were 118 major exploration projects. The more numerous early stage exploration projects are not shown.

The ratio of active mines to mines in development is low in British Columbia, since the province experienced a hiatus of exploration and development in response to the provincial government's 1997 decision to bar the development of a promising large mine in northwest B.C. due to its location in an environmentally sensitive zone. As a result, since 1997 there has been only one moderately sized molybdenum mine opened in B.C. (Chalmers, pers. comm.).

While many of the mines are underground, a surprisingly large number are open pit mines. In part this reflects the more appealing economics associated with this approach, including a more rapid mine start-up once all of the permits have been obtained. A review of the ten operating metal mines in British Columbia indicates that 6 are open pit mines, yielding minerals ranging from gold to copper to molybdenum (Source 2009 Map of Major Mining Projects in BC). Of four mines in advanced development, three are open pit projects (see Table 5).

Many of the non-metallic resources are extracted from open pit mines. Of the 9 active coal mines in the province, only one, the Quinsam Coal Mine near Campbell River, British Columbia, is an underground mine. In fact, it is Canada's last operating underground coal mine – all of the others are open pit/strip mines. Many of the uranium and diamond mines are open pit as well.

Many metal mines are also of the open pit variety, or begin with an open pit process before transitioning to an underground operation once the upper layers of the resource have been removed.

Figure 1. Insert map BC major projects mapsOF2009.pdf

There is some level of mining in almost all provinces and territories, with Prince Edward Island being the exception. Figure 2 below shows the distribution of mining expenditures by province and territory in 2008. Ontario attracted the greatest total expenditure, with 20 % of the total. Saskatchewan and Quebec were close behind, attracting 17.7 and 16.6 % of total expenditures, respectively. Saskatchewan attracted the highest share of mine development expenditures, at 20%. British Columbia attracted 13.6% of total expenditures, and the distribution of spending was notable in that 30% of all deposit appraisal expenditures were in that province. This suggests that B.C. will be the location of a greater proportion of future incidental take than its share of overall expenditures would indicate. Nunavut and Northwest Territories have attracted significant capital in recent years, and they account for 8.7 and 10.1 % of all expenditures. There is a significant gap between the expenditures in the next most active provinces – Alberta, Manitoba and Newfoundland and Labrador each attracted between 2-4% of total spending.

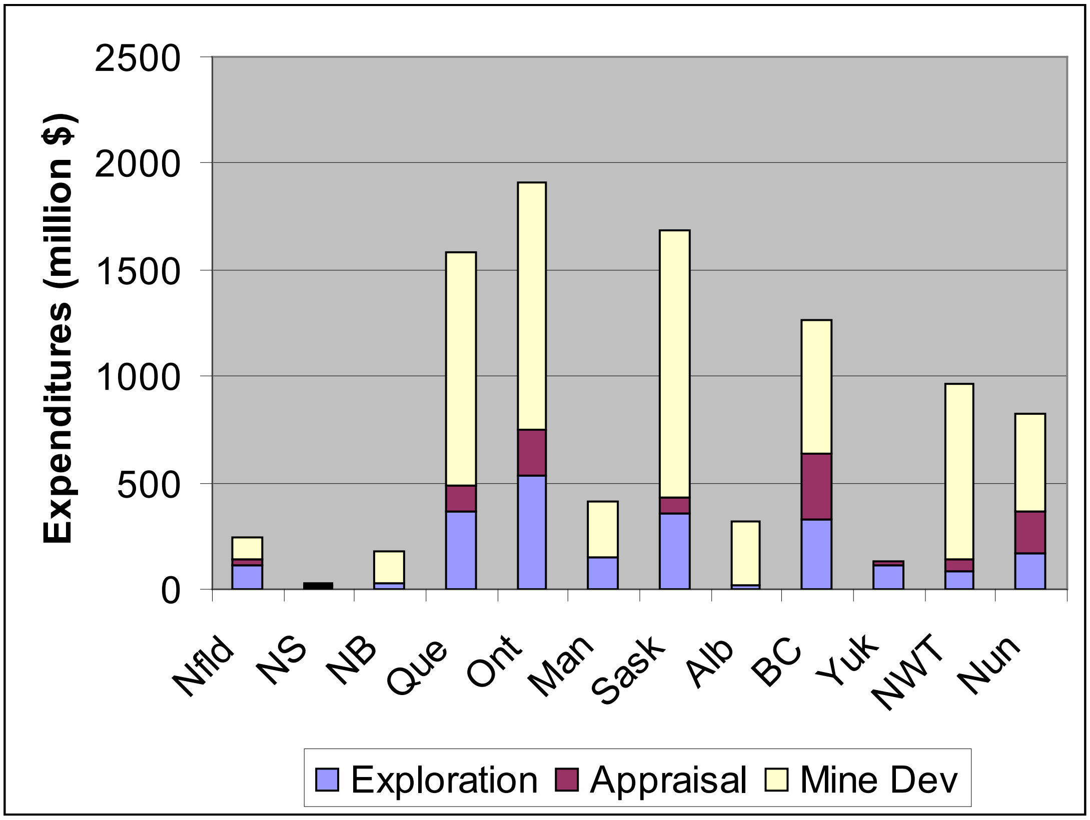


Figure 2. 2008 Mining expenditures, by major activity: Exploration, Deposit Appraisal, and Mine Complex Development (million $).

Source: The Mining Association of Canada. 2009. Facts and Figures 2009.

To optimize resource use in this project, the more detailed investigation of incidental take will focus on Ontario, Saskatchewan, British Columbia and Nunavut & Northwest Territories. The results of the analysis in Ontario will be pro-rated to estimate incidental take in Quebec, Manitoba and eastern Canada on the basis of expenditure levels, all of the provinces from Manitoba east are expected to have very similar rates of IT of similar species. The same logic is used to estimate Alberta's IT based on the estimate for Saskatchewan, and expenditures will be used to pro-rate incidental take estimates from Northwest Territories and Nunavut to apply to Yukon Territory.

The next section of the report will discuss the extent and timing of the operations that could potentially lead to incidental take. In general, there was little documentation that was obtained that provided specific information about the season in which land clearing was undertaken. However, interviews with various industry members, and what documentation was found, all pointed to winter as being when the majority of the land clearing work was undertaken, whether it was for exploration activities or for clearing land for mine development (including for associated infrastructure).

BRITISH COLUMBIA

British Columbia has historically been a major mining province but experienced a decade of minimal activity in the wake of the decision to halt a proposed mine in the Tatshenshini region. However, with changes in the provincial government and a boom in commodities, exploration in B.C. has increased significantly in (See for example Figure 1). Currently, there are 5 new mines expected to start up in the next 4-5 years (See Table 2), and these are highly likely to proceed to operating mines unless there is another economic downturn. This translates into an average of 1-1.25 new mines opening in each of the next four or five years. Most of these are open pit mines.

Mine	Company	Mineral	Mine Type	BCR
Tulsequah Chief	Redfern Resources	Gold-Zinc-Lead-Copper	Open Pit	Northwestern interior forest
Ruby Creek	Adanac Molybdenum Corp	Molybdenum	Open Pit	Northwestern interior forest
New Afton	New Gold	Copper-Gold	Underground	Great Basin
Prosperity Mine	Taseko Mines Ltd	Copper-Gold	Open Pit	Northern Rockies
Willow Creek	Western Coal	Coal	Open pit	Northwestern interior forest

Table 2. **B.C. Mines in the late stages of development and expected to open within the next 5 years.**

Data provided by the B.C. Ministry of Energy, Mines, and Petroleum Resources show that the total disturbed area associated with coal mines is 21,645 ha and the disturbed area associated with metal and mineral mines is 24,507 ha. The disturbed areas include roads, tailings ponds, waste piles, and pits, as well as other less area-intensive uses. Some rehabilitated area that has not yet been taken out of the database is also included. There are about 50 metal mines that report – approximately 25 operating and 25 closed (D. Howe, British Columbia Ministry of Energy, Mines and Petroleum Resources; pers. comm.). About 20 coal mines report – 10 active and 10 closed or in start up.

These data suggest that the average footprint of a metal mine is 0.5 sq km, and for a coal mine it is 1.1 sq km. There is considerable variation in mine size; the Kemess and Highland Valley mines are huge, each having a distance of 7 km between the mine site and tailings. (D. Howe, British Columbia Ministry of Energy, Mines and Petroleum Resources; pers. comm.). Based on these data, the author has assumed that the full footprint of the underground mine is created immediately, whereas an open pit mine starts with a 0.5 sq km. The four new open pit mines were assumed to come on stream at a rate of one per year for the next four years, and the underground mine was assumed to come on stream in 2011. All but one of the existing coal mines are open pit. Open pit mines expand their footprint over time, however the consultant did not find any information that provided a basis for estimating the average annual rate of expansion. Therefore, a high rate of 0.25 sq km /year and a low rate of 0.1 sq. km/yr were used. The author did not have data regarding the number of existing metal mines that are open pit versus underground, but estimated that the proportion ranged from 25 – 50%.

The author used the map of major projects to identify the numbers of mines in each BCR. Hobson et al. (2009) provided forest bird density information for each BCR. In the northern Rockies and northwest interior BCRs, 100% of the area cleared was assumed to be forest, while in the Great Basin BCR, 50% of the area cleared was estimated to be forest and the remainder grassland.

It is reasonable to expect that a certain amount of the clearing and development work will be done out of nesting season, but an estimate of the timing of operations was not obtained from industry sources. The author selected a range of 10 – 30% of the cleared area as a reasonable estimate, largely based on the expectation that the seasonality dynamics are similar to those described in Saskatchewan (See next section). Table 3 shows the estimated range of incidental take due to mine development in B.C., which totaled 32,453 eggs and young birds. The data elements shown in the table are for the upper estimate. The lower IT estimate, which totaled 6,722 eggs and young birds, was calculated based on the estimate that 25% of the existing metal mines were open pit (underground mines were assumed not to expand their footprint on a predictable basis), that the annual rate of expansion was 100 ha/year and on the basis that only 10% of the clearing took place during nesting season.

Parameter\BCR	Great Basin	North Rockies	NW Interior
# new mines in 2011	1	1	0
Avg mine foot print (ha)	500	500	500
# existing metal mines	5	8	12
% open pit	50	50	50
avg annual expansion (ha/open pit mine)	250	250	250
# existing coal mines	0	5	3
% open pit	100	100	100
avg annual expansion (ha/open pit mine)	250	250	250
Mine area cleared (ha/yr)	1125	2750	2250
% forest cleared	50	100	100
% grassland cleared	50	0	0
% area cleared in nesting season	30	30	30
forest bird density (pairs/ha)	7.72	6.56	3.7
Grassland bird density (pairs/ha)	0.2	0.2	0.2
clutch size (eggs/nest)	3.51	3.51	3.51
% destroyed during clearing	100	100	100
IT estimate (upper)	4691	18996	8766
IT estimate (lower)	869	4490	1364

Table 3. Estimated Range of Incidental Take due to Mining in British Columbia.

For this segment of the mining sector, there is assumed to be very little in-pit mortality of bank swallows and killdeer, primarily because the mines operate 365 days per year and there is no quiet time during which the birds would begin to nest. In addition, the pit walls are more likely to be rocky which would limit bank swallow nesting opportunities.

The consultant was unable to obtain any information relating to area disturbed during exploration, and there is surely some and surely some of the disturbance occurs during nesting season and causes incidental take. However there was very little information available upon which to make an estimate, and it is anticipated that mine expansion produces considerably more IT than does exploration.

SASKATCHEWAN

As of September, 2009, there were 4,969 active mineral dispositions totaling 7,079,479 ha. In addition, there were 182 active potash dispositions covering 4,313,171 ha and 6,444 coal dispositions on 4,060,390 ha, the latter having increased markedly since 2008 after a major find was made in that year in the Hudson Bay area (Saskatchewan Ministry of Energy and Resources 2009). This would seem to indicate that there is considerable potential for incidental take in the mining sector, and the large amounts of exploration and mine development expenditures would seem to further support this expectation. However our analysis suggests that incidental take within the metals and mineral portion of the Saskatchewan mining sector is minor.

There are approximately 15 operating or soon-to-be operating mines in the province. They are roughly evenly-split between open pit and underground mines. A review of active mines in the province indicates that all of the nine major potash mines are underground (two are solution mines which inject water into the underground ore; the water becomes saturated and the mineral is extracted from the water). Many of the existing potash mines are expanding significantly in light of higher prices in 2007 and especially in 2008. Three of five operating and soon-to-be-operating uranium mines are underground, and there is one underground gold mine (Seabee). There are presently three operating coal mines in Saskatchewan; all of which are surface mines.

Exploration is especially active for gold, and there is a large open pit diamond mine under development in the central part of the province that will likely reach commercial production in a few years.

Discussions with government staff indicated that the average underground metal mine has an above ground footprint of roughly 50 ha, whereas an open pit mine would typically be between 250 and 350 ha in extent. This is consistent with the estimated average mine footprint of 0.5-2 sq km provided in ArborVitae Environmental Services (2004). The potash mines are extensive and we have estimated that they might have a large footprint in the order of 200 ha. Therefore, the footprint of the existing mines, excluding access roads, is estimated at 3750 ha, as shown in Table 4. These mines have, in some cases, been operating for twenty years or more, and so there has been on average roughly one new mine per year. The average footprint is 233 ha/mine.

Mineral/mine type	# Mines	Footprint (ha/mine)	Total Area (ha)
coal	3	350	1050
uranium (open pit)	2	350	700
uranium (underground)	3	50	150

potash	9	200	1800
gold	1	50	50
SUM	18		3750

Table 4. Estimated footprint of operating mines in Saskatchewan (Incl Cigar Lake).

The run up in the price of potash that culminated in 2008 has led almost all of the potash mines in the province to expand significantly, most are in the process of doubling in size (Stilling, pers comm.), however most of the clearing associated with the expansions appears to have taken place. The consultant reviewed the Environmental Impact Statement assessments that had been prepared and approved in support of two significant potash mine expansions in Saskatchewan (K2 Tailings Management Area Expansion submitted by Mosaic Potash in January 2009; Potash Corp for its Rocanville West Expansion submitted August 2008) and a coal mine expansion project submission (Poplar River North Mine Extension Project submitted by Prairie Mines and Royalty Ltd in December 2008). These reports, provided by the provincial Environmental Assessment Branch, had varying levels of discussion relevant to incidental take.

The Rocanville West application requested permission to expand the operation by approximately 368 ha for a larger tailings management area to accommodate a proposed major increase in mining and mill capacity. The project assessment stated the following regarding the timing of disturbance: “Given the existing disturbance within the Project area from agricultural and industrial activities (e.g., brush clearing, modified pasture, and the PCS mine site including rail lines, roads, and other support infrastructures), wildlife is expected to have become habituated, or at least tolerate increased noise and activity levels. Construction for the new Service Shaft is scheduled to start before the breeding periods for sensitive species, such that they will naturally find alternate breeding areas.”

The K2 expansion covers only 60 ha, and there were no wildlife issues noted; in fact, the EIS had very little to say about biology.

One of the major exploration projects in the province is being undertaken by Shore Gold, which is in the later stages of assessing a diamond resource in the central part of the province, east of Prince Albert. The mines are expected to be open pit, at least during the first number of years, and they should be quite large. The footprint of the Star – Orion South deposits (two pits) is expected to be 5000 ha, the Orion centre and north deposits are also approximately 5000 ha, and the Taurus deposit appears to be approximately 6500 ha. These mines would likely be developed over a multi-decade period.

Because the Shore Gold project has not yet developed its official resource estimate nor has it yet applied for an environmental assessment, it is estimated that approval for the mine is at least three years away. Therefore, going forward, we will use a baseline assumption that there will be one new mine developed each year, requiring an average area of 233 ha cleared for the mine and associated facilities each year.

Discussions with Saskatchewan government staff indicate that the amount of incidental take associated with coal mine development is also limited. In spite of the interest in the coal discovery, the south western part of the province lies within the Western Sedimentary basin, where coal is abundant and it frequently can be found close to or at surface. The 2008 discovery was some depth underground and the economics are not as appealing as developing a surface mine, hence the discovery is not expected to lead to the development of any new coal mines in the province.

The three surface coal mines are in fairly close proximity and were last expanded in 1992, when a new electricity generating plant was built nearby. The mines tend to clear an area of about 1.6 km long by 100 m wide, extract the coal to a depth of some 30 m, reclaim the area and then repeat the process adjacent to the previous operation. Concerns over climate change and associated regulations and potential carbon taxes, together with a lack of new demand sources for coal in Saskatchewan, have limited interest in the development of new coal mines. While the footprint of the existing mines does gradually shift, as described above, the amount of incidental take associated with coal mining in Saskatchewan is considered to be very low. This general assessment was supported by staff from the Saskatchewan Dept of the Environment, who stated that they encourage any land clearing to take place as early in the season as possible to enable birds to find another nest location (hopefully before they have built their first nest) (Riemer, pers. comm.). And it was mentioned that land clearance for mining would not be permitted during the nesting season if there was evidence that species of concern were nesting in the area.

The consultant reviewed the Environmental Impact Statement (EIS) reports that had been prepared and approved in support of a significant coal mine expansion – the Poplar River North Mine Extension Project submitted by Prairie Mines and Royalty Ltd in December 2008. The EIS stated that the existing Poplar River North area covered 4,340 ha, and the proposed extension was to include 3,038 ha, of which 1,711 ha will be disturbed by mine activity. Project life extends from 2010 to 2039.

However, the EIS contained the following provision to minimize the potential for incidental take: "the removal of native vegetation will not be conducted between April 15 and August 15, where possible, to avoid the disruption of breeding grassland birds (SKCDC, 2007b); consultation with MOE will be conducted should salvage operations be required inside timing window restrictions …". In addition, the EIS stated that it would "conduct drainage and alteration of wetlands in the fall to minimize the impacts on amphibian breeding habitat". Finally, vehicle speeds were limited to from 50 – 80 km/hr to reduce the potential for wildlife-vehicle collisions. The set of proposals in the EIS hold out the prospect that there will be very little incidental take associated with this major expansion project.

The consultant was only able to make a rough estimate of the number of new mines or significant mine expansions planned for the province in the next five years – an average of one new mine, or the equivalent, is forecast. In other words, it will be assumed that 233 ha will be cleared annually for the mining of potash and metals. In addition, there is land clearing for coal production. The Poplar River North project will result in a significant amount of clearing – if all of the clearing is to take place within the first 15 years of the time period indicated, an average of 114 ha will be cleared annually. Because there are other strip mining operations in place, this area will be doubled to develop an annual estimate of 228 ha cleared for coal. It is assumed that all of this area will be grassland.

The information provided by various interviewees and suggested in the EIS' suggests that much of the land clearing that is done for mining takes place outside of nesting season. No quantitative estimates were obtained of what proportion of clearing activity took place in the nesting season – the consultant interpreted the relevant information to suggest that between 5 and 20% of the land clearing takes place during the nesting season, and so estimates were made using these two proportions as upper and lower limits. As indicated above, a considerable amount of IT is thought to occur in grassland ecosystems, where the majority of the coal strip mining takes place. It was estimated that 80% of the cleared area is grassland, and 20% forest. The average clutch size figure was obtained from Garrison (1999).

Table 5 shows the results of the analysis, with the high end estimate data shown in the table. The upper estimate of IT in the province due to mining is 745 birds, versus a low end estimate of 186 birds.

Parameter	Sask
avg ann mine expan (ha)	233
avg ann coal expan (ha)	228
area cleared (ha/yr)	461
% forest cleared	20
% grassland cleared	80
% area cleared in nesting season	20
forest bird density (pairs/ha)	7.5
grassland density (pairs/ha)	0.2
clutch size (eggs/nest)	4.87
% destroyed during clearing	100
IT estimate (upper)	745
IT estimate (lower)	186

Table 5. Estimated Range of Incidental Take due to Mining in Saskatchewan.

This estimate is much lower than it was in British Columbia, due to two main factors – the majority of Saskatchewan mines are underground and so do not expand on a regular basis, and the majority of the cleared area was grassland, which has a lower density of birds than forest. Finally, B.C. has more mines than Saskatchewan.

ONTARIO

There is expected to be approximately 1 new mine per year for the next five years in Ontario. Data on footprint size was rather general – the Ontario Mining Association stated that the footprint for a mine was less than five square kilometers, but it was not clear how much less. The consultant used a range of footprint size of 1.0 - 2.5 sq km.

The majority of new mine development is taking place in the north of Ontario, generally in forested lands. Using the average of Hobson et al (2009)'s nesting densities for Ontario yields an average of 7.8 nests/ha. The author could not find information on the timing of land clearing – a range of 10 to 30 percent cleared during nesting season was used.

Table 6 shows that the upper estimate of IT is almost 26,000 eggs and birds, versus a low end estimate of approximately 3,500. The considerable width of the range is due to the relatively high degree of uncertainty around some key data points.

Parameter	Ontario
area cleared (ha/yr)	2500
% forest cleared	100

% grassland cleared	0
% area cleared in nesting season	30
forest bird density (pairs/ha)	7.8
grassland density (pairs/ha)	0.2
clutch size (eggs/nest)	4.44
% destroyed during clearing	100
IT estimate (upper)	25974
IT estimate (lower)	3463

Table 6. Estimated Range of Incidental Take due to Mining in Ontario.

NUNAVUT AND NORTHWEST TERRITORIES

The Nunavut and Northwest Territories have a fairly long history of commercial mining, however a new wave was started in 1991 with Charles Fipke and Stuart Blussom's discovery of diamond-bearing kimberlites on the shores of Lac de Gras in the Northwest Territories.

Currently, there are three diamond mines in the Northwest Territories – Ekati (owned by BHP Billiton), Diavik (owned by Harry Winston), and Snap Lake owned by de Beers. Nunavut had one diamond mine – the Jericho mine owned by Tahera – that closed in 2008 as it was losing money. The Meadowbank gold mine, which began operations in February 2010, is the only operating mine in Nunavut at present (April 2010).

There was considerable exploration in both territories during the commodity boom, but both are high-cost jurisdictions and the failure of the Jericho mine well illustrates the risks associated with mining in the two territories.

Nunavut is seen as being more friendly to mining than NWT. John F. Kearney, President of the NWT & Nunavut Chamber of Mines (2010), stated that "Unfortunately, the NWT is getting a reputation as a difficult place to gain land access for exploration or to get permits for mining projects, or even for basic exploration programs, or to get permits within a reasonable time."

On April 10, 2010, the Globe and Mail ran a feature on mining in the Northwest Territories (The North scrapes bottom, Page B1). The report observed that exploration spending in the Northwest Territories had declined from $148 million in 2008 to $29 million in 2009. This was the steepest percentage decline in Canada. In sharp contrast, 2009 expenditures in Nunavut were $189 million, and $75 million in the Yukon, which is the first time in 15 years that the Yukon had seen more exploration expenditure than the NWT (NWT and Nunavut Chamber of Mines 2010).

The NWT and Nunavut Chamber of Mines (2010) continued by stating that: "For 2010, NRCAN's preliminary estimates show expected exploration expenditure in NWT at $66.3 million, which will represent more than a 100% increase from 2009. Of the [projected amount], it seems that $36 million is projected for diamond mine appraisal, and presumably represents the feasibility study on Gahcho Kue, so actual projected pure exploration is again only about $30 million. Expenditures in Nunavut for 2010 are estimated at $238 million and the Yukon again at $75 million."

There are two mines in an advanced stage of development in NWT – a rare earths mine being planned by Avalon Resources (Thor Lake) and a second diamond mine at Snap Lake (the Gahcho

Kue mine), owned de Beers. Fortune Minerals is also working on developing a gold-cobalt-bismuth project in NWT that is delayed at present due to a request by the Tlicho government for Fortune to wait until the Tlicho have completed land use planning for their traditional territory, which includes not only the mine but also a proposed road to the mine that is the main source of controversy. Given these legal issues, the timing of mine development, if it occurs, is difficult to forecast. That is all that is in the NWT pipeline for the next five years. Despite the greater receptivity to mining in Nunavut, there is probably no more than 2-3 new mines anticipated in that territory over the next five years.

There is a wide range of impact sizes associated with various mines. The existing diamond mines are very large. The Ekati mine had a footprint of 1758 ha in 2005 and that was planned to expand by 239 ha per year (Male and Nol 2005), so that it would be 2953 ha in 2010 if it kept to the planned rate of expansion. The Diavik mine has a 9 sq km footprint (www.diavik.ca). At the other end of the spectrum, the footprint of the Doris North gold project will be 41 ha of land (25.1 ha for road and building pad construction plus 15.4 ha as rock quarries) and an additional 13 ha that will be flooded by the final water level in Tail Lake.

The Meadowbank gold mine (operated by Cumberland Resources), is a complex of three open-pit gold mines located about 70 km north of the community of Baker Lake. Access to the mine from Baker Lake is by a 115 km all-weather access road. The project submission to the Nunavut Impact Review Board (NIRB), which is the equivalent of the territorial environmental assessment review board, estimated that a total of 478 ha would be developed for the mine and access road, of which 288 ha was high suitability habitat for terrestrial birds. There was little discussion in the submission regarding timing of activities or impacts on migratory birds.

Estimates of potential incidental take were developed by reviewing the environmental assessment applications for new mines /mine expansions. These provided information relating to the mine footprint, seasonality of development and operational activities, the bird species that might be affected, and measures taken to mitigate impacts. While some of the EA reports provided more complete information than others, the total amount of evidence presents a consistent analysis of potential IT impacts.

Summary of EA Reports

Other projects that have recently gone to review by the NIRB include the Doris North project, the Baffinland Iron Mine Project and the Hackett River Project.

As indicated, the Doris North is a small project. Initially, it will be set up to redevelop an existing mine, requiring little additional land clearing. However, under these circumstances, the project would only operate for a total of 24 months; the intention is that some of the neighbouring deposits would prove to be viable and would be developed. The infrastructure that would be constructed at the mine and camp sites would consist of a mill, crushing plant, fuel storage tank farm, camp, office complex, workshops, power generation plant, and sewage treatment plant, as well as an all-weather airstrip. In addition, a 4.8 km road will be built from the mine to the sealift loading area and another 5 km road will be constructed to the appropriately named Tail Lake, where the tailings would be stored.

The Doris North Environmental Impact Statement (EIS) indicated that waterfowl and upland breeding birds were among the valued ecosystem components identified at an Elders Workshop. However, because most of the road and mine pad construction will take place during winter; incidental take will be the minimal. The EIS states that “Construction rock will be placed directly onto the tundra *in winter* to protect the permafrost when building roads, laydown areas and building pads" [italics added].

The following mitigation measures were included in the EIS:

- conduct land clearing in summer for site infrastructure (*e.g.*, building pad construction and roads) outside of the breeding season (June 1 to August 1);
- prevent upland birds from nesting on mine infrastructure and man-made structures; and
- if a nest site is established and eggs are present, avoid the nest as much as possible and monitor for nest success.

The project being undertaken by Baffinland is the construction of a large, open pit iron ore mine located on north central Baffin Island. The ore would be shipped via rail to an all-season, deepwater port at Steensby Inlet. The rail line would be 143 km, and be constructed by Baffinland, as would the mine facilities and Steensby port facilities. A tote road would also be available for transport /access. This project would necessitate the construction of significant infrastructure, but discussions of impact area and seasonality could not be found in the literature.

The Hackett River project is based on deposits of zinc, silver, copper lead and gold; the proposal is for two open pits and one underground mine. The mine would make use of the proposed Bathurst Inlet Port and Road, and a 23 km access road would connect the project site with the BIPR road. Total footprint or area disturbed was not reported in the EIS, but key sources of IT were discussed and mitigation factors provided (i.e., avoid sensitive areas, try to operate outside of sensitive time periods such as breeding season). In addition, the project operator will try to avoid stray light, limit vehicle speeds and road access to minimize bird-vehicle strikes.

In March 2010, the Canadian Zinc Corporation submitted a Project Proposal Report in support of the Environmental Assessment of the proposed Prairie Creek Mine, which is a proposed redevelopment of an old mine site in NWT. The report indicated that the current 52 ha footprint of the mine will be expanded by about 6 ha to accommodate a new waste rock pile, removing an area of black spruce-lichen habitat. The main mine access road, which is 175 km long, will have some re-design to improve safety and reduce environmental impacts – the work is expected to be undertaken in the first winter. The report did not speak to incidental take but did note for the SARA and COSWEIC bird species that the truck haul would be undertaken in winter, "well outside" of the breeding period.

Territory	Mine	Footprint
NWT	Ekati	239 ha /yr expansion
Nunavut	Doris North	41 ha
NWT	Canadian Zinc	< 20 ha
Nunavut	Hackett River	Increased by 6 ha
Nunavut	Baffinland	unknown
NWT	Nico	unknown

The forecast footprint and rate of creation of that footprint are unknown for the Baffinland and Nico projects, however they are likely to be relatively large since both are open pit mines and there are new access roads also proposed. It is unknown when either mine will enter construction. If each of the Baffinland and Nico mines was to have a 1 sq km footprint created within the next five years, and the rate of expansion at Ekati remains 239 ha/year, then the expected total clearing in the two territories would be 3.25 sq km, which is equivalent to an annual rate of clearing of 650 ha/yr. This is the high estimate. On the other hand, if only one of the Baffinland or Nico mines goes ahead in the next five years, its foot print is 500 ha and the rate of expansion at Ekati slows to 100 ha/yr, then the amount of clearing will be about 220 ha/year. This is the low estimate.

Bird Species and Densities

The Meadowbank and Doris North EA submissions provided information about bird species and densities. In these studies, Lapland longspurs and horned larks were the most common birds observed. Other common migratory songbird species observed included redpolls, savannah sparrows, and America tree sparrows. The most common species of shorebirds were golden plovers, semipalmated plovers, and semipalmated sandpipers.

Assessment work undertaken for the Doris North project reported fifteen species of upland breeding birds during baseline surveys with densities ranging from 0.1 to 0.79 birds/ha. Mean density estimates for individual species ranged from 0.01 birds/ha for semipalmated plovers to 0.18 birds/ha, 0.47 birds/ha and 0.79 birds/ha for American tree sparrows, savannah sparrows, and Lapland longspurs, respectively. Seven ptarmigan were observed in the 1997 aerial survey with a mean density of 0.35 ptarmigan/km2 (0.004 ptarmigan/ha), and was consistent with the low frequency of incidental observations throughout the year. Note that no horned lark densities are estimated, despite this being the most commonly observed bird species in the Doris North area.

The waterfowl assessment work reported that during all three years, Canada geese and white-fronted geese were the most abundant birds observed. Other common species included tundra swans, long-tailed ducks, Pacific loons and sandhill cranes. Thirteen species of ducks and geese, three species of loons, one swan and one crane species were observed during baseline surveys. Estimated waterfowl density ranged from 2.5 to 10.2 birds/ha, presumably in appropriate habitat.

Of the 14 bird species considered to be breeding within the Meadowbank area, the Lapland longspur was by far the most common, averaging (i.e., of all 88 plots to date) approximately seven pairs per 16 ha plot or 43 pairs per 100 ha. Relatively few shorebirds were recorded during baseline surveys. The most common shorebird species was the semipalmated sandpiper, which was recorded in several extensive sedge meadows, often adjacent to small lakes and ponds, during the breeding bird surveys. Average number of pairs per plot was 0.2 or 1.5 pairs per 100 ha.

Densities of breeding bird species observed during the 2003 to 2005 breeding bird surveys indicate that the mine development will displace approximately 200 pairs (0.43 pair/ha) of Lapland longspurs, 60 pairs (0.12 pair/ha) of horned larks, 20 pairs (0.04 pair/ha) of savannah sparrow, 15 to 20 pairs (0.035 pair/ha) of rock ptarmigan, and minor numbers of other passerine species. The EIS focused heavily on the area of habitat loss, and devoted a relatively low amount of attention to direct mortality of birds through incidental take. It was noted that the ice-free period is only three months and so most of the construction activities are likely to be undertaken outside of breeding season.

Species	Density Data (birds /ha)	Average Reported Density (birds/ha)
Lapland longspur	0.86 (MB), 0.79 (DN)	0.83
Horned lark	0.24 (MB)	0.60
Savannah sparrow	0.08 (MB), 0.47 (DN)	0.28
American tree sparrow	0.18 (DN)	0.18

Semipalmated sandpiper	0.06 (MB)	0.06
TOTAL		1.95

If each species is assumed to lay four eggs once each year, then there are an average of 6 birds and eggs per ha during nesting season, plus some amount of waterfowl.

The high estimate is for an average area of 650 ha disturbed per year, implying that the maximum amount of potential incidental take will be 3900 birds and eggs, however it is estimated that 10% or less of the area will be cleared during breeding season, so that the maximum expected level of IT is 390 birds and eggs per year. At the low end, there is forecast to be 220 ha cleared per annum, indicating a potential IT level of 1,320 eggs and birds; 10% of this is 132. As a result, the best guess of the level of IT per year over the next five years is between 132 – 390 eggs and birds per year.

SUMMARY

The analysis of incidental take due to metal and mineral mining activities is summarized below in Table 7, and expanded to other jurisdictions to develop a national estimate. The Ontario data were scaled by a factor of 2.28 to derive an estimate for Manitoba and all of eastern Canada (including Quebec) and the Saskatchewan data was scaled up by 1.19 to capture mining in Alberta. The basis for the scaling factors was mining expenditures for 2008 (Figure 2). The data from Nunavut and NWT were increased by 25% to account for the Yukon Territory.

Jurisdiction	High IT Estimate	Low IT Estimate
British Columbia	32,453	6,722
Alberta	887	221
Saskatchewan	745	186
Ontario	25,974	3,463
Manitoba, Quebec & E Canada	59,221	7,896
Territories	488	165
CANADA	119,768	18,653

Table 7. Estimated Range of Incidental Take due to Mining in Canada.

There is considerable uncertainty in these estimates, primarily due to the lack of information about likely rates of mine footprint expansion, and the proportion of land cleared during the nesting season.

Another gap in the estimates is the lack of an estimate of incidental take due to exploration. It is anticipated that there is some IT associated with exploration, however much of the evidence obtained suggested that the largest proportion of vegetation and land clearing takes place outside of the breeding season. On the other hand, there is pressure on exploration departments to achieve results and it is likely that the dominant mindset is to undertake operations as soon as possible. Thus, if a company has determined that they would like to drill a specific target, and the first opportunity to do so is in spring, then it probably happens as soon as equipment is available and the site becomes accessible. Some of the later exploration work done to delineate a deposit would be captured in the amount of IT estimated for mines that reach production, however some initially promising deposits never become mines and any associated IT would not be captured in the estimates above. One final consideration is that it is expensive and time consuming to clear land and there have been a number of technological advances, such as heli-drills, that reduce the amount of disturbance, and the amount of associated IT. In sum, the range of IT levels shown in Table 7 is thought to be a reasonable range that probably bounds the true figure.

Incidental Take Associated with Aggregate Pits

The term “pits and quarries” refers to the excavations required to extract sand, aggregate material, gravel, stone, cement, and other such products that are typically used in construction projects. Quarries are excavations into a rock bed where the rock is the desired product – limestone, granite and quartz are typical types of rock that are quarried. The sides of the quarry are frequently very steep and rocky, except for where the access road enters into the quarry. Pits are excavations into sand, gravel or other loose material that is the desired product – the slopes may be steep but are often graded. Other metals and minerals may be mined from pits but may also be extracted from below surface mines – these materials were dealt with in the Metals and Minerals mining analysis in the preceding section.

The majority of pits and quarries in Canada are on private land located close to major population centres, which are the main markets for these materials. Most aggregate materials are fairly widely abundant and the economics encourages extraction close to the location of use – i.e. near large cities. Statistics Canada (2008) reported figures for non-metallic mining and quarrying that included potash, asbestos, diamonds, and peat, which are all reviewed in other sections of this report. An estimate was developed of the value of stone, sand, gravel, clay, gypsum, and salt production from each province and territory from the Statistics Canada data. This was challenging because the production of some material types was not shown due to confidentiality concerns, and had to be estimated. The basic process was to subtract from the total production value the values associated potash, asbestos, diamonds, salt and peat. The results showed that approximately 55% of the value of stone, sand, gravel, clay, gypsum, and salt production originated in Ontario, with 22% in Quebec, 9% in British Columbia and 7% in Nova Scotia (due largely to gypsum mining there). A considerable amount of production occurred in Alberta as well, and there were minor amounts of production in the other provinces, and negligible amounts in PEI, Saskatchewan and the three Territories. As a result, this section looks in detail at Ontario, Quebec, Alberta and British Columbia.

ONTARIO

The majority of the aggregate pits in Ontario are found on private land, especially when expressed in terms of their productive capacity. Aggregate pits on private land are required to be licensed. There are a significant number of aggregate pits on Crown land as well; tenure usually is provided through a permit. There are also what are known as Category 14 aggregate pits that are operated by forest management companies to provide aggregate for forest road construction and maintenance. Category 14 is actually an exemption from requirements that each pit be permitted – thus there are no permits for category 14 pits. However, the 2010 version of the Forest Management Planning Manual requests that all category 14 pits be identified, and thus the Forest Management Plans and Annual Work Schedules provide information on the number of pits that exist on each forest management unit. A review of these plans and reports found that many plan authors provided the information as a map product or in other formats that were not readily usable for the purposes of this project; a limited sample was obtained and used as the basis for estimation.

The table below provides a summary of key legislation and regulatory requirements.

Instrument	**Location**
Governing Mining Legislation	Aggregate Resources Act
Lead Provincial Dept	Natural Resources, Aggregates and Petroleum Resource Section. Category 14 pits are transitioning to the Ministry of Forest Section of the Ministry of Natural Resources.
Crown Land Requirements	A permit is issued under ARA. Forestry exempt under category 14.
Private Land Requirements	Either owner applies or owner consents. A licence is required under the ARA. A Class B licence permits removal of less than 20,000 tonnes/year, a Class A licence permits a greater removal.
Industry Association	The Ontario Aggregate Resource Corp collects the royalty and publishes an excellent annual statistical report. Ontario Stone, Sand and Gravel Assn
Guidance re: Migratory Birds	Section 5.00.17 in the June 1, 2007 Aggregate Resources Program Manual requires the consideration of migratory birds.

Ontario's aggregate sector is organized differently from that of other provinces in that The Ontario Aggregate Resources Corporation (TOARC) has been formed to collect royalties and other fees from the industry and distribute them back to the province. TOARC publishes an annual association report as well as an annual statistical report that handily exceed the available statistics from other provinces. Key for this study are data on the area under licence, under permit, and the amount of area under licence that is newly disturbed each year. Annual rehabilitation area is also provided.

The average area of land cleared on private lands between 2006 and 2008 was 992 ha/year. The area data were sub-divided to provide a total for each of the three Ontario regions (southern, central and northern). A disturbed area figure was not available for Crown land, however it was inferred by applying the annual rate of disturbance per area of private land under licence to the area of Crown land under permit. The resulting estimate of the area disturbed annually on Crown land was 1,380 ha/year, excluding Category 14 pits.

The majority of the provincial aggregate production takes place in southern Ontario, where the major demand centres are located. Interviews with staff of TOARC and MNR indicated that very little forest land was felled for aggregate pits in the south – the pit design would almost always avoid woodlots although some fencerows might be felled. Felling is largely done in winter. However, the overburden is primarily removed when it is unfrozen and dry, in part because the topsoil is stored and replaced during rehabilitation and removing it when wet or frozen damages its structure. As a result, the author estimated that most of the overburden removal takes place during nesting season; an estimate of 80% was used, which none of the interviewees contradicted.

In the central and northern regions, where more Crown land is cleared, it is anticipated that a minor proportion of the forest land is cleared during nesting season. Other than limits on operations caused by poor road conditions during spring breakup and the late fall, due to rain and freeze-up, there is no reason to think that there would be other sources of seasonality. Subtracting two months for each of the spring and fall operational breaks, and assuming an equal rate of clearing in the other months leads to an assumption that 25% of the forest would be cleared during nesting season.

I have also estimated proportions of forest and non-forest land cleared by general region – in the south, 95% of the land cleared is scrub, field, pasture or plowed agricultural land, and the remaining 5% is assumed to be forest. In the central part of the province – Bancroft, Pembroke, Parry Sound, North Bay – the ratio was estimated at one-third grassland and brushland and 67% forest, while in the north it is estimated at 5% grassland and brushland and 95% forest.

Category 14 Pits

So far, the analysis has not considered category 14 pits, so-called because they are authorized under category 14 of the Aggregate Resources of Ontario Provincial Standards. These pits are in fact exempted from permitting requirements so long as they meet a number of conditions, including having a size less than 3 ha. MNR staff suggested that the average site of a Category 14 pit might be 1.5 ha (Polhill, pers comm.). The Forest Management Planning process is beginning to report information about aggregate pits, however it is provided in different formats and different degrees of detail. Table 8 shows the results of a scan of 12 Forest Management Plans and/or Annual Work Schedules; data are not shown for the five plans in which no data could be found.

Forest	Number of Pits			Forest Area (ha)
	Cat 9	Cat 14	All Pits	
Dog River Matawin	78	54	132	859079
English River			61	1032771
Spruce River			21	711159
Lake Nipigon			1	900070
Nipissing	103	39	142	761985
Romeo Malette	99	14	113	629000
Crossroute			150	874000
SUM	280	107	620	5768064

Table 8. Summary of Pit Information provided in seven Forest Management Plans.

In total, there are 107 active Category 14 pits on three of the forests, which collectively cover 5.8 million hectares. On average, there is one Category 14 pit per 21,000 ha on these three forests. Applying this same ratio on the entire Area of the Undertaking, which is 38.5 million ha, leads to an estimate of 1830 Cat 14 pits. The consultants made the assumption that the Category 9 pits would be covered in the TOARC statistics, however it is not known conclusively how true this assumption is.

Category 14 pits cannot remain open for more than ten years, and if the road used to access them is to be decommissioned, the pits must be rehabilitated beforehand. Since there is little incentive to close a pit early, especially when one might need to access it in future, it is likely that most category 14 pits are kept open for a considerable length of time – perhaps 7 to 10 years. This would suggest that the average number of pits opened in a given year would be between 261 and 183. At an area of 1.5 ha each, this suggests that the average area cleared annually for category 14 pits is on the order of 392 to 275 ha (the midpoint area of 333 ha was used, of which 83 ha was assumed to be located in central Ontario and he remainder in the north). It was estimated that these pits were all created by clearing forested land.

Therefore, in 2008, the estimated area of Crown land disturbed in Ontario was 1,713 ha, or 17.1 sq km.

Derivation of Incidental Take due to Land Clearing

The calculation of the incidental take associated with land clearing for aggregate pits in Ontario is shown in Table 9. The upper rows are the estimated areas of land disturbed by region and ownership, below that the proportions of cover type are shown and the proportion of area cleared during the nesting season. Nest densities in the two habitat types were based on estimates of incidental take in Canada due to forestry operations (Hobson 2009), and on IT losses due to mowing and other mechanical operations in agricultural landscapes (Tews et al. 2009).

Parameter	Region			
	South	Central	North	TOTAL
Area Disturbed (ha/yr)				
- Crown land	2	228	1483	1713
- private land	744	148	100	992
Total	746	376	1583	2705
Prop'n grassland	0.95	0.33	0.05	
Prop'n forest	0.05	0.67	0.95	
Prop'n grassland cleared during nesting	0.8	0.8	0.8	
Prop'n forest cleared during nesting	0.25	0.25	0.25	
Forest density (pairs/ha)	7.8	7.8	7.8	
Grassl'd density (pairs/ha)	0.2	0.2	0.2	
No eggs/nest	4	4	4	
IT grassland	454	79	51	584
IT forest	291	1965	11730	13986
Total IT	745	2044	11781	14570

Table 9. Incidental take in Ontario due to land clearing for pits and quarries.

Table 9 shows that there is a total of 14,570 young birds and eggs killed due to land clearing for aggregate pits. This is a meaningful amount of IT, and the majority of it takes place on Crown land in central and northern Ontario, with relatively little taking place on private land.

Derivation of Incidental Take due to Pit Operations

In addition to land clearing, incidental take also occurs due to pit operations. The killdeer nests in open sandy or gravelly areas and is known to nest readily in gravel pits. Bank swallows nest by digging dens within the pit walls – they do not nest in quarries where the pit faces are rock. Operations in the pits during nesting season could cause incidental take of both species.

Killdeer
The key factors in estimating the IT of killdeer consisted of:

- the number of pits and quarries with killdeer nests in them, and the number of nests per pit;

- the proportion of pits and quarries that would have active operations in them during nesting season;
- number of eggs and young per nest; and
- the amount of mortality per nest caused by active operations.

Unfortunately there was little of the above data available.

The number of pits and quarries in operations was estimated to equal the number of licenses and permits. In 2008, there were 3,762 licences and 3,199 permits issued in Ontario (note that Category 14 pits are not included in these numbers). Some of the licence and permit areas are very large and probably have numerous pits, and there are some very large pits, so there may well be more than one nesting killdeer on some permits or licences. On the other hand, some pits will have no nesting killdeer.

The analysis above resulted in a mid-point estimate that there are 222 category 14 pits opened each year and if they remain open for eight years, then at any given time there will 1776 category nine pits open. In total therefore, there was an estimated 8,737 pits open at any given time. If we assume that 50% of these pits have a single active killdeer nest in them, and we estimate 4 eggs per nest, zero destruction of the adults, but complete loss of the brood if the nest is damaged, and that the harvesters operate in 25% of the available number of pits, then the amount IT caused by pit and quarry operations would be 4,369 eggs and very young birds.

Bank Swallow

The data required to estimate IT of bank swallow due to pit operations is similar to that used to estimate the IT of killdeer. The key differences are that bank swallows do not nest in quarries, since they cannot make their nesting cavities in rock, and that the swallows live in colonies that can be very large.

As in the case of the killdeer, there is relatively little information that can be gleaned from other studies. Most of the relevant information in the literature is associated with colony size, and those figures vary by region, and also have the risk of being out of date as Ontario bank swallow populations have declined significantly in recent decades; the Atlas of the Breeding Birds of Ontario, 2001-2005 reports that the Breeding Bird Survey has found an average annual rate of decline of 6.6% since 1981.

The literature describes a considerable range in colony sizes, with figures ranging from less than 10 nesting pairs to several thousand. Larger colonies tend to be found along larger river systems. Garrison (1999) provides the following data regarding average colony size:

Location	Average colony size (pairs of birds)	Citation
California	141 - 227	Lay-mon et al. 1988
Saskatchewan	8	Hiertaas 1984
Ontario	45	Peck and James 1987
Michigan	58.6	Hoogland and Sherman 1976
Alaska	64.5*	Hickman 1979
Pennsylvania and Vermont	95.4*	Spencer 1962

California	367.8*	Campbell et al 1997

Table 10. Bank swallow colony size estimates from literature.

* number of burrows. Note that Garrison (1999) cited study results indicating that from 43-77% of burrows have nests in them.

Table 10 suggests that colony sizes are quite large in California (with two citations indicating similar results), and figures from that state probably do not apply to Ontario, although Garrison (1999) did report that one colony in Ontario had 1500 pairs and Cadman (pers. comm.. 2010) reported that one big pit he visited in southern Ontario had 2000 swallows in it in numerous nesting locations. The figure from Ontario is very close to a natural average figure of 42 pairs per colony (Erskine 1979), and so an average colony size of 44 pairs of birds will be used.

The proportion of pits with colonies in it varies geographically, with higher occupancy rates in southern Ontario locations. Cadman (pers. comm.. 2010) reported that in southern Ontario (he is working in Wellington County), virtually every sand and gravel pit has bank swallows in it. In 13 pits there was a total of 27 colonies, so there is usually more than one colony per pit.

The available data did not always differentiate pits and quarries. Production statistics from TOARC (2008) indicated that between 2001 and 2008, an average of 87.5% of aggregate production in Ontario was from private land permits. In 2008, of 204 permits for above ground pits and quarries in southern Ontario, 169 (83%) were for pits, 28 (14%) for quarries and 7 (3%) for combinations of the two. Therefore, the assumption will be made that in southern Ontario, bank swallows will be nesting in 169 of the permitted areas while none will occur in the quarries or combination pit & quarry sites. Most of the Crown land licences are issued in central and northern Ontario, outside of the main range of bank swallow, and will not be considered in this estimate of bank swallow IT.

Based on the information provided by Cadman (2010), it will be assumed that there are two colonies per pit and that 20% of these colonies will be destroyed in a given year.

Therefore no. bank swallow colonies in southern Ontario aggregate pits = 169 *2 = 338.
No. bank swallow colonies destroyed = 0.2 * 338 = 68
No. of bank swallow nests destroyed = # colonies x # nests/colony = 68 * 44 = 2992
No. bank swallow eggs or young birds destroyed = 2992 * 4.44 = 13,284

This calculation is based on an average clutch size of 4.44 in Ontario (Garrison 1999), and assumes that none of the parent birds are killed.

Ontario Incidental Take Summary

In summary, it is estimated that a total of 35,000 birds and eggs are destroyed by pit and quarry operations each year in Ontario. The majority of the losses are estimated to occur in southern Ontario, where there are many pits but also large populations of killdeer and bank swallows. The estimates show that roughly 60% of the IT takes place during operations, affecting killdeer and bank swallow, and roughly 40% occurring due to forest harvesting and overburden removal practices on land as it is being cleared.

Parameter	Region			
	South	Central	North	TOTAL
Area Disturbed (ha/yr)				

- Crown land	2	228	1,483	1713
- private land	744	148	100	992
Total	746	376	1,583	2,705
Prop'n grassland	0.95	0.33	0.05	
Prop'n forest	0.05	0.67	0.95	
Prop'n grassland cleared during nesting	0.8	0.8	0.8	
Prop'n forest cleared during nesting	0.25	0.25	0.25	
Forest density (pairs/ha)	7.8	7.8	7.8	
Grassl'd density (pairs/ha)	0.2	0.2	0.2	
No eggs/nest	4	4	4	
IT grassland	454	79	51	584
IT forest	291	1,965	11,730	13,986
IT killdeer during operations	4,369	0	0	4,369
IT bank swallow during operations	13,284	0	0	13,284
Total IT	18,398	2,044	11,781	32,223

Table 11. Estimated Incidental Take due to Ontario Aggregate Pit Operations.

There are a few key areas of uncertainty, including such factors as the timing of when the land is cleared. There are also opportunities for further refinement of key factors such as elements of the calculation of in-pit mortality of killdeer and bank swallows.

QUEBEC

Aggregate Mining in Quebec is largely regulated by the provincial Environment Department, under the legislation identified below.

Instrument	**Location**
Governing Mining Legislation	Environmental Quality Act (EQA) – Regulation respecting Pits and Quarries
Lead Provincial Dept	Ministry of Sustainable Development, Environment and Parks
Crown Land Requirements	Certificate issued by Minister of SDEP is required under section 22 of EQA
Private Land Requirements	
Industry Association	
Guidance re: Mig Birds	The regulation[1] does not permit new pits to be established within 75 m of water unless an environmental impact assessment is done that includes consideration of migratory birds.

---

[1] http://www2.publicationsduquebec.gouv.qc.ca/dynamicSearch/telecharge.php?type=3&file=/Q_2/Q2R2_A.HTM

The consultant was unable to locate information pertaining to the area of aggregate pit activity in Quebec, including the number of leases or licences and the area affected. Instead, the incidental take estimates have been derived by pro-rating Ontario incidental take numbers by the ratio of pit operation activity in Ontario and Quebec. Statistics Canada (26-226-2006) reported that the value of aggregate extraction in Quebec was 45.7% of the comparable value in Ontario – 0.457 was the factor used to scale Ontario data and apply it to Quebec.

Hobson et al's (2009) figures on forest pair density, averaged between conifer and deciduous forest types, came to 8.45 pairs/ha, somewhat higher than in Ontario.

Parameter	Region			
	South	Central	North	TOTAL
Area Disturbed (ha/yr)				
- Crown land	1	104	678	783
- private land	340	68	46	453
Total	341	172	723	1,236
Prop'n grassland	0.95	0.33	0.05	
Prop'n forest	0.05	0.67	0.95	
Prop'n grassland cleared during nesting	0.8	0.8	0.8	
Prop'n forest cleared during nesting	0.25	0.25	0.25	
Forest density (pairs/ha)	8.45	8.45	8.45	
Grassl'd density (pairs/ha)	0.2	0.2	0.2	
No eggs/nest	4	4	4	
IT grassland	207	36	23	267
IT forest	144	973	5,807	6,924
IT killdeer during operations	1,997	0	0	1,997
IT bank swallow during operations	6,071	0	0	6,071
Total IT	8,419	1,009	5,830	15,258

Table 12. Estimated Incidental Take due to Quebec Aggregate Pit Operations.

The resulting analysis shows that the incidental take associated with aggregate pit operations in Quebec is estimated at 16,086 eggs and young birds per year, of which about 6,100 are bank swallows and 2,000 are killdeer.

ALBERTA

While there is a reasonable amount of regulation of the aggregate pit sector in Alberta, there is considerably less monitoring and oversight on private land pits, which make up the majority of provincial pits (an estimated 66% of production comes from private land).

Instrument	**Location**
Governing Mining Legislation	Public Lands Act for pits on Crown land; Environmental Enhancement and Protection

	Act (private land)
Lead Provincial Dept	Sustainable Resource Development (SRD)
Crown Land Requirements	Surface Material Licences (SMC's) are for area up to 2 ha and will be operated less than 1 year. A Surface Materials Lease (SML) is issued upon request, subject to approvals, when the facility will be operating for 10 years or less, and the lease area is less than 80 acres. When the lease area > 80 acres, tenders are invited for the lease.
Private Land Requirements	Class I pits • five hectares or more in area • subject to the Code of Practice for Pits or an existing approval under the *Environmental Protection and Enhancement Act* • Pits with an existing approval must convert to a registration by November 1, 2008 • Approximately 550 Class I pits on private land in Alberta Class II pits • less than five hectares (on private land) • any size (on public land) • subject to the requirements of the Act and the Conservation and Reclamation Regulation • Estimated 1,500 to 2,000 smaller pits (private land) and 650 pits on public • Operators must comply with all requirements of the *Environmental Protection and Enhancement Act* and its regulations and Codes of Practice. In addition, they must comply with the Alberta Water Act and all other applicable provincial and federal laws.
Industry Association	Alberta Sand and Gravel Association does not have any statistics – tried to collect pit area data from its members who refused to provide it.
Guidance re: Mig Birds	The 2008 Guideline references the Migratory Bird Act and advises against tree clearing between April 1 – June 30. The Hay_Zama Lakes complex requires specific precautionary measures (see EUB Interim Directive 96-1).

Source: Alberta Sustainable Resource Development. undated. Acquiring Surface Material Dispositions on Public Land. Available at http://www.srd.alberta.ca/ManagingPrograms/Lands/

Alberta Energy provided the consultant with a list of the Surface Material Lease (SML) and Surface Material Licence (SMC) data for the province, which included the area under lease or licence and the year of issuance. The area and issuance date information was summarized. The listing contained the surface leases for the oil sands operations – these were very large leases that were readily identifiable and removed from the calculation. There were a number of smaller leases covering areas in the 1 – 15 ha range that were also issued to oil sands companies, and it was assumed that these were for pits to obtain material for road and other purposes. These leases were retained in the summary. Similarly, leases to two known peat moss extractors were also removed from the calculation.

The 2009 SMC area was 77.7 ha, and since these are one-year licences, 100% of the entire area was assumed to be disturbed (Brenda Huxley, SRD, pers comm. Mar 31).

Figure 3 shows the area associated with SMLs, which are ten-year leases for larger deposits. The figure shows the average area of each type of lease for each year of issuance. Higher than normal average lease sizes occurred in 1998 and 2003, which are years when a large aggregate company, Athabasca Minerals, obtained some very large lease areas. Because the leases have a ten-year term, the ten-year running total area is shown, as the area under lease each year. The trend lines show that not only is there a greater area under lease over time, but the average lease area size is also increasing. During the last five years (2005-09), an average of 10,100 ha was under lease.

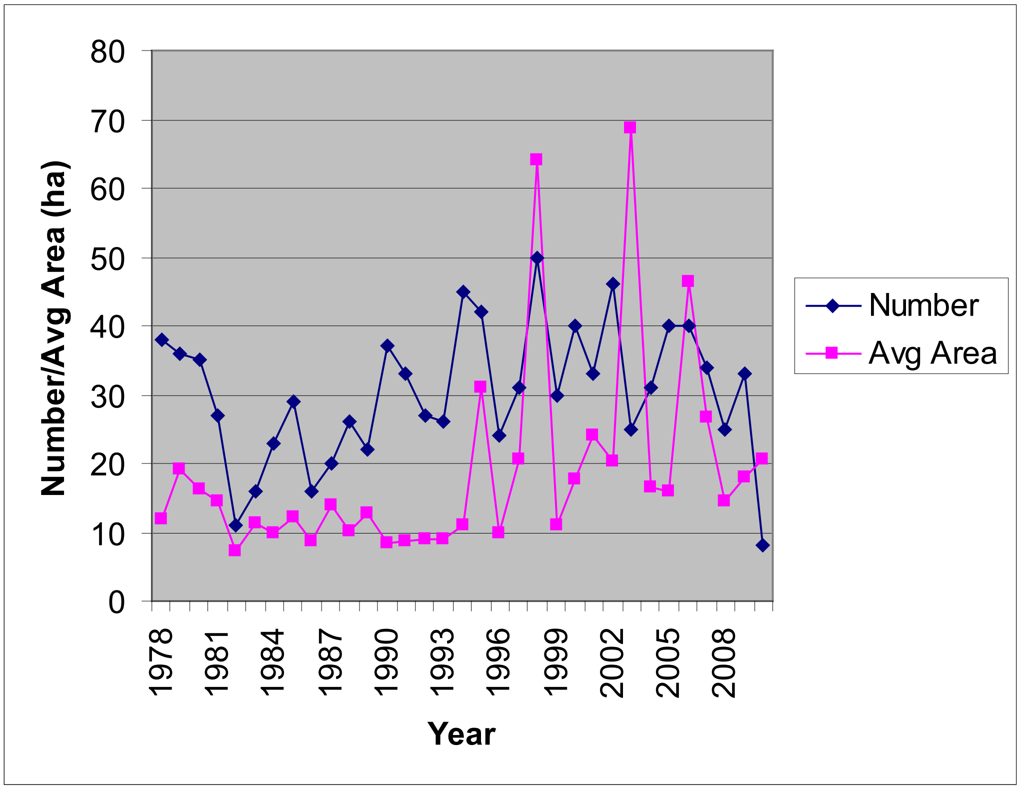


Figure 3. Number of New Leases/Year and Average Area per Lease (ha). (Source: Alberta Energy)

It was assumed that 8% of the surface area of each SML was disturbed annually – this was estimated to equate to an annual rate of extraction of ten percent reduced to provide allowance for inoperable areas, roads, buffers, etc. The calculation yields a result of 808 ha/year that is freshly disturbed, and with the area of licences added in, the total newly disturbed area per year is estimated at 886 ha/yr.

In addition to the pits on public land, there is also a significant number of pits on private land. The Alberta government does not track or report on the area of pits in private land, nor are production figures available. However, a Crown land production estimate was available for the 2007-08 fiscal year, of 14,538,181.83 cubic yards. The weight of material in a cubic yard was set at 2600 pounds, based on crushed stone weighing 2500 lbs/cubic yard, sand weighing 2500-2700 lbs/cubic yard, and gravel weighing 2700-2750 lbs/cubic yard[2]. Total provincial sand and gravel production in 2007 was preliminarily reported at 50,248,368 tonnes (Energy Resources Conservation Board and Alberta Geological Survey 2008). Therefore, Crown land production is only 34% of total provincial production, and the Crown land figures were tripled to scale them up to a provincial level.

In order to account for losses on private land pits, the Crown land IT estimated was tripled. We then increased the anticipated rate of IT per unit of private land disturbed, due to the relative lack of regulation on private land. With fewer regulations on private land, the manner in which pits are developed and exploited may be quite different than it is on Crown land. Our best guess estimate is that IT is 25% higher on private land, per unit of activity, than it is on Crown land (it is unlikely to be lower).

Parameter	TOTAL
Area Disturbed (ha/yr)	
- Crown land	886
- private land	1772
Total	2658
Prop'n grassland	0.95
Prop'n forest	0.05
Prop'n grassland cleared during nesting	0.8
Prop'n forest cleared during nesting	0.25
Forest density (pairs/ha)	4.6
Grassl'd density (pairs/ha)	0.2
No eggs/nest	4
IT grassland	1616
IT forest	611
IT killdeer during operations	168
IT bank swallow during operations	4838
Total IT	9,247

---

[2] The on-line sources for the weight/volume conversions were www.earthhaulers.com/faqs.html and www.abe.psu.edu/extension/factsheets/h/H2O.pdf .

Table 13. Estimated Incidental Take due to Alberta Aggregate Pit Operations.

The Alberta Breeding Bird Atlas (1992) shows that bank swallows are found in central and southern Alberta, but are not common in the boreal part of the province. The Atlas reports that "Colonies are fairly common in cutbanks and gravel pits in central Alberta …" and the populations may have increased locally because of human activity.

Only inferential information was found regarding the regional distribution of aggregate pits – there are considerable concentrations of them near Edmonton and Calgary as well as near the oil sands. The area data above have all of the permits issued to oil sands companies removed but there may still be some boreal pits in the summary data – it is estimated that perhaps 20% of the area may be boreal. There is also a lack of local information regarding frequency of colonization of pits, colony size and disturbance rates. If the Ontario data are applied, the estimated IT of killdeer is 168 eggs and young birds, and 26,256 bank swallows. However, Table 10 shows that in Saskatchewan, the average bank swallow colony size is eight nests – using this figure gives a bank swallow IT estimate of 4,774. Our estimate is that the true figure lies somewhere in the mid point of this range.

BRITISH COLUMBIA

British Columbia has seen considerable construction over the past decade, associated with a booming property market and most recently the construction of the Olympic facilities and associated developments (e.g. Sea-Sky Highway widening). The aggregate sector is relatively closely regulated, with the main legislation and other requirements summarized below. Authorization to develop the pit requires a pit management plan and site plan that requires current land use to be identified, final boundaries of excavation, etc. In theory this information is available to indicate the amount of various habitat types that will be removed, however it is generally not compiled.

Instrument	**Location**
Governing Mining Legislation	Mines Act
Lead Provincial Dept	Energy, Mines and Petroleum Resources
Crown Land Requirements	Most quarry and pit operations receive a Licence of Occupation to secure the land. This lasts for five years; a replacement licence valid for up to ten years may be granted. A permit under the Mines Act is required to develop and operate an aggregate pit – the application to obtain the permit is a Notice of Work and Reclamation Program.
Private Land Requirements	Either owner applies or owner consents.
Industry Association	Aggregate Producers Association of British Columbia provides a greater range of info but no statistics relevant to migratory bird incidental take.
Guidance re: Migratory Birds	Not mentioned in 2010 guide

Source: B.C. Ministry of Energy, Mines and Petroleum Resources. 2010. Guide to Preparing Mine Permit Applications for Aggregate Pits and Quarries in British Columbia. February 2010.

B.C. is divided into six regions for administrative purposes, although the number of regions is presently being reduced to five. The regions are: Northwest, Northcentral and Northeast, Kootenay, Southeast and Southwest. The web site http://www.empr.gov.bc.ca/Mining/MineralStatistics/Regional/southwest/Pages/Overview.aspx listed the number of aggregate pits in each region. A total of 470 pits were identified – in most regions, the website stated that at least the indicated number of pits were in operation. (No mention of active pits was made in any of the northern region overviews, hence this figure is assumed to apply to the southern and central part of the province, or in other words, the range of the bank swallow). The Mining and Minerals Division of the Ministry of Energy, Mines and Petroleum Resources kindly compiled data on total area disturbed by region by land use that resulted in land clearing for pits and quarries (e.g. for roads). Removing the area of pits from northeast and northwest region gave a total area of 3940 ha, of which 20% was assumed to be quarryland. It was assumed that on average, each pit is operated for five years and therefore, the annual area of newly cleared land equaled one-fifth of the total cleared land area, or 630 ha.

Hobson et al (2009) give the forest bird densities in BC as being 6.71 bird pairs/ha, which was used in this analysis.

Parameter	TOTAL
Area Disturbed (ha/yr)	630
Prop'n grassland	0.65
Prop'n forest	0.35
Prop'n grassland cleared during nesting	0.8
Prop'n forest cleared during nesting	0.25
Forest density (pairs/ha)	6.71
Grassl'd density (pairs/ha)	0.2
No eggs/nest	4
IT grassland	262
IT forest	1480
IT killdeer during operations	188
IT bank swallow during operations	31674
Total IT	33604

Table 14. Estimated Incidental Take due to B.C. Aggregate Pit Operations.

Campbell (1997) reported that the bank swallow was uncommon to rare in the coastal region and on Vancouver Island, fairly common to locally very common in the southern and central interior and the Peace Lowland, and fairly common in the sub boreal interior and northern boreal mountain regions. Of 491 colony records, the range in number of nests is 3 to 3,035, with the most common number being between 15 and 75. Campbell (1997) reviewed Garrison's study of bank swallow in southern California (average of 269 pairs per colony) and opined that colonies tend to be larger in the mountains of western North America than in the remainder of the continent. A figure of 60 pairs per colony was used in this estimate. However, this somewhat larger colony size is counterbalanced by a lower average clutch size – 3.51 for B.C. (Garrison 1999). Maintaining the assumption that there were 2 colonies per pit, and that 20% of the colonies were destroyed gives an estimate of IT of 31,675 eggs and young birds.

NATIONAL RESULTS

The amount of IT associated with aggregate pit operations in the other Canadian provinces and territories was calculated by extrapolating the total IT for the four provinces by the value of aggregate production in the remaining provinces (there is negligible aggregate production in PEI and the territories, hence the calculation covered the other provinces only).

The 2006 Statistics Canada publication 26-226 provided the value of sand and gravel production in most provinces and nationally (SIC 212323). The production from Ontario, Quebec, Alberta and British Columbia accounted for 90.3% of the national total. Thus, the IT associated with aggregate mining in the other provinces and territories was essentially 10% of the national total. The IT for the provinces not analyzed in detail was pro-rated based on relative value of sand and gravel production in Ontario and in eastern Canada and Manitoba, while the IT associated with Saskatchewan sand and gravel production was pro-rated from the Alberta rate using relative provincial value of production. The results of that calculation are shown in Table 14.

The results indicate that more than 50% of the incidental take associated with aggregate pits is due to the mortality of bank swallows, while killdeer mortality is approximately 7% of the total amount of IT. One of the main reasons why the IT due to clearing is relatively low is because the majority of trees are felled or pruned outside of nesting season, and because a substantial portion of the area cleared is grassland, which has a lower density of nesting birds than does forest.

As was described in the Ontario section, where the bank swallow determination was described in detail, there is a great deal of uncertainty regarding key variables such as proportion of aggregate pits with colonies, average colony size, proportion of pits with colonies that get operated during nesting season, and the proportion of the colony that succumbs to IT when operations take place during nesting season. Similar uncertainty is associated with the estimate of killdeer mortality.

Province	IT due to clearing	Killdeer	Bank Swallow	SUM
Nfld, NS, NB	2179	295	898	3373
Quebec	7191	1997	6071	15259
Ontario	32223	4369	13284	49876
Manitoba	2177	295	897	3369
Saskatchewan	308	23	661	993
Alberta	2227	168	4774	7169
British Columbia	1742	188	31674	33604
SUM	48047	7336	58260	113643

Table 15. Estimated Incidental Take of Bird Species of Interest in the Canada due to Aggregate Pit Operations using 1983 and estimated 2010 population figures.

Incidental Take Associated with Commercial Peat Harvesting

Peat has been mined in Canada since the early 1890's, but it was not on a large scale until the Second World War led to the disruption of shipments from Europe, especially Scandinavia, who were traditional suppliers to Canada.[3]

New Brunswick is the largest peat producing province in Canada, producing 14 million bales in 2002-03, or 45% of Canadian production (Canadian Sphagnum Peat Moss Association). There are approximately 140,000 ha of peatlands in New Brunswick; of this, approximately 70% is Crown land. The industry is concentrated in the NE part of the province. Peat mining on Crown Lands is covered by the Quarriable Substances Act.

In New Brunswick, a total of 5,448 ha were actively used for peat production, 77% of which were on Crown land (New Brunswick 2009). While the amount of area actively used is expected to gradually increase, it has been partially capped. In 2001, the New Brunswick government passed a regulation that would prevent the existing capacity of "basic" peat mining from increasing beyond the amount leased in 2001 (which included some areas that were not opened up). Since 2001, the province has only issued leases based on replacement – for additional area to be added, there must be value-added use, which is defined as producing a product with a value of at least 2x the value of basic peat.

Quebec's commercial peatlands tend to be found in the South Shore region; Quebec produced 10 million bales in 2002-03, equivalent to 32% of national production. Alberta is the third most significant producer province (4 million bales in 2002-03), followed by Saskatchewan and Manitoba (2 million bales each in 2002-03).

PEAT HARVESTING

To ready a peatland for harvesting, it must be drained which is accomplished by first removing the trees on site followed by ditching, often at 30 m intervals (Secretariat to the North American Wetlands Conservation Council Committee, 2001). Ditching is undertaken to facilitate the drying of the peat. After an interval of one or years when it is draining, the site is ready for production. The surface layer of vegetation may be removed prior to ditching, or a newer approach is the mix the surface vegetation with the upper layers of peat so that the mixture can be harvested and sold. This avoids the need to removed and dump the surface vegetation, saving expenses.

Peat is harvested using a large machine that disturbs the top layer of peat and then vacuums up the loosened dried peat. This approach was introduced in the 1960's as the cost of hand cutting and stacking became exorbitant. The average rate of mining is to remove 7 cm of depth per year (Thibault, pers comm.). The process is very weather dependent – a wet season curtails production opportunities.

The felling of the trees on a site where mining is to begin is done in winter, since that is the best time to move over the peatland, which at this point has not begun to drain. The other preparatory

---

[3] Source: www.gnb.ca/0078/minerals/Peat_Menu-e.aspx

operations, such as ditching and stripping, are most often done in the late summer and fall – the ground has to be unfrozen and drier is better than wet. Because peat harvesting has stopped by the fall, the growers also find that by doing the preparatory operations in the fall they can keep their labour force employed longer. The majority of the labour is seasonal and extending employment allows the labourers to qualify for unemployment insurance. While most interviewees said that there is some possibility that stripping or other operations would be done in the fall, very little takes place then. Once the peat bog is in production, it does not provide nesting habitat.

As a result, this study concludes that there is negligible incidental take associated with peat harvesting in Canada.

When mining has been completed in an area, there is typically a layer of peat about 3 feet deep left. Sphagnum fragments are spread on the surface and these contain seeds of all types of bog plants – within five years, there is usually a good re-growth of typical species, ranging from herbaceous to lab tea, bog rosemary, and spruce.

Literature Cited

Abraham, D., D. Pickard and C. Wedeles. 2010. Avian Incidental Take due to Roadside Maintenance Operations in Canada. Report Prepared by ESSA Technologies Ltd. and ArborVitae Environmental Services Ltd. for Environment Canada, Western Arctic Unit, Yellowknife. **Error! Bookmark not defined.** pp.

Alberta Energy Resources Conservation Board and Alberta Geological Survey. 2008. 2007 Alberta Mineral Exploration Highlights and Industrial Minerals Production Update.

Alberta SRD. 2008 edition. Guidelines for Acquiring Surface Material Dispositions on Public Land.

ArborVitae Environmental Services. 2004. Estimation of Future Carbon Losses from Deforestation in Canada. Prepared for NRCan as project 04-0927.

Blancher, P.J. 2002. Importance of breeding birds exported from Canada – Information on landbirds and shorebirds. Environment Canada. 46 pp + appendices.

Campbell, Robert W. 1997. The Birds of British Columbia: passerines: flycatchers through vireos. UBC Press.

Canadian Intergovernmental Working Group on the Mining Industry. 2010. Overview of Trends in Canadian Mineral Exploration. Document prepared by Minerals, Metals and Materials Knowledge Branch, Mineral and Metals Sector, Natural Resources Canada.

Canadian Zinc Corporation. 2010. Prairie Creek Mine Developer's Assessment Report. Main Report Vol 1 of 4. Submitted to Mackenzie Valley Review Board in support of the Environmental Assessment of the proposed Prairie Creek Mine.

Hobson, Keith A. 2009. An Estimate of Incidental Take of Nests of Forest Birds in Canada due to Mining Operations. Draft dated 14 April 2009. Prepared for Environment Canada, Western Arctic Unit, Yellowknife.

Kennedy, J, P. Dilworth-Christie and Erskine. 1999. The Canadian Breeding Bird (Mapping) Census Database. Technical Report Series No.342, Canadian Wildlife Service, Ottawa, Ontario.

Garrison, Barrett A. 1999. Bank Swallow (*Riparia riparia*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/414

Miramar Hope Bay Ltd. Final Environmental Impact Statement: Doris North Project, Nunavut, Canada. Submitted October 28, 2005.

New Brunswick Department of Natural Resources. 2009. Peat Industry Review – 2008. Minerals and Petroleum Development Branch. March 2009. 6 pp.

NIRB Public Scoping Meetings for the Part 5 review of the Mary River Project 2009.

NWT and Nunavut Chamber of Mines. 2010. Mineral Exploration Declining in Northwest Territories; Aboriginal Support for Regulatory Improvements, Government Investment in Infrastructure. News release April 15, 2010

Source: Ontario Ministry of Natural Resources. 2007. Aggregate Resources Program Manual. June 1, 2007. Available on-line at http://www.mnr.gov.on.ca/en/Business/Aggregates/2ColumnSubPage/266561.html

The Ontario Aggregate Resources Corp (TOARC). various years. Statistics.

The Ontario Aggregate Resources Corp (TOARC). various years. Annual Report.

Polhill, Brian. 2010. Forest Management Planning Section, Ontario Ministry of Natural Resources.

Sabina Silver Corporation. Hackett River Project, Nunavut: Project Proposal Report. Submitted January 2008.

Saskatchewan Ministry of Energy and Resources. 2009. Saskatchewan Exploration and Development Highlights 2009. (28 pp)

Saskatchewan Ministry of Energy and Resources. 2009. Saskatchewan Operating Mines List. Mines Branch, Mining and Minerals Statistics. February 2009. 15 pp.

Sauer, J. R., J. E. Hines, and J. Fallon. 2008. *The North American Breeding Bird Survey, Results and Analysis 1966 - 2007. Version 5.15.2008. USGS Patuxent Wildlife Research Center, Laurel, MD*

Secretariat to the North American Wetlands Conservation Council Committee. 2001. Canadian Peat Harvesting and the Environment (2nd edition). Sustaining Wetlands Issue Paper 2001-1. Published in partnership with the Canadian Sphagnum Peat Moss Association and Environment Canada.

Semenchuk, Glen Peter. 1992. The Atlas of Breeding Birds of Alberta. Nature Alberta.

Statistics Canada. 2008. Non-metallic Mineral Mining and Quarrying. Cat. 26-226-X. October 2008.

Tews, J., Mineau, P. & Bert, D. G. 2009 DRAFT Avian mortality related to mowing and other mechanical operations in agricultural landscapes, pp. 41: Environment Canada.

Tyhee Development Corp, 2010. Tyhee Development Corp provides Pre-feasibility Guidance and Exploration Update on the Clan Lake Zone, Yellowknife Gold Project, NWT, Canada. News release April 19, 2010.

People contacted:
Mr. Jacques Thibault, DNR New Brunswick at 506 547-2070 Jacques.Thibault@gnb.ca

Dr. Line Rochefort, head of Peatland Ecology Research Group, Laval University

Jean-Pierre Savard, Canadian Wildlife Service, Environment Canada

Paul Short, President, Canadian Sphagnum Peat Moss Association.

Avian mortality from pesticides used in agriculture in Canada

Pierre Mineau[1]

[1]Science and Technology Branch, Environment Canada, Ottawa, ON K1A 0H3

Executive Summary

A serious impediment to estimating the impact of pesticides on migratory birds is the lack of comprehensive pesticide use data. Canada is one of the few developed countries that do not collect such information. A clear recommendation of this report (and of many others) is that Canada should establish a pesticide use reporting system.

Based on areas in various crop types and on low, average and high pesticide use patterns for those same crops in the US, our best estimate for the incidental take from pesticides in Canada is between 0.96 and 4.4 million bird annually. This estimate assumes a kill rate of approximately 0.52 – 2.4 birds per hectare – the range from several industry studies carried out in typical farmland. A very approximate expert opinion is that a nest could be lost for every 4 birds killed. Given average nest success rates, this would add 50% more individuals to the above total.

The number of birds killed by pesticides has been decreasing as more toxic products are slowly being replaced for human health reasons. However, several potential impacts of pesticides, namely reproductive and indirect effects are not included in this total. Large kills of migrating birds are also not considered here although this would be more of a problem for a full accounting of pesticide impacts under US conditions than for Canada.

Approximately half of the total estimated kill is in Saskatchewan. The impact from pesticides is thought to be a clear contribution to the steep decline shown by several of grassland/farmland species. Because birds are killed on the breeding grounds, and because both adults and nests are vulnerable, this impact is proportionately higher than similar estimates derived for other sources of mortality.

Mitigation of kills is relatively easy. The products that have a high probability of causing avian mortality have been identified. In most cases, substitution products of lower toxicity to birds already exist. Regulatory inaction is the only impediment to a reduction of the direct incidental take. Chronic and indirect effects will be slightly harder to mitigate although here also, much information exists on which products carry the highest risk.

Introduction

Pesticides have been documented to impact birds in many different ways (Mineau 2003). The continued use of acutely toxic products (primarily insecticides) has been shown to kill birds regularly and predictably even when used according to label directions (Mineau 2004). This can be a dramatic event when birds are killed in large numbers on migration. Most of the time, however, birds breeding at low density on the agricultural landscape are killed singly or in small groups and these losses go unnoticed.

Pesticides can also have indirect effects, notably the removal of valuable plant and/or insect components of agro-ecosystems necessary for successful reproduction. Finally, several products have the potential to affect bird sub-lethally, especially their long-term survival and reproductive fitness.

Modern pesticides have limited ability to bio-concentrate and bio-accumulate; most are readily metabolised in warm blooded organisms. There are some exceptions (e.g. rodenticides) but we lack enough information to assess the cumulative impacts of the latter[1]. The only 'legacy' aspects of pesticides are therefore the habitat modification (simplification) aspects that form part of the indirect effects.

It is only possible to quantify the direct lethal impact on birds and even this presents special challenges. One of the main difficulties is that Canada does not systematically collect pesticide use information. Partial surveys are available for some provinces but our knowledge of what pesticides are used where and in what quantity remains fragmentary and incomplete. It is possible to draw parallels to US agriculture where good pesticide use data are available but, since insect pressure tends to increase in warmer climates, extrapolation is difficult.

There have been very few attempts to estimate the total incidental take resulting from direct intoxications following the use of toxic pesticides anywhere. Pimentel (1992), in an oft-cited study, estimated that pesticide-induced direct mortality numbered approximately 67 million per year in the U.S. He based this estimate on the fact that 160 million ha of cropland received a very heavy dose of pesticides per year (3 kg a.i./ha on average – including a number of very toxic pesticides), a breeding density of 4.2 birds per ha (from census plot data) and a conservative kill estimate of 10% of exposed birds. This estimate ignores kills of wintering birds which could be substantial (Mineau and Whiteside 2006). Also, some of the largest kills recorded in North America have been of migrants (e.g. Lapland longspurs) which would not be captured in estimates based on breeding densities in farmland.

---

[1] Research on the impact of rodenticides has been going on for several years in S&T. It should be noted however that the main species under threat are non-migratory raptorial species (e.g. buteos, eagles, various owl species).

The insecticide carbofuran (Furadan^{TM}) has been more studied than any other insecticide and can stand as the 'poster-pesticide' for bird mortality. Studies on a granular formulation of carbofuran as well as search efficiency and scavenging studies were used to provide an estimate of bird mortality per treated surface (Mineau 2005). Two major field studies, both from the U.S., were retained for purposes of extrapolation. Estimated kill rates were 3.05 birds per ha for an Iowa site (once raw carcass counts were corrected for scavenging and for unsearched areas of the field) and 15.9 per ha for an Illinois site. A third study gave estimates that were simply too high to lead to a credible wide-ranging kill rate, a full 799 carcasses of a single species (Horned lark) having been recovered from slightly more than 100 ha of crop. It was estimated that, at the height of its popularity, in the late 70s to mid 80s, this single product was killing approximately 17 to 91 million songbirds annually in the 32 million ha of U.S. corn fields alone[2].

Use of similar products in canola in the Canadian prairies was found to be correlated with regional declines in several grassland species (Mineau et al. 2005) even though the maximum proportion of treated cropland averaged about 3% and never exceeded 7% in any region of the prairies.

We will attempt to estimate the total number of birds killed by pesticides in Canada. Because most of the mortality is of breeding birds, there is an associated loss of nests and breeding potential which can be estimated also.

Methods

As mentioned above, this type of analysis is exceedingly difficult to do in Canada because we are one of the few developed countries around the world that does not assemble good pesticide use or sales statistics. In order to assess the likelihood of pesticide mortality for any given application of a pesticide, the following procedures were followed:

Estimating the toxicity of pesticides to birds

Very few species are typically tested for their sensitivity to pesticides. Interspecies differences in susceptibility can be very large. Also, the number of species tested with any given product can bias any toxicity estimate which is based on the most sensitive species tested. What is needed is a field-relevant unbiased measure of toxicity that can be used to provide a fair comparison of the kill potential of all registered pesticides. As a first step, a measure of acute pesticide toxicity for sensitive bird species ranging from 20 to 1,000 grams (a weight range that covers most bird species found dead in farm fields) was obtained by applying species sensitivity distribution techniques (Mineau et al. 2001) . A value called the HD_5 ('Hazardous Dose at the 5% tail of the species distribution') was derived. The HD_5 is

---

[2] The product is no longer registered in Europe, the U.S. or Canada but continues to be used heavily in the developing world including countries of Latin America where many of our migrants winter.

the amount of pesticide in mg of chemical per kg of body weight estimated to lead to 50% mortality in a species more sensitive than 95% of all bird species, calculated with a 50 percent probability of over- or underestimation. The HD_5 was calculated mathematically where several toxicity values exist, or extrapolation factors were applied to single (or even multiple combinations of species-specific toxicity values – see Table 1 in Mineau et al. 2001).

Estimating the proportion of cropland at risk of sustaining a bird kill

First approach

The probability of finding a bird kill (of any size) following a pesticide application was derived from models based on a large sample of empirical field studies where known insecticides were applied and searching was carried out to detect casualties. Models were developed for field and orchard crops separately. Because few of the studies were quantitative in nature, logistic modeling was used and the output of the models is the likelihood that a kill of undefined size would occur and be found assuming an adequate search effort[3]. Aside from the HD_5 values, the models uses application rate, as well as physico-chemical constants such as octanol-water partition coefficient, molecular weight and size as well as the ratio of rat oral to dermal data, when available (details provided in Mineau 2002). Independent validation of the model for a sample of studies in field crops indicate that better than 81% of studies were correctly classified – as to whether they gave rise to mortality or not.

Using these models, Mineau and Whiteside (2006) analysed the insecticide use pattern for all U.S. crops on a State by State basis. They provided a minimum, weighted average and maximum proportion of each crop area where bird lethality was expected. It is possible to estimate the proportion of Canadian cropland at similar risk if we assume that pesticide use conditions in at least one of the censused U.S. States correspond to how the crop is treated in Canada.

Crop data for Canada was obtained from the 2006 quinquennial census of agriculture (Statistics Canada 2009).

Inadequate and incomplete recording of seed treatment chemicals as well as our inability to fit these uses into existing risk models means that they are essentially ignored in the estimates.

Second approach

Models developed in Mineau (2002) and described above were modified to take into account the addition of a few more field studies and a recent re-evaluation of all the component agricultural studies by a panel of four evaluators mandated by

---

[3] Carcass searches in most field studies employ lines of searchers systematically covering the field area as well as search dogs on occasion. The probability of seeing kills otherwise is negligible.

the European Food Safety Authority (EFSA 2008). Mineau (2002) argued for the importance of dermal exposure when assessing the field data; however, because of the uncertainty surrounding dermal exposure to new classes of insecticides for which field studies do not exist (EFSA op. cit.), the basic risk model was modified to consider only the toxicity of the various pesticides to birds (here the HD_5) in arriving at a probability of kill.

This simpler single model was applied to a summary of Canadian insecticide use assembled from disparate provincial sources of information on pesticide sales or use (Brimble et al. 2005). Pesticide sales or use data were not available for Québec (because several active ingredients are combined before the data are released) or for Saskatchewan. It should be noted that the quality of the data emanating from the other provinces is uneven and of unproven quality.

Because some of this survey information was already dated in 2005, several listed insecticides are no longer registered today. These were removed from the list. Without any knowledge of their replacements, a full accounting of insecticide use in Canada is not possible and whatever kills are estimated must be under-estimates.

Application rates per hectare were obtained from pesticide labels. In reviewing available labels for each active ingredient, we tried to retain modal application rates – those rates that came up the most frequently, especially foliar rates of application associated with large area field crops. Mean application rates were calculated when modal rates were not evident (Appendix 2).

Most or all seed treatment pesticides currently registered and marketed in Canada were not included in the provincial totals. The risk from several of these compounds appears to be high in Canada (Smith 2006) although no field studies have been carried out and these uses therefore fall outside of the field models created to estimate the risk of mortality. Our inability to adequately assess the risk to birds from the growing use of seed treatments is a serious regulatory issue – as well as a serious gap for the purpose of this exercise.

Estimating the number of birds involved in a kill

As mentioned earlier, the majority of field studies provide a very poor basis on which to base a quantitative estimate of kills. Several field studies were carried out with carbofuran – either the liquid or granular formulations; in a few cases, alternative pesticides were tested as well under the same conditions (FMC 1989a,b summarised in Mineau 1993). Kills resulting from the use of the granular formulation were already quantified for the U.S. and reported above. Because the silica-based granular formulation of carbofuran is a rather unusual product (because of the combination of high toxicity and a granule base very attractive to birds) and is no longer registered in Canada, the studies reporting on spray applications will be used instead.

One substantial advantage of using these studies to try to arrive at a quantified estimate of a 'typical' kill is that carbofuran, being a carbamate insecticide, kills more quickly than most other toxic insecticides. With several other products, birds are more likely to ingest a lethal dose but die later away from the field area, or ingest a dose which might have been sub-lethal had the bird not been subject to delayed mortality as a result of cold, food stress or predation (reviewed in Mineau 2003). Even with this rapid mode of action, some birds have been shown to leave the field area and die in surrounding fields and field margins. Also, these studies were carried out by the same group of experimenters under similar conditions, search plots were cleared of old carcasses prior to the study to minimise any confusion over the attribution of mortality to the pesticide and search and scavenging rates were well assessed in each plot by means of 3-day old black chicks of domestic chickens – a reasonable stand in for small to medium sized songbirds.

Table 1 below gives raw unadjusted rates of carcass counts for these carbofuran and associated[4] field trials. In every case, the search area was divided equally between the field and surrounding non field habitat. Unlike the granular formulation, the liquid formulation of carbofuran is still registered in Canada. Chlorpyrifos and methomyl are also two major use insecticides in this country.

Table 1. Uncorrected kill rates for several pesticide field studies carried out under standardised conditions of searching employing teams of observers and search dogs.

Pesticide	Crop	Location	Uncorrected kill rate (carcasses/searched ha)
carbofuran	corn	Nebraska	0.43
carbofuran	corn	Texas	0.53
carbofuran	alfalfa	Kansas	0.47
carbofuran	alfalfa	Oklahoma	0.22
chlorpyrifos	alfalfa	Kansas	0.22
Chlorpyrifos and methomyl	alfalfa	Oklahoma	0.53

Table X. Uncorrected raw kill rates observed in several field studies reviewed in Mineau (1993).

Carbofuran is quite acutely toxic to birds so extrapolations based on this pesticide might be considered worst case. However, plots treated with chlorpyrifos, an insecticide of much lower acute toxicity to birds had similar levels of mortality. Also, because our methods of estimating the number of kills in Canada already factor in toxicity to estimate the probability that a kill will occur, it could be argued

---

[4] Alternate pesticides were applied to control plots in these studies.

that the actual body count per hectare, when a kill does occur, is less a factor of toxicity and more dependant on the number of birds frequenting the field and potentially exposed.

Search rates and scavenging were measured in detail in these studies[5]. Plot by plot estimates vary widely but overall means are provided below for the combination of all habitats surveyed in the studies: fields, field margins and roads for the corn study; fields and field margins in the case of the alfalfa studies (Table 2).

Table 2. Measured rates of search efficiency and scavenging.

Pesticide	Crop	Search efficiency averaged among all habitat types	Scavenging rate averaged among all habitat types	Combined detection rate
corn	Nebraska	0.22	0.19	0.18
corn	Texas	0.37	0.26	0.27
alfalfa	Kansas	0.50	0.16	0.42
alfalfa	Oklahoma	0.46	0.21	0.36

These are one time search and scavenging correction estimates. In theory, repeated visits to the site (daily searches for a week were carried out in the studies outlined above) increase the probability of finding carcasses not found during a previous search. However, because of the skewed nature of carcass life expectancies (fresh carcasses disappear quickly, older carcasses cease to be of interest to scavengers), attempts to calculate overall probabilities of detection by using mean carcass ‘life-expectancies’ have generally been unsatisfactory and heavily biased (Smallwood 2007). A carcass missed on the first day of searching and subject to a further 24 hours of scavenging has a rapidly decreasing probability of being detected on subsequent days. Also, if a carcass was not found on the first search day, it is likely well hidden and the probability that it will be found on subsequent days is considerably less than the average search rate would suggest. For these reasons, simple one time estimates were used here to estimate the number of birds that would have gone undetected in the field studies (Table 3).

---

[5] The help of Mélanie Whiteside is gratefully acknowledged for extracting the relevant information from lengthy industry reports.

Table 3. Corrected kill rates for several pesticide field studies.

Pesticide	Crop	Location	Uncorrected kill rate (carcasses / searched ha)	Corrected kill rate (carcasses per ha)
carbofuran	Corn	Nebraska	0.43	2.4
carbofuran	Corn	Texas	0.53	2.0
carbofuran	alfalfa	Kansas	0.47	1.1
carbofuran	alfalfa	Oklahoma	0.22	0.61
chlorpyrifos	alfalfa	Kansas	0.22	0.52
Chlorpyrifos and methomyl	alfalfa	Oklahoma	0.53	1.5

I propose to use the range of mortality rates calculated from these studies to quantify mortality when the risk model predicts that mortality will occur. For example, if the logistic model predicts that a certain pesticide application has a 0.50 probability of mortality based on the combined sample of field studies, and assuming that the pesticide is applied to 100,000 ha, the low and high estimates of mortality will be:

Low: 0.50 * 100,000 ha * 0.52 carcasses/ha
High: 0.50 * 100,000 ha* 2.4 carcasses/ha

The reader is reminded that these studies used for this quantification ignore any kills of migrants which, as mentioned earlier, can be substantial. Secondary poisoning of scavengers is also not included nor is delayed mortality or reproductive effects. It will be assumed that all mortality is on adult birds and very rough estimates of the number of failed nests will also be made.

Which species are killed by pesticides?

A total of 50 agricultural field studies with demonstrated avian mortality[6] were tallied in order to identify which species are most often killed in the course of pesticide applications. The sample of studies was fairly broadly based, both in terms of the crops sampled (table 4) and the locations of the fields (table 5). The number of studies in which species were found dead is given in table 6. Not all of these species are relevant to Canadian conditions but they were left there because they can provide information on ecologically equivalent species.

---

[6] Most of these studies are proprietary industry studies submitted to the U.S. government. Those dealing with spray applications (29 studies) were reviewed in Mineau 2002. A sample of studies on granular formulations (21 studies) was similarly obtained and reviewed.

Table 4. The number of study-crop combinations for which mortality was detected and which were used in the species tally presented in table 3.

Crop	No. studies
alfalfa	6
apple	4
bare field	1
barley	1
canola	2
carrots	2
citrus	4
corn	13
cotton	6
potatoes	6
rangeland	2
sunflower	1
wheat	2

Table 5. Geographical representation of the studies for which mortality was detected and which were used in the species tally presented in table 3.

State/province	No. studies
Alabama	1
Arizona	3
California	2
Colorado	1
Delaware	1
Florida	3
Idaho	3
Illinois	1
Iowa	3
Kansas	2
Manitoba	1
Maryland	1
Michigan	2
Nebraska	1
New Jersey	1
New Mexico	1
North Carolina	1
North Dakota	1
Oklahoma	2
Pennsylvania	1
Saskatchewan	2
Texas	6
Virginia	1

Washington	5
Wisconsin	2
Wyoming	2

Table 6a, b. Species found dead in the studies tallied in tables 1 and 2 and the number of studies that reported kills of that species. Species are ordered by frequency of occurrence – the number of studies in which one or more of the given species was found dead (a) and taxonomic order (b).

a)

Species	**TOTAL MENTIONS**
mourning dove	22
American robin	14
house sparrow	14
brown-headed cowbird	12
horned Lark	12
red-winged blackbird	12
meadowlark (eastern & western)	11
common grackle	10
chipping sparrow	9
European starling	9
northern bobwhite	9
northern cardinal	9
savannah sparrow	8
blue jay	7
indigo bunting	7
vesper sparrow	7
brown thrasher	6
killdeer	6
ring-necked pheasant	6
gray catbird	5
eastern bluebird	4
house wren	4
mallard	4
northern flicker	4
northern mockingbird	4
white-crowned sparrow	4
American crow	3
American goldfinch	3
American kestrel	3
black-billed magpie	3
California quail	3
common ground dove	3
downy woodpecker	3
greater sage grouse	3

great-tailed grackle	3
lark sparrow	3
northern harrier	3
American pipit	2
Brewer's blackbird	2
Carolina wren	2
cedar waxwing	2
dickcissel	2
eastern kingbird	2
eastern towhee	2
Gambel's quail	2
grasshopper sparrow	2
gray partridge	2
house finch	2
rock pigeon	2
rose-breated grosbeak	2
ruffed grouse	2
song sparrow	2
western kingbird	2
wood thrush	2
Abert's towhee	1
American coot	1
Baltimore oriole	1
bank swallow	1
barn swallow	1
black-bellied whistling ducks	1
black-capped chickadee	1
blue grosbeak	1
boat-tailed grackle	1
bobolink	1
burrowing owl	1
Canada goose	1
Carolina chickadee	1
Cassin's sparrow	1
chestnut-collared longspur	1
cinnamon teal	1
clay-coloured sparrow	1
common nighthawk	1
dark-eyed junco	1
Eurasian Tree sparrow	1
ferrugineous pigmy owl	1
field sparrow	1
fish crow	1
fox sparrow	1
Franklin's gull	1
golden-crowned kinglet	1
greater roadrunner	1

greater white-fronted goose	1
Harris's sparrow	1
lapland longspur	1
lark bunting	1
laughing gull	1
lazuli bunting	1
least sandpiper	1
LeConte's sparrow	1
lesser nighthawk	1
loggerhead shrike	1
long-billed dowitchers	1
mottled ducks	1
northern pintail	1
orange-crowned warbler	1
rusty blackbird	1
scarlet tanager	1
semipalmated sandpiper	1
short-eared owl	1
sora rail	1
spotted sandpiper	1
Sprague's pipit	1
Steller's Jay	1
summer tanager	1
swallow (unidentified)	1
swamp sparrow	1
tree swallow	1
western tanager	1
white-throated sparrow	1
white-winged dove	1
yellow-breasted chat	1
yellow-headed blackbird	1
yellow-rumped warbler	1

b)

Species	**TOTAL MENTIONS**
black-bellied whistling duck	1
greater white-fronted goose	1
Canada goose	1
mallard	4
mottled ducks	1
cinnamon teal	1
northern pintail	1
gray partridge	2
ring-necked pheasant	6
ruffed grouse	2

greater sage grouse	3
California quail	3
Gambel's quail	2
northern bobwhite	9
northern harrier	3
American kestrel	3
sora rail	1
American coot	1
killdeer	6
spotted sandpiper	1
semipalmated sandpiper	1
least sandpiper	1
long-billed dowitchers	1
laughing gull	1
Franklin's gull	1
rock pigeon	2
white-winged dove	1
mourning dove	22
common ground dove	3
greater roadrunner	1
ferrugineous pigmy owl	1
burrowing owl	1
short-eared owl	1
lesser nighthawk	1
common nighthawk	1
downy woodpecker	3
northern flicker	4
western kingbird	2
eastern kingbird	2
loggerhead shrike	1
Steller's Jay	1
blue jay	7
black-billed magpie	3
American crow	3
fish crow	1
horned Lark	12
tree swallow	1
bank swallow	1
barn swallow	1
swallow (unidentified)	1
Carolina chickadee	1
black-capped chickadee	1
Carolina wren	2
house wren	4
golden-crowned kinglet	1
eastern bluebird	4
wood thrush	2

American robin	14
gray catbird	5
northern mockingbird	4
brown thrasher	6
European starling	9
American pipit	2
Sprague's pipit	1
cedar waxwing	2
orange-crowned warbler	1
yellow-rumped warbler	1
yellow-breasted chat	1
summer tanager	1
scarlet tanager	1
western tanager	1
eastern towhee	2
Abert's towhee	1
Cassin's sparrow	1
chipping sparrow	9
clay-coloured sparrow	1
field sparrow	1
vesper sparrow	7
lark sparrow	3
lark bunting	1
savannah sparrow	8
grasshopper sparrow	2
LeConte's sparrow	1
fox sparrow	1
song sparrow	2
swamp sparrow	1
white-throated sparrow	1
Harris's sparrow	1
white-crowned sparrow	4
dark-eyed junco	1
lapland longspur	1
chestnut-collared longspur	1
northern cardinal	9
rose-breated grosbeak	2
blue grosbeak	1
lazuli bunting	1
indigo bunting	7
dickcissel	2
bobolink	1
red-winged blackbird	12
meadowlark (eastern & western)	11
yellow-headed blackbird	1
rusty blackbird	1
Brewer's blackbird	2

common grackle	10
boat-tailed grackle	1
great-tailed grackle	3
brown-headed cowbird	12
Baltimore oriole	1
house finch	2
American goldfinch	3
house sparrow	14
Eurasian Tree sparrow	1

Species most frequently implicated in kills are those that are cosmopolitan, closely associated with agriculture and reasonably common; e.g. mourning doves, several sparrows, horned larks and meadowlarks, robins, house sparrows and several blackbird species. However, the sheer diversity of birds potentially killed by pesticides is impressive and suggests that toxicological or ecological susceptibility are less important than being simply in the wrong place at the wrong time. These studies were all carried out in the breeding season and underestimate the impact of pesticide use on migrant species or wintering species. Kills during the breeding season are more relevant to Canadian conditions because of the limited use of pesticides outside the breeding season. A fuller account of species killed by pesticides can be found in the incident record (http://www.abcbirds.org/abcprograms/policy/pesticides/aims/aims/index.cfm). The list also does not include species that are preferentially killed by pesticides on non-agricultural sites; e.g. golf courses and other turf areas. A number of waterfowl species fall in this group. Finally, birds of prey are underrepresented because they typically die well away from application sites. These are not migratory birds so no effort will be made to quantify the kills but Mineau et al. (1999) provided an extensive review of recorded incidents for both Canada and the U.S.

Results

First approach

Based on US pesticide application data, the following are estimated kills for Canada assuming that each censused crop is grown with the least risk to birds shown by any US State, an average risk to birds based on the weighted average of the 50 conterminous US States or the maximum risk to birds based on the worst State profile for each individual crop. Details for each crop are given in Appendix 1. High and low estimates based on the two kill rates calculated above are summarised in table 7 below.

Table 7. Summarised results of predicted incidental take from pesticides. This method assumes that the probability of kill for each commodity will be within the range shown for the State by State US analysis of kill probabilities as calculated in Mineau and Whiteside (2006). See appendix 1.

	Canadian growers grow the crop like growers in the 'best' US State	Canadian growers grow the crop like growers in the 'worst' US State	Canadian growers grow the crop like growers in an average US State
Low kill rate per ha	220,160	4,473,161	960,011
High kill rate per ha	1,016,121	20,645,358	4,430,819

It is unlikely that we grow each and every crop with less impact on birds than any of the 50 conterminous US States. Assuming that we fall around the average US State in terms of use quantities and avian toxicity of product choice for each commodity, this would place mortality at between 0.96 and 4.4 million birds annually under current (2000-2003) conditions.

It is possible to parse out the expected mortality on a province by province basis based on crop data for each province. Table 7 shows the 6 kill estimates for each province and table 8 shows what percentage of the total Canadian kill each province represents under the same assumptions.

Table 6. The estimated kill by province under varying assumptions of commodity-specific risk to bird (based on the 50 conterminous US States) and a low and high mortality rate as detailed above. (Numbers will not add up exactly with the Canadian totals shown above because of rounding errors)

COMMODITY-SPECIFIC RISK TO BIRDS	MIN	MAX	AVE	MIN	MAX	AVE
MORTALITY ESTIMATE PER HECTARE	LOW	LOW	LOW	HIGH	HIGH	HIGH
Newfoundland	154	1845	849	713	8515	3920
Prince Edward Island	815	44286	17242	3763	204398	79579
Nova Scotia	2963	32168	14538	13674	148469	67099
New Brunswick	1649	36887	16064	7611	170247	74140
Québec	7000	265193	57665	32309	1223966	266145
Ontario	8182	635847	95105	37764	2934679	438944
Manitoba	21709	567545	95500	100197	2619440	440767
Saskatchewan	128329	1761299	443756	592286	8129072	2048106
Alberta	44383	1027433	195321	204846	4742001	901483
British Columbia	4811	100211	23692	22206	462511	109347
TOTAL	219997	4472715	959731	1015369	20643299	4429530

Table 7. The percentage of the total Canadian kill by province under varying assumptions of commodity-specific risk to bird (based on the 50 conterminous US states) and a low and high mortality rate as detailed above.

COMMODITY-SPECIFIC RISK TO BIRDS	MIN	MAX	AVE	MIN	MAX	AVE
MORTALITY ESTIMATE PER HECTARE	LOW	LOW	LOW	HIGH	HIGH	HIGH
Newfoundland	0.1%	0.0%	0.1%	0.1%	0.0%	0.1%
Prince Edward Island	0.4%	1.0%	1.8%	0.4%	1.0%	1.8%
Nova Scotia	1.3%	0.7%	1.5%	1.3%	0.7%	1.5%
New Brunswick	0.7%	0.8%	1.7%	0.7%	0.8%	1.7%
Québec	3.2%	5.9%	6.0%	3.2%	5.9%	6.0%
Ontario	3.7%	14.2%	9.9%	3.7%	14.2%	9.9%
Manitoba	9.9%	12.7%	10.0%	9.9%	12.7%	10.0%
Saskatchewan	58.3%	39.4%	46.2%	58.3%	39.4%	46.2%
Alberta	20.2%	23.0%	20.4%	20.2%	23.0%	20.4%
British Columbia	2.2%	2.2%	2.5%	2.2%	2.2%	2.5%

Saskatchewan accounts for approximately half of the total estimated bird mortality, followed by Alberta and Manitoba. The prairies represent most of our area under crop and even if pesticide use in cereal or oilseed crops is less on a per hectare basis than in fruit and vegetable crops, to have this large of an area under crop means that a poorly chosen insecticide can have a major impact on birds.

In comparison, the cumulative number of cropped hectares over which avian mortality was likely, was a little over 6 million hectares in the U.S. (Mineau and Whiteside 2006). Using the range of kill rates documented above, this would mean an annual U.S. mortality of 3.16 to 14.6 million birds. This is a substantial reduction from just a few years earlier (1994-1998) when mortality was predicted on a little over 17 million ha. Using the same kill factors, the annual incidental take then would have been estimated at 8.88 to 41.0 million birds annually – approaching the 67 million estimated by Pimentel (1992). Because of restrictions imposed on the most toxic products, the number of 'hectares at lethal risk' has been dropping for most crops[7]. Again, these kill estimates are based solely on those species breeding in heavily agricultural landscapes and frequenting cropped fields – migrants are not included in this calculation. Also unaccounted are seed treatments, some of which could represent important sources of mortality as well as the few herbicides and most rodenticides which have the potential to kill birds.

Second approach

Based on a simplified field model and the incomplete list of pesticide sales information, the estimated incidental takes were compiled by active ingredient and presumed modal application rate (Table 8). Model results (in the form of predicted number of hectares sustaining mortality per province/territory) are given in appendix 2. The mortality estimates given here assume, as above, that when mortality occurs, there will be a loss of 0.52-2.4 adult individuals per ha.

Table 8. Predicted incidental take based on incomplete characterisation of insecticide sales data for Canada excluding Québec and Saskatchewan. Pesticides are ranked in decreasing order from most to least damaging to birds as measured by the estimated incidental take of adults.

Pesticide	Modal application rate (g a.i./ha)	Avian HD5 mg/kg bw	Predicted risk of mortality based on simple toxicity model	Estimated incidental take at low kill rate	Estimated incidental take at high kill rate
Chlorpyrifos	576	3.76	0.15	35054	161787
Diazinon	550	0.59	0.49	28909	133424
Carbofuran	528	0.21	0.71	14144	65279

---

[7] These restrictions were the result of U.S. legislation intended to better protect human health, especially children, and not in an effort to reduce avian mortality (Mineau 2006).

Terbufos	1200	0.16	0.87	4649	21456
Azinphos-Methyl	1128	2.28	0.35	3813	17601
Phorate	3320	0.34	0.90	3561	16434
Phosmet	1475	1.24	0.55	3431	15834
Dimethoate	312	5.78	0.06	2897	13369
Methamidophos	600	1.70	0.28	2406	11103
Imidacloprid	60	8.43	0.01	1762	8132
Trichlorfon	1200	13.36	0.10	1536	7091
Carbaryl	2500	30.05	0.09	1520	7017
Endosulfan	550	9.53	0.07	1423	6567
Naled	950	1.72	0.37	619	2855
Methomyl	870	8.46	0.11	480	2213
Acephate	694	18.52	0.05	407	1876
Malathion	875	139.10	0.01	168	776
Pirimicarb	567	6.78	0.09	127	584
Oxamyl	2244	0.78	0.73	121	558
Phosalone	1000	106.27	0.01	31	141
Dicofol	638	72.37	0.01	11	50
Formetanate Hydrochloride	1290	8.77	0.15	3	13
Amitraz	850	41.83	0.03	0	1
Acetamiprid	50	20.91	0.00	0	0
Pyridaben	213	279.50	0.00	0	0
Tefluthrin	120	178.63	0.00	0	0
Tebufenozide	144	249.71	0.00	0	0
Spinosad	87	170.00	0.00	0	0

Pymetrozine	97	208.12	0.00	0	0
Clofentezine	200	493.59	0.00	0	0
Abamectin	17	42.80	0.00	0	0
Cyhalothrin-Lambda	89	428.14	0.00	0	0
Fenbutatin Oxide	38	291.52	0.00	0	0
Cypermethrin	70	579.15	0.00	0	0
Deltamethrin	10	97.09	0.00	0	0
Permethrin	106	3127.00	0.00	0	0
TOTAL				**107069**	**494163**

These estimates are lower than those obtained using the first method, in part because of the incomplete and dated sales and use data available. Given that Saskatchewan accounted for approximately half of the total estimated mortality according to our first estimation method, the absence of any use data for that province is a clear problem. Estimates derived from this second approach therefore lack credibility. They are kept here because they do indicate which pesticides are likely causing the most mortality.

Associated loss of nesting opportunities

Incidental killing of adult birds by pesticides could take place at any point in the breeding season. Granular pesticides (or seed treatments not tallied here) would kill breeding individuals early in the season. Insecticide use is typically carried out at any point between seedling emergence up to a few weeks before harvest.

A very rough assessment of the number of lost nests is possible if we are willing to make a number of simplifying assumptions, viz.

1) Paired individuals from the same nest are likely to be killed together; there will be half the number of nests at risk than there are affected individuals;
2) Most agricultural species will have one re-nesting attempt;

3) An average success rate for most agricultural species will be one fledged young per nesting attempt;
4) Half of the kills will take place at the time when a nest is present and therefore result in the loss of the nest;

We can therefore easily envision the loss of 50% more individuals as a result of lost nesting opportunity. These assumptions are not very extreme and the additional breeding deficit is likely higher than this.

Discussion

Population relevance of the mortality

Many of the species most affected are well distributed farmland species. However, several of them (e.g. Horned lark, Vesper sparrow) are already in clear decline over most or all of their range. A link between pesticide use and regional population levels in the prairies has already been made (Mineau et al. 2005). Other forthcoming analyses (Mineau, unpublished) suggest that the direct acute and sub-acute toxicity of pesticides has significantly contributed to the decline of grassland/farmland bird species in North America.

The birds that are killed are ‘valuable members’ of the population. They have survived at least two full migrations, have returned to the breeding grounds and have successfully defended a territory. Therefore, any impact on this cohort is proportionately higher than similar estimates derived for other sources of mortality.

Mitigation

Mitigation of kills is relatively easy. Products that kill birds readily and reliably are well known and have been so identified. In most cases, substitution products of lower toxicity to birds already exist. Regulatory inaction is the only impediment to a reduction of the direct incidental take. Chronic and indirect effects will be slightly harder to mitigate although here also, much information exists on which products carry the highest risk.

References

Brimble, S., P. Bacchus and P.-Y. Caux. 2005. Pesticide utilization in Canada: A compilation of current sales and use data. Environment Canada Unpublished report. 144 pp.

EFSA. 2008. Scientific Opinion of the Panel on Plant protection products and their residues on a request from the EFSA PRAPeR Unit on risk assessment for birds and mammals. The EFSA Journal (2008) 734, 1-181.

FMC (FMC Corporation). 1989a. Effects of Furadan 4F on birds associated with Nebraska and Texas/New Mexico corn fields. [C.D. Jorgensen, R.C. Whitmore, G.M. Booth, M.W. Carter, and H.D. Smith] Unpublished report. 751 pp.

FMC (FMC Corporation). 1989b. Effects of Furadan 4F on birds associated with Kansas and Oklahoma alfalfa fields. [G.M. Booth, L.B. Best, M.W. Carter, and C.D. Jorgensen] Unpublished report. 810 pp.

Mineau, P. 1993. The hazard of carbofuran to birds and other vertebrate wildlife. Technical Report Series. No. 177. Environment Canada, Canadian Wildlife Service, Ottawa. XXii+96 pp.

Mineau, P., M.R. Fletcher, L.C. Glazer, N.J. Thomas, C. Brassard, L.K. Wilson, J.E. Elliott, L.A. Lyon, C.J. Henny, T. Bollinger, and S.L. Porter. 1999 Poisoning of raptors with organophosphorous and carbamates pesticides with emphasis on Canada, U.S. and U.K. J. Raptor Research 33(1):1-37.

Mineau, P., A. Baril, B.T. Collins , J. Duffe, G. Joerman, and R. Luttik. 2001. Reference values for comparing the acute toxicity of pesticides to birds. Reviews of Environmental Contamination and Toxicology. 170:13-74.

Mineau, P. 2002. Estimating the probability of bird mortality from pesticide sprays on the basis of the field study record. Environmental Toxicology and Chemistry. 24(7):1497-1506.

Mineau, P. 2003. Avian species. In: Plimmer, J.R., D.W. Gammon, and N.N. Ragsdale (Eds.). Encyclopedia of Agrochemicals. Vol. 1. Wiley Interscience. pp. 129-156.

Mineau, P. 2004. Birds and pesticides: are pesticide regulatory decisions consistent with the protection afforded migratory bird species under the Migratory Bird Treaty Act? The William and Mary Environmental Law and Policy Review. 28(2): 313-338.

Mineau P. 2005. Direct losses of birds to pesticides - Beginnings of a quantification. IN Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference 2002 (C.J. Ralph and T.D. Rich, eds.), U.S.D.A. Forest Service, GTR-PSW-191, Albany, CA; Vol. 2, pp. 1065-1070.

Mineau, P., C.M. Downes, D.A. Kirk, E. Bayne, & M. Csizy. 2005. Patterns of bird species abundance in relation to granular insecticide use in the Canadian prairies. Ecoscience 12(2):267-278.

Mineau, P. 2005. A review and analysis of study endpoints relevant to the assessment of ‘long term’ pesticide toxicity in avian and mammalian wildlife. Ecotoxicology. 14(8):775-799.

Mineau, P. and M. Whiteside. 2006. The lethal risk to birds from insecticide use in the U.S. – a spatial and temporal analysis. Environmental Toxicology and Chemistry. 25(5):1214-1222.

Mineau, P., T. Dawson, M. Whiteside, C. Morrison, K. Harding, L. Singh, T. Längle, and D.A.R. McQueen. Environmental Risk-based Standards for Pesticide Use in Canada. National Agri-Environmental Standards Initiative Synthesis Report. Environment Canada, In Press (Jan 08).

Pimentel, D., H. Acquay, M. Biltonen, P. Rice, M. Silva, J. Nelson, V. Lipner, S. Giordano, A. Horowitz, and M. D'Amore. 1992. Environmental and economic costs of pesticide use. BioScience 42:750-760.

Ruben N. Lubowski, Marlow Vesterby, Shawn Bucholtz, Alba Baez, and Michael J. Roberts. Major Uses of Land in the United States, 2002. Economic Information Bulletin No. (EIB-14) 54 pp, May 2006 http://www.ers.usda.gov/Publications/EIB14/

Smallwood, K.S. 2007. Estimating Wind Turbine–Caused Bird Mortality. J. Wildl. Manage. 71(8):2781-2791.

Smith, G.K. 2006. Risks to birds from pesticide-treated seed and the possible role of ultraviolet reflection in seed colour preferences and repellent strategies. MSc. Thesis (unpublished). Carleton University. Ottawa, Ontario. 175 p.

Statistic Canada. 2009. Agriculture overview, Canada and the provinces & Farm data and farm operator data tables. 2006 Census of Agriculture. http://www.statcan.gc.ca/pub/95-629-x/2007000/4182409-eng.htm , accessed March-April 2009.

Appendix 1.

Crop	No. of States surveyed	Year of survey	Canadian area of crop (ha) 2008	Min. number of ha with mortality risk	Max. number of ha with mortality risk	Ave. number of ha with mortality risk if pesticide use corresponds to weighted US average
Alfalfa	47	1997	5075560	25378	2913371	451725
Apples	8	2001	22101	2122	95300	15117
Apricots	1	2001	200	42	42	42
Asparagus	3	2002	2104	688	1523	1290
Barley	2	2003	4039563	0	20198	12119
Beets	6	1997	3139	9	1585	421
Blackberries	1	2001	1757	307	307	307
Blueberries	4	2001	52608	15940	117737	75387
Broccoli	1	2002	4489	3228	3228	3228
Brussel sprouts	1	2000	561	1337	1337	1337
Cabbage	9	2002	5490	0	2300	994
Canola	8	1997	5164038	129101	1962334	170413
Carrots	4	2002	9857	0	9275	315
Cauliflower	1	2002	2144	845	845	845
Celery	1	2002	908	298	298	298
Cherries	5	2001	2945	241	5375	1358
Corn	16	2003	1392100	0	318791	62645
Cranberries	5	1997	3415	2326	8794	7236
Cucumbers	6	2002	2903	0	1527	203
Dry beans	17	1997	184842	0	56192	10536
Dry peas	5	1997	1915783	181999	1383195	568988
Eggplant	2	2000	5257	400	1130	904
Flax	3	1997	807975	0	0	0
Grapes	5	2001	12164	36	8770	511
Green beans	9	2002	10998	0	5059	1716
Green onions	2	1997	1008	216	274	235
Green peas	4	2002	16831	0	572	135
Lettuce	2	2002	3911	1072	2835	2405
Oats	37	1997	2063612	0	70163	10318
Onions	6	2002	5823	1473	8746	4041
Other hay	33	1997	2893649	0	2894	1447
Peaches	5	2001	3802	2365	24504	6779
Pears	3	2001	1486	499	1051	744
Plums/prunes	1	2001	751	177	177	177
Potatoes	10	2003	162515	488	258561	103522
Pumpkins	3	2002	3765	0	184	49
Radishes	7	1997	682	1	839	239
Raspberries	2	2001	3635	1327	1796	1661
Rye	15	1997	215185	0	0	0
Safflower	2	1997	91371	26589	26589	26589

Seed crops	21	1997	412985	18584	44602	41711
Sod	23	1997	27960	28	1454	1398
Soybeans	8	2002	1202098	0	580613	22840
Spinach	2	2002	711	0	171	152
Squash	6	2002	9571	0	6374	2728
Strawberries	3	2002	5204	1093	3471	3148
Sugar beets	9	2000	19488	2865	16565	12511
Sugarcane	3	1997		0	0	0
Sunflowers	9	1997	85402	1281	62941	6149
Sweet corn	12	2002	30229	0	49455	7739
Sweet peppers	4	2002	2458	22	3380	1428
Tobacco	16	1997	12918	1008	22322	10670
Tomatoes	5	2002	9010	0	18849	1667
Wheat	3	2002	9881991	0	474336	187758

Notes: The following crop combinations and substitutions were made in order to make the Census of Agriculture data to conform with USDA data from Mineau and Whiteside (2006).

- Barley includes mixed grain and buckwheat
- Beets includes rutabagas and turnip
- ‘Other berries’ assumed to be similar to blackberries
- Blueberries includes Saskatoon berries
- Cabbage includes Chinese cabbage
- Canola includes mustard seed
- Cherries includes both sweet and sour cherries
- Dry peas includes dry lentils and chick peas
- ‘Other vegetables’ assumed to be most similar to eggplant
- ‘Other field crops’ assumed to be similar to safflower
- ‘Seed crops’ includes forage seed, canary seed and caraway
- Squash included zucchini and mixed squash/pumpkin fields
- Wheat includes triticale

Appendix 2

				Estimated area (ha) over which avian mortality will occur as a result of the insecticide indicated.									
Pesticide	Modal application rate (g a.i./ha)	Avian HD5 mg/kg bw	Predicted risk of mortality based on simplified field model	B.C. (2003)	Alta. (1998)	Man. (2003)	Ont. (2003)	N.B. (2003)	N.S. (2003)	P.E.I. (2002)	N.L. (2003)	Y.T. (1994)	N.W.T. (1995)
Phorate	3320	0.34	0.90	0	5184	647	0	237	779	0	0	0	0
Terbufos	1200	0.16	0.87	2329	4860	0	1255	326	170	0	0	0	0
Oxamyl	2244	0.78	0.73	229	3	0	0	1	0	0	0	0	0
Carbofuran	528	0.21	0.71	650	8618	8313	2389	1061	122	6046	0	0	0
Phosmet	1475	1.24	0.55	778	138	149	4604	15	914	0	0	0	0
Diazinon	550	0.59	0.49	24261	3663	0	3558	2950	3393	0	17767	1	2
Naled	950	1.72	0.37	555	495	0	124	0	15	0	0	0	0
Azinphos-Methyl	1128	2.28	0.35	2019	81	1091	3077	986	78	0	0	0	0
Methamidophos	600	1.7	0.28	464	9	197	462	1367	7	2121	0	0	0
Chlorpyrifos	576	3.76	0.15	1217	58006	5564	1432	734	458	0	1	0	0
Formetanate Hydrochloride	1290	8.77	0.15	0	0	0	0	0	5	0	0	0	0
Methomyl	870	8.46	0.11	43	56	0	71	742	10	0	0	0	0
Trichlorfon	1200	13.36	0.10	0	2849	0	18	83	3	0	0	0	0
Pirimicarb	567	6.78	0.09	85	25	0	106	3	24	0	0	0	0
Carbaryl	2500	30.05	0.09	462	117	1841	181	71	216	0	35	0	0
Endosulfan	550	9.53	0.07	587	95	226	458	762	48	559	0	0	0
Dimethoate	312	5.78	0.06	859	1009	931	1355	305	177	930	5	0	0
Acephate	694	18.52	0.05	66	17	0	634	12	6	0	0	46	0

Amitraz	850	41.83	0.03	0	0	0	0	0	0	0	0	0	0
Phosalone	1000	106.27	0.01	25	0	0	24	3	7	0	0	0	0
Dicofol	638	72.37	0.01	12	8	0	0	0	0	0	0	0	0
Imidacloprid	60	8.43	0.01	91	2	1028	91	1354	43	779	0	0	0
Malathion	875	139.1	0.01	49	236	12	16	6	3	0	0	0	0
Acetamiprid	50	20.91	0.00	0	0	0	0	0	0	0	0	0	0
Pyridaben	213	279.5	0.00	0	0	0	0	0	0	0	0	0	0
Tefluthrin	120	178.63	0.00	0	0	0	0	0	0	0	0	0	0
Tebufenozide	144	249.71	0.00	0	0	0	0	0	0	0	0	0	0
Spinosad	87	170	0.00	0	0	0	0	0	0	0	0	0	0
Pymetrozine	96.5	208.12	0.00	0	0	0	0	0	0	0	0	0	0
Clofentezine	200	493.59	0.00	0	0	0	0	0	0	0	0	0	0
Abamectin	17	42.8	0.00	0	0	0	0	0	0	0	0	0	0
Cyhalothrin-Lambda	89	428.14	0.00	0	0	0	0	0	0	0	0	0	0
Fenbutatin Oxide	37.5	291.52	0.00	0	0	0	0	0	0	0	0	0	0
Cypermethrin	70	579.15	0.00	0	0	0	0	0	0	0	0	0	0
Deltamethrin	10	97.09	0.00	0	0	0	0	0	0	0	0	0	0
Permethrin	106	3127	0.00	0	0	0	0	0	0	0	0	0	0

Bird Casualty Related to Electrocution on Distribution Power Lines, Maintenance of Transmission Power lines and Hydro-power Reservoirs in Canada.

By

Jean-Pierre L. Savard

Environment Canada, Science and Technology Branch, 801-1550 av d'Estimauville, Québec, G1J 0C3.

and

Sébastien Rioux

Independent researcher, 3474 Boulevard Neilson Apartment 7, Québec, QC, Canada, G1W 2W1

ABSTRACT

This study provides estimates for three sources related to power industry in Canada, which cause avian mortality: electrocutions, construction and transmission line maintenance, and water reservoirs. Estimates of avian mortality due to electrocution mortality for Canada (number of poles*birds/pole/year) ranged from 160,836 to 801,962 birds annually. Impacts are likely to be greater on raptors, owls, herons and cranes than on smaller, but more highly productive birds. Construction of transmission line likely impacted 2,588,494 nests and transmission line maintenance can possibly affect 388,274 nests each year. Avian mortality related to the construction and maintenance of transmission and distribution power lines is relatively small, and likely does not cause any significant impact at the population level. Operations of large water reservoirs created for hydro-power will rarely affect adults but result in the destruction of eggs in nidifigous species such as waterfowl and shorebirds or altricial species nestlings. An approximate estimate of avian mortality for Quebec due to hydro-power reservoirs gave us 152,162 nests/year, and does not cause a significant impact on a population level for any species. However, reservoirs within the breeding range of the Piping Plover (*Charadrius melodus)*, an endangered species, could affect the local population if highly estimated losses were recurrent every year.

INTRODUCTION

Power industry in Canada causes multiple impacts on bird species, due to electrocutions, construction and transmission line maintenance, establishment and operation of large reservoirs for hydro-power. This impact varies depending on species and habitat.

Electrocution

Electrocution mortality can have population level impacts in some areas on select species (Rubolini et al. 2001). The most publicized impacts occurred on large raptors such as Golden Eagle, *Aquila chrysaetos* (Boeker and Dikerson 1975, Benson 1981). While most of the literature about bird electrocutions focused on raptors, many non-raptors and migratory birds were listed as casualties, including waterfowl, herons, gulls, ravens and other passerines (Lasch et al. 2010, Janss 2000, Bevanger 1998, O'Neil 1988, Dexter 1953, Cartron et al. 2005, Manzano-Fischer 2006, Platt 2005, Anderson 1933). The extent of mortality on non-raptors is difficult to assess.

Recent reviews of available information worldwide concluded that reliable estimates of electrocution mortality are generally unavailable, several studies being affected by design and sampling issues (Lehman et al. 2007, 2010). Several factors contribute to electrocution risks (Roig-Soles and Navazo-Lopez 1997, Platt 2005, Lehman 2007) including bird morphology, age and sex (Ferrer et al. 1991, Dawson and Mannan 1995, Janss 2000, Harness and Wilson 2001), pole type, design and configuration (Boeker and Nikerson 1975, Orlendorff et al. 1981, Ferrer et al. 1991, Slater and Smith 2010) habitat and topography (Boeker and Nickerson 1975, Kochert and Orlendoff 1999), season and weather (Benson 1981, Janss and Ferrer 1999a, b, Harness and Wilson 2001, Platt 2005) which make global estimates of electrocution casualties difficult to collect.

Available estimates tend to be localised and biased by lack of information on detectability, and scavenging and crippling rates (Bevanger 1999). In the case of electrocution, detectability is not a major bias because birds tend to die close to the pole. However, scavenging and crippling rates estimates or lack of, can introduce important biases (Lehman et al. 2007). Reliable scavenging estimates are difficult to obtain as the use of surrogate species (i.e. chicken instead of eagles) can greatly bias estimates because small birds can be removed 10-20 time faster than larger birds (Smallwood 2007). Also, scavenging rates vary between seasons and sites (Bevanger 1995, Janss and Ferrer 1999a, b).

To date there is overwhelming evidence that most mortalities related to electrocution involve large birds mostly owls and raptors (Bevanger 1998, Lehman 2001, Platt 2005, Lehman et al. 2007, 2010, Manville II 2005). In Québec, confirmed bird electrocutions are mostly owls and raptors (Table 1). However, other species are electrocuted in larger numbers than raptors (Anderson 1933, Bevanger 1998, Dedon and Colson 1988, Janss and Ferrer 1999a, b, Janss 2000, Platt 2005, Tinto et al. 2010). Lasch et al. (2010) found that 56% of mortalities were corvids and gulls. Likewise Manzano-Fisher (2006) documented >50% birds that were electrocuted were ravens in her study. Platt (2005) in Alberta found 78% of electrocutions were non-raptors including ducks, gulls, sharp-tailed grouse, ravens, and other passerines. Janss (2000) found 33% of electrocutions were two species of migratory birds. Two old references provide insight into potentially overlooked causes of electrocution. Dexter (1953) found an electrocuted Northern Oriole (*Icterus galbula*) that appeared to have shorted out between a wire and a branch. Anderson (1933) recorded roosting Purple Martins (*Progne subis*) shorting out between wing tips resulting in group electrocutions.

Bird electrocution has been a continuous preoccupation for power line managers as it often causes power outage. In the United States, it is an important source of mortality for eagles (Harness and Wilson 2001). Several studies have looked at the efficiency of various measures to reduce casualties (Miller et al. 1975, Ledger 1984, Roig-Soles and Navazo-Lopez 1997, Janss and Ferrer 2001, APLIC 2006, Lammers and Collopy 2007, Slater and Smith 2010) but their efficiency is poorly documented (Lehman et al. 2007).

A detailed study in southeast Alberta (Platt 2005) in a 113,400 km^2 area yielded, after correcting for the effect of scavengers, losses of 542-2762 raptors, mostly Great Horned Owls (*Bubo virginianus*) and Red-tailed Hawks (*Buteo jamaicensis*) over a six week period spanning June-August. However, this study documented 61 non-raptor mortalities (page 30, Appendix D) compared to 33 raptor mortalities, or a ratio of nearly two to one. Thus the non-raptor losses would be about 1084-5524 birds in a 6 week period in the detailed study area which was only a small proportion of prairie Canada. This number may even be greater as removal experiments used large carcasses and likely underestimated removal rates of smaller birds. Because of the lack of standardized study in Canada, it is impossible to evaluate the number of migratory birds electrocuted each year. Because of their size and persistence, casual reporting of electrocution is likely biased towards large birds.

Construction and maintenance

Transmission line construction, maintenance, and creation of hydro-power reservoirs change a bird habitat during the breeding season, and therefore, may cause inadvertent nest destruction. In most cases it will rarely affect adults but will result in destruction of eggs in nidifugous species, and eggs or nestlings in atricial species. Sometimes, habitat modification and loss of nest may force adults to move to adjacent habitats and render them more vulnerable to predation.

The amount of casualties depends on nest abundance in habitat types destroyed during vegetation clearing for construction or during habitat vegetation maintenance activities. Casualties can be partitioned into two components: a) nests that would be destroyed during clearing of vegetation in construction phase, which is a one-time impact, b) nests that would be destroyed during maintenance activities, which is a recurring impact.

The main impact of reservoirs is the loss of habitats through inundation (Baxter and Claude 1980). However, fluctuating water levels associated with reservoir exploitation may also flood nests (Wolf 1955, Books 1985). Nest mortality here is partitioned into three components: a) nests that would be destroyed during clearing of vegetation prior to initial flooding; b) nests that would be flooded during reservoir filling; c) nests that would be flooded during annual water fluctuations related to reservoir exploitation. The first two are one time effects whereas the third one is a recurring effect leading to cumulative impacts.

To our knowledge, few adequate studies of bird mortality due to power lines have been done in Canada (Platt 2005) to generate credible estimates for each province. Here, we coarsely estimate losses due to electrocution, construction and maintenance of transmission and distribution power lines, and grossly estimate IT due to creation and operation of large water hydro-power reservoirs in Canada.

METHODS

Electrocutions

As expected, estimates of bird electrocution rates varied wildly between 11 studies compiled (Table 2). When estimates are expressed in number of birds/pole/year, we often obtain minimum and maximum values depending on the study (Table 2). Minimum values are based on confirmed cases of electrocution only whereas maximum values include all birds found (It is often difficult to determine the exact cause of mortality). We derived average values using: 1) the smaller of two values when two estimates were provided and 2) the maximum value. This yielded average estimates of 0.0281 and 0.1401 bird/pole/year respectively (Table 2). However, results from the Alberta study are based on a relatively short period and contrast with other values. If we exclude values from this study, we obtain average estimates of 0.0066 and 0.0797 bird/pole/year (min and max; Table 2). Estimates are usually per year although this is not clearly stated in some studies. The coefficient of variation was quite high (minimum estimate = 172%; maximum = 132%) indicating the wide range in estimates. If we exclude the Alberta study, the coefficient of variation drops to 52-97%. Given differences between minimum and maximum average estimates we derived estimates for both. Also, because of the unique high estimates obtained in the Alberta study compared to other studies, we derived estimates excluding that study.

Transmission line maintenance and construction

To derive an estimate of casualties in terms of number of nests destroyed during construction or maintenance, we multiply area cleared during the breeding season by nest density at the time of vegetation clearing.

Landbird density estimates

DesGranges et al. (2003) compiled and derived breeding bird estimates in diverse types of forested habitats in Quebec (Table A1.1). Estimates of breeding densities ranged between 2.73 and 4.64 pairs/ha and averaged 3.78 pairs/ha. One forest type left out of this average is jack pine which averaged 0.82 pairs/ha. Another source of breeding bird density data is the Bird Census database (Kennedy et al. 1999) which covers several areas of Canada. Estimates of breeding densities varied between locations and habitat types from 0.33 birds/ha in young Englemann spruce/subalpine fir to 11.9 birds/ ha in mid-age bur oak/green ash/Manitoba maple. Estimates for regenerating clearcuts, a typical habitat found under managed power lines, averaged 8.02 birds/ha (n = 18 plots) or 4.01 pairs/ha (Table A1.2; Kennedy et al. 1999).

Yahner et al. (2004) reported breeding densities of 11.4, 5.0 and 3.8 pairs/ha in right of way corridors. Bramble et al. (1994) reported densities of 9.63 to 15.81 pairs/ha for differently managed right of way corridors. Thus there could be large fluctuations in breeding bird densities depending on location, habitat types and years. Breeding bird densities varied between BCR zones from 3.70 pairs/ha in the Northwestern Interior Forest Zone to 7.74/ha in the Northern Pacific Rainforest Zone (Hobson 2011). However, Savard et al. (2000) reported estimates based on spot-mapping results for the coastal forests of British Columbia ranging between 1.25 and 4.64 pairs/ha depending on forest type and age (Table A1.3).

The above density values represent total breeding density estimates and assume that all species breed simultaneously which is not the case. At any one time, it assumes that all species would have nests at the time of vegetation clearing which is not realistic as the breeding season extends from early may for resident species to late June-early July for neotropical migrants, and several species do re-nest when their nests are destroyed early in the season. Also, a small proportion of nests would have already failed at the time of habitat modifications.

Clearing of a given area will likely take only a few days and the number of active nests will vary according to the timing of the clearing. Also, breeding bird densities and predation pressures can vary greatly between years in relation to weather, insect epidemics and other resources abundance. Because of the difficulties of quantifying these factors and their great yearly variability, for the purpose of this exercise, we assume that 30% of the nests were active in May, 90% in June and 30% in July. These proportions vary between areas (north vs south) and years depending on climate conditions. Therefore, we also generate estimates assuming that 100% of the nests were active each month.

Transmission lines length

In Quebec, it is estimated that there are about 12,216 km of transmission lines (Tecsul 2009) and 219,750 km in the rest of Canada (Canadian Electricity Association). However, according to Hydro Quebec web site, the number calculated by Tecsul (2009) may not cover the whole province as it is reported that there is 32,000 km of transmission lines in Quebec. The latter figure will be used in this report yielding a total of 251,750 km of transmission lines in Canada (32,000 km in Quebec and 219,750 km in the rest of Canada). The total length of distribution lines in Canada is 572,370 km.

Reservoirs

Area covered by reservoirs

Approximately 14,831km^2 were inundated by the creation of reservoirs in northern Quebec, within the boreal forest Bird Conservation Area (BCR 8; Table A2.1). These estimates represent the total area of the current reservoirs but naturally occurring water bodies were already covering a portion of the landscape prior to the creation of the reservoirs. For example Tecsul (2009) estimated the area actually flooded in BCR 8 at 4,112 ha, nearly 3 times less than the total area covered (Table A2.2). For the rest of the current exercise, we will use the data from Table A2.2 (Tecsul 2009).

Waterfowl breeding densities

Waterfowl densities vary temporally and spatially throughout the various Canadian ecosystems. Savard and Lamothe (1991) summarise values for northern Quebec and Labrador for scoters (Surf and American Scoters, *Melanitta perspicillata and M. americana*) with a maximum value of 18 pairs/100km^2 (0.18/km^2). Transect results yielded an estimate of 0.514 pairs/km^2 for the entire waterfowl community. Lemelin et al. (2004) report densities ranging from 0.89 to 1.33 pairs/ km^2 in the forested areas south of 51°0 15’ N, and Bordage et al. (2002) report a density of 0.86 pairs/km^2 in the area of the Gouin reservoir. None of these estimates have been corrected for detectability biases so they should be considered as minimums. Recent surveys in Labrador yielded waterfowl densities in 25m^2 plots ranging from 0 to 4.14 pairs/ km^2 (Table A1.4; Gilliland et al. 2008, 2009). The maximum estimate of 1.33 pairs/km^2 (Lemelin et al. 2004) was used to derive casualties related to flooding of northern reservoirs. The estimate is similar to the mean obtained in Labrador in 2009 (Table A1.4; Gilliland et al. 2009).

Waterfowl species composition

The abundance and diversity of breeding waterfowl varies throughout the boreal forest depending on location and scale considered (Tables 4 and 5). In the areas affected by northern reservoirs in Quebec, the most numerous waterfowl species average 8.4 eggs/ nest and approximately 8.0 eggs/nest in the area of the reservoir Gouin (Table A1.5). None of the species involved are considered of concern in Canada.

RESULTS

Electrocutions

To derive reliable estimates in relation to casualties in Canada due to electrocution, we used data from the literature on the numbers of bird killed/pole/year (Table 2) and applied it to Canada. The total length of distribution lines is estimated at 572 370 km. If we assume about 10 poles/km, we obtain a total of 5 723 700 poles. Estimates of avian mortality (poles * birds/pole/year) ranged from 160 836 (min) to 801 962 birds annually. If we exclude the Alberta study, estimates drop to 37 490 and 456 261 birds per year. Based on the Alberta study (Platt 2005; Table 3), only about 10% of the birds electrocuted are migratory, whereas the rest are species under provincial jurisdiction. It gives us an estimate from 16 084 to 80 196 migratory birds electrocuted annually in Canada.

Transmission and distribution line construction and maintenance

We averaged the breeding bird density of each data source found in Tables 1-3 (3.78; 4.48; 3.38). This yielded an average of 3.88 ± 0.56 pairs/ha (SD; CV = 14.4%). If we take the maximum from each data base (7.76, DesGranges et al. 2003; 11.9, Kennedy et al. 1999; 6.98, Savard et al. 2000) we obtain an average estimate of 8.88 ± 2.64 (SD; CV = 29.7%).

Assuming a width of about 100m (0.1km) we derive an area of 25,175 km² or 2,517,500 ha of habitats cleared for transmission lines. In the estimates below, we assume that only half of the area was cleared during the breeding season in the following pattern: 10% in May; 40% in June; and 50% in July. We also assume that 20% of nests are active on any given day in May; 90% in June; and 30% in July. Based on these assumptions, we derive two estimates, one based on average values (3.88 pairs/ha) and one based on maximum values (8.88 pairs/ha).

Those yielded respectively casualties of 2,588,494 and 5,924,181 nests related to the construction of transmission lines in Canada. If we change the proportion of nests active in May from 20% to 50%, in June from 90% to 90% and in July from 30 to 50% we obtain casualties of 3,223,407 and 7,377,282 nests respectively. Also, changing the proportion of clearing done in May, June and July affects estimates only slightly but changing the average breeding bird density has the most impacts (Fig. 1). I should point out that those are cumulative estimates as the construction of transmission lines in Canada was spread over several decades so that the yearly impact was much smaller in any given area.

To derive casualty estimates for maintenance, we assumed that the impact was similar to the one related to the construction phase and occurred only every 5 years or 10 years. Estimates were generated for both scenarios. Assuming a five years recurring management results in estimates that are one fifth of those previously derived (min = 517,699 nests/year, max = 1,184,836 nests/year); if maintenance was only done every 10 years which may be the case in the boreal forest where vegetation growth is slower, casualty estimates are half again (min = 258,849, max = 592,418).

Final casualty estimates based on the authors' unsupported assumptions (educated guess) are: 1) use of average breeding bird density estimates as best representing the variability in habitat types and yearly fluctuations; 2) use of a 5 years recurring maintenance schedule for 60% of the lines, of 10 years for 30% and of 0 maintenance for 10%. This scenario yield initial casualties related to construction of 2,588,494 nests and recurring nest mortalities of: 0.60 * 517,699 nests/year + 0.30 * 258,849 = 388,274 nests/year.

Estimated avian mortality in relation to hydro-electric reservoirs

Hydro-electric reservoirs in Quebec

Approximately 8,342 km^2 were inundated by the creation of reservoirs in northern Quebec over the last 40 years (Table A2.2). This yields an estimate of 11 095 nests (8,342 km^2 X 1.33 pairs/km^2) potentially affected if these reservoirs were all filled during the breeding season. However, this is not the case as most large reservoirs take two to three years to fill up covering multiple breeding seasons but affecting different areas. As the breeding season is fairly short in the boreal forest we assumed that waterfowl nests are only vulnerable for a period of two months each year.

Assuming a constant rate of reservoir filling throughout the year over a two year horizon, nests would be vulnerable for four of 24 months (16.6%). This assumption is questionable as reservoir filling may take more than two years, the area flooded depends on slope and filling would be quicker during spring runoff than at any other time of the year and will depend also on precipitation levels. However, each reservoir situation is different so that it is difficult to determine adequate assumptions. If we apply this percentage (16.6%) to the 8,342 km^2 flooded area, 1,385 km^2 would have been affected during the breeding season. This translates into 1,842 waterfowl nests that could have been affected.

Assuming an average clutch size of 8.4 eggs (Table A2.2; weighted average), it represents 15,473 eggs lost in relation to the filling of the reservoirs. This would have been a one-time impact.

Other reservoirs in Quebec

Lehoux et al. (1991) conducted a study of the impact of fluctuating water levels in the Montreal/lac Saint-Pierre sector of the St. Lawrence River. These fluctuations were not directly related to hydro-electricity but were mostly for navigation considerations. However, because of the high productivity of the impacted areas, it affects productive waterfowl habitats and results in casualties. Impacts varied yearly with the level of water fluctuation and its timing (Fig. 2). Waterfowl breeding densities in the freshwater portion affected by water level controls were evaluated at 23 nests/km^2 (0.23 nest/ha), densities very high compared to northern forested habitats. As expected, the highest impacts occur with the highest water levels and the number of nests potentially impacted varies with the timing in regard to nesting chronology (Fig. 2). It should be noted that increase in water levels before or after the breeding season will not result in casualties. Unlike reservoirs for which the major impact was at the time of filling, in the case of the St. Lawrence, it occurs at various levels every year and with various timing, making it difficult to generate credible estimates.

British Columbia

A detailed study of avian nest mortality in relation to water level fluctuations in reservoirs was made for the Kinbasket and Arrow Lakes reservoirs in the Columbia valley of British Columbia (BC Hydro unpublished data). Most nest failures were due to predation (78.3%, n = 258 nests, in the Arrow Lakes Reservoir and 77%, n = 352 nests, in the Kinbasket Reservoir). The failure of seven nests (5.8%) was directly caused by reservoir operations, all in the Arrow Lakes Reservoir. No nest losses could be attributed to reservoir operations in the Kinbasket Reservoir. Clearly, in this study at least, avian mortality was low. However a study of the drawdown zones of the Columbia River reservoir network documented several nest flooded by rising water levels but concluded that impacts were negligible from a population perspective but could be significant locally when locally rare species are affected (BC Hydro unpublished data).

Other potential losses of non-waterfowl species due to reservoir flooding

Activities related to the initial creation of reservoirs may cause some avian mortality when the habitat is modified prior to flooding. However, the area affected cannot be adequately measured as habitat modification does not occur in all reservoirs (in some, trees are cut prior to flooding, in others not). Also, there is no easily available information as to the period when the clearing was done. Assuming that 75% of the reservoir area in northern Quebec was cleared (6,257 km^2 or 625,700 ha) and that half of the clearing was done during the breeding season (3,129 km^2 or 312,850 ha) we obtain, assuming that all the area cleared was forested and sustained a density of breeding birds of 37.8 pairs/10ha (3.78/ha; Table A1.5), an estimate of 1 182 573 nests affected. This is very likely a maximum estimate as breeding bird densities in these areas are likely lower and that a mixture of habitats were affected. Hobson (2011) calculated that the proportion of forest harvesting occurring during the breeding season in Canada ranged from a low of 12% and a high 26%. Application of these percentages here yield casualties of 280,063 nests (75,084 ha * 3.73 nest/ha) and 606, 804 nests (162,682 * 3.73nest/ha), respectively.

In the worst case scenario, water levels would rise quickly to the 7.98 meter at Sorel in early to mid-June. Such a scenario could impact 600 nests which, with an average clutch size of 8 eggs would represent 4800 eggs. Clearly, such a scenario would significantly impact the productivity of the local waterfowl population estimated at about 900 nests.

Impacts at the population level

Indeed the worst case scenario in Northern Quebec, the province with the greatest number of reservoirs in terms of area, resulted in less than 1842 nests affected total and, this distributed across several species. The impact of such losses at the population level will have to consider natural mortality at both the nest and brood stages. As mortality factors vary greatly from year to year, the impact on the local population will also vary accordingly. Assuming a survival of 50% of nests and a 50% survival of broods reduce the impact to a loss of 461 waterfowl nests and of (using Hobson 2011 estimate of 26 % harvest during the breeding season) 151,701 non waterfowl nests . Thus, once natural mortality is considered, a total of 152,162 nests were lost due directly to reservoir flooding.

DISCUSSION

Summarizing calculations from multiple sources analyzed above, we obtain the combined estimates of casualties caused by power lines ranging from 160,836 to 801,962 adult birds and 388,274 nests in Canada, annually. Due to lack of data, we cannot provide a reliable estimate of casualties caused by hydro-power reservoirs for Canada, but Quebec, the province with the greatest number of reservoirs in terms of area gives us 152,162 nests affected.

Electrocution

Electrocutions are mostly associated with distribution lines and are relatively uncommon on transmission lines, which is the reverse for collision casualties. Clearly better data are needed, especially for poles in the boreal forest which may not cause excessive mortality because of habitat structure, species composition and behaviour of raptors there. We also need more accurate data for open areas, i.e. prairies with greater raptor densities, where poles provide an attractive structure for hunting and resting birds. The abundance and types of poles in Canada need to be quantified better, as electrocution risks are directly related to pole types. Their spatial occurrence has to be evaluated as risks vary greatly for a given type of pole depending on the surrounding habitat.

Due to relatively small amount of migratory birds reported electrocuted (most are raptors and owls), mortality of migratory birds due to electrocution cannot be properly evaluated. Thus impacts at the population level are hard to assess. Impacts are likely to be greater for the long-lived species, such as raptors, owls, herons, and cranes than on smaller, short-lived, but highly productive birds. In some cases, local populations of some owls and raptors could be significantly affected (Sergio et al. 2004). Newly developed strategies to identify problematic poles have been focused on modeling to identify problematic pole types (Manosa 2001, Tinto et al. 2010) but this approach has still to be applied in Canada. Electrocution of birds has not been recognised as a national issue in Canada, in part because of the focus of the literature on large raptors and lack of studies.

Construction and maintenance

To derive accurate estimates of avian mortality related to the construction of transmission lines, we need an estimate of the length of diverse habitats traversed by these lines throughout Canada as well as estimates of breeding bird densities within these habitats. It also requires an estimate of the period of the year when vegetation was cleared, which is not currently available.

On transmission system lines, the wires are not insulated by a sheath and air acts as the insulator. When vegetation comes close to the conductors (wires), there is a risk of an electrical arc forming which may cause a power outage, start a fire and even electrocute people in the vicinity. To avoid this occurrence, vegetation under transmission lines has to be kept relatively short and thus need to be managed on a regular basis.

For Hydro-Québec, the vegetation management period begins after snow melting in spring and continues into the fall. Vegetation control under transmission lines is done about every five years, depending on the climate zone and the method used. The farther north a line is located, the less frequent the clearing operations, since vegetation at higher latitudes tends to grow at a slower rate.

Hydro-Québec uses three methods for clearing rights-of-way, either alone or in combination: a) selective cutting (using chainsaws, brush cutters and mowers); b) selective application of herbicides (pesticides that kill certain plants or inhibit their growth, while allowing other plants to develop); c) land-use development (bicycle paths, crop cultivation, gardens, etc.). The last one creates habitats not suitable for breeding. In general, Hydro-Québec uses only mechanical cutting to control vegetation in rights-of-way in 70% of all cases. The other work consists of a combination of mechanical cutting and selective application of herbicides. As the proportion of lines managed by each method is unknown and given that the use of herbicide is often preceded by vegetation clearing, it will be assumed here that all methods result in similar impact. The maintenance of distribution lines may result in some nest mortalty but it is done differently and involves mostly branch trimming rather than whole tree removal.

Reservoirs

Losses associated with creation of hydro-electric reservoirs at the population level are not significant locally, globally, and at the species level, for most if not all species of waterfowl, considering the populations of several millions. However, we have to take into account that losses are calculated for Quebec only and do not include other provinces. More factual data on each reservoir in each province are needed to obtain refined estimates.

This exercise, although highly speculative, suggests that avian mortality related to reservoir flooding is negligible at provincial scale, and it is unlikely to cause significant impact for any species. One cautionary note: reservoirs within the breeding range of the Piping Plover (*Charadrius melodus)*, an endangered species could be used for nesting by the species, rendering nests susceptible to flooding and could affect the local population if such losses were recurrent every year.

There is no impact related to vegetation removal if it is done outside of the breeding season. Often, prior to reservoir flooding, trees are cut to reduce boating hazards and limit the vegetation decomposition, which affects water chemistry. However, within the breeding season the impact will be similar to that of forest harvesting (in forested areas) and mostly limited to the destruction of eggs and/or nestlings, whereas adults remain unaffected. Therefore, nest mortality is proportional to the number of active nests in the harvested area.

Similarly, no impact related to flooding occurs outside the breeding season. If done during the breeding season, it will affect mostly ground nesting species in the flooded area. In some cases, especially when shrubs are abundant, it will harm shrub nesting species and could even take species breeding in small trees.

Most artificial reservoirs have fluctuating water levels in relation to precipitation and water usage. These levels often do not coincide with natural water fluctuations and could flood nests built in the affected zone (Nilsson and Dynesius 1994, Lehoux et al. 2003). In most large reservoirs (km^2), especially those with unnatural and important fluctuations (a few meters), little vegetation is established in the affected zone, and nesting is minimal. However, in the north of Canada, and also possibly in the prairies, this bare zone attracts some species of ground nesting shorebirds. In those cases, primarily eggs are impacted as the nidifugous young can avoid flooding (they may perish indirectly due to lack of habitat and greater susceptibility to predation). However, the impact is limited to the breeding season, mostly eggs and nestlings, and it is local. In the special case of the Great Lakes-St. Lawrence system where water levels are controlled for navigation, unnatural water fluctuations occur often and have potential of flooding waterfowl, terns and other ground nesting waterfowl nests (Lehoux et al. 1991).

Unfortunately, reliable estimates for the area flooded by reservoirs in most of the other provinces could not be obtained. However, it is much smaller than the area in Quebec, and in general most reservoirs in other provinces are smaller. There might be localised losses due to fluctuations in water levels each year but this is very likely insignificant as for most reservoirs, the marnage zone is often devoid of vegetation and not very attractive for ground nesting birds. Besides, to cause an impact, the water rise would have to coincide with the nesting period. Furthermore, the area affected by flooding due to yearly water fluctuations is much smaller than the area initially flooded. However, if flooding occurs each year at the time birds have already initiated their breeding activities, it would result in recurring yearly losses. These conditions vary from reservoir to reservoir, and they require local data to estimate losses.

CONCLUSIONS

Given IT numbers for electrocutions unlikely result in significant population effect on individual species with possibly some exception for some endangered species such as Whooping Cranes (*Grus americana*). Nest mortality related to the construction and maintenance of transmission and distribution power lines was grossly estimated but seems relatively small, and would not cause any significant impact at the population level. Nest mortality caused by hydro-power reservoirs is considered negligible, however, it is highly speculative, in great part because of the coarseness of the data available on reservoirs size, the way they were filled, and the yearly water fluctuations and timing. Data on breeding bird densities could also be refined. Finally, detailed studies similar to those in British Columbia (BC Hydro unpublished data) or to Lehoux et al. (2003) in the St. Lawrence are greatly needed to derive more realistic and credible estimates for each reservoir.

ACKNOWLEGEMENTS

We would like to thank Geoff Holroyd for his pertinent comments and suggestions, and Dr. Robert Elner for his insightful comments.

LITERATURE CITED

Avian Power Line Interaction Committee (APLIC). 2006. *Suggested practices for avian protection on power lines — the state of the art in 2006.* Edison Electric Institute, Washington, D.C., USA.

Anderson, A. H. 1933. Electrocution of Purple Martins. *Condor* 35:204.

Baxter, R. M., and P. Claude. 1980. Environmental effects of dams and impoundments in Canada: experience and prospects. *Canadian Bulletin of Fishery and Aquatic Sciences* 205:1-34.

Benson, P. C. 1981. *Large raptor electrocution and power pole utilisation: a study in six western states.* Dissertation. Brigham Young University, Provo, Utah, USA.

Bevanger, K. 1995. Estimates and population consequences of tetranoid mortality caused by collisions with high tension power lines in Norway. *Journal of Applied Ecology* 32:745-753.

Bevanger, K. 1998. Biological and conservation aspects of bird mortality caused by electric power lines: a review. *Biological Conservation* 86:67-76.

Bevanger, K. 1999. Estimating bird mortality caused by collision and electrocution with power lines: a review of methodology. Pages 29-56 *in* M. Ferrer and G. F. Janss, editors. *Birds and power lines: collision, electrocution, and breeding*. Quercus, Madrid, Spain.

Boeker, E. L., and P. R. Nikerson. 1975. Raptor electrocutions. *Wildlife Society Bulletin* 3:79-81.

Books, G. G. 1985. Avian interactions with Mid-Columbia River water level fluctuations. *Northwest Science* 59: 304-312.

Bordage, D., M. Grenier, N. Plante, and C. Lepage. 2002. *Répartition potentielle de la sauvagine dans la region du reservoir Gouin, Québec.* Technical Report Series No. 374, Canadian Wildlife Service, Sainte-Foy, Canada.

Bramble, R. H., R. H. Yahner, and W. R. Byrnes. 1994. Nesting of breeding birds on an electric utility line right-of-way. *Journal of Arboriculture* 20:124-129.

Cartron, J.-L. E., R. E. Harness, R. C. Rogers, and P. Manzano-Fisher. 2005. Impact of concrete power poles on raptors and ravens in northwestern Chihuahua, Mexico. Pages 357-369 *in* J.-L. Cartron, G. Ceballos and R. S. Felger, editors. *Biodiversity,ecosystems,* *and conservation in northern Mexico.* Oxford University Press, New York, New York, USA.

Dawson, J. W., and R. W. Mannan. 1995. Electrocution as a mortality factor in an urban population of Harris' Hawks. *Journal of Raptor Research* 29:55.

Dedon, M. F., and E. W. Colson. 1988. Investigation of bird-caused outages in the Pacific gas and electric company service area. Pages 34-45 *in* W. R. Byrnes and H. A. Holt, editors. *Proceedings of the fourth Symposium on environmental concerns in Rights-of-way management.* Purdue University, Department of Forestry and Natural Resources, West Lafayette, Indiana, USA.

DesGranges, J.-L., Y. Grégoire, P. Belleau, P. Agin, and L. Coté. 2003. *Identification d'aires prioritaires de conservation par l'analyse de la diversité aviaire: le cas des forêts du Bas St-Laurent.* Technical Report Series No. 386, Canadian Wildlife Service, Quebec, Canada.

Dexter, R. W. 1953. Electrocution of a Baltimore Oriole. *Journal of Field Ornithology* 24:109.

Ferrer, M., M. De La Riva, and J. Castroviejo. 1991. Electrocution of raptors on power lines in Southern Spain. *Journal of Field Ornithology* 62:54-69.

Gilliland, S. G., C. Lepage, J.-P. L. Savard, D. Bordage, and G. J. Robertson. 2009. An assessment of distribution and abundance of Surf and Black Scoters breeding within the eastern section of Labrador low level Flight Training Area 732. Report submitted to the Institute for Environmental Monitoring and Research, Happy Valley-Goose Bay, Labrador. (www.iemr.org/pdfs/R_Waterfowl/Scoter09_english.pdf · PDF file)

Gilliland, S. G., C. Lepage, J.-P. L. Savard, D. Bordage and G. J. Robertson. 2008. An assessment of distribution and abundance of Surf and Black Scoters breeding within the eastern section of Labrador low level Flight Training Area 732. Report submitted to the Institute for Environmental Monitoring and Research, Happy Valley-Goose Bay, Labrador. (www.iemr.org/pdfs/R_Waterfowl/Scoter08_english.pdf · PDF file)

Harness, R. E., and Wilson, K. R. 2001. Electric-utility structures associated with raptor electrocutions in rural areas. *Wildlife Society Bulletin* 29:612-623.

Hobson, K. A. 2011. An estimate of incidental take of nests of forest birds in Canada due to forestry operations. Unpublished Report, Science and Technology, Environment Canada, (Branch, City?),Canada..

Janss, G. F. E. 2000. Avian mortality from power lines: a morphologic approach of a species-specific mortality. *Biological Conservation* 95:353-359.

Janss, G. F. E., and M. Ferrer. 1999a. Avian electrocution on power poles: European experiences. Pages 145-159 *in* M. Ferrer and G. F. E. Janss, editors. *Birds and power lines: collision, electrocution, and breeding*. Quercus, Madrid, Spain.

Janss, G. F. E., and M. Ferrer. 1999b. Mitigation of raptor electrocution on steel power poles. *Wildlife Society Bulletin* 27:263-273.

Janss, G. F. E., and M. Ferrer. 2001. Avian electrocution mortality in relation to pole design and adjacent habitat in Spain. *Bird Conservation International* 11:3-12.

Kennedy, J. A., P. Dilworth-Christie, and A. J. Erskine 1999. *The Canadian breeding bird (mapping) census database.* Technical Report Series No. 342, Canadian Wildlife Service, Ottawa, Canada.

Kochert, M. N., and R. R. Orlendoff. 1999. Creating raptor benefits from power line problems. *Journal of Raptor Research* 33:39-42.

Lammers, W. M., and M. W. Collopy. 2007. Effectiveness of avian predator perch deterrents on electric transmission lines. *Journal of Wildlife Management* 71:2752-2758.

Ledger, J. A. 1984. Engineering solutions to the problem of vulture electrocutions on electricity towers. *Certified Engineer* 57:92-95.

Lehman, R. N. 2001. Raptor electrocution on power lines: current issues and outlook. *Wildlife Society Bulletin* 29:804-813.

Lehman, R. N., P. L. Kennedy and J. A. Savidge. 2007. The state of the art in raptor electrocution research: a global view. *Biological Conservation* 136:159-174.

Lehman, R. N., J. A. Savidge, P. L. Kennedy, and R. E. Harness. 2010. Raptor electrocution rates for a utility in the intermountain western United States. *Journal of Wildlife Management* 74:459-470.

Lehoux, D., D. Dauphin, O. Champoux, J. Morin and G. Létourneau. 2003. *Impacts des fluctuations des niveaux d'eau sur les canards barboteurs en reproduction dans le tronçon lac Saint-Louis/lac Saint-Pierre.* Environment Canada, Canadian Wildlife Service, Sainte-Foy, Canada.

Lemelin, L.-V., D. Bordage, M. Darveau and C. Lepage. 2004. *Répartition de la sauvagine et d'autres oiseaux utilisant les milieux aquatiques en période de nidification dans le Québec forestier. Technical Report Series No. 422.* Environment Canada, Canadian Wildlife Service, Sainte-Foy, Canada.

Manosa, S. 2001. Strategies to identify dangerous electricity pylons for birds. *Biological Conservation* 10:1997-2012.

Manville, A. M. II. 2005. Bird strikes and electrocution at power lines, communication towers, and wind turbines: state of the art and state of the science-next step toward mitigation. *U.S. Forest Service General Technical Report PSW-GTR-191*, Washington D.C., USA.

Manzano-Fischer, P. 2006. Power-line electrocution of birds (summary). Pages 69-70 *in* X. Basurto, and D. Hadley, editors. *Grasslands ecosystems, endangered species and sustainable ranching in the Mexico-U.S. borderlands: conference proceedings.* RMRS-P-40. Fort Collins, CO., U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Miller, D., E. L. Boeker, R. S. Thorsell, and R. R. Orlendoff. 1975. Suggested practices for raptor protection on power lines. *Electric Institute, Washington D. C., and Raptor Research Foundation*, Provo, Utah, USA.

Nilsson, C., and M. Dynesius. 1994. Ecological effects of river regulation on mammals and birds: a review. *Regulated Rivers: Research and Management* 9:45-53.

Orlendorff, R. R., A. D. Miller, and R. N. Lehman. 1981. Suggested practices for raptor protection on power lines: the state of the art in 1981. *Raptor research report* No. 4. Raptor Research Foundation, Provo, Utah, USA.

O'Neil, T. 1988. An analysis of bird electrocutions in Montana. *Journal of Raptor Research* 22:27-28.

Platt, C. M. 2005. Patterns of raptor electrocution mortality on distribution power lines in southeast Alberta*. Dissertation, University of Alberta*, Edmonton, Canada.

Roig-Soles, J., and V. Navazo-Lopez. 1997. A five-year Spanish research project on bird electrocution and collision with electric lines. Pages 317-325 *in* J. R. Williams, J. W. Goodrich-Mahoney, J. R. Wisniewski and J. Wisniewski, editors*. The sixth international symposium on environmental concerns in rights-of-way management.* New Orleans, Louisiana, USA.

Rubolini, D., E. Bassi, G. Bogliana, P. Galeotti, and R. Garavaglia. 2001. Eagle Owl *Bubo bubo* and power line interactions in the Italian Alps. *Bird Conservation International* 11:319-324.

Rubolini, D., M. Gustin, G. Bogliana, and R. Garavaglia. 2005. Birds and power lines in Italy: an assessment. *Bird Consevation International* 15:131-145.

Savard, J.-P. L., and P. Lamothe. 1991. Distribution, abundance, and aspects of breeding ecology of Black scoters, Melanitta nigra, and Surf Scoters, M. perspicillata, in Northern Quebec. *Canadian Field-Naturalist* 105:488-496.

Savard, J.-P. L., D. A. Seip, and L. Waterhouse. 2000. *Avian diversity in relation to logging in the coastal rainforests of British Columbia.* Technical Report Series No. 349, Canadian Wildlife Service, Pacific and Yukon Region, Delta, Canada.

Sergio, F., L. Marchesi, P. Pedrini, M. Ferrer, and V. Penteriani. 2004. Electrocution alters the distribution and density of a top predator, the Eagle Owl *Bubo bubo*. *Journal of Applied Ecology* 41:836-845.

Slater, S. J., and J. P. Smith. 2010. Effectiveness of raptor perch deterrents on an electrical transmission line in Southern Wyoming. *Journal of Wildlife Management* 74:1080-1088.

Smallwood, K. S. 2007. Estimating wind turbine-caused bird mortality. *Journal of Wildlife Management* 71:2781-2791.

Tecsult Inc. 2009. Portrait détaillé de l'occupation humaine du territoire et des activités reliées aux divers secteurs de l'industrie des six régions de conservation des oiseaux du Québec. Québec, Canada.

Tinto, A., J. Real, and S. Manosa. 2010. Predicting and correcting electrocution of birds in Mediterranean areas. *Journal of Wildlife Management* 74:1852-1862.

Wolf, K. 1955. Some effects of fluctuating and falling water levels on waterfowl production. *Journal of Wildlife Management* 19:13-23.

Yahner, R. H., B. D. Ross, R. T. Yahner, R. J. Hutnik, and S. A. Liscinski. 2004. Long term effects of rights-of-way maintenance via the wire-border zone method on bird nesting ecology. *Journal of Arboriculture* 30:288-294.

Table 1. Number of birds received by the ‘Union Québécoise de réhabilitation des oiseaux de proie’ between 1995 and 2009.

Species	Collision	Electrocuted
American Crow		1
Bald Eagle		1
Barred Owl	1	
Boreal Owl	1	
Broad-winged Hawk		1
Great grey Owl		1
Great-horned Owl	2	9
Hawk Owl	1	
Merlin	1	
Nighthawk	1	
Northern Harrier	3	
Osprey	3	1
Peregrine Falcon	1	
Red-tailed Hawk		5
Rough-legged Hawk	2	
Short-eared Owl	1	
Snowy Owl		2
Turkey Vulture	1	1
Total	18	22

Table 2. Estimate of bird electrocution rates from the literature.

Location	Bird/ pole	Length of study	Period covered	Year	Minimum estimate bird/pole/ year	Maximum estimate bird/pole/ year	Source
Spain	0.13	334	Annual	1982-1983	-	0.1377	Ferrer et al. 1991
Utah	-	-	Annual	2001-2003	0.0112	-	Lehman et al. 2010
Utah	-	-	Annual	2001-2003	0.0036	-	Lehman et al. 2010
Utah	-	-	Annual	2001-2003	0.0045	-	Lehman et al. 2010
Spain	0.03	365	Spring&Fall	1991-1995	-	0.0311	Janss et Ferrer 1999a
Spain	0.23	549	Annual	1993-1994		0.1541	Janss et Ferrer 1999a
USA	?	?	?	?	0.0069	0.0176	Lehman et al. 2010
Alberta[†]	0.21	43	Summer	2003	0.1143	0.5629	Platt 2005
Spain	0.01	1492	Annual	1995- 1999	-	0.0019	Manosa 2001
Spain	0.11	1492	Annual	1995- 1999	-	0.0259	Manosa 2001
Spain	0.78	1492	Annual	1995- 1999	-	0.1897	Manosa 2001
Average					0.0281	0.1401	
Average2[‡]					0.0066	0.0797	
IT					160 836	801 962	This study
IT[‡]					37 490	456 261	This study

[†] The study was done over a 6 weeks period in June and July. To derive annual estimates we extrapolated to 6 months or 20 weeks (May to October included). Rates: 64 birds for 379 poles during 6 weeks = 0.1689 birds/pole/6 weeks; this yield an estimate of 0.5629 birds/pole/20 weeks. We assumed no death from November to late April. Only 13 birds were confirmed as electrocuted; this yields a minimum estimate of 0.1143 birds/pole/20 weeks.

[‡] Excluding the Alberta study.

Table 3. Number of individuals recovered during a 6 weeks period (June and July) in Alberta during two searches of 379 poles (Only 13 of the birds recovered could be confirmed as being electrocuted). Scavenging efficiency was estimated at 62% over this period.

Species	Numbers recovered	%
Raptors		
Great Horned Owl	11	12
Red-tailed Hawk	6	6
American Kestrel	4	4
Golden Eagle		0
Raptor sp.	3	3
Non-raptors		
Black-billed Magpie	5	5
Sharp-tailed Grouse	2	2
Duck	2	2
Blackbird sp.	2	2
Passerine sp.	3	3
Corvid	12	13
Gull	0	0
Northern Flicker	0	0
Unknown	14	15
Total migratory birds	7	7
Total raptors	24	26
Total other non-migratory birds	19	20
Unknown	14	15
Grand total	**64**	

Table 4. Estimates of the number of nests lost in relation to the construction and maintenance of transmission lines.

Construction					100%[†] during breeding season		50%[†] during breeding season	
	Proportion nesting	Mean number of nests/ha	Max number of nests/ha	% cleared	Mean[‡]	Max[‡]	Mean[‡]	Max[‡]
May	0.20	0.776	1.776	0.10	195,358	447,108	97,679	223,554
June	0.90	3.492	7.992	0.40	3,516,444	8,047,944	1,758,222	4,023,972
July	0.30	1.164	2.664	0.50	1,465,185	3,353,310	732,593	1,676,655
Total					5,176,987	11,848,362	**2,588,494**	**5,924,181**
Maintenance at 5 years interval								
May	0.20	0.776	1.776	0.10	39,072	89421.6	19,536	44,711
June	0.90	3.492	7.992	0.40	703,289	1609589	351,644	804,794
July	0.30	1.164	2.664	0.50	293,037	670662	146,519	335,331
Total					1,035,397	2369672	**517,699**	**1,184,836**
Maintenance at 10 years interval								
May	0.20	0.776	1.776	0.10	19,536	44,711	9,768	22,355
June	0.90	3.492	7.992	0.40	351,644	804,794	175,822	402,397
July	0.30	1.164	2.664	0.50	146,519	335,331	73,259	167,666
Total					517,699	1,184,836	**258,849**	**592,418**

[†] Assuming all maintenance activities (100%) are done in May, June and July or that only 50% are.

[‡] Number of nests affected

Table 5. Relative abundance of ground nesting waterfowl in northern Quebec in the area of important Hydro-electric reservoirs (Savard and Lamothe 1991).

Species	Young counted, %	Clutch size
Merganser (*Mergus* sp)	30.9	11
Canada Goose (*Branta canadensis*)	20.5	5
Black Scoter (*Melanitta. americana*)	19.8	8
Surf Scoter (*M. perspicillata*)	13.2	8
Scaups (*Aythya sp.*)	7.2	9
Scoter (*Melanita* sp.)	3.0	8
American Black Duck (*Anas rubripes*)	2.4	12
Common Loon (*Gavia immer*)	1.3	2
Mallard *(A. platyrhyncos*)	0.8	10
White-winged Scoter (*Melanitta deglandi*)	0.5	8
Red-throated Loon (*Gavia stellata*)	0.4	2
Mean		9.5
SD		1.5
CV (%)		16

Table 6. Relative abundance of waterfowl (% of pairs observed) in northern Quebec near the Hydro-electric reservoir Gouin (Bordage et al. 2002).

Species	% pairs	Clutch size
American Black Duck (*A. rubripes*)	30.6	12
Common Merganser (*Mergus merganser*)	22.1	12
Common Goldeneye (*Bucephala clangula*)	18.8	-
Ring-necked Duck (*Aythya collaris*)	11.3	9
Common Loon (*Gavia immer*)	6.7	2
Canada Goose (*Branta canadensis*)	5.1	5
Mallard (*A. platyrhyncos*)	1.7	12
Green-winged Teal (*Annas crecca*)	1.4	10
Bufflehead (*Bucephala albeola*)	1.3	10
Hooded Merganser (*Lophodytes cucullatus)*	0.9	11
Mean		9.2
SD		3.5
CV (%)		38

APPENDIX 1. Breeding bird density estimates from the literature.

Table 1. Breeding birds densities (pairs/ha) in major forest types in Quebec (DesGranges et al. 2003).

Forest type	Mean	SD	SE	n	CV
Maple	4.64	1.14	0.57	4	25
Aspen	3.90	1.51	0.87	3	39
Balsam-fir	4.09	0.92	0.41	5	22
Birch	3.50	0.83	0.48	3	24
Sruce	2.73	0.90	0.37	6	33
Poplar	4.06	-	-	1	0
Larch	3.76	0.65	0.46	2	17
Pine	3.53	0.21	0.12	3	6
Average	**3.78**	**0.56**	**0.20**	**8**	**15**

Table 2. Breeding birds densities (Pairs/ha) in major forest types in Quebec (Kennedy et al. 1999).

Primary habitats	Low	High
Broad-leafed forest/woodland	1.70	5.95
Conifer and mixed forest/woodland	0.17	4.60
Wetlands	0.73	5.09
Open land	0.22	3.51
Urban area	2.00	3.25
Average	**0.96**	**4.48**
(SD)	**(0.85)**	**(1.12)**
(SE)	**(0.35)**	**(0.46)**

Table 3. Breeding bird densities (Pairs/ha) in coastal forests of British Columbia (Savard et al. 2000).

Location	Forest type	Mean	SE	n	Range
Queen Charlotte Islands	Old growth	4.64	0.67	3	3.32-5.17
	40-80 years old	3.17	0.06	3	3.12-3.29
	Clearcuts	1.25	0.24	2	1.09-1.42
Vancouver island	Old growth	3.27	0.05	3	3.17-3.34
	40-80 years old	2.64	0.12	3	2.41-2.77
Mainland South Coast	Old growth	4.38	0.92	4	2.98-6.98
	40-80 years old	3.29	0.30	4	2.46-3.82
	Deciduous stands	3.91	0.70	3	2.72-5.14
	Clearcuts	3.85	0.34	2	3.61-4.09
Average		**3.38**	**0.34**	**9**	**1.25-4.64**

Table 4. Breeding densities (pair/km^2) of waterfowl in Labrador.

	Mean	Range	n
1998	1.15	0.08 - 3.92	31
1999	1.45	0.00 - 4.14	31

APPENDIX 2. Area covered[†] by hydroelectric reservoirs.

Table 1. Area covered[†] by hydroelectric reservoirs in northern Quebec, BCR 8 (Wikipedia, September 2010).

Reservoir	Area (km^2)
Gouin	1570
Dozouais	319
Manicouagan	1942
Caniapiscau	4318
Eastmain	6682
Total	14,831

[†] this likely represent the area currently covered by reservoirs which is greater than the actual flooded areas.

Table 2. Area covered by hydroelectric reservoirs in the different BCR in Quebec (Tecsul 2009).

Bird conservation region	Area (km^2)
14	91
13	292
12	3665
8	4112
7	91
3	91
Total	8342

Appendix 2 – Details of parameter values and distributions used in stochastic model of anthropogenic avian mortality in Canada.

Table A2.1 – Distributions used to describe species-group composition, age-group breakdown and seasonal distribution of anthropogenic avian mortality for each source, used in the stochastic model to convert stage-specific losses to a total loss of potential adult breeders. When all characteristics were known, no distributions were necessary (e.g. agricultural mortality was entirely measured in loss of eggs of landbirds, and therefore there was no uncertainty in species-, age- or seasonal-breakdown).

		Central tendency		Variation or range of values		
Parameter	**Distribution**	**Type**	**Value**	**Type***	**Values**	**Source+**
Cats						
Proportion landbirds	Uniform	Midpoint	0.99	Range	0.02	1
Proportion waterbirds	Uniform	Midpoint	0.005	Conditional range	0.00-0.02	1
Proportion waterfowl	Uniform	Midpoint	0.005	Conditional range	0.00-0.02	1
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.5	Random		1
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Buildings – Houses						
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.42	Random		3
Buildings – Low- and mid-rise						
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Uniform, binomial	Mean	0.565	Range, random	0.42-0.71	4
Proportion landbirds	Uniform	Midpoint	0.9	Range	0.2	4
Proportion waterbirds	Uniform	Midpoint	0.033	Conditional range	0.0-0.2	4
Proportion waterfowl	Uniform	Midpoint	0.033	Conditional range	0.0-0.2	4
Proportion shorebirds	Uniform	Midpoint	0.033	Conditional range	0.0-0.2	4
Buildings – Tall						
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.71	Random		3
Proportion landbirds	Uniform	Midpoint	0.95	Range	0.1	3,5
Proportion waterbirds	Uniform	Midpoint	0.0167	Conditional range	0.0-0.1	3,5
Proportion waterfowl	Uniform	Midpoint	0.0167	Conditional range	0.0-0.1	3,5
Proportion shorebirds	Uniform	Midpoint	0.0167	Conditional range	0.0-0.1	3,5

Transportation - Road vehicle collisions						
Kill: landbirds	Log-normal	Point est.	8743000	Standard deviation /mean	0.5	6
Kill: shorebirds	Log-normal	Point est.	197100	Standard deviation /mean	0.5	6
Kill: waterbirds	Log-normal	Point est.	187200	Standard deviation /mean	0.5	6
Kill: waterfowl	Log-normal	Point est.	218500	Standard deviation /mean	0.5	6
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Uniform, binomial	Mean	0.33	Range, random	0.167-0.5	7
Proportion landbirds	Uniform	Midpoint	0.9	Range	0.2	7
Proportion waterbirds	Uniform	Midpoint	0.033	Conditional range	0.0-0.2	7
Proportion waterfowl	Uniform	Midpoint	0.033	Conditional range	0.0-0.2	7
Proportion shorebirds	Uniform	Midpoint	0.033	Conditional range	0.0-0.2	7
Power – Electrocution						
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.75	Random		8
Proportion landbirds	Multinomial	Mean	0.974	Random		8
Proportion waterbirds	Multinomial	Mean	0.008	Random		8
Proportion waterfowl	Multinomial	Mean	0.01	Random		8
Proportion shorebirds	Multinomial	Mean	0.008	Random		8
Power - Transmission line collisions						
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.75	Random		9
Proportion landbirds	Multinomial	Mean	0.045	Random		9
Proportion waterbirds	Multinomial	Mean	0.384	Random		9
Proportion waterfowl	Multinomial	Mean	0.408	Random		9
Proportion shorebirds	Multinomial	Mean	0.163	Random		9
Power - Line maintenance						
Proportion landbirds	Multinomial	Mean	0.7007	Random		10
Proportion waterfowl	Multinomial	Mean	0.0806	Random		10
Proportion shorebirds	Multinomial	Mean	0.2187	Random		10
Power – Hydro reservoirs						
Kill: non-waterfowl	Log-normal	Point est.	151707	Standard deviation /mean	0.5	6
Kill: waterfowl	Log-normal	Point est.	461	Standard deviation /mean	0.5	6

Proportion landbirds	Uniform	Midpoint	0.9	Range	0.2	7
Proportion waterbirds	Uniform	Midpoint	0.5	Conditional range	0.0-0.2	7
Proportion shorebirds	Uniform	Midpoint	0.5	Conditional range	0.0-0.2	7
Oil and Gas - Marine - produced water						
Proportion juveniles in fall	Binomial	Mean	0.173	Random		11
Proportion subadults	Binomial	Mean	0.242	Random		11
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.5	Random		11,12
Oil and Gas – Marine - platform and vessel strandings						
Proportion juveniles impacted	Fixed	Value	1	None	0	13
Proportion of kill in fall/winter (i.e. including juveniles)	Fixed	Value	1	None	0	13
Fisheries - Marine bycatch						
Proportion adults - gill nets	Fixed	Value	1	None	0	13
Proportion of kill during breeding - gill nets	Fixed	Value	1	None	0	13
Proportion adults - long lines, otter trawls	Fixed	Value	1	None	0	13
Proportion of kill during breeding - long lines, otter trawls	Uniform	Midpoint	0.5	Range	0-1	7
Power - Wind energy						
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Uniform, binomial	Mean	0.33	Range, random	0.167-0.5	7
Agriculture - Pesticides						
Proportion landbirds	Uniform	Midpoint	0.95	Range	0.1	7
Proportion waterbirds	Uniform	Midpoint	0.0167	Conditional range	0.0-0.1	7
Proportion waterfowl	Uniform	Midpoint	0.0167	Conditional range	0.0-0.1	7
Proportion shorebirds	Uniform	Midpoint	0.0167	Conditional range	0.0-0.1	7
Proportion of kill during breeding	Fixed	Value	1	None	0	14
Mining - Pits and quarries						
Proportion landbirds	Uniform	Midpoint	0.95	Range	0.2	7
Proportion waterbirds	Uniform	Midpoint	0.025	Conditional range	0.0-0.2	7
Proportion shorebirds	Uniform	Midpoint	0.025	Conditional range	0.0-0.2	7
Kill	Log-normal	Point est.	125529	Standard deviation /mean	1	6
Mining – Metals and minerals						
All landbird eggs						

Agriculture – Haying						
All landbird eggs						
Transportation - Road maintenance						
Proportion landbirds	Multinomial	Mean	0.7007	Random		15
Proportion waterfowl	Multinomial	Mean	0.0806	Random		15
Proportion shorebirds	Multinomial	Mean	0.2187	Random		15
Harvest – Migratory birds						
Proportion juveniles: ducks	Beta	Mean	0.735	Standard deviation	0.104	16
Proportion juveniles: geese	Beta	Mean	0.30	Standard deviation	0.194	16
Proportion juveniles: snipe and woodcock	Beta	Mean	0.515	Standard deviation	0.099	16
Proportion juveniles: cranes, rails and coots	Beta	Mean	0.515	Standard deviation	0.099	17
Proportion juveniles: pigeons and doves	Beta	Mean	0.515	Standard deviation	0.099	17
Proportion juveniles: murres	Beta	Mean	0.5	Standard deviation	0.1	18
Proportion subadults: murres	Beta	Mean	0.3	Standard deviation	0.1	19
Communication – Tower collisions						
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.75	Random		8
Proportion landbirds	Multinomial	Mean	0.974	Random		8
Proportion waterbirds	Multinomial	Mean	0.008	Random		8
Proportion waterfowl	Multinomial	Mean	0.01	Random		8
Proportion shorebirds	Multinomial	Mean	0.008	Random		8
Transportation - Chronic ship-source oil						
Proportion juveniles in fall	Binomial	Mean	0.173	Random		11
Proportion subadults	Binomial	Mean	0.242	Random		11
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.5	Random		11,12

---

[*] *Conditional ranges were values that were constrained by the requirement that the proportion of the kill assigned across species groups must sum to 1.*

[+] *References for distributions: 1 – Blancher 2013; 2 – Canadian Migration Monitoring Network data from western Canada; 3 – Machtans et al. 2013; 4 – range between tall buildings and houses, no source; 5 – Fatal Light Awareness Program (www.flap.org; see Machtans et al. 2013); 6 – no data, wide distribution assigned; 7 – vague prior, no source; 8 – Longcore et al. 2012 (note that communication tower values were used for seasonal and species-composition of electrocutions); 9 – Rioux et al. unpublished manuscript, 10 – no data, assumed same distribution as road maintenance (Abraham et al. 2010; Appendix 1); 11 – Wiese et al. 2004; 12 – Fraser et al. 2006; 13 – Ellis et al. 2013; 14 – Mineau 2010 (Appendix 1);15 – Abraham et al. 2010 (Appendix 1); 16 – National Harvest Survey data, 2000-2011; 17 – snipe and woodcock data from National Harvest Survey (2000-2011); 18 – Elliot 1991; 19 – Gaston and Robertson 2010 (band recovery data).*

Table A2.2 – Demographic rates used in the stochastic model for anthropogenic avian mortality, to convert stage-specific losses for each of the five major species-groups to a total loss of potential adult breeders.

		Central tendency		Variation or range of values		
Vital rate	**Distribution**	**Type**	**Values**	**Type**	**Values**	**Source**$^+$
Waterfowl						
Clutch size (C)	Uniform	Midpoint	4.55	Range	1	1
Hatchability/hatch success (H)	Beta	Mean	0.91	Std. deviation	0.05	1
Nest survival/nest success (N)	Beta	Mean	0.13	Std. deviation	0.075	1
Survival to fledge (S_y)	Beta	Mean	0.39	Std. deviation	0.11	1
Nesting attempts (B)	Beta	Mean	2.77	Std. deviation	0.25	1
Juvenile overwinter survival (S_o)	Beta	Mean	0.8	Std. deviation	0.051	1
Adult overwinter survival (S_a)	Beta	Mean	0.8	Std. deviation	0.051	1
Shorebirds						
Fecundity ($C*N*H*S_y$)	Random draws	Mean of vector	0.357	Values	0.26, 0.49, 0.65, 0.05, 0.14, 0.55	2,3
Juvenile overwinter survival (S_o)	Random draws	Mean of vector	0.4095	Values	0.367, 0.452	2,3
Adult overwinter survival (S_a)	Random draws	Mean of vector	0.86	Values	0.85, 087	2,3
Waterbirds						
Fecundity ($C*N*H*S_y$)	Uniform	Midpoint	1.6	Range	0.5 to 2.7	4,5
Juvenile overwinter survival (S_o)	Beta	Mean	0.273	Std. deviation	0.273×0.5	5
Adult overwinter survival (S_a)	Uniform	Midpoint	0.823	Range	0.727 to 0.918	4,5
Landbirds (except upland game)						
Clutch size	Random draws	Mean / Median	4.31 / 4.00	Values	(see source 6, Appendix 1)	6,7
Nest success	Random draws	Mean / Median	0.515 / 0.463	Values	(see source 6, Appendix 1)	6,7
Survival to fledge (S_y)	Random draws	Mean / Median	0.442 / 0.395	Values	(see source 6, Appendix 1)	6,7
Juvenile overwinter survival (S_o)	Complementary beta	mean	0.32	Minimum range	0.18	8*
Adult overwinter survival (S_a)	Complementary beta	Mean	0.53	Minimum range	0.29	8
Upland game birds						
Juvenile overwinter survival (S_o)	Random draws	Mean of vector	0.441	Values	(0.366, 0.337, 0.486, 0.473, 0.518, 0.578, 0.505, 0.354, 0.565, 0.46, 0.71, 0.279, 0.014, 0.38, 0.51, 0.48, 0.48)	9-13
Adult overwinter survival (S_a)	Random draws	Mean of vector	0.441	Values	(0.366, 0.337, 0.486, 0.473, 0.518, 0.578, 0.505, 0.354, 0.565, 0.46, 0.71, 0.279, 0.014, 0.38, 0.51, 0.48, 0.48)	9-13

Seabirds						
Juvenile overwinter survival (S_o)	Beta	Mean	0.52	Std. deviation	0.52×0.05	14
Adult overwinter survival (S_a)	Beta	Mean	0.91	Std. deviation	0.91×0.05	14
Age of first breeding	None	Median	5	None	0	14
Immature survival ($S_o{*}S_a^3$)	Uniform	Midpoint	0.1988	Range	0.086-0.316	15*

+References for vital rates:1 – Hoekman et al. 2002; 2 – Gratto-Trevor 2000; 3 – Lowther et al. 2001; 4 – Tacha et al. 1992; 5 – Vennesland and Butler 2011; 6 – Hobson et al. 2013; 7 – Van Wilgenburg et al. 2013; 8 – Johnston et al. 1997; 9 – Gutierrez et al. 2003; 10 – Devers et al. 2007; 11 – Jones et al. 2008; 12 – Skrip et al. 2011; 13 – Harrison 2001; 14 – Wiese et al. 2004; 15 – Huntington et al. 1996

** Estimated using the other vital rates available, assuming a stable population ($S_o = (1- S_a)/F$), where S_a is adult survival and F is fecundity*

Literature Cited (Appendix 2)

Blancher, P. J. 2013. Estimated number of birds killed by house cats (*Felis catus*) in Canada. *Avian Conservation and Ecology* (this issue).

Devers, P. K., D. F. Stauffer, G. W. Norman, D. E. Steffen, D. M. Whitaker, J. D. Sole, T. J. Allen, S. L. Bittner, D. A. Buehler, J. W. Edwards, D. E. Figert, S. T. Friedhoff, W. W. Giuliano, C. A. Harper, W. K. Igo, R. L. Kirkpatrick, M. H. Seamster, H. A. Spiker Jr., D. A. Swanson, and B. C. Tefft. 2007. Ruffed grouse population ecology in the Appalachian Region. *Wildlife Monograph* 168:1-36.

Elliot, R.D. 1991. The management of the Newfoundland turr hunt. Pages *in* 29-35 A.J. Gaston and R.D. Elliot, editors. *Studies of High-Latitude Seabirds 2: Conservation Biology of Thick-Billed Murres in the Northwest Atlantic*. Canadian Wildlife Service, Ottawa, Ontario, Canada.
.
Ellis, J. I., S. I. Wilhelm, A. Hedd, G. S. Fraser, G. J. Robertson, J.-F. Rail, M. Fowler, and K. H. Morgan. 2013. Mortality of migratory birds from marine commercial fisheries and offshore oil and gas production in Canada. *Avian Conservation and Ecology* (this issue).

Fraser, G., J. Russell, and W. Von Zharen. 2006. Produced water from offshore oil and gas installations on the Grand Banks, Newfoundland and Labrador: Are the potential effects of seabirds sufficiently known. *Marine Ornithology* 34:147–156.

Gaston, A. J., and G. J. Robertson. 2010. Trends in the harvest of Brünnich's Guillemots in Newfoundland: Effects of regulatory changes and winter sea-ice conditions. *Wildlife Biology* 16:47-55.

Gratto-Trevor, C. L. 2000. Marbled Godwit (*Limosa fedoa*). *In* A. Poole, editor. The Birds of North America Online. Birds of North America, Inc. [online] URL: http://bna.birds.cornell.edu/bna/species/492

Gutierrez, R.J., G. S. Zimmerman, and G.W. Gullion. 2003. Daily survival rates of ruffed grouse *Bonasa umbellus* in northern Minnesota. *Wildlife Biology* 9: 351-356.

Harrison, S. 2001. Effects of forest connectivity on ecological processes: using spruce grouse as a model system. Dissertation. University of British Columbia, Vancouver, British Columbia, Canada.
Hobson, K. A., A. Wilson, S. L. Van Wilgenburg, and E. Bayne. 2013. An estimate of nest loss in Canada due to industrial forestry operations. *Avian Conservation and Ecology* (this issue).

Hoekman, S.T., L. S. Mills, D. W. Howerter, J.H. Devries, and I. J. Ball. 2002. Sensitivity analyses of the life cycle of Midcontinent Mallards. *Journal of Wildlife Management* 66:883-900.

Huntington, C. E., R. G. Butler, and R. A. Mauck. 1996. Leach's Storm-Petrel (*Oceanodroma leucorhoa*). *In* A. Poole, editor. The Birds of North America Online. Birds of North America, Inc. [online] URL: http://bna.birds.cornell.edu/bna/species/233

Johnston, J. P., W. J. Peach, R. D. Gregory, and S. A. White. 1997. Survival rates of tropical and temperate passerines: A Trinidadian perspective. *American Naturalist* 150: 771-789.

Jones, B. C., C. L. Dobey, J. L. Kleitch, C.A. Harper, D.A. Buehler, W.G. Minser III, and G.S. Warburton. 2008. Ruffed Grouse Survival and Population Structure in Western North Carolina. *Proceedings of the Annual Conference of the Southeast Association of Fish and Wildlife Agencies* 62:51–57.

Longcore, T., C. Rich, P. Mineau, B. MacDonald, D. G. Bert, L. M. Sullivan, E. Mutrie, S. A. Gauthreaux Jr., M. L. Avery, R. L. Crawford, A. M. Manville II, E. R. Travis, and D. Drake. 2012. An estimate of avian mortality at communication towers in the United States and Canada. *PLoS ONE* 7(4): e34025. URL: doi:10.1371/journal.pone.oo34025

Lowther, P. E., H. D. Douglas III, and C. L. Gratto-Trevor. 2001. Willet (Tringa *semipalmata*). *In* A. Poole, editor. The Birds of North America Online. Birds of North America, Inc. [online] URL: http://bna.birds.cornell.edu/bna/species/579

Machtans, C. S., C. H. R. Wedeles, and E. M. Bayne. 2013. A first estimate for Canada of the number of birds killed by colliding with buildings. *Avian Conservation and Ecology* (this issue).

Skrip, M. M., W. F. Porter, B. L. Swift, and M. V. Schiavone 2011. Fall-winter survival of Ruffed Grouse in New York State. *Northeastern Naturalist* 18:395-410. 2011.

Tacha, T. C., S. A. Nesbitt, and P. A. Vohs. 1992. Sandhill Crane (Grus *canadensis*). *In* A. Poole, editor. The Birds of North America Online. Birds of North America, Inc. [online] URL: http://bna.birds.cornell.edu/bna/species/031

Van Wilgenburg, S. L., K. A. Hobson, E. M. Bayne, and N. Koper. 2013. Estimated avian nest loss associated with oil and gas exploration and extraction in the Western Canadian Sedimentary Basin. *Avian Conservation and Ecology* (this issue).

Vennesland, R. G., and R. W. Butler. 2011. Great Blue Heron (*Ardea herodias*). *In* A. Poole, editor. The Birds of North America Online. Birds of North America, Inc. [online] URL: http://bna.birds.cornell.edu/bna/species/025

Wiese, F. K., G. J. Robertson, and A. J. Gaston. 2004. Impacts of chronic marine oil pollution and the murre hunt in Newfoundland on thick-billed murre *Uria lomvia* populations in the eastern Canadian Arctic. *Biological Conservation* 116: 205-216.

Appendix 3. Details of population-level impacts of anthropogenic avian mortality in Canada.

Table A3.1 –Total mortality relative to abundance for species (or regional populations) and families, as illustrated in Fig. 2. Original stage-specific mortality totals presented in each paper are listed by life stage (*Ke*: eggs/nestlings, *K-unk.*: unknown-age mobile individuals; *Kf*: fledglings; *Ka*: adults), as well as the total converted mortality in equivalent number of adult breeders is also shown (*M*). The proportion value in the final column (%) represents the ratio between M and abundance. Abundance estimates are those provided directly by authors, except for building collisions, where family-level abundance was derived from current Canadian estimates (Blancher 2002, P. Blancher *unpubl. data*), and used to estimate proportional kill (M / abundance).

Source	**Species or family (region)**		**Group**	***Ke***	***K-unk.***	***Kf***	***Ka***	***M***	**Abundance**	**%**
Marine bycatch	Common Murre (Funk Is.)	*Uria aalge*	Seabirds	-	-	-	4,500	4,500	984,000	**0.46%**
Marine bycatch	Black-footed Albatross	*Phoebastria nigripes*	Seabirds	-	-	-	99	99	2,500	**3.96%**
Marine bycatch	Common Eider (SW NS)	*Somateria mollissima*	Seabirds	-	-	-	532	532	7,600	**7.00%**
Marine bycatch	Northern Gannet	*Morus bassanus*	Seabirds	-	-	-	320	320	160,000	**0.20%**
Marine bycatch	Great Shearwater	*Puffinus gravis*	Seabirds	-	-	-	2,346	2,135	1,500,000	**0.14%**
Oil and gas - marine	Leach's Storm-Petrel	*Oceanodroma leucorhoa*	Seabirds	-	-	62	-	12	20,000,000	**0.00%**
Oil and gas - marine	Thick-billed Murre	*Uria lomvia*	Seabirds	-	126	-	-	71	8,000,000	**0.00%**
Oil and gas - marine	Common Murre	*Uria aalge*	Seabirds	-	32	-	-	18	2,000,000	**0.00%**
Oil and gas - marine	Dovekie	*Alle alle*	Seabirds	-	2,086	-	-	1,157	132,000,000	**0.00%**
Oil and gas - terrestrial	Sprague's Pipit	*Anthus spragueii*	Landbirds	-	-	-	482	482	613,000	**0.08%**
Oil and gas - terrestrial	Western Meadowlark	*Sturnella neglecta*	Landbirds	-	-	-	550	550	2,100,000	**0.03%**
Oil and gas - terrestrial	Canada Warbler	*Cardellina canadensis*	Landbirds	-	-	-	74	74	210,000	**0.04%**
Oil and gas - terrestrial	Ovenbird	*Seiurus aurocapilla*	Landbirds	-	-	-	730	730	1,750,000	**0.04%**
Wind energy	Horned Lark	*Eremophilia alpestris*	Landbirds	-	1,480	-	-	1,171	30,000,000	**0.00%**

Wind energy	Golden-crowned Kinglet	*Regulus satrapa*	Landbirds	-	888	-	-	702	23,000,000	**0.00%**
Wind energy	Red-eyed Vireo	*Vireo olivaceus*	Landbirds	-	888	-	-	702	96,000,000	**0.00%**
Wind energy	European Starling	*Sturnus vulgaris*	Landbirds	-	740	-	-	585	30,000,000	**0.00%**
Wind energy	Tree Swallow	*Tachycineta bicolor*	Landbirds	-	592	-	-	468	12,000,000	**0.00%**
Wind energy	Canada Warbler	*Cardellina canadensis*	Landbirds	-	44	-	-	35	1,350,000	**0.00%**
Wind energy	Chimney Swift	*Chaetura pelagica*	Landbirds	-	44	-	-	35	145,000	**0.02%**
Agriculture (haying)	Bobolink	*Dolichonyx oryzivorus*	Landbirds	666,784	-	-	-	48,570	3,991,300	**1.22%**
Agriculture (haying)	Savannah Sparrow	*Passerculus sandwichensis*	Landbirds	940,697	-	-	-	68,522	23,628,000	**0.29%**
Agriculture (haying)	Clay-coloured Sparrow	*Spizella pallida*	Landbirds	215,321	-	-	-	15,684	20,174,600	**0.08%**
Agriculture (haying)	Vesper Sparrow	*Pooecetes gramineus*	Landbirds	249,074	-	-	-	18,143	10,012,100	**0.18%**
Agriculture (haying)	Horned Lark	*Eremophila alpestris*	Landbirds	137,524	-	-	-	10,017	11,476,240	**0.09%**
Road maintenance	Killdeer	*Charadrius vociferous*	Shorebirds	2,026	-	-	-	74	1,613,200	**0.00%**
Road maintenance	Savannah Sparrow	*Passerculus sandwichensis*	Landbirds	9,306	-	-	-	703	35,770,000	**0.00%**
Road maintenance	Song Sparrow	*Melospiza melodia*	Landbirds	4,175	-	-	-	316	24,030,000	**0.00%**
Road maintenance	Clay-colored Sparrow	*Spizella pallida*	Landbirds	1,088	-	-	-	82	18,982,000	**0.00%**
Road maintenance	Vesper Sparrow	*Pooecetes gramineus*	Landbirds	3,053	-	-	-	231	10,692,600	**0.00%**
Road maintenance	Mallard	*Anas platyrhynchos*	Waterfowl	5,501	-	-	149	352	3,857,800	**0.01%**
Mining – Pits/quarries	Killdeer (ON/QC/BC/AB)	*Charadrius vociferus*	Shorebirds	6,725	-	-	-	246	1,230,000	**0.02%**
Mining – Pits/quarries	Bank Swallow (ON/QC/BC/AB)	*Riparia riparia*	Landbirds	66,573	-	-	-	5,031	1,540,000	**0.33%**
Buildings - Houses	Hawks	*Accipitridae*	Landbirds	-	66,207	-	-	48,758	2,622,622	**1.86%**

Buildings - Houses	Pigeons	*Colombidae*	Landbirds	-	573,793	-	-	422,570	7,740,543	**5.46%**
Buildings - Houses	Hummingbirds	*Trochilidae*	Landbirds	-	220,690	-	-	162,527	10,227,596	**1.59%**
Buildings - Houses	Woodpeckers	*Picidae*	Landbirds	-	286,897	-	-	211,285	66,624,318	**0.32%**
Buildings - Houses	Jays and crows	*Corvidae*	Landbirds	-	331,034	-	-	243,790	39,786,259	**0.61%**
Buildings - Houses	Chickadees	*Paridae*	Landbirds	-	2,891,034	-	-	2,129,102	48,613,670	**4.38%**
Buildings - Houses	Nuthatches	*Sittidae*	Landbirds	-	640,000	-	-	471,328	19,349,207	**2.44%**
Buildings - Houses	Robins and thrushes	*Turdidae*	Landbirds	-	3,553,103	-	-	2,616,683	333,229,833	**0.79%**
Buildings - Houses	Warblers	*Parulidae*	Landbirds	-	573,793	-	-	422,570	1,342,494,691	**0.03%**
Buildings - Houses	Sparrows	*Emberizidae*	Landbirds	-	7,260,690	-	-	5,347,135	913,357,792	**0.59%**
Buildings - Low/mid	Warblers	*Parulidae*	Landbirds	-	508,800	-	-	328,411	1,342,494,691	**0.02%**
Buildings - Low/mid	Sparrows	*Emberizidae*	Landbirds	-	422,400	-	-	272,643	913,357,792	**0.03%**
Buildings - Low/mid	Robins and thrushes	*Turdidae*	Landbirds	-	355,200	-	-	229,268	333,229,833	**0.07%**
Buildings - Low/mid	Cardinals	*Cardinalidae*	Landbirds	-	151,200	-	-	97,594	14,699,849	**0.66%**
Buildings - Low/mid	Finches	*Fringillidae*	Landbirds	-	96,000	-	-	61,964	62,185,839	**0.10%**
Buildings - Low/mid	Mimids	*Mimidae*	Landbirds	-	96,000	-	-	61,964	7,284,285	**0.85%**
Buildings – Tall	Warblers	*Parulidae*	Landbirds	-	17,688	-	-	9,808	1,342,494,691	**0.00%**
Buildings – Tall	Sparrows	*Emberizidae*	Landbirds	-	15,745	-	-	8,730	913,357,792	**0.00%**
Buildings – Tall	Robins and thrushes	*Turdidae*	Landbirds	-	4,221	-	-	2,340	333,229,833	**0.00%**
Buildings – Tall	Creepers	*Certhiidae*	Landbirds	-	2,278	-	-	1,263	16,106,293	**0.01%**
Buildings – Tall	Chickadees	*Paridae*	Landbirds	-	2,211	-	-	1,226	48,613,670	**0.00%**

Literature Cited (Appendix 3)

Blancher, P. J. 2002. Importance of breeding birds exported from Canada – information on landbirds and shorebirds. Unpublished report to the North American Bird Conservation Initiative Canada National Council, Ottawa, Ontario, Canada.

Appendix 4. Methodology for maps of anthropogenic avian mortality risk.

Overview

The two maps shown in main manuscript were created by assembling vector format data layers and overlaying a 50 × 50 km tile grid for summarizing the data. We calculated the relative proportion of each source of mortality occurring in each grid square as a function of direct or indirect measures of intensity of each mortality source. The estimated kill for each source was then allocated across the applicable grid tile according to the proportional intensity of the mortality source calculated. The tile grid was used to summarize the overall bird mortalities occurring across Canada based on the following seven data layers representing eight sources of terrestrial mortality:

- Roads
- Communication Towers
- Terrestrial Oil and Gas
- Forestry
- Agriculture
- Population Density (used as an index of building and cat distribution)
- Wind Farms.

These were the only sources for which suitable data were available for mapping. A detailed summary of data sources, manipulations, and a map for each mortality source is provided in this appendix. All work was done in ArcGIS 10.0 and area calculations were done in Albers Equal Area Conic projection. Specific procedures/functions are noted to encourage replication or improvement.

The general approach for each layer followed this example: The total amount of disturbance for each mortality source was calculated for all of Canada (e.g. km of roads or km^2 of oil and gas disturbance). Grid tiles overlapping that mortality source were identified. For instance, if 137 grid tiles had oil and gas activity, the total area of oil and gas disturbance was taken from the previous calculation and the proportion of disturbance in each tile was derived by simple division. The proportional kill for that entire mortality source was then assigned to each applicable tile. If a single tile had 5% of the total national disturbance, the total kill for oil and gas was multiplied by 0.05 and assigned to that tile. Therefore the units for each mortality source are in birds or nests taken as per the original research paper. Standardized values from our manuscript Table 3 were not used because they were not calculated at the same geographic level of specificity (e.g. kills for agriculture were converted nationally, not at the BCR level).

Grid totals (number of kills) were created by summing the values for the eight mortality sources above. Each map was coloured in a colour ramp of 10 classes and the natural breaks (Jenks) classification method was applied for all datasets (http://en.wikipedia.org/wiki/Jenks_natural_breaks_optimization). Note that this classifier does not produce equal width classes, but does optimize the splits for presentation.

As noted generally in the manuscript text, the following caveats apply:

- The map is a gross approximation only and we acknowledge that none of the sources/sectors above would be expected to have kill exactly proportional to their intensity. Technically we consider it to be a map of potential risk that remains unrealized until the sources of mortality interact with birds and result in deaths.

- Actual kill in any given tile would depend on many factors that cannot be mapped with currently available national data: the density of birds, the specific interaction of the source/sector with those birds in each environment (i.e. traffic volume, height of roadside verges, local features attracting birds), the seasonal timing of the activity, and even local weather conditions in any given year.
- In certain cases, such as forestry, a realistic calculation should be based on the location of actual cutting in Canada rather than the entire area available for cutting. This would be similar for farming; the location and spatially explicit footprint of each crop or farm type would ideally be known nationally. Such data are not available.
- In spite of these caveats, it remains self-evident that kills occur where the source/sector operates and, as a generalization, more activity by a given source/sector would result in some incremental increase in kill. We have constrained the scale of the map and smoothed the final product to minimize the perceived precision of the mapping classes.

Each section below contains the data source for each source of mortality, how we derived the maps and sector-specific maps that are not presented in the main paper.

Bird-vehicle Collisions

- Source: GeoBase website (http://www.geobase.ca/) National Roads Database, 2011.
- Spatial Reference: NAD83CSRS (North American Datum 1983 in Canadian Spatial Reference System)
- Ellipsoid Name: GRS80 (Geodetic Reference System 1980)
- Total kill figure used: Kills per km/day of road, by ecotype, from Table 3 in Bishop and Brogan 2013.

The National Road Network (NRN) is produced, updated, and distributed (with the support of GeoConnections) through collaborative agreements between Natural Resources Canada, Statistics Canada, and the provincial and territorial governments. A detailed summary of the product is here:

http://www.geobase.ca/geobase/en/data/nrn/description.html

Methodology:

A roads layer was created from the NRN which displayed only 1 and 2 lane paved roads that occurred outside of urban areas using a ‘select by attributes’ query and did not contain Ramp features. A ‘create layer from selected features’ was then used to create a new layer containing only these selected features. The query used to extract this data was: ("NBRLANES" <3 AND ("PAVSTATUS" = '1Paved' OR "PAVSTATUS" = '2Paved' OR "PAVSTATUS" = 'Paved') AND "ROADCLASS" <> 'Ramp').

Roads were separated by ecozone type following the methods in Bishop and Brogan (2013); ecozone types consisted of: Broadleaf and Mixed Forest (classified as one ecozone), Coniferous High Volume (1%), Coniferous Low Volume (99%), Cropland, 90% Rangeland Area, 10% Rangeland Area and Wetlands. Each ecozone type was assigned a kill value for the number of birds killed per kilometre of road based on Table 3 in Bishop and Brogan (2013).

Roads were separated into each individual 50 km tile by using the 'Intersect' tool**.** The intersect output contained numerous road segments and types by tile; each ecotype total was multiplied by the value for birds killed per kilometre per day corresponding to the ecotype classification of that segment and then multiplied by the number of days (122) and adjusted for scavenging by multiplying by 2.97 (Table 3, Bishop and Brogan 2013).

The 'merge' tool was then used to join all 7 ecozone types together with all of their final road values for the number of birds killed by unique tile ID. The 'Dissolve' tool was then run to dissolve all roads by Tile ID and sum the total number of birds killed annually for all 7 ecozones.

The result of the road analysis is shown in Fig. A4.1.

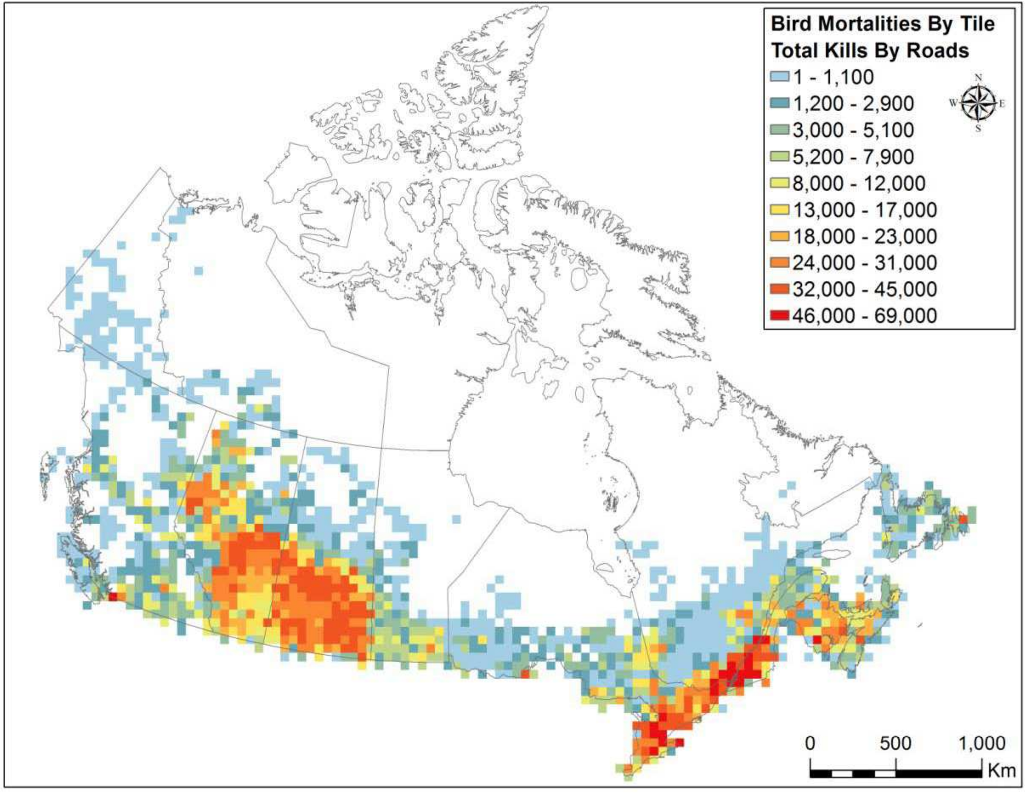


Fig. A4.1 – Approximated distribution of bird-vehicle collisions in Canada on road types considered by Bishop and Brogan (2013).

Communication Towers

- Source: NAVCAN database of tower locations. License paid for by Environment Canada for EC use as specified in agreement. Substantial corrections on the original data were performed by Beau MacDonald (The Urban Wildlands Group, Los Angeles, CA, USA) for use in Longcore et al. (2012).
- Spatial Reference: n/a
- Ellipsoid Name: n/a
- Total kill figure used: ~221,000 (Table 7, Longcore et al. 2012).

Methodology

NavCan tower data were provided in a proofread and cleaned format. The equation from Fig. 3 of Longcore et al. (2012) was used to calculate predicted tower mortality for each tower. Longcore et al. (2012) used a probability-based reduction of totals at the BCR level to account for towers that were guyed or not and steadily lit or not. We applied a BCR-specific static adjustment to each tower kill value such that our BCR total matched those from Longcore et al (2012) because we calculated mortality at the individual tower level. Only towers > 60m tall were considered in our analysis, the same restriction used by Longcore et al. (2012).

The 50 × 50 km tile grid was overlaid with the communications tower point layer and a spatial join was performed to link each point to the proper tile that it fell within. The Dissolve tool was then run to sum the number of kills by tile ID using the statistics function.

The results of our communication towers analysis is shown in Fig. A4.2

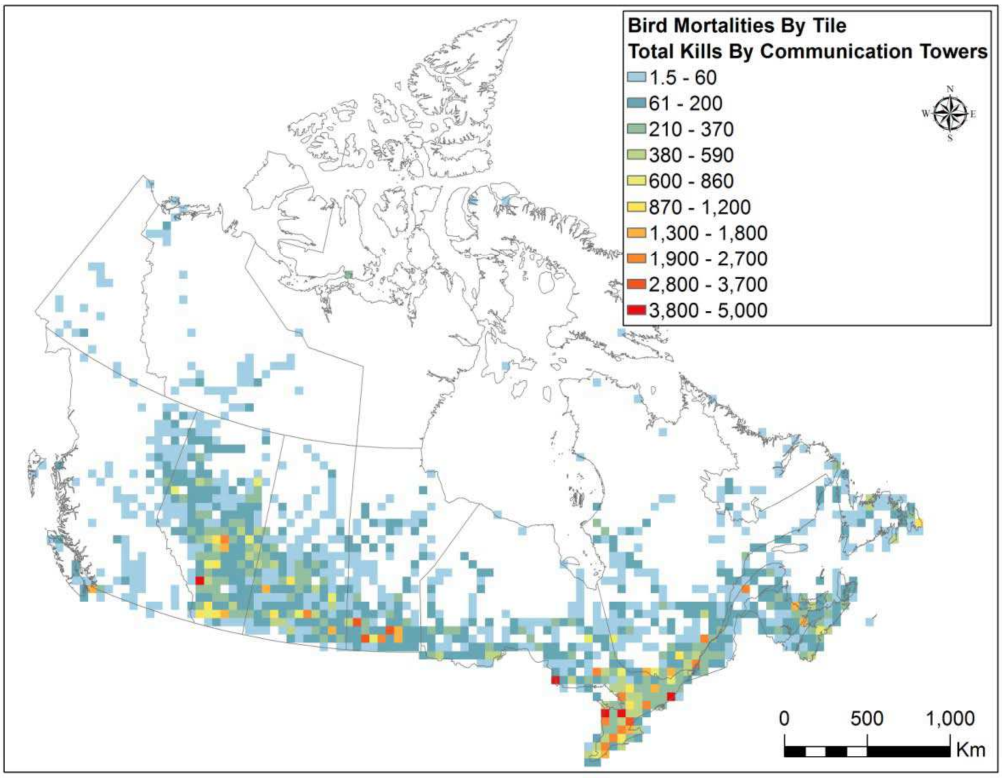


Fig. A4.2 – Approximated distribution of kills from birds colliding with communication towers >60 m in Canada.

Terrestrial Oil and Gas (wells, seismic lines, pipelines)

Total kill figures are from the mean value column of Table 3 (number of nests) in Van Wilgenburg et al. (2013). Those data are split in each province into boreal areas and prairie areas.

Manitoba

- Source: Manitoba Innovation, Energy and Mines http://www.gov.mb.ca/iem/petroleum/gis/index.html
- Spatial Reference: North American 1983 CSRS UTM Zone 14N
- Ellipsoid Name: GRS 80
- Total kill figure used: Boreal: 211, Prairie: 92

Metadata are not provided with the wells file on the above noted website.

The data was displayed by township (6 mile by 6 mile square area polygons) which contained the number of wells within each township.

Saskatchewan

- Source: Saskatchewan Energy and Resources oil and gas information viewer, http://www.infomaps.gov.sk.ca/website/SIR_Oil_And_Gas_Wells/viewer.htm
- Spatial Reference: North American 1983 UTM Zone 13N
- Ellipsoid Name: GRS 80
- Total kill figure used: Boreal: 284, Prairie: 2602

Metadata are available at https://www.geosask.ca by entering the Spatial Gallery, searching for the data layer “wells” and using the metadata viewer.

The data was displayed by township (6mile by 6mile squares) which contained the number of wells within each township.

Alberta

- Source: Energy Resources Conservation Board (http://www.ercb.ca/) data subscription for well data to Environment Canada.
- Spatial Reference: North American 1983 UTM Zone 10N
- Ellipsoid Name: GRS 80
- Total kill figure used: Boreal: 1125, Prairie: 5677

The data were in point format and each point contained a value for the number of wells at that specific location.

Metadata are provided via Environment Canada’s digital subscription (i.e. not on the ERCB website) and are available by contacting the authors.

British Columbia

- Source: British Columbia Oil and Gas Commission, ftp://www.bcogc.ca/outgoing/OGC_Data/Wells/
- Spatial Reference: BC Albers, NAD83
- Ellipsoid Name: GRS 80
- Total kill figure used: Boreal: 1125, Prairie: n/a

In addition to the short metadata associated with the above link, more information on the data is available here:
ftp://www.bcogc.ca/outgoing/OGC_Data/ePASS_Documents/ePASS_Standards_Requirements.pdf

Methodology

We restricted our analysis to the area covered by Van Wilgenburg et al. (2013). Raw well data for Manitoba and Saskatchewan were processed by S. Van Wilgenburg and overlaid with the official township grid for those provinces. The township grid (polygon data) for Manitoba and Saskatchewan were placed into one dataset by using the 'Merge' tool to place all townships into one dataset (containing the number of wells by township).

No township data was available without an associated fee for British Columbia and Alberta so a 6 × 6 mile tiled grid was created using the Fishnet tool in order to represent the size of townships within Alberta and British Columbia (Taylor 1975). The 6 × 6 mile tiled grid was then overlaid with the point layer that was provided for AB and BC in order to assign a well count value to each township grid using a spatial join. The output was a polygon vector that contained numerous point data (many points) to one township. The dissolve tool was used to sum up the total count value of wells by township. The township polygon for AB and BC was then added to the MB and SK township dataset using the 'Merge' tool.

Using the Bird Conservation Regions (BCR) layer (http://www.nabci-us.org/bcrs.htm) the townships were classified as Boreal or Prairie based on which larger proportion of the township fell within the specified BCR (11 for prairie, 6 for boreal).

We calculated the area in each township disturbed by seismic line and pipelines using the following formulas from Appendix 1 of Van Wilgenburg et al. (2013) based on the well count value.

- The percent of township disturbed by seismic lines in the Boreal Plain Ecozone can be estimated as: $\% = (0.974 + 0.807*\log(\text{wells}))^2$
- The percent of a township disturbed by seismic lines in the Grassland Natural Region (Prairie) can be estimated as: $\% = (0.430 + 0.006*\log(\text{wells}))^2$
- The percent of a township disturbed by pipeline right-of-ways in the Boreal Plain Ecozone can be estimated as: $\% = (0.699 + 1.866*\log(\text{wells}))^2$
- The percent of a township disturbed by pipeline right-of ways in the Grassland Natural Region (Prairie) can be estimated as: $\% = (0.655 + 1.811*\log(\text{wells}))^2$

We had to convert well count to well area within each township. A value of 20,000 m^2 (2 ha) was assigned to each well based on written advice from the Canadian Association of Petroleum Producers as used in Van Wilgenburg et al. (2013). The sum of the area disturbance by seismic lines, pipelines and the total well areas by township were summed to obtain the overall area of disturbance by township.

Townships were intersected with the 50 × 50 km tile grid. An area calculation was done on the divided (intersected) townships in order to determine the proportion of that township that fell within each tile. The proportion value was then multiplied by the overall area of disturbance by township (sum of Seismic, Pipeline and Well area) in order to determine the total area of disturbance within each tile. The 'Dissolve' tool was run to dissolve all townships by tile and the statistics field was used to 'SUM' the area of disturbance values for each portion of the townships that fell within each individual tile.

The BCR layer was then overlaid with the 50 × 50 km tiled disturbance area layer and each tile was reclassified as 'Boreal' or 'Prairie'. Whichever larger portion (>50%) of the cell fell within the specified BCR then that tile was classified as that region.

The proportion value for each tile was calculated from the final disturbance value depending on which province and part of a province (boreal or prairie) the tile fell into. Total disturbance value by each provincial region was calculated. In areas where tiles overlapped with provinces and/or prairie/boreal regions, the proportion of each had to be calculated using the area field and multiplying those proportions based off of the total tile area of 2500 km^2; in all other cases the tile had a value of 100% for the province/region intersect.

The proportion of each 50 × 50 km tile disturbed were then multiplied by the kill values listed above for each of the 7 intersections of province and habitat. Calculations were all performed within the Field Calculator.

The result of our oil and gas analysis is shown in Fig. A4.3.

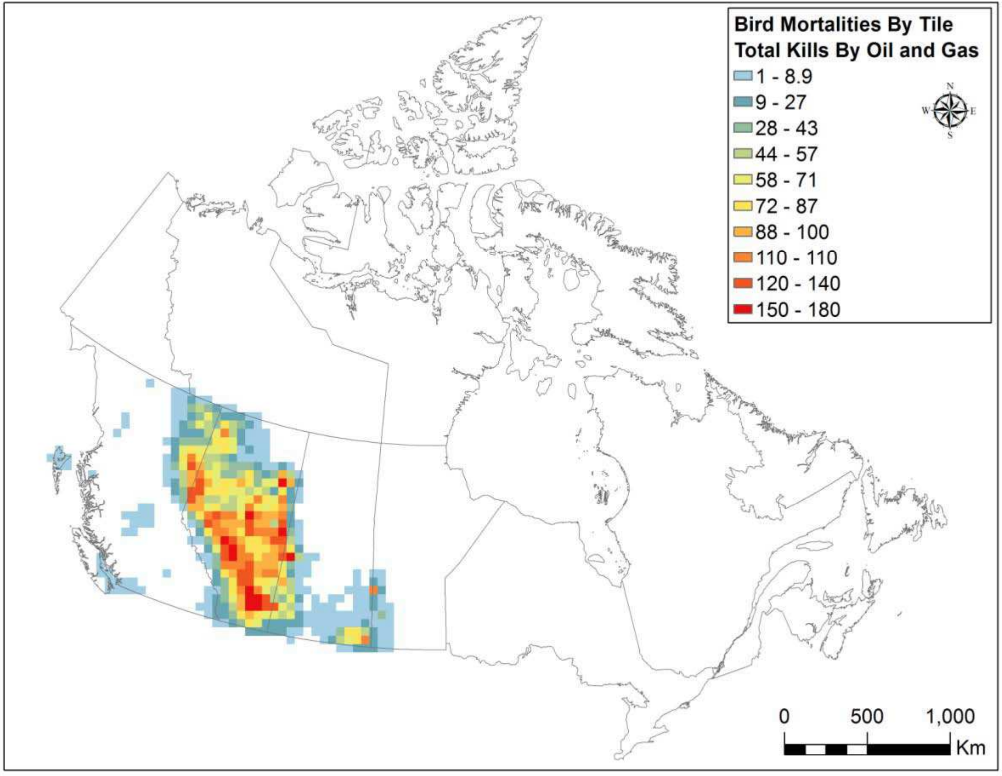


Fig. A4.3 – Approximated distribution of nests destroyed from the oil and gas sector in the western Canadian sedimentary basin as enumerated by Van Wilgenburg et al. (2013).

Forestry

- Source: Global Forest Watch Canada data warehouse (http://datawarehouse.globalforestwatch.ca/), Canadian Commercial Forest Tenures Map (last updated on January 30th, 2004)
- Spatial Reference: Lambert Conformal Conic
- Ellipsoid Name: Clarke 1866
- Total kill figures (nests) from Hobson et al. (2013, Table 6) by averaging the low PIF estimate and the high BAM estimate (see Table A4.1)

A brief description of the data from Global Forest Watch Canada is: "A compilation of the basic forest tenure/concession data from all of the provinces. [It] includes companies in order of allowable annual cut (where applicable/available). Tenures/concession polygons will contain areas restricted to logging and other resources extraction activities by protected areas legislation and by other legislative and policy restrictions. We attempted to include only crown lands and exclude all private lands where the data was available (e.g., New Brunswick), but other jurisdictions may have inadvertently included private lands."

Metadata: http://www.globalforestwatch.ca/data/tenure_spatial/CANADA/canada_tenures.txt

Table A4.1 – Estimated nests destroyed by forestry from Hobson et al. (2013).

Province	Estimated nests destroyed
BC	387,926
AB	62,210
SK	15,316
MB	6039
ON	255,832
QC	372,680
NB	126,316
NS	88,924
PEI	6938
NF	15,576
NT, YK, NU	0 (no forest tenure map data available, no tenures, or no forestry in the region)

Methodology

The forestry tenure data (Fig. A4.4) was dissolved and overlaid with the 50 × 50 km tile grid and clipped by tile. Tiles were broken down by province and the proportion of forestry tenure that occurred within each tile, within a province was determined. The proportion of forestry by tile by province was then multiplied by the kill values (above) by province in order to determine the total kills by tile. This value represents the number of nests destroyed by tile.

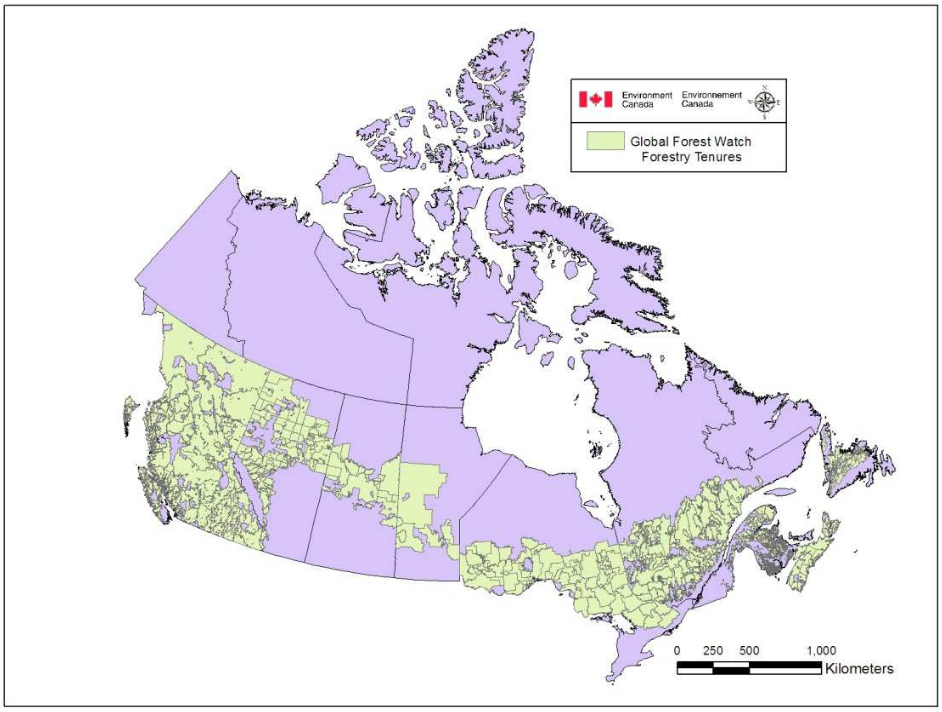


Fig. A4.4: Forestry tenures across Canada as mapped by Global Forest Watch. Data are current to 2004.

The result of our forestry analysis is shown in Fig. A4.5.

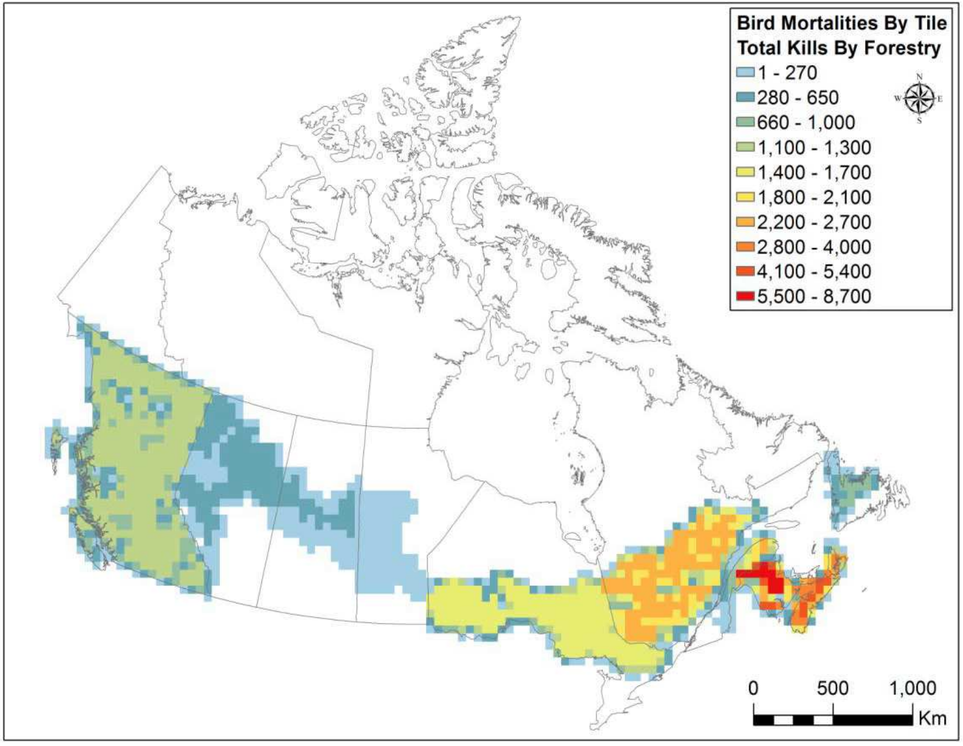


Fig. A4.5 - Approximated distribution of nests destroyed from the forestry sector in Canada as enumerated by Hobson et al. (2013).

Agriculture

- Source: Statisics Canada 2006 Agriculture Census (http://www.statcan.gc.ca/ca-ra2006/index-eng.htm) tabular data (no shapefiles)
- Spatial Reference: n/a
- Ellipsoid Name: n/a
- Total kill figures (nestlings or eggs) taken from data appendices of Tews et al. (2013):

Table A4.2 – Total kills of nestlings/eggs for five species from data appendix of Tews et. al. (2013) broken down by BCR and type of farming. BCR and grand totals match Table 3 of Tews et al. (2013).

BCR	Grain	Haying	Vegetable	Totals
5	1	209,913	0	**209,915**
6	5,276	167,061	0	**172,337**
8	2,345	43,778	2810	**48,933**
9	1	7,460	0	**7,461**
10	31	36,602	0	**36,633**
11	12,075	610,821	0	**622,897**
12	5,079	155,270	1,672	**162,021**
13	22,777	618,698	49,252	**690,727**
14	41,568	203,789	13,119	**258,477**
Totals	**89,155**	**2,053,393**	**66,853**	**2,209,401**

Agriculture Census information: http://www.statcan.gc.ca/ca-ra2006/about-apropos-eng.htm

Methodology

Tabular agricultural data from the 2006 Agricultural Census was manually combined with the Canadian Census Subdivision (CD) data (http://www12.statcan.gc.ca/census-recensement/2011/geo/bound-limit/bound-limit-2011-eng.cfm). The number of each farm types that were present within that CD was entered from the Agriculture Census Data tables.

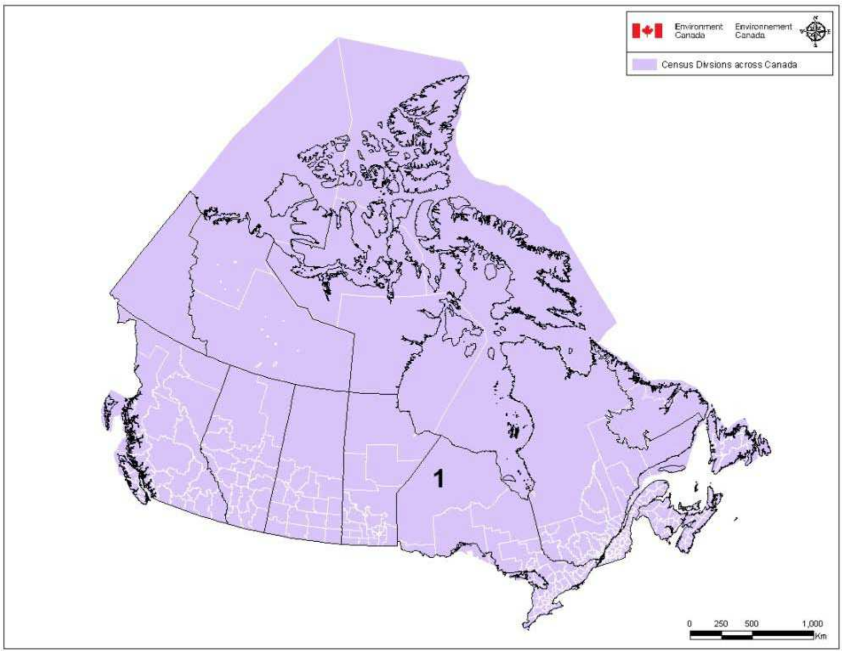


Fig. A4.6 – Census divisions (CDs) of Canada from Statistics Canada. Note that the northern portion of most provinces and all of the territories have very large divisions. The CD labeled with a '1' is Kenora and is discussed in the text as an example of how the large divisions were problematic.

Below is the list of farm types that have been identified in the Agriculture Census Data. The number in front of each is how we classified them into the aggregate groups following the main list:

2 Hay Farming
3 Fruit and vegetable combination farming
3 All other miscellaneous crop farming
3 Floriculture Production
3 Tobacco Farming
3 Other food crops grown under cover
5 Nursery and tree production
3 Fruit and tree nut farming
3 Mushroom Production
6 Livestock combination farming
4 All other miscellaneous animal production
4 Horse and other equine production
4 Fur bearing animal and rabbit production
6 Goat Farming
5 Apiculture
4 Other poultry production
6 Sheep farming
4 Poultry Hatcheries
3 Potato Farming
3 Other Vegetables (except potatoes) and melon farming
1 Corn farming
1 Other grain farming
1 Dry pea and bean farming
1 Wheat Farming
1 Soybean Farming
1 Oilseed (except soybean) farming
4 Combination poultry and egg production
4 Broiler and other meat type chicken production
4 Turkey Production
4 Hog Pig Farming
4 Chicken Egg Production
4 Dairy Cattle Milk Production
6 Beef Cattle Ranching Farming Feedlots

Aggregated Groups:

1 – annual grain type cropping
2 – hay farming
3 – fruit, vegetable, other miscellaneous farming
4 – animal farming, not big grazers
5 – farming without regular harvesting (bees, tree growing)
6 – livestock/grazers

Tews et al. (2013) only calculated mortality estimates for the first 3 groups above. Mortality from grazing was calculated by Bleho et al. (2013) separately and is not mapped.

Methodology

Since there were no geospatial files available with this agricultural data, the CD's geospatial data was downloaded from Statistics Canada in order to link the unique CD ID's with the CD ID's from the 2006 Census of Agriculture dataset. The datasets were merged by using the 'join' operation based on the CD Unique ID's.

CDs in Canada are not equally sized (Fig. A4.6), nor particularly representative of areas of the country where agriculture occurs (Fig. A4.7). This creates a problem as the number and type of farms is only summarized at the CD level. For large CDs with very little agriculture (such as Kenora in Fig. A4.6), we initially had uniformly distributed the farm count across all of our 50 × 50 km tiles covering the entire CD. The result of that process was that it appeared as though hay farming occurred everywhere at a low level in Ontario, from the US border right to James Bay.

To fix this problem we constrained our 50 × 50 km tile grid by the extent of agriculture land in Canada. The tile layer was intersected with the agriculture lands layer (Fig. A4.7), producing a much smaller potential tile grid in Canada. This is identical to the process used to display forestry in Canada where our tile grid was constrained by the forestry tenure layer. The result is that large and/or northern CDs like Kenora now only had grid tiles where agriculture occurs (in this case at the extreme southern end).

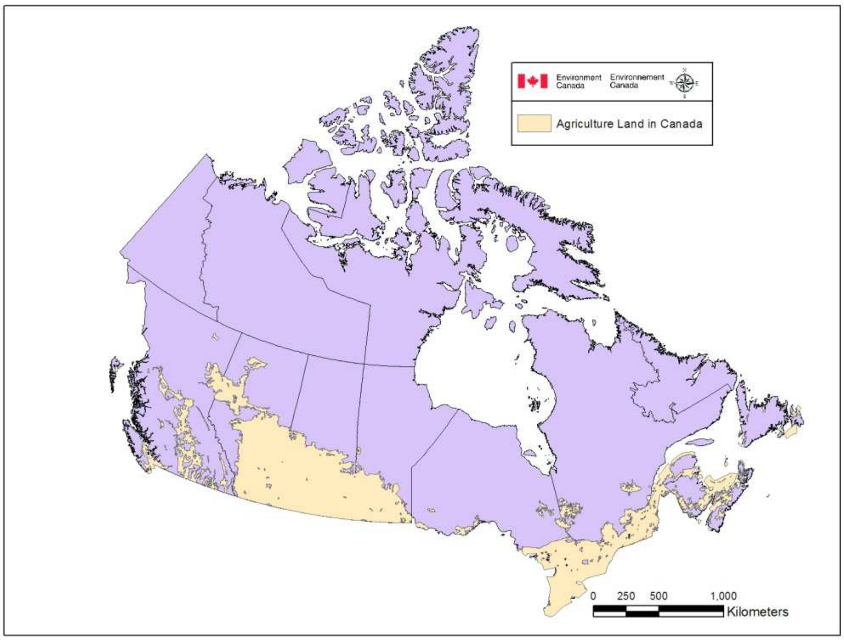


Fig. A4.7 – Distribution of agricultural land in Canada. Data provided by T. Rounce, Agriculture and Agri-Food Canada. Original derivation is from the Census of Agriculture interpolated variable called 'PERAGR' which is the percent of agriculture within a Soil Landscape of Canada (v3.1) polygon.

Agricultural data was displayed by CD across Canada. In order to determine the total percentage of each farm type that occurs by tile across Canada we did the following:

- Census Divisions were intersected to each 50 × 50 km tile. The sub-area for each divided CD (CDs crossing tile boundaries) was calculated and the area value was then used to calculate the percentage of each CD's that fell within each tile (assumes population is homogenously distributed in each CD, likely not true).
- The number of each farm type within each CD (Grain, Haying, Vegetables) was multiplied by the proportion of each CD that fell within each unique tile ID in order to obtain the number of farms within each tile for each farm type.
    - The 'Dissolve' tool was then used so that all CD's were dissolved by each 50 × 50 km tile and the statistics field was used to 'SUM' the number of farms within each tile. This was done separately for each of the 3 farm types.
    - Ideally we need the area of each farm type in each CD. However, Statistics Canada does not provide the area associated with each farm or in aggregate, so all we have is a count of farms by type in each CD.
- Equally distribute the quotient to each tile.

A map of Bird Conservation Regions (BCRs) was then overlaid on the tile grid with all the farming data. The two layers were intersected and each tile was assigned to its respective BCR (overlap cases were put into the BCR which contained the greater proportion of the tile area). The total number of farms of each type for all tiles in each BCR was calculated and the proportion in each tile was then derived.

Kills by farm type and BCR (Table A4.2) were then multiplied by the proportion of that farm type in that BCR for each 50 × 50 km tile. This represents the total nestlings or eggs killed per tile.

The results of our agriculture analysis are shown in Fig. A4.8: Grain Cropping, Fig. A4.9: Haying, and Fig. A4.10: Vegetable Cropping.

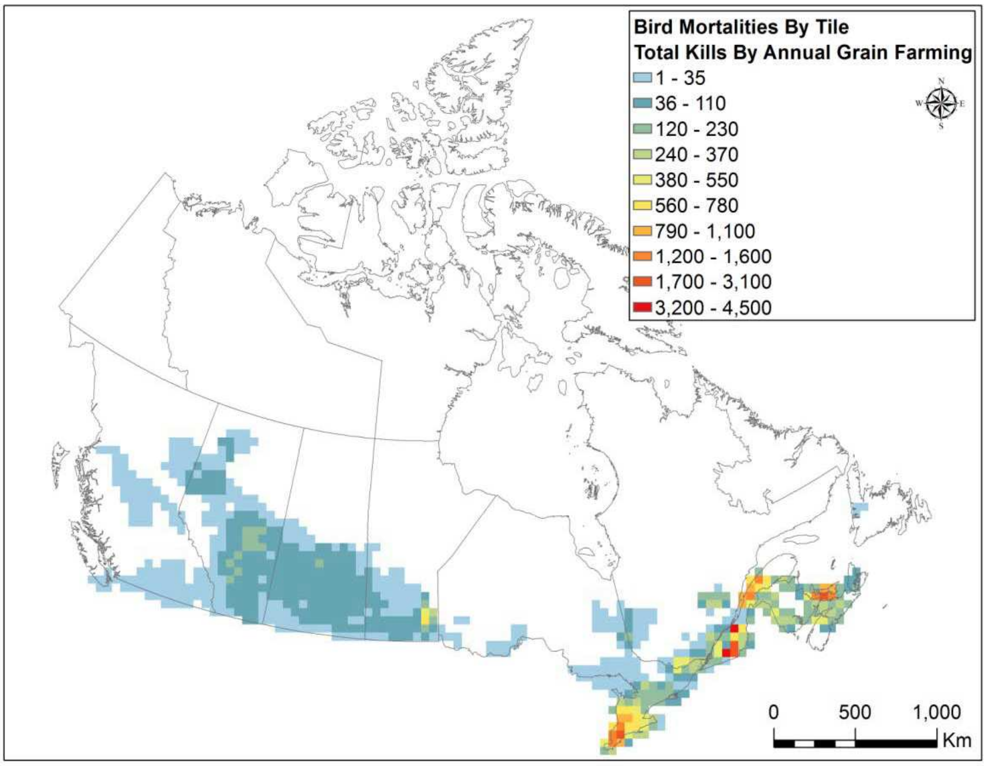


Fig. A4.8 – Approximated distribution of nestlings and eggs destroyed from the grain cropping in Canada as enumerated by Tews et al. (2013).

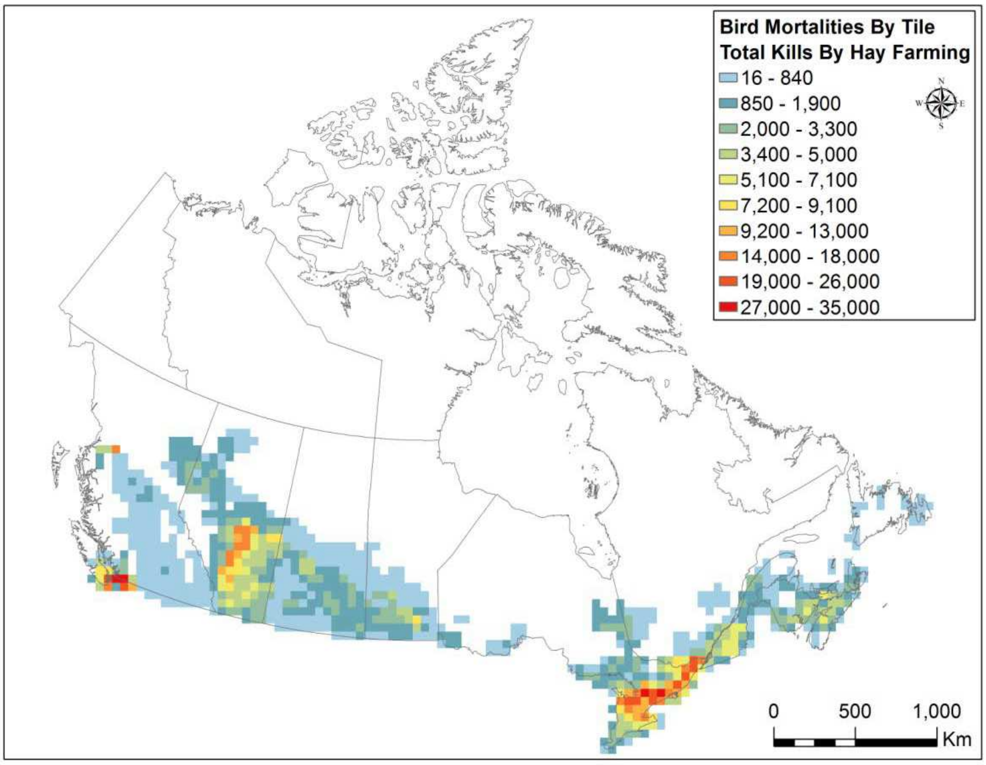


Fig. A4.9 - Approximated distribution of nestlings and eggs destroyed from the haying in Canada as enumerated by Tews et al. (2013).

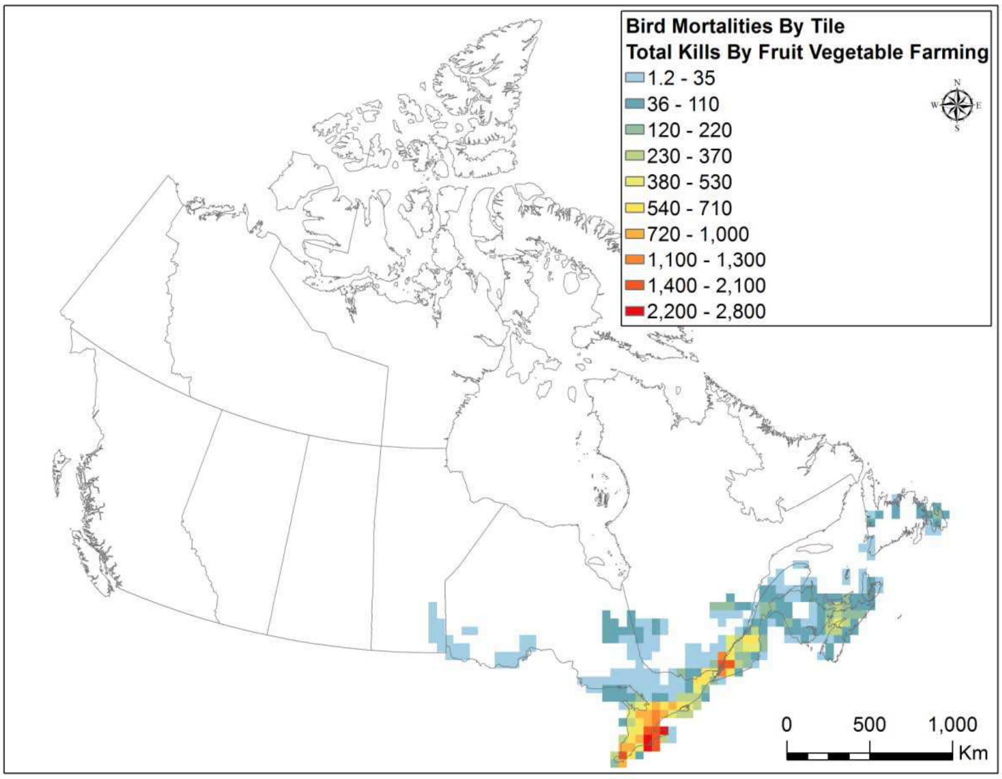


Fig. A4.10 – Approximated distribution of nestlings and eggs destroyed from the vegetable (and fruit) cropping in Canada as enumerated by Tews et al. (2013). Agriculture Census data had entries fruit and vegetable farms in western Canada (as expected), but the species analyzed and results from Tews et al.

(2013) had zero deaths for the western BCRs (such as BCRs 5 and 9 covering the lower mainland of BC).

Cats and Buildings (based on Population Density)

- Source: 2006 Census of Human Population, Statistics Canada (http://www12.statcan.gc.ca/census-recensement/2006/index-eng.cfm)
- Spatial Reference: n/a
- Ellipsoid Name: n/a
- Total kill figure used: Cats: 204 million (median value, Blancher 2013); Buildings: 24,900,000 (total average values from Table 5 in Machtans et al. (2013).

The 2006 Census Population Density data for Canada was used to display the data by Census Division (CD). The Census Division data was not spatially represented so the geospatial file containing the Census Divisions for Canada were also obtained from Statistics Canada in order to acquire the desired results.

Methodology

Human population density was used as a proxy for the spatial distribution of both cats and buildings across Canada. We provide rationale below for using population data as the proxy for the two sources of mortality.

Cats: Per capita pet ownership in Canada was tabulated by Leger Marketing (http://www.legermarketing.com/documents/SPCLM/020617eng.pdf) and varied somewhat across Canada. In the absence of spatial data on pet ownership however, we calculated ≤ 2% difference between the proportion of cats per province (number of households × % cat ownership) and the % of total human population per province (Table A4.3). Although the results are autocorrelated from using population to calculate cats, this exercise demonstrates that the regional variation in cat ownership rates is a trivial deviation from simply approximating ownership by population. We recognize that if the number of cats per household varies radically across the country that it would introduce another inaccuracy into our map (Perrin [2009] indicates an average of 1.76 cats per owner). We expected unowned cat numbers to be associated with owned cats in some unknown, but constant ratio (fewer people in rural settings, fewer pet cats total, and fewer feral cats, with the opposite in cities). We did not explicitly extrapolate the unowned cats into the totals below. Because we assumed a constant ratio between the two types, and allocated the total kill of all cats to the proportional representation of population, no mapping differences would appear from calculating unowned cats in the table below.

Table A4.3: Comparison of geographic distribution of population by province and calculated owned cats per province.

Prov	Population (2011)	Proportional Population	People/ Household	2002 Cats Ownership Rate	Number of Owned Cats	Proportional Cat Population	Difference (% Human - %Cat)
BC	4,400,057	13%	2.5	32%	991,245	15%	-2%
AB	3,645,257	11%	2.6	31%	764,943	11%	0%
SK	1,033,381	3%	2.4	21%	159,141	2%	1%

Prov	Population (2011)	Proportional Population	People/ Household	2002 Cats Ownership Rate	Number of Owned Cats	Proportional Cat Population	Difference (% Human - %Cat)
MB	1,208,268	4%	2.5	21%	178,630	3%	1%
ON	12,851,821	38%	2.6	28%	2,435,914	36%	2%
QC	8,080,550	24%	2.3	26%	1,607,678	24%	0%
NB	751,171	2%	2.4	37%	203,818	3%	-1%
NF	514,536	2%	2.5	37%	134,026	2%	0%
NS	921,727	3%	2.4	37%	250,095	4%	-1%
PEI	140,204	0%	2.5	37%	36,520	1%	0%
NT	41,462	0%					
NU	31,906	0%					
YT	33,897	0%					

Notes:

1. People/household is from 2006 Population Census, statistics Canada.
2. Average cat ownership rate was higher (about 36% compared to 31% here) in Perrin (2009) as cited by Blancher (2013), but we could not get updated geographic breakdowns of ownership rate and therefore used the 2002 figures from the Leger survey. Therefore the sum of the column "number of cats" is lower than the estimated number of pet cats given in Blancher (2013).

Buildings: The number of people per household in Canada varies little (2.3 - 2.6 persons per household for all major provinces [2006 Census data]), and since each household should be a unit represented in the analysis of Machtans et al. (2013), the proxy of population for buildings is gross (not 1:1), but suitable for broad scale mapping. This relationship would be confounded slightly since high rise apartments have many households in them and are technically counted in the high rise buildings section of Machtans et al. (2013). However, we did not break out the three categories of buildings separately in the mapping exercise so this confounding would be largely inconsequential. We did not have data to correlate the number of low-rise commercial buildings to population but assumed it was a linear relationship so proportional population could represent the kills from this class.

The number of tall buildings is highly correlated with log(population) in cities but is not completely log-linear (Fig. A4.11). We ignored both the logarithmic curve function and its inflection given that of the ~25M birds killed by buildings in Canada, only 1% in total is ascribed to tall buildings and slight adjustments for the proportion of buildings in each city in Canada in each 50 × 50 km tile would not be visible in the final map. While technically this would have been a better map of tall building density, Machtans et al. (2013) provides evidence that the number of buildings alone is a poor predictor of tall building bird-collision deaths (geography seems very important).

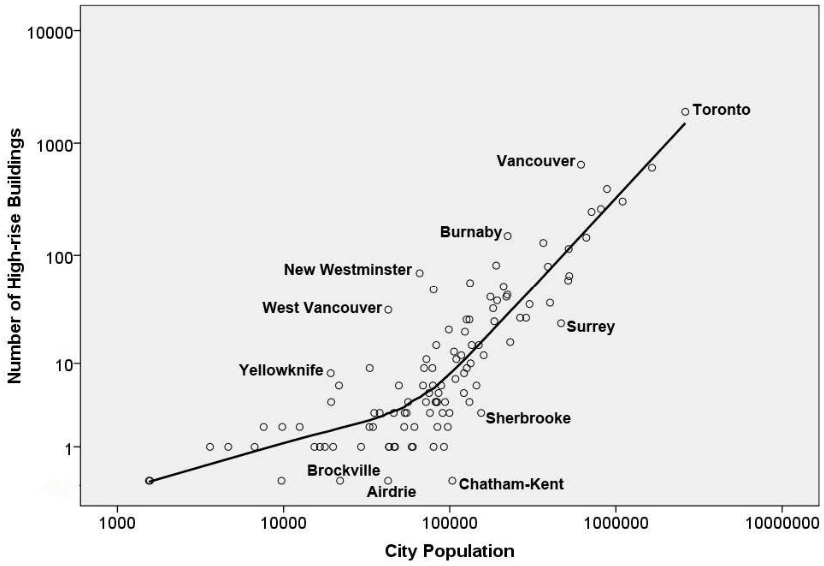


Fig. A4.11 – The relationship between city population and number of high-rise buildings in Canada. High-rise data from http://skyscraperpage.com/cities/?s=0&c=2&p=0&r=50&10=0

Population data were exported from Statistics Canada and merged together for all CD's in Canada. Tabular data were joined with the CD shapefile which contained the polygons for each CD. The join was performed based on the unique ID's from the CD's ID field. Using the 'Field Calculator', the area for each CD was calculated.

Census Divisions were intersected to each 50 × 50 km tile. The sub-area for each divided CD (CDs crossing tile boundaries) was calculated and the area value was then used to calculate the percentage of each CD's that fell within each tile (assumes population is homogenously distributed in each CD, likely not true). The result was multiplied by the 2006 Population Density for each unique CD based on the percentage of the CD's that fall within each individual tile.

Census Divisions were dissolved by each 50 × 50 km tile and population densities were summed. Proportion of the total national population in each 50 × 50 km tile was calculated.

Proportional population in each tile was multiplied by the kill values for cats and buildings separately to produce the two data layers. The problem with large census divisions explained in the Agriculture section was also encountered for the population layer. We arbitrarily removed all tiles with population densities of < 100 people per tile (0.04/km^2). We then reinserted only the tiles that contained communities.

The results of our analyses (Fig. A4.12: cats; Fig. A4.13: buildings) appear identical because the 10 colours chosen for each class are identical and the underlying population distribution is the same. Note the different estimate of take per tile in the legends however.

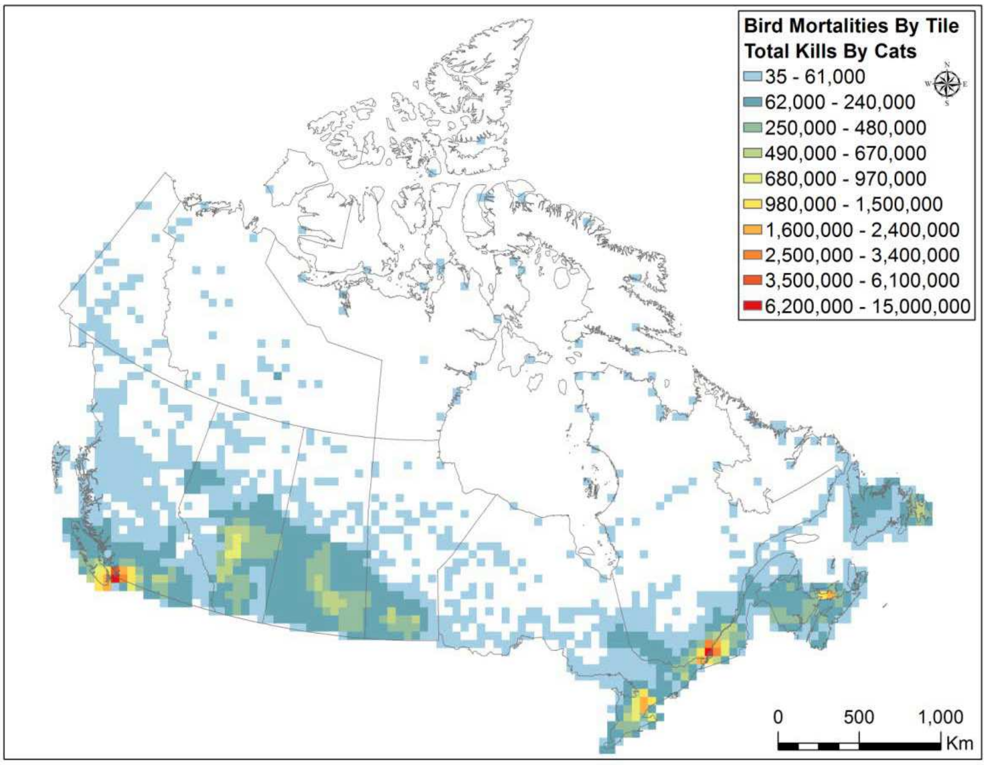


Fig. A4.12 –Approximated distribution of birds killed by cats in Canada from values in Blancher (2013).

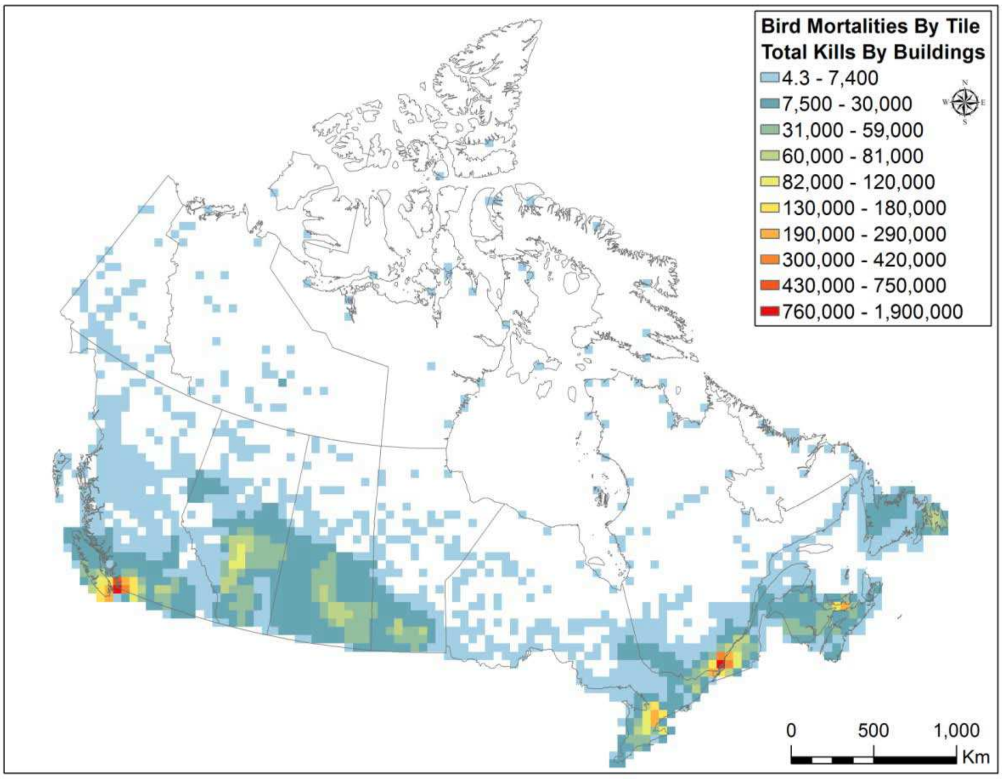


Fig. A4.13 – Approximated distribution of birds killed by colliding with windows in buildings in Canada from values in Machtans et al. (2013). Note that the legend values are different than in the similarly coloured Fig. A4.12.

Wind Power

- Source: Canadian Wind Energy Association (http://www.canwea.ca/farms/wind-farms_e.php) web table and on-line map
- Spatial Reference: n/a
- Ellipsoid Name: n/a
- Total kill figure used: 5.9 birds per turbine from Zimmerling et al. (2013).

We created our own point layer shapefile by deriving coordinates for each wind farm from the above noted source. We entered the provided data for each wind farm (number of turbines and type) in the attribute file.

Methodology

Each point in our wind farm layer (one wind farm) was assigned a total kills by multiplying the number of turbines at that facility by the average kills per turbine noted above. The 50 × 50 km tile grid was overlaid with the wind farm point layer and a spatial join was performed in order to assign a tile ID to each wind farm point location. The Dissolve tool was then run to sum all kills within each unique tile ID using the statistics filed within the dissolve tool.

The result of our analysis on wind farms is in Fig. A4.14.

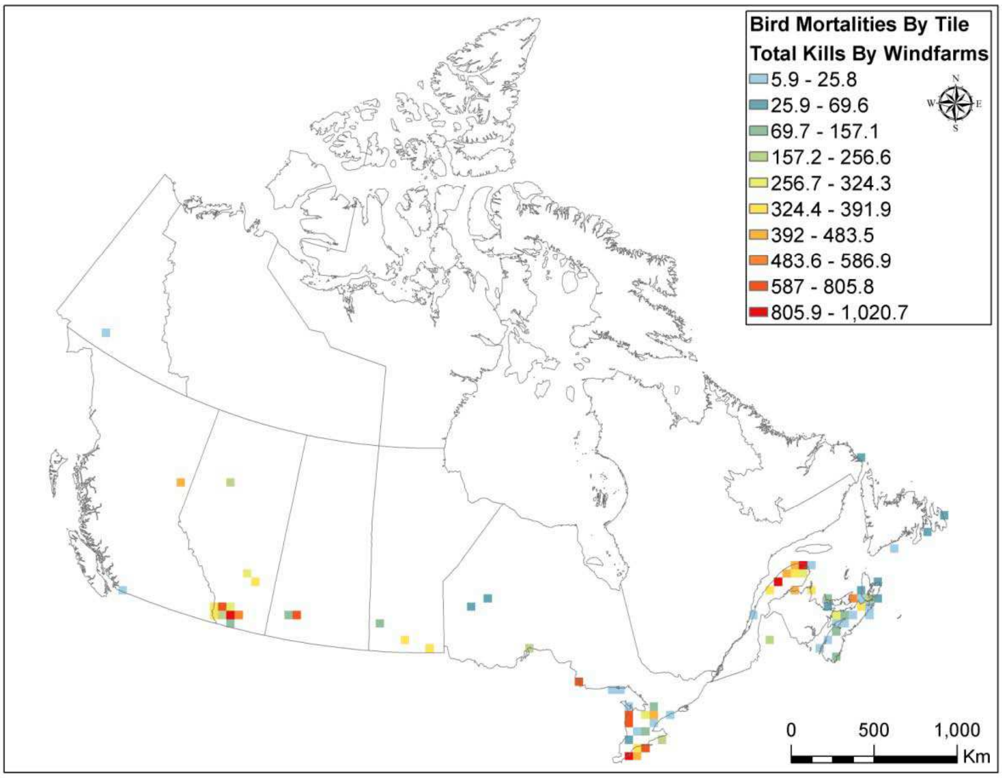


Fig. A4.14: Approximated distribution of kill of birds by wind farm operation in Canada based on average kill per turbine in Zimmerling et al. (2013).

Combined layers used in main paper

The final analysis involves summing all tile values for each of the specified mortality sources. Two maps were created. First, a map summing all layers was made. However, since so much kill in Canada is attributed to cats, bird-building collisions, and bird-vehicle collisions, a second map without these three sources was created.

The results of the summed layers for all mortality sources are shown in Fig. A4.15 and the results without the three sources noted above are in Fig. A4.16. Finally, the distribution of total mortality from only the top three sources (cats, bird-building collisions and bird-vehicle collisions) is presented in Fig. A4.17.

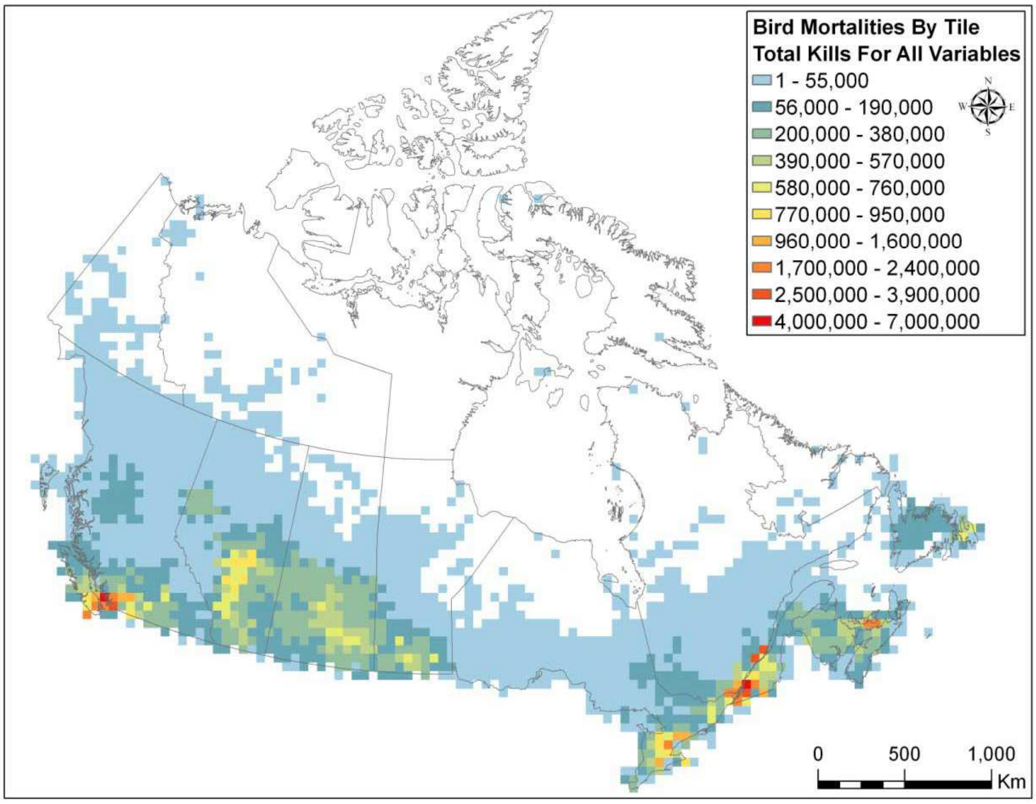


Fig. A4.15 – Approximated distribution of all bird mortalities across all sources considered.

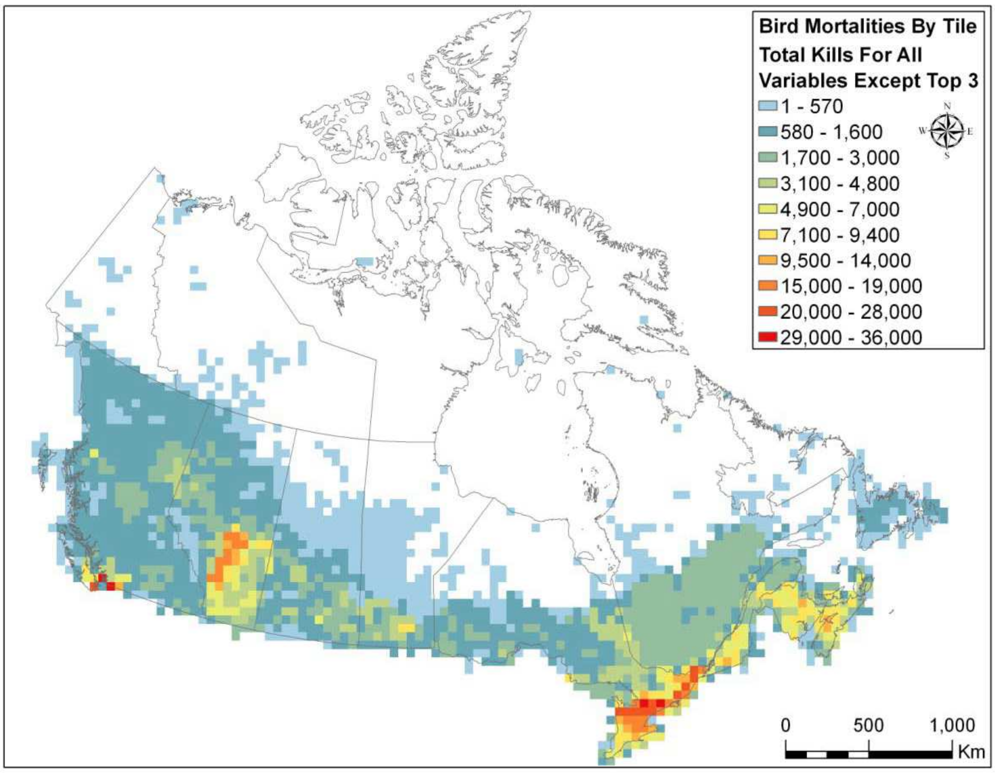


Fig. A4.16: Approximated distribution of all bird mortalities for all sources except cats, bird-building collisions and bird-vehicle collisions.

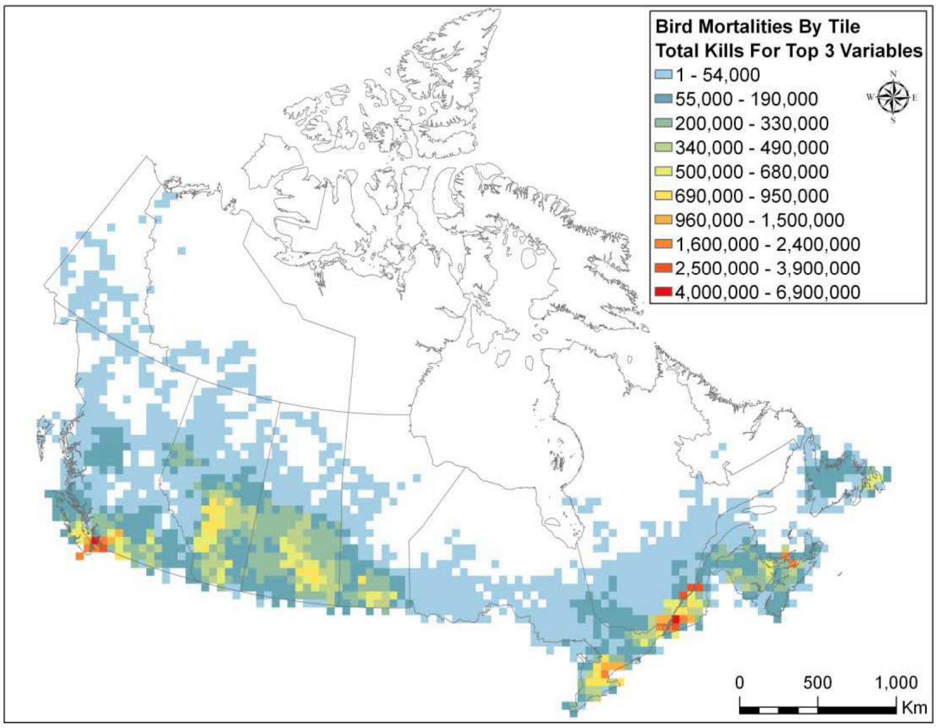


Fig. A4.17 – Approximated distribution of all bird mortalities from cats, bird-building collisions and bird-vehicle collisions only.

Literature Cited (Appendix 4)

Bishop, C. A., and J. M. Brogan. 2013. Estimates of avian mortality due to vehicle collisions on the Canadian road network. *Avian Conservation and Ecology* (this issue).

Blancher, P. J. 2013. Estimated number of birds killed by house cats (*Felis catus*) in Canada. *Avian Conservation and Ecology* (this issue).

Bleho, B., N. Koper, and C. Machtans. *Submitted*. Effects of incidental take of nests by livestock on grassland birds. Submitted to *Conservation Biology*, August 2012.

Hobson, K. A., A. Wilson, S. L. Van Wilgenburg, and E. Bayne. 2013. An estimate of nest loss in Canada due to industrial forestry operations. *Avian Conservation and Ecology* (this issue).

Longcore, T., C. Rich, P. Mineau, B. MacDonald, D. G. Bert, L. M. Sullivan, E. Mutrie, S. A. Gauthreaux Jr., M. L. Avery, R. L. Crawford, A. M. Manville II, E. R. Travis, and D. Drake. 2012. An estimate of avian mortality at communication towers in the United States and Canada. *PLoS ONE* 7(4): e34025. doi:10.1371/journal.pone.oo34025

Machtans, C. S., C. H. R. Wedeles, and E. M. Bayne. 2013. A first estimate for Canada of the number of birds killed by colliding with building window. *Avian Conservation and Ecology* (this issue).

Perrin, J. 2009. The Business of Urban Animals Survey: The facts and statistics on companion animals in Canada. *Canadian Veterinary Journal* 50:48-52.

Taylor, W. A. 1975. A History of Survey Systems. Ministry of Sustainable Resource Management. Victoria, British Columbia.

Tews, J., D. G. Bert, and P. Mineau. 2013. Estimated mortality of selected migratory bird species from mowing and other mechanical operations in Canadian agriculture. *Avian Conservation and Ecology* (this issue).

Van Wilgenburg, S. L., K. A. Hobson, E. M. Bayne, and N. Koper. 2013. Estimated avian nest loss associated with oil and gas exploration and extraction in the Western Canadian Sedimentary Basin. *Avian Conservation and Ecology* (this issue).

Zimmerling, J. R., A. Pomeroy, M. d'Entremont, and C. M. Francis. 2013. Canadian estimate of bird mortality due to collisions and direct habitat loss associated with wind turbine developments. *Avian Conservation and Ecology* (this issue).

Avian and Wildlife Reporting Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Observation Made During (circle one):

Evaporation Pond Monitoring / Scheduled Mortality Survey / [✓ Incidental]

Date: 6/28/2013 Observer: Eric German

Type of Incident (circle one): Injury / [✓ Fatality] / Nest

Condition (circle one): [✓ Intact Carcass] / Dismembered Carcass / Feathers Only

Age of Remains (circle one): [✓ 1-5 (fluid filled eyes)] / 6-30 (maggots) / 30+ (bones)

Photo No.

Carcass Condition Details, Behavior of Injured Animal or Nest Details: Carcass was against evap pond netting. The bird was not entangled nor signs of blunt trauma. Last incidental evap pond monitoring afternoon, 6/27/13.

LOCATION

DATUM: UTM Z11 NAD83 (m) UTM N: 3727428 UTM E: 685612

Found Near (circle one):

Solar Trough / [✓ Evaporation Pond] / Road / Power Line / Other (explain below)

Location Details: West side of north evap pond. Water in pond. Packed dirt around enclosure. Carcass against netting. Pond contains water.

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)

Species (if unknown, write 'unknown'): Great Blue Heron

Color/Markings: Grey color large bird.

Sex (circle one): -Male / Female / Unknown Age (circle one): [✓ Adult] / Juvenile / Unknown

Is Animal Tagged? (circle one): Yes / [✓ No]

Identification Remarks: N/A

ENVIRONMENTAL CONDITION

Weather (circle one): Clear / Fog / Cloudy / Rain

Approx. Temperature (circle one): [✓ °F] / °C: 84

Wind (circle one): [✓ Calm] / Gusty / Storm / Violent Storm

Habitat (circle all that apply):

Bare Ground / Creosote Bush Scrub / Sand Dunes

Sand Drifts over Playa / Ephemeral Wash / Desert Pavement

NOTIFICATION

Who was notified, and When? DB notified of find by reporting party. CM notified at 1000. on 6/28/2013 9:30:00 AM

Actions Taken (e.g., left in place, taken to rehab): Bird removed and disposed via burial.

COMMENTS:

Weather: overcast Feels humid. Ponds checked 6/27 afternoon without findings. Burial at 0688055 / 3726307

* Turn in completed form and incident photos to the on-site Environmental Manager.

* Report any incidental observations of dead birds or other wildlife at the evaporation ponds to the Designated Biologist within one day of the detection of the carcass.

* Report any nests immediately to the on-site Environmental Manager.


Date & Time: Fri Jun 28 09:42:12 PDT 2013
Position: 11 N 685609 3727431
Altitude: 419ft
Azimuth/Bearing: 156° S24E 2773mils (True)
Elevation Angle: -13.3°
Horizon Angle: +07.8°
Zoom: 1X
g h mortality


Date & Time: Fri Jun 28 09:41:12 PDT 2013
Position: 11 N 685605 3727429
Altitude: 403ft
Azimuth/Bearing: 110° S70E 1956mils (True)
Elevation Angle: -15.9°
Horizon Angle: +00.3°
Zoom: 1X
g h mortality

Additional Documentation Attachment to Comment 2-F1
Attachment I-4

											Observation											Notification				
Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_Dat	Northing	Easting	Location	Details	Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Who	Date	Time	Actions	Comments
Gregg Lukasek	17-Jul-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Bird appears to be vehicle mortality					Unit 2, block 5	Bullocks oriole		Unk	Adult	NO	Sunny	96	Calm	Bare Ground	DB	7/17/2012		Buried off-site	N/A
Shelly Dayman	17-Jul-12	Construction	Plant Site (incidental)									Assembly building, unit1	Great-horned owl		Unk	Adult	NO	Sunny	110	Calm	Bare Ground	DB	7/17/2012		Evaporation coolers left on to keep building cool to not stress animal, no work in vicinity of owl, all doors of building left open to allow owl to leave after dark, owl was gone by 9pm	Owl appeared to be somewhat heat stressed during day, coolers running to cool building, left on own volition after dark, did not return
Shelly Dayman	18-Jul-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Found in mirror array, burn marks on back of neck	UTM Z11 NAD83 (m)	3726885	685899	Solar Trough	Unit 2, northern area, block 1 or 2	Bullocks oriole		Unk	Adult	NO	Sunny	97	Calm	Bare Ground	DB, Bureau veritas	7/18/2012	4:08:00 PM	Photographs of burn marks taken, animal disposed and buried	N/A
Eric German	23-Jul-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)					Other (explain below)	Plant site	Western meadowlark		Unk	Adult	NO	Sunny	95	Calm	Bare Ground	Form to agencies			Buried off-site	N/A
Eric German	23-Jul-12	Construction	Plant Site (incidental)	Injury							Other (explain below)	Assembly building	Brewers blackbird		Unk	Adult	NO	Sunny	95	Calm	Bare Ground	Form to agencies			Reported to be injured, but can fly and was foraging, appears to be molting, bird last seen outside building	N/A
Eric German	24-Jul-12	Construction	Access road (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)					Road	Access road	Unknown		Unk	Adult	NO	Sunny	89	Calm	Creosote Bush Scrub	Form to agencies			Carcass along access road, cause of death unknown, removed and buried off-site	N/A
Eric German	24-Jul-12	Construction	Plant Site (incidental)								Other (explain below)	Assembly building, Unit 1	Lesser nighthawk		Unk	Adult	NO	Sunny	101	Calm	Bare Ground	Bureau veritas	7/24/2012	2:00:00 PM	Was able to flush bird from building, temps in building hotter than outside	N/A
Shelly Dayman	24-Jul-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Bird died in assembly building likely due to heat exhaustion				Other (explain below)	Assembly building, Unit 1	Brewer's blackbird		Unk	Adult	NO	Sunny	101	Calm	Bare Ground	Bureau veritas, DB	7/24/2012	1:50:00 PM	While bird was in distress was put in ventilated cardboard box but bird died within minutes, carcass buried off-site	N/A
Eric German	27-Jul-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	No signs of trauma				Other (explain below)	Powerblock 2	Mourning dove		Unk	Adult	NO	Sunny	98	Calm	Bare Ground	Form to agencies			Removed and buried off-site	N/A
Eric German	18-Aug-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)					Other (explain below)	Powerblock 1	Mourning dove		Unk	Adult	NO	Sunny	85	Calm	Bare Ground	Form to agencies			Buried off-site	N/A
Eric German	09-Sep-12	Construction	Plant Site (incidental)	Injury							Other (explain below)	Powerblock 2, under vehicle	Common snipe		Unk	Adult	NO	Sunny	98	Calm	Bare Ground	Form to agencies			Heat stressed under vehicle, would not flush, removed and released off-site in moist palo verde area	N/A

											Observation											Notification				
Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_ Dat	Northing	Easting	Location	Details	Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Who	Date	Time	Actions	Comments
Eric German	24-Sep-12	Construction	Plant Site (incidental)	Injury			Report of bird striking a mirror				Other (explain below)	Powerblock 2	Gull		Unk	Adult	NO	Sunny	104	Calm	Bare Ground	Form to agencies			Report of injured bird near powerblock 2, bird was gull and able to fly, allowed bird to rest and recover, checked again in a few hours and gull not present	N/A
Eric German	02-Oct-12	Construction	Plant Site (incidental)								Other (explain below)	Powerblock 2	American bittern		Unk	Adult	NO	Sunny	100	Calm	Bare Ground	Form to agencies			Report of bird in powerblock 2, alive, bird flushed soon after observation, could not relocate	N/A
Eric German	03-Oct-12	Construction	Plant Site (incidental)								Other (explain below)	Powerblock 2	American coot		Unk	Adult	NO	Sunny	99	Calm	Bare Ground	Form to agencies			Bird alive, no signs of physical injury, left in place	N/A
Eric German	03-Oct-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Deceased more than a day, cause unknown				Other (explain below)	Unit 2, Block 2	American coot		Unk	Adult	NO	Sunny	99	Calm	Bare Ground	Form to agencies			Removed and buried off-site	N/A
Eric German	03-Oct-12	Construction	Plant Site (incidental)	Injury							Other (explain below)	Powerblock 2	American bittern		Unk	Adult	NO	Sunny	99	Calm	Bare Ground	CDFG	10/3/2012	8:10:00 AM	Bird in powerblock2 for second day, contacted CDFG and it was decided to make capture attempt, bird flushed and not captured, moved between mirrors of Unit 2 and by 1:30 had left site	N/A
Eric German	04-Oct-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Unknown cause				Other (explain below)	Unit 2, block 10	Unknown small bird		Unk	Adult	NO	Sunny	92	Calm	Bare Ground	Form to agencies			Buried remains off-site	N/A
Eric German	15-Oct-12	Construction	Access road (incidental)	Atypical behavior	N/A	N/A	The bird was laying on its belly near the main access road after consultation with cdfg a flush attempt was made. The bird made alarm sounds and feints with its beak. It was allowed to remain and was monitored. Two hours later it made some movement attempt.	UTM Z11 NAD83 (m)	3726177	686890	Road	Access road unit 2 ne corner block 4.	Western Grebe	Black and white. Red eyes. Long neck	Unk	Unk	N/A	Sunny	80	Calm	Bare Ground	Designated Bio and CDFG	10/15/2012	9:00:00 AM	Flush attempt. Then monitored. Two hours later a second flush attempt. Recovered from main access road and delivered to Blythe CDFG.	N/A

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Eric German	23-Oct-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass appeared to be at least two days old. Unknown cause of death. Some carcass damage.	UTM Z11 NAD83 (m)	3726294	686965	Other (explain below)	Powerblock 2, unit 2.	American Kestrel	Brown back. Some red and grey noted Falcon type head	Fem	Unk	NO	Partly Sunny	74	Calm	Bare Ground	Contractor notified designated bio.	10/23/2012	9:50:00 AM	Bird was collected and disposed of by burial.	N/A
Gregg Lukasek	25-Oct-12	Construction	Access road (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Eric german received call that a vehicle struck an owl along access road. The owl was located and was dead on arrival. Carcass is intact and very fresh.	UTM Z11 NAD83 (m)	3722008	692134	Road	On the access road.	Barn owl	White breast with dark spots. Black stripe banding on tail.	Fem	Adult	NO	Sunny	52	Calm	Creosote Bush Scrub	Eric German	10/25/2012	6:05:00 AM	Removed owl from access road and buried it. Took photographs. Took GPS locations for where owl was found on access road and where it was buried.	N/A
Eric German	27-Feb-13	Construction	Gas Line (incidental)	Injury				UTM Z11 NAD83 (m)	3721231	695179	Other (explain below)	Near transmission pole 54	Red-tailed hawk		Unk	Adult	NO				Creosote Bush Scrub	CDFW	2/27/2013		Taken to licensed Blythe avian rehabilitation location per discussion with CDFW	Located beneath existing powerlines and near interstate 10, injury may be power line strike or vehicle collision
Eric German	13-Mar-13	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Unknown cause of mortality				Other (explain below)	Powerblock 2	Lesser goldfinch		Unk	Adult	NO	Partly Sunny	85	Calm	Bare Ground	Form to agencies			Buried off-site	N/A
Shelly Dayman	19-Mar-13	Construction	Transmission Line (incidental)	Fatality	Dismembered Carcass	6-30 (maggots)	Maggots, body in pieces, unknown cause of death	UTM Z11 NAD83 (m)	3726268	687027	Other (explain below)	On access road, under power lines	Lesser goldfinch		Unk	Juv	NO	Partly Sunny	72	Gusty	Creosote Bush Scrub	DB	3/19/2013		Buried off-site	N/A
Eric German	20-Mar-13	Construction	Plant Site (incidental)				Two red-winged blackbirds inside evaporation pond netting, one great-tailed grackle attempting to enter				Evaporation Pond	Southern evap pond	Red-winged blackbirds		Unk	Adult	NO	Cloudy	72	Calm	Evaporation pond	Wildlife agencies present	3/20/2013		Gate of evaporation pond opened and red-winged blackbirds flushed out of netted area, grackle not seen	N/A
Eick German	28-Mar-13	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	No aparent scorching from mirrors	UTM Z11 NAD83 (m)	3726124	687468	Solar Trough	Unit 2, Block 9, between mirrors	Bufflehead	None	Fem	Adult	NO	Sunny	75	Calm	Graded	CEC, BLM, USFWS, CDFW	4/10/2013		Photo taken, removed and disposed	N/A
Mike Rathbun	17-Apr-13	Construction	Gas Line (incidental)	Fatality	Dismembered Carcass	6-30 (maggots)	Three dead birds, likely transmission line strikes				Other (explain below)	Gas line between poles 49 to 56 (east of access road)	Black-throated grey warbler, house wren, orange-crowned warbler		Unk	Adult	NO	Sunny	72	Calm	Creosote Bush Scrub	DB	4/17/2013		Buried off-site	N/A

											Observation											Notification				
Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_ Dat	Northing	Easting	Location	Details	Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Who	Date	Time	Actions	Comments
Eric German	25-Apr-13	Construction	Access road (incidental)	Injury			Some blood above beak and not able to fly any distance	UTM Z11 NAD83 (m)			Solar Trough	Unit 2, block 10, row 52	Barn owl		Unk	Adult	NO				Bare Ground	CDFW	4/25/2013		Taken to Blythe avian rehabilitation facility	N/A
Eric German	30-Apr-13	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass entangled in evap pond netting, looks to be in place longer than one day but less than one week	UTM Z11 NAD83 (m)	3727414	685660	Evaporation Pond	Netting, north pond	Pied-billed grebe		Unk	Adult	NO	Sunny	100	Gusty	Other (note)	Form to agencies			Could not remove carcass, left in place	Mortality observed due to two great-tailed grackles observed within enclosure
Eric German	30-Apr-13	Construction	Plant Site (incidental)				Two grackles inside evaporation pond netting				Evaporation Pond		Great-tailed grackles		Unk	Adult	NO	Sunny	100	Calm	Other (note)	Form to agencies			Flushed grackles from netted area	N/A
Andrew Fisher	01-May-13	Construction	Plant Site (incidental)	Injury			Live, resting on bare ground, picked up and placed in ventilated cardboard box	UTM Z11 NAD83 (m)	3726261	686787	Solar Trough		Eared grebe		Unk	Adult	NO	Sunny	80	Calm	Bare Ground	DB, CDFW	5/1/2013	10:40:00 AM	Taken to wildlife rehab center, bird seemed active and responsive	N/A
Eric German	01-May-13	Construction	Plant Site (incidental)				Swainson's thrush within southern evaporation pond				Evaporation Pond	Southern	Swainson's thrush		Unk	Adult	NO	Sunny	88	Calm	Other (note)	Form to agencies			Gate of evap pond opened, appeared that bird exited prior to gate opening	N/A
Eric German	01-May-13	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass entangled in evaporation pond netting.	UTM Z11 NAD83 (m)	3727414	685660	Evaporation Pond	Northern evap pond. Middle of western half of pond.	Pied billed grebe		Unk	Adult	NO	Sunny	100	Gusty	Other (note)	Agencies	5/1/2013	11:00:00 AM	Carcass left in place.	Plant site evap pond. Discovered while flushing two great tailed grackles from pond.
Eric German	07-May-13	Construction	Plant Site (incidental)				Spotted sandpiper in south evap pond				Evaporation Pond	South pond	Spotted sandpiper		Unk	Adult	NO	Windy	72		Other (note)	Form to agencies			Opened evap pond gate for bird to exit, but bird exited through a hole in the south side of the netting, environmental compliance and contractor notified of hole	N/A
David charlton	08-May-13	Construction	Transmission Line (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)		UTM Z11 NAD83 (m)	3718540	701913	Road	On gravel road at transmission line curves toward sub station.	Wilsons Warbler	Yellow with dark cap	Male	Adult	NO	Sunny	60	Calm	Graded	Eric German (DB)	5/8/2013	7:29:00 AM	Identify and bury	N/A
Eric German	14-May-13	Construction	Plant Site (incidental)	Injury			Nothing appears broken. Bird does not flush.	UTM Z11 NAD83 (m)	3727200	684485	Other (explain below)	Powerblock 1. There are no solar troughs in immediate area. Hot and in shade.	Yellow headed blackbird	Orange throat. White on wings.		Juv	NO	Sunny	106	Calm	Bare Ground	Form to agencies			Bird did not flush when approached. Captured and taken to rehab.	N/A

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Eric German	14-May-13	Construction	Plant Site (incidental)	Injury			Young yellow-headed blackbird in distress				Other (explain below)	Powerblock 1	Yellow-headed blackbird		Unk	Juv	NO	Sunny	106	Calm	Bare Ground	Form to agencies			Removed bird and taken to avian rehab in Blythe	N/A
Mike Rathbun	14-May-13	Construction	Plant Site (incidental)				Barn owl reported near cooling fans of powerblock 2, not injured				Other (explain below)	Powerblock 2, near cooling fans	Barn owl		Unk	Adult	NO	Sunny	105	Calm	Bare Ground	DB	5/14/2013		Monitored to determine bird out of harm's way	N/A
Eric German	15-May-13	Construction	Transmission Line (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Found beneath tracks of equipment. Not compressed or pinned. Near existing powerlines.	UTM Z11 NAD83 (m)	3718569	701855	Power Line	Found beneath tracks of equipment. Not compressed or pinned. Near existing powerlines. East end of crs road.	Hermit thrush	Spots on chest. Rufous tail		Adult	NO	Sunny	106	Calm	Sand Dune	Form to agencies			Removed and buried.	N/A
Eric German	16-May-13	Construction	Transmission Line (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass intact.	UTM Z11 NAD83 (m)	3720336	695206	Power Line	Beneath power line south of i10	Townsends warbler	Yellow head and chest with black around eyes.		Adult	NO	Sunny	102	Calm	Creosote Bush Scrub	Form to agencies			Photographed and buried.	N/A
Eric German	16-May-13	Construction	Transmission Line (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Intact carcass missing wing	UTM Z11 NAD83 (m)	3720376	695222	Power Line	Beneath powerlines south of i10.	Wilsons warbler	Possible red stripes on breast.		Adult	NO	Sunny	97	Calm	Creosote Bush Scrub	Form to agencies			Removed and buried.	N/A
Mike Rathbun	22-May-13	Construction	Plant Site (incidental)	Injury			Injured, did not try to fly or run, when captured tried to bite and noisy call		114.9935	33.6573	Solar Trough	Unit 2, Block 4, between rows 50&51	Western grebe	Black below red eyes, long shape bill	Unk	Adult	NO	Sunny	92	Calm	Bare Ground	DB	5/22/2013	11:34:00 AM	Bird taken to Blythe avian rehab center	N/A
Mike Rathbun	22-May-13	Construction	Transmission Line (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Intact carcass	UTM Z11 NAD83 (m)	3721275	695203	Power Line	Under tower 54, 30 feet away, under powerline	Yellow warbler		Fem	Adult	NO	Sunny	72	Calm	Creosote Bush Scrub	DB	5/22/2013	6:45:00 AM	Buried off-site	N/A
Eric German	23-May-13	Construction	Access road (incidental)	Fatality	Dismembered Carcass	1-5 (fluid in eyes)	Crushed on access road.	UTM Z11 NAD83 (m)	3721112	693393	Road	Access road mortality. Creosote bush scrub. Near powerlines.	Unknown warbler	Yellow breast. Yellow green back and head.	Unk	Adult	NO	Sunny	80	Calm	Creosote Bush Scrub	To be reported. Form completed	5/23/2013	8:30:00 AM	Bird disposed of by burial.	N/A

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_ Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Eric German	24-May-13	Construction	Access road (incidental)	Fatality	Dismembered Carcass	1-5 (fluid in eyes)	Crushed on access road.	UTM Z11 NAD83 (m)	3725489	688010	Road	Access road mortality. Creosote bush scrub. Near powerlines. Found on road ahoulder.	Unkown sparrow	Dark wings.	Unk	Adult	NO	Sunny	85	Calm	Creosote Bush Scrub	Designated bio. Form to be submitted in MCR.	5/24/2013	8:30:00 AM	Bird disposed of by burial.	N/A
Mike Rathbun	30-May-13	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	No maggots, but smelled of death	UTM Z11 NAD83 (m)	3726773	684534	Other (explain below)	Next to permanent fence, directly south of PB1	American coot		Unk	Adult	NO	Sunny	90	Calm	Graded	DB	5/30/2013	4:00:00 PM	Buried off-site	N/A
Ron Walker	04-Jun-13	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass intact	UTM Z11 NAD83 (m)	3727397	683967	Solar Trough	Unit 1 block 3	Mourning dove	Brown/ grey	Unk	Unk	NO	Sunny	102	Calm	Bare Ground	Ron Walker	6/4/2013	12:45:00 PM	Bird removed and buried	N/A
Eric German	05-Jun-13	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Blood from beak area indicating impact. Appeared to be gripping onto perch as rigor set in.	UTM Z11 NAD83 (m)	3726094	687120	Solar Trough	Pillar in solar field.	Barn Owl	White face/ buff and white.	Unk	Adult	NO	Sunny	106	Calm	Bare Ground	DB notified / Notified compliance.	6/5/2013	1:00:00 PM	Animal collected put on ice and then disposed of by burial.	N/A
Ron Walker	10-Jun-13	Operations	Plant Site (incidental)	Injury	N/A	N/A	Injured brown pelican found in unit 2 in power block area under HTF overhead pipes, above power block access road. Pelican appeared to be suffering from heat stress. Pelican transported to wildlife rehabilitation center in Blythe, CA. It was reported later that the pelican recovered and was released uninjured.	UTM Z11 NAD83 (m)	3726434	686893	Other (explain below)	Unit 2, west side of power block, under HTF pipe overhead crossing	Brown Pelican	Brown, light underbelly	Unk	Unk	NO	Sunny	109	Gusty	Other (note)	Designated biologist	6/10/2013	4:30:00 PM	Brown pelican picked up and transported to wildlife rehabilitation center in Blythe CA	Injured brown pelican found in unit 2 in power block area under HTF overhead pipes, above power block access road. Pelican appeared to be suffering from heat stress. Pelican transported to wildlife rehabilitation center in Blythe, CA. It was reported later that the pelican recovered and was released uninjured.

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_ Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Eric German	28-Jun-13	Operations	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass was against evap pond netting. The bird was not entangled nor signs of blunt trauma. Last incidental evap pond monitoring afternoon, 6/27/13.	UTM Z11 NAD83 (m)	3727428	685612	Evaporation Pond	West side of north evap pond. Water in pond. Packed dirt around enclosure. Carcass against netting. Pond contains water.	Great Blue Heron	Grey color large bird.	Unk	Adult	NO	Other (note)	84	Calm	Graded	DB notified of find by reporting party. CM notified at 1000.	6/28/2013	9:30:00 AM	Bird removed and disposed via burial.	Weather: overcast Feels humid. Ponds checked 6/27 afternoon without findings. Burial at 0688055 / 3726307
Mike Anguiano	28-Jun-13	Operations	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Condition good. Likely overheated and died. Temps up to 122.	UTM Z11 NAD83 (m)	3726802	685760	Other (explain below)	found dead in water treatment building. Reported earlier in the day about 1300 but bird flew out of building	Barn owl	Adult barn owl	Unk	Adult	NO	Sunny	119	Calm	Other (note)	Eric German	6/28/2013	3:12:00 PM	Bird removed from building and buried off main access road. Buried at easting 0688214 northing 3725072	N/A
Eric German	7/1/2013	Construction	Access road (incidental)	Fatality	Dismembered Carcass	1-5 (fluid in eyes)	Carcass reported Saturday. Carcass moved off road for disposal on Monday by DB. Carcass missing when DB arrived. Some downy feathers found. Probable scavenge.	UTM Z11 NAD83 (m)	3725480	687980	Road	Owl mortality reported Saturday. Remains moved from road area for disposal on Monday.	Barn Owl	Buff and white	Unk	Unk	NO	Cloudy	100	Calm	Creosote Bush Scrub	DB and compliance manager	6/30/2013	9:00:00 AM	Bird remained in place. Instructed reporting party to contact compliance to remove. If compliance not available carcass to be moved off road area to prevent further damage. Deceased Owl was moved to bush on south side of road for later disposal. Only feathers found Monday.	Bird was likely scavenged by mammals. No remains other than a few feathers.
Eric German	7/1/2013	Operations	Evaporation Pond Monitoring	Fatality	Intact Carcass	1-5 (fluid in eyes)	Intact.	UTM Z11 NAD83 (m)	3727430	685607	Evaporation Pond	Bare ground proximate to evap pond.	Cliff swallow	Rufus neck. White nose patch	Unk	Adult	NO	Cloudy	102	Calm	Other (note)	Compliance manager. Discovered by DB.	7/1/2013	10:30:00 AM	Bird removed for disposal by burial.	Proximate to evap ponds. While investigating found two live yellow headed blackbirds. One in south evap pond one in north evap pond. Additional yellow headed blackbird mortality found within south pond enclosure. Report forthcoming.
Eric German	7/1/2013	Construction	Plant Site (incidental)	Injury	N/A	N/A	Bird appears hot, very lethargic. In shock possibly due to heat.	UTM Z11 NAD83 (m)	3726323	686968	Other (explain below)	Bird was in power block 2 area 15.	Red tailed hawk	Dark morph	Fem	Unk	NO	Partly Sunny	110	Calm	Other (note)	Compliance manager and db	7/1/2013	2:00:00 PM	Bird was brought to rehabilitation center in Blythe.	Rtha in power block proximate to person working. Beak open.

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_ Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Eric German	7/1/2013	Construction	Plant Site (incidental)	Injury	N/A	N/A	Not walking well. Did not flush.	UTM Z11 NAD83 (m)	3726927	685588	Other (explain below)	Near building, bare ground	Ruddy duck	Dark top of head whitish cheeks flattened blue grey bill	Fem	Unk	NO	Cloudy	90	Calm	Other (note)	Compliance manager and designated biologist.	7/1/2013	6:40:00 AM	Brought to Blythe rehabilitation.	Collected from assembly building area. Habitat construction staging by building: bare ground
Ron Walker	7/1/2013	Operations	Evaporation Pond Monitoring	Fatality	Intact Carcass	1-5 (fluid in eyes)	Yellow headed blackbird found on ground, intact	UTM Z11 NAD83 (m)	3727349	685776	Evaporation Pond	Eastern edge of southern evaporation pond, bird within two feet of netting, at top of pond berm	Yellow headed blackbird	Brown body, yellowish head	Fem	Unk	NO	Sunny	103	Calm	Bare Ground	Designated biologist	7/1/2013	10:07:00 AM	Removed carcass and buried outside of project site	N/A
Eric German	7/2/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Bird did not appear to have trauma	UTM Z11 NAD83 (m)	3726323	686968	Other (explain below)	Power block 2 pipe rack	Mourning dove	Grey	Unk	Adult	NO	Cloudy	95	Calm	Other (note)	Compliance manager and DB notified.	7/1/2013	1:30:00 PM	Bird removed and disposed by burial.	Bird was reported on July 1
Ron Walker	7/3/2013	Operations	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass appeared to be 2-3 days old	UTM Z11 NAD83 (m)	3726436	686891	Other (explain below)	Found at base of pipe rack in power block area of unit 2, next to dirt access road	Barn owl	White face, brown/tan back	Unk	Adult	NO	Sunny	104	Calm	Other (note)	Eric German	7/2/2013	3:30:00 PM	Retrieved owl and buried off site	N/A
Eric German	7/8/2013	Construction	Plant Site (incidental)	Injury	N/A	N/A	Bird was moving. Beak gaping. Allowed self to be captured.				Solar Trough	No utms taken. Unit 2 block 9 row 52. North end of mirrors.	Western Tanager	Greenish feathers. No orange/red head.	Fem	Adult	NO	Partly Sunny	100	Calm	Other (note)	Compliance and DB.	7/8/2013	11:00:00 AM	Bird collected and brought to Blythe rehabilitation center.	Bird brought to Blythe rehabilitation location. Found in mirrors by crew. Unit 2, block 9, row 52.
Eric German	7/8/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass located within electrical building (no doors).	UTM Z11 NAD83 (m)	3726323	686968	Other (explain below)	Electrical building power block 2.	Great Blue Heron	Greyish blue feathers	Unk	Adult	NO	Partly Sunny	102	Calm	Other (note)	Environmental Manager and DB.	7/8/2013	9:30:00 AM	Bird was removed and disposed by burial. Buried at NAD83 3720479 696323	N/A
Eric German	7/8/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass located in 5 gallon bucket with water. Bird may have drowned.	UTM Z11 NAD83 (m)	3726368	687059	Other (explain below)	Water bucket south of demineralization tank power block 2.	American kestrel		Unk	Adult	NO	Cloudy	100	Calm	Other (note)	Environmental Manager and DB	7/8/2013	9:00:00 AM	Bird removed and disposed, bucket emptied.	Power block 2, in 5 gallon bucket bird mortality reported by contractor.

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_ Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Michael Rathbun	7/8/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Intact, sunken eyes, some smell, no ants, maggots, etc.	UTM Z11 NAD83 (m)	3728049	684278	Solar Trough	20 feet north of solar trough next to a small shed on north side of Unit 1.	American coot	Dark grey body, black head, webbed feet	Unk	Adult	NO	Sunny	102	Calm	Creosote Bush Scrub	The Designated Biologist	7/8/2013	8:30:00 AM	Notified DB. Transferred off site and buried.	N/A
Michael Rathbun	7/8/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Intact, sunken eyes, no smell, some ants, no maggots	UTM Z11 NAD83 (m)	3727402	683446	Solar Trough	Unit 1, block 3, at the north end and below solar array on west side.	Yellow-headed black bird	Black bird, yellow head, white wing patch	Male	Adult	NO	Sunny	102	Calm	Creosote Bush Scrub	Designated Biologist	7/8/2013	8:35:00 AM	Notified DB, carried carcass off site and buried.	N/A
Michael Rathbun	7/8/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass perfectly intact as animal was alive earlier in day.	UTM Z11 NAD83 (m)	3726214	687909	Other (explain below)	Found in admin building entrance. It was moved to the permanent bridge on east side of unit 2 where it had later expired.	Western Pipestrelle? Myotis?	Tan fur, dark snout, ears, tail	Unk	Adult	NO	Sunny	110	Calm	Creosote Bush Scrub	Designated Biologist	7/8/2013	12:30:00 PM	Buried offsite after it was found deceased.	N/A
Eric German	7/9/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Drying out found on ground.				Other (explain below)	Located in power block 1. No utms provided.	Unknown (bat)	Black around edges less than two inches	Unk	Unk	NO	Partly Sunny	106	Calm	Other (note)	Compliance Manager and DB.	7/9/2013	10:00:00 AM	Animal originally not found. Contractor found later.	N/A
Michael Rathbun	7/9/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Intact and very dry, no ants or maggots	UTM Z11 NAD83 (m)	3726766	684402	Other (explain below)	Outside permanent fence but inside	Greater Roadrunner	Greenish feathers	Fem	Adult	NO	Sunny	98	Calm	Creosote Bush Scrub	DB	7/9/2013	12:41:00 PM	Buried carcass off site after notifying DB.	N/A
Michael Rathbun	7/9/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass was intact, animal was alive when found but expired within 10 minutes of moving.	UTM Z11 NAD83 (m)	3727607	685729	Other (explain below)	Found in fabrication tent near coolers	Western pipistrelle	Tan fur with dark nose, ears, and tail	Unk	Adult	NO	Cloudy	105	Calm	Creosote Bush Scrub	DB	7/9/2013	3:02:00 PM	Buried carcass off site	N/A

											Observation											Notification				
Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_Dat	Northing	Easting	Location	Details	Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Who	Date	Time	Actions	Comments
Eric German	7/10/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Bird had been seen at power block 2 at 1330 and was reported to be heat stressed. Observer saw bird fly nw at 1345. At 1515 report of bird mortality unit 1 block 5 mirror row 52. Carcass intact, no rigor, possible cervical dislocation noted when animal was removed.	UTM Z11 NAD83 (m)	3727672	685376	Solar Trough	Shaded side of solar mirror. No heat from mirrors in location of bird mortality.	Brown Pelican	Gray brown body. Gray feet.	Unk	Unk	NO	Partly Sunny	109	Calm	Other (note)	Compliance and DB notified.	7/10/2013	1:30:00 PM	Bird was searched for when reported alive. Bird not found. Remains collected and disposed of by burial.	Bird had been seen flying prior to discovery in solar field.
Eric German	7/16/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	6-30 (maggots)	Carcass was worn and located in an area of pipes and welding.	UTM Z11 NAD83 (m)	3727312	684746	Other (explain below)	East of power block near welding area and lunch area.	Lesser Nighthawk	White wing bars.	Unk	Adult	NO	Sunny	108	Calm	Other (note)	USFWS and CDFW	7/16/2013	1:30:00 PM	Contacted agencies at same time as 7/16 cliff swallow. CDFW representative collected 1730.	Bare ground near power block 1.
Eric German	7/16/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	When bird was first observed it was not moving and lying on stomach but some breathing. Expired before it could be taken to rehab.	UTM Z11 NAD83 (m)	3727287	684625	Other (explain below)	In power block on pipe stand.	Cliff swallow	Rufous neck	Unk	Adult	NO	Sunny	108	Calm	Other (note)	USFWS and CDFW	7/16/2013	1:30:00 PM	Contacted agencies. CDFW representative collected 1730.	Beneath power block structure.
Michael Rathbun	7/16/2013	Construction	Plant Site (incidental)	Injury	N/A	N/A	Still alive		33.6719	114.997	Other (explain below)	Found in structure alive but was taken to rehab off site.	Canyon Bat	Tan fur with dark ears, nose, and tail.	Unk	Unk	NO	Sunny	102	Calm	Creosote Bush Scrub	DB	7/16/2013	7:00:00 AM	Saw and identified and DB took action by notifying agencies.	N/A
Eric German	7/17/2013	Construction	Plant Site (incidental)	Injury	Intact Carcass	N/A	Bat was brought to 1400 meeting by construction personnel. The bat had been in assembly building. Inspected bat and brought to rehabilitation for release.	UTM Z11 NAD83 (m)	3726919	685583	Other (explain below)	Bat was in assembly building with workers present. Photo taken 7/18 of location.	Canyon bat	Greyish brown with dark edges.	Unk	Unk	NO	Sunny	108	Calm	Other (note)	CDFW notified.	7/17/2013	2:50:00 PM	Contacted CDFW, discussed releasing at day roost. Talked with rehab. Decision was made to bring bat to rehab.	Habitat was within building.

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_ Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Ron Walker	7/17/2013	Operations	Plant Site (incidental)	Injury	Intact Carcass	N/A	Injured bat, left wing appeared to be injured. Other than potentially injured wing, bat appeared healthy.	UTM Z11 NAD83 (m)	3726436	686957	Other (explain below)	Bat found in section 22W of power block in unit 2, bat on concrete floor of power block	Myotis sp.	Brown/grey	Unk	Unk	NO	Sunny	109	Calm	Other (note)	Eric German	7/17/2013	1:25:00 PM	Bat monitored during work hours and left in place	Small bat found in section 22W of unit 2 power block, bat on concrete foundation of power block, bat appeared to have injured left wing, bat left in place
Michael Rathbun	7/18/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass in intact condition	UTM Z11 NAD83 (m)	3728232	685067	Other (explain below)	North in Unit 1 near pipe laydown area.	Brown-headed cowbird	Black body with brown head	Male	Adult	NO	Sunny	95	Calm	Creosote Bush Scrub	I notified DB	7/18/2013	12:47:00 PM	Carcass left in place as instructed by DB	N/A
Michael Rathbun	7/18/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass is intact and good condition	UTM Z11 NAD83 (m)	3726436	686946	Other (explain below)	Power block 2, pipe structure 22 on west end	Cliff swallow	Tan throat and rump	Unk	Unk	NO	Sunny	102	Calm	Creosote Bush Scrub	DB notified me about a bird and I identified for him to pass along.	7/18/2013	11:27:00 AM	Left carcass in place as instructed by DB	N/A
Eric German	7/18/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Bat appeared to be fatality. Possibly some movement. Placed in air conditioned vehicle. No movement. Bat deceased.	UTM Z11 NAD83 (m)	3726351	687054	Other (explain below)	Bat located in power block area. Bat was in a box in the shade.	Canyon bat	Greyish brown with dark edges.	Unk	Unk	NO	Sunny	109	Calm	Other (note)	CDFW notified.	7/18/2013	2:45:00 PM	Contacted CDFW prior to removing from construction area and assessing mortality status.	Habitat was in power block.
Eric German	7/19/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass on bare ground in vicinity of power blocks.	UTM Z11 NAD83 (m)	3726362	687039	Other (explain below)	Located on bare ground in power block 2.	Unknown Bat	Brown	Unk	Unk	NO	Partly Sunny	102	Calm	Other (note)	CDFW	7/19/2013	12:15:00 PM	CDFW escorted to bat and bat was removed.	Habitat bare ground proximate to power block.
Ron Walker	7/24/2013	Operations	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass fairly dessicated, intact body	UTM Z11 NAD83 (m)	3726339	687007	Other (explain below)	Unit 2 power block area ACC, top floor of evaporation towers, bird on floor	Say's phoebe	Light buff color on breast, darker grey on neck	Unk	Unk	NO	Partly Sunny	105	Calm	Other (note)	Eric German, designated biologist	7/23/2013	1:57:00 PM	Called CDFW, on 7/24. Ms Kendra Peters came out to site and removed bird at 1:57 PM.	Bird picked up by CDFW Kendra Peters on 7/24/13

											Observation											Notification				
Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_ Dat	Northing	Easting	Location	Details	Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Who	Date	Time	Actions	Comments
Ron Walker	7/29/2013	Operations	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass intact, 2-3 days old	UTM Z11 NAD83 (m)	3727379	684601	Other (explain below)	Unit 1 power block section 17 on concrete floor	Cowbird	Brown	Fem	Unk	NO	Sunny	100	Calm	Other (note)	Ron Walker and Ed Nieves	7/29/2013	11:00:00 AM	Bird picked up, bagged and placed in freezer, Ed Nieves of USFWS was notified of collection	Ed Nieves of USFWS was notified and advised us to pick up carcass and label and put in freezer, female cowbird, photos sent to Amy Gardner and Eric German
Ron Walker	7/29/2013	Operations	Plant Site (incidental)	Fatality	Dismembered Carcass	30+ (bones)	Scattered remains of Great Blue Heron, cause of death unknown, very old carcass, totally desiccated	UTM Z11 NAD83 (m)	3727011	684699	Other (explain below)	Scattered remains found in unit 1 block 8 row 13, no mirrors in this area, just mirror pylons	Great blue heron	Bluish grey	Unk	Unk	NO	Sunny	106	Calm	Other (note)	Ron Walker and Ed Nieves	7/29/2013	3:02:00 PM	Carcass remains picked up and bagged and placed in freezer, Ed Nieves of USFWS was notified	Great Blue Heron remains discovered scattered over a 50 foot area, bird parts collected and bagged and placed in freezer
Eric German	7/30/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass on back and intact. No ants.	UTM Z11 NAD83 (m)	3726946	685610	Other (explain below)	located within the mirror assembly building, on	Brown-headed Cowbird	Large beak, paler than black feathers.	Fem	Unk	NO	Sunny	106	Calm	Other (note)	USFWS	7/30/2013	3:10:00 PM	Left in place. Contacted USFWS for guidance.	Salvaged and placed in freezer 0645, 07/31/2013.
Eric German	7/31/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	6-30 (maggots)	Carcass appears older, beginning to disarticulate. Feathers worn with matting.	UTM Z11 NAD83 (m)	3727395	685704	Evaporation Pond	North evaporation pond.	American Kestrel	Brownish red	Fem	Adult	NO	Sunny	106	Calm	Other (note)	USFWS	7/31/2013	10:30:00 AM	Left in place.	Mortality located within north evap pond. Location pictures taken 8/1/13.
Eric German	7/31/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	6-30 (maggots)	Carcass worn. Intact.	UTM Z11 NAD83 (m)	3725858	685956	Other (explain below)	Beneath drain pipe unit 2 block 5 nw corner.	Great tailed grackle	Long tail black	Unk	Adult	NO	Sunny	109	Calm	Other (note)	USFWS law enforcement	8/1/2013	8:30:00 AM	Left in place. Could not be located for USFWS law enforcement collection.	Habitat. Rip rap beneath drain pipe. Bare ground around.

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_ Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Gregg Lukasek	17-Jul-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Bird appears to be vehicle mortality					Unit 2, block 5	Bullocks oriole		Unk	Adult	NO	Sunny	96	Calm	Bare Ground	DB	7/17/2012		Buried off-site	N/A
Shelly Dayman	17-Jul-12	Construction	Plant Site (incidental)									Assembly building, unit1	Great-horned owl		Unk	Adult	NO	Sunny	110	Calm	Bare Ground	DB	7/17/2012		Evaporation coolers left on to keep building cool to not stress animal, no work in vicinity of owl, all doors of building left open to allow owl to leave after dark, owl was gone by 9pm	Owl appeared to be somewhat heat stressed during day, coolers running to cool building, left on own volition after dark, did not return
Shelly Dayman	18-Jul-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Found in mirror array, burn marks on back of neck	UTM Z11 NAD83 (m)	3726885	685899	Solar Trough	Unit 2, northern area, block 1 or 2	Bullocks oriole		Unk	Adult	NO	Sunny	97	Calm	Bare Ground	DB, Bureau veritas	7/18/2012	4:08:00 PM	Photographs of burn marks taken, animal disposed and buried	N/A
Eric German	23-Jul-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)					Other (explain below)	Plant site	Western meadowlark		Unk	Adult	NO	Sunny	95	Calm	Bare Ground	Form to agencies			Buried off-site	N/A
Eric German	23-Jul-12	Construction	Plant Site (incidental)	Injury							Other (explain below)	Assembly building	Brewers blackbird		Unk	Adult	NO	Sunny	95	Calm	Bare Ground	Form to agencies			Reported to be injured, but can fly and was foraging, appears to be molting, bird last seen outside building	N/A
Eric German	24-Jul-12	Construction	Access road (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)					Road	Access road	Unknown		Unk	Adult	NO	Sunny	89	Calm	Creosote Bush Scrub	Form to agencies			Carcass along access road, cause of death unknown, removed and buried off-site	N/A
Eric German	24-Jul-12	Construction	Plant Site (incidental)								Other (explain below)	Assembly building, Unit 1	Lesser nighthawk		Unk	Adult	NO	Sunny	101	Calm	Bare Ground	Bureau veritas	7/24/2012	2:00:00 PM	Was able to flush bird from building, temps in building hotter than outside	N/A
Shelly Dayman	24-Jul-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Bird died in assembly building likely due to heat exhaustion				Other (explain below)	Assembly building, Unit 1	Brewer's blackbird		Unk	Adult	NO	Sunny	101	Calm	Bare Ground	Bureau veritas, DB	7/24/2012	1:50:00 PM	While bird was in distress was put in ventilated cardboard box but bird died within minutes, carcass buried off-site	N/A
Eric German	27-Jul-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	No signs of trauma				Other (explain below)	Powerblock 2	Mourning dove		Unk	Adult	NO	Sunny	98	Calm	Bare Ground	Form to agencies			Removed and buried off-site	N/A
Eric German	18-Aug-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)					Other (explain below)	Powerblock 1	Mourning dove		Unk	Adult	NO	Sunny	85	Calm	Bare Ground	Form to agencies			Buried off-site	N/A
Eric German	09-Sep-12	Construction	Plant Site (incidental)	Injury							Other (explain below)	Powerblock 2, under vehicle	Common snipe		Unk	Adult	NO	Sunny	98	Calm	Bare Ground	Form to agencies			Heat stressed under vehicle, would not flush, removed and released off-site in moist palo verde area	N/A

											Observation											Notification				
Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_Dat	Northing	Easting	Location	Details	Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Who	Date	Time	Actions	Comments
Eric German	24-Sep-12	Construction	Plant Site (incidental)	Injury			Report of bird striking a mirror				Other (explain below)	Powerblock 2	Gull		Unk	Adult	NO	Sunny	104	Calm	Bare Ground	Form to agencies			Report of injured bird near powerblock 2, bird was gull and able to fly, allowed bird to rest and recover, checked again in a few hours and gull not present	N/A
Eric German	02-Oct-12	Construction	Plant Site (incidental)								Other (explain below)	Powerblock 2	American bittern		Unk	Adult	NO	Sunny	100	Calm	Bare Ground	Form to agencies			Report of bird in powerblock 2, alive, bird flushed soon after observation, could not relocate	N/A
Eric German	03-Oct-12	Construction	Plant Site (incidental)								Other (explain below)	Powerblock 2	American coot		Unk	Adult	NO	Sunny	99	Calm	Bare Ground	Form to agencies			Bird alive, no signs of physical injury, left in place	N/A
Eric German	03-Oct-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Deceased more than a day, cause unknown				Other (explain below)	Unit 2, Block 2	American coot		Unk	Adult	NO	Sunny	99	Calm	Bare Ground	Form to agencies			Removed and buried off-site	N/A
Eric German	03-Oct-12	Construction	Plant Site (incidental)	Injury							Other (explain below)	Powerblock 2	American bittern		Unk	Adult	NO	Sunny	99	Calm	Bare Ground	CDFG	10/3/2012	8:10:00 AM	Bird in powerblock2 for second day, contacted CDFG and it was decided to make capture attempt, bird flushed and not captured, moved between mirrors of Unit 2 and by 1:30 had left site	N/A
Eric German	04-Oct-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Unknown cause				Other (explain below)	Unit 2, block 10	Unknown small bird		Unk	Adult	NO	Sunny	92	Calm	Bare Ground	Form to agencies			Buried remains off-site	N/A
Eric German	15-Oct-12	Construction	Access road (incidental)	Atypical behavior	N/A	N/A	The bird was laying on its belly near the main access road after consultation with cdfg a flush attempt was made. The bird made alarm sounds and feints with its beak. It was allowed to remain and was monitored. Two hours later it made some movement attempt.	UTM Z11 NAD83 (m)	3726177	686890	Road	Access road unit 2 ne corner block 4.	Western Grebe	Black and white. Red eyes. Long neck	Unk	Unk	N/A	Sunny	80	Calm	Bare Ground	Designated Bio and CDFG	10/15/2012	9:00:00 AM	Flush attempt. Then monitored. Two hours later a second flush attempt. Recovered from main access road and delivered to Blythe CDFG.	N/A

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_ Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Eric German	23-Oct-12	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass appeared to be at least two days old. Unknown cause of death. Some carcass damage.	UTM Z11 NAD83 (m)	3726294	686965	Other (explain below)	Powerblock 2, unit 2.	American Kestrel	Brown back. Some red and grey noted Falcon type head	Fem	Unk	NO	Partly Sunny	74	Calm	Bare Ground	Contractor notified designated bio.	10/23/2012	9:50:00 AM	Bird was collected and disposed of by burial.	N/A
Gregg Lukasek	25-Oct-12	Construction	Access road (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Eric german received call that a vehicle struck an owl along access road. The owl was located and was dead on arrival. Carcass is intact and very fresh.	UTM Z11 NAD83 (m)	3722008	692134	Road	On the access road.	Barn owl	White breast with dark spots. Black stripe banding on tail.	Fem	Adult	NO	Sunny	52	Calm	Creosote Bush Scrub	Eric German	10/25/2012	6:05:00 AM	Removed owl from access road and buried it. Took photographs. Took GPS locations for where owl was found on access road and where it was buried.	N/A
Eric German	27-Feb-13	Construction	Gas Line (incidental)	Injury				UTM Z11 NAD83 (m)	3721231	695179	Other (explain below)	Near transmission pole 54	Red-tailed hawk		Unk	Adult	NO				Creosote Bush Scrub	CDFW	2/27/2013		Taken to licensed Blythe avian rehabilitation location per discussion with CDFW	Located beneath existing powerlines and near interstate 10, injury may be power line strike or vehicle collision
Eric German	13-Mar-13	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Unknown cause of mortality				Other (explain below)	Powerblock 2	Lesser goldfinch		Unk	Adult	NO	Partly Sunny	85	Calm	Bare Ground	Form to agencies			Buried off-site	N/A
Shelly Dayman	19-Mar-13	Construction	Transmission Line (incidental)	Fatality	Dismembered Carcass	6-30 (maggots)	Maggots, body in pieces, unknown cause of death	UTM Z11 NAD83 (m)	3726268	687027	Other (explain below)	On access road, under power lines	Lesser goldfinch		Unk	Juv	NO	Partly Sunny	72	Gusty	Creosote Bush Scrub	DB	3/19/2013		Buried off-site	N/A
Eric German	20-Mar-13	Construction	Plant Site (incidental)				Two red-winged blackbirds inside evaporation pond netting, one great-tailed grackle attempting to enter				Evaporation Pond	Southern evap pond	Red-winged blackbirds		Unk	Adult	NO	Cloudy	72	Calm	Evaporation pond	Wildlife agencies present	3/20/2013		Gate of evaporation pond opened and red-winged blackbirds flushed out of netted area, grackle not seen	N/A
Eick German	28-Mar-13	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	No aparent scorching from mirrors	UTM Z11 NAD83 (m)	3726124	687468	Solar Trough	Unit 2, Block 9, between mirrors	Bufflehead	None	Fem	Adult	NO	Sunny	75	Calm	Graded	CEC, BLM, USFWS, CDFW	4/10/2013		Photo taken, removed and disposed	N/A
Mike Rathbun	17-Apr-13	Construction	Gas Line (incidental)	Fatality	Dismembered Carcass	6-30 (maggots)	Three dead birds, likely transmission line strikes				Other (explain below)	Gas line between poles 49 to 56 (east of access road)	Black-throated grey warbler, house wren, orange-crowned warbler		Unk	Adult	NO	Sunny	72	Calm	Creosote Bush Scrub	DB	4/17/2013		Buried off-site	N/A

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_ Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Eric German	25-Apr-13	Construction	Access road (incidental)	Injury			Some blood above beak and not able to fly any distance	UTM Z11 NAD83 (m)			Solar Trough	Unit 2, block 10, row 52	Barn owl		Unk	Adult	NO				Bare Ground	CDFW	4/25/2013		Taken to Blythe avian rehabitation facility	N/A
Eric German	30-Apr-13	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass entangled in evap pond netting, looks to be in place longer than one day but less than one week	UTM Z11 NAD83 (m)	3727414	685660	Evaporation Pond	Netting, north pond	Pied-billed grebe		Unk	Adult	NO	Sunny	100	Gusty	Other (note)	Form to agencies			Could not remove carcass, left in place	Mortality observed due to two great-tailed grackles observed within enclosure
Eric German	30-Apr-13	Construction	Plant Site (incidental)				Two grackles inside evaporation pond netting				Evaporation Pond		Great-tailed grackles		Unk	Adult	NO	Sunny	100	Calm	Other (note)	Form to agencies			Flushed grackles from netted area	N/A
Andrew Fisher	01-May-13	Construction	Plant Site (incidental)	Injury			Live, resting on bare ground, picked up and placed in ventilated cardboard box	UTM Z11 NAD83 (m)	3726261	686787	Solar Trough		Eared grebe		Unk	Adult	NO	Sunny	80	Calm	Bare Ground	DB, CDFW	5/1/2013	10:40:00 AM	Taken to wildlife rehab center, bird seemed active and responsive	N/A
Eric German	01-May-13	Construction	Plant Site (incidental)				Swainson's thrush within southern evaporation pond				Evaporation Pond	Southern	Swainson's thrush		Unk	Adult	NO	Sunny	88	Calm	Other (note)	Form to agencies			Gate of evap pond opened, appeared that bird exited prior to gate opening	N/A
Eric German	01-May-13	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass entangled in evaporation pond netting.	UTM Z11 NAD83 (m)	3727414	685660	Evaporation Pond	Northern evap pond. Middle of western half of pond.	Pied billed grebe		Unk	Adult	NO	Sunny	100	Gusty	Other (note)	Agencies	5/1/2013	11:00:00 AM	Carcass left in place.	Plant site evap pond. Discovered while flushing two great tailed grackles from pond.
Eric German	07-May-13	Construction	Plant Site (incidental)				Spotted sandpiper in south evap pond				Evaporation Pond	South pond	Spotted sandpiper		Unk	Adult	NO	Windy	72		Other (note)	Form to agencies			Opened evap pond gate for bird to exit, but bird exited through a hole in the south side of the netting, environmental compliance and contractor notified of hole	N/A
David charlton	08-May-13	Construction	Transmission Line (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)		UTM Z11 NAD83 (m)	3718540	701913	Road	On gravel road at transmission line curves toward sub station.	Wilsons Warbler	Yellow with dark cap	Male	Adult	NO	Sunny	60	Calm	Graded	Eric German (DB)	5/8/2013	7:29:00 AM	Identify and bury	N/A
Eric German	14-May-13	Construction	Plant Site (incidental)	Injury			Nothing appears broken. Bird does not flush.	UTM Z11 NAD83 (m)	3727200	684485	Other (explain below)	Powerblock 1. There are no solar troughs in immediate area. Hot and in shade.	Yellow headed blackbird	Orange throat. White on wings.		Juv	NO	Sunny	106	Calm	Bare Ground	Form to agencies			Bird did not flush when approached. Captured and taken to rehab.	N/A

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Eric German	14-May-13	Construction	Plant Site (incidental)	Injury			Young yellow-headed blackbird in distress				Other (explain below)	Powerblock 1	Yellow-headed blackbird		Unk	Juv	NO	Sunny	106	Calm	Bare Ground	Form to agencies			Removed bird and taken to avian rehab in Blythe	N/A
Mike Rathbun	14-May-13	Construction	Plant Site (incidental)				Barn owl reported near cooling fans of powerblock 2, not injured				Other (explain below)	Powerblock 2, near cooling fans	Barn owl		Unk	Adult	NO	Sunny	105	Calm	Bare Ground	DB	5/14/2013		Monitored to determine bird out of harm's way	N/A
Eric German	15-May-13	Construction	Transmission Line (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Found beneath tracks of equipment. Not compressed or pinned. Near existing powerlines.	UTM Z11 NAD83 (m)	3718569	701855	Power Line	Found beneath tracks of equipment. Not compressed or pinned. Near existing powerlines. East end of crs road.	Hermit thrush	Spots on chest. Rufous tail		Adult	NO	Sunny	106	Calm	Sand Dune	Form to agencies			Removed and buried.	N/A
Eric German	16-May-13	Construction	Transmission Line (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass intact.	UTM Z11 NAD83 (m)	3720336	695206	Power Line	Beneath power line south of i10	Townsends warbler	Yellow head and chest with black around eyes.		Adult	NO	Sunny	102	Calm	Creosote Bush Scrub	Form to agencies			Photographed and buried.	N/A
Eric German	16-May-13	Construction	Transmission Line (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Intact carcass missing wing	UTM Z11 NAD83 (m)	3720376	695222	Power Line	Beneath powerlines south of i10.	Wilsons warbler	Possible red stripes on breast.		Adult	NO	Sunny	97	Calm	Creosote Bush Scrub	Form to agencies			Removed and buried.	N/A
Mike Rathbun	22-May-13	Construction	Plant Site (incidental)	Injury			Injured, did not try to fly or run, when captured tried to bite and noisy call		114.9935	33.6573	Solar Trough	Unit 2, Block 4, between rows 50&51	Western grebe	Black below red eyes, long shape bill	Unk	Adult	NO	Sunny	92	Calm	Bare Ground	DB	5/22/2013	11:34:00 AM	Bird taken to Blythe avian rehab center	N/A
Mike Rathbun	22-May-13	Construction	Transmission Line (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Intact carcass	UTM Z11 NAD83 (m)	3721275	695203	Power Line	Under tower 54, 30 feet away, under powerline	Yellow warbler		Fem	Adult	NO	Sunny	72	Calm	Creosote Bush Scrub	DB	5/22/2013	6:45:00 AM	Buried off-site	N/A
Eric German	23-May-13	Construction	Access road (incidental)	Fatality	Dismembered Carcass	1-5 (fluid in eyes)	Crushed on access road.	UTM Z11 NAD83 (m)	3721112	693393	Road	Access road mortality. Creosote bush scrub. Near powerlines.	Unknown warbler	Yellow breast. Yellow green back and head.	Unk	Adult	NO	Sunny	80	Calm	Creosote Bush Scrub	To be reported. Form completed	5/23/2013	8:30:00 AM	Bird disposed of by burial.	N/A

											Observation											Notification				
Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_Dat	Northing	Easting	Location	Details	Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Who	Date	Time	Actions	Comments
Eric German	24-May-13	Construction	Access road (incidental)	Fatality	Dismembered Carcass	1-5 (fluid in eyes)	Crushed on access road.	UTM Z11 NAD83 (m)	3725489	688010	Road	Access road mortality. Creosote bush scrub. Near powerlines. Found on road ahoulder.	Unkown sparrow	Dark wings.	Unk	Adult	NO	Sunny	85	Calm	Creosote Bush Scrub	Designated bio. Form to be submitted in MCR.	5/24/2013	8:30:00 AM	Bird disposed of by burial.	N/A
Mike Rathbun	30-May-13	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	No maggots, but smelled of death	UTM Z11 NAD83 (m)	3726773	684534	Other (explain below)	Next to permanent fence, directly south of PB1	American coot		Unk	Adult	NO	Sunny	90	Calm	Graded	DB	5/30/2013	4:00:00 PM	Buried off-site	N/A
Ron Walker	04-Jun-13	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass intact	UTM Z11 NAD83 (m)	3727397	683967	Solar Trough	Unit 1 block 3	Mourning dove	Brown/ grey	Unk	Unk	NO	Sunny	102	Calm	Bare Ground	Ron Walker	6/4/2013	12:45:00 PM	Bird removed and buried	N/A
Eric German	05-Jun-13	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Blood from beak area indicating impact. Appeared to be gripping onto perch as rigor set in.	UTM Z11 NAD83 (m)	3726094	687120	Solar Trough	Pillar in solar field.	Barn Owl	White face/ buff and white.	Unk	Adult	NO	Sunny	106	Calm	Bare Ground	DB notified / Notified compliance.	6/5/2013	1:00:00 PM	Animal collected put on ice and then disposed of by burial.	N/A
Ron Walker	10-Jun-13	Operations	Plant Site (incidental)	Injury	N/A	N/A	Injured brown pelican found in unit 2 in power block area under HTF overhead pipes, above power block access road. Pelican appeared to be suffering from heat stress. Pelican transported to wildlife rehabilitation center in Blythe, CA. It was reported later that the pelican recovered and was released uninjured.	UTM Z11 NAD83 (m)	3726434	686893	Other (explain below)	Unit 2, west side of power block, under HTF pipe overhead crossing	Brown Pelican	Brown, light underbelly	Unk	Unk	NO	Sunny	109	Gusty	Other (note)	Designated biologist	6/10/2013	4:30:00 PM	Brown pelican picked up and transported to wildlife rehabilitation center in Blythe CA	Injured brown pelican found in unit 2 in power block area under HTF overhead pipes, above power block access road. Pelican appeared to be suffering from heat stress. Pelican transported to wildlife rehabilitation center in Blythe, CA. It was reported later that the pelican recovered and was released uninjured.

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_ Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Eric German	28-Jun-13	Operations	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass was against evap pond netting. The bird was not entangled nor signs of blunt trauma. Last incidental evap pond monitoring afternoon, 6/27/13.	UTM Z11 NAD83 (m)	3727428	685612	Evaporation Pond	West side of north evap pond. Water in pond. Packed dirt around enclosure. Carcass against netting. Pond contains water.	Great Blue Heron	Grey color large bird.	Unk	Adult	NO	Other (note)	84	Calm	Graded	DB notified of find by reporting party. CM notified at 1000.	6/28/2013	9:30:00 AM	Bird removed and disposed via burial.	Weather: overcast Feels humid. Ponds checked 6/27 afternoon without findings. Burial at 0688055 / 3726307
Mike Anguiano	28-Jun-13	Operations	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Condition good. Likely overheated and died. Temps up to 122.	UTM Z11 NAD83 (m)	3726802	685760	Other (explain below)	found dead in water treatment building. Reported earlier in the day about 1300 but bird flew out of building	Barn owl	Adult barn owl	Unk	Adult	NO	Sunny	119	Calm	Other (note)	Eric German	6/28/2013	3:12:00 PM	Bird removed from building and buried off main access road. Buried at easting 0688214 northing 3725072	N/A
Eric German	7/1/2013	Construction	Access road (incidental)	Fatality	Dismembered Carcass	1-5 (fluid in eyes)	Carcass reported Saturday. Carcass moved off road for disposal on Monday by DB. Carcass missing when DB arrived. Some downy feathers found. Probable scavenge.	UTM Z11 NAD83 (m)	3725480	687980	Road	Owl mortality reported Saturday. Remains moved from road area for disposal on Monday.	Barn Owl	Buff and white	Unk	Unk	NO	Cloudy	100	Calm	Creosote Bush Scrub	DB and compliance manager	6/30/2013	9:00:00 AM	Bird remained in place. Instructed reporting party to contact compliance to remove. If compliance not available carcass to be moved off road area to prevent further damage. Deceased Owl was moved to bush on south side of road for later disposal. Only feathers found Monday.	Bird was likely scavenged by mammals. No remains other than a few feathers.
Eric German	7/1/2013	Operations	Evaporation Pond Monitoring	Fatality	Intact Carcass	1-5 (fluid in eyes)	Intact.	UTM Z11 NAD83 (m)	3727430	685607	Evaporation Pond	Bare ground proximate to evap pond.	Cliff swallow	Rufus neck. White nose patch	Unk	Adult	NO	Cloudy	102	Calm	Other (note)	Compliance manager. Discovered by DB.	7/1/2013	10:30:00 AM	Bird removed for disposal by burial.	Proximate to evap ponds. While investigating found two live yellow headed blackbirds. One in south evap pond one in north evap pond. Additional yellow headed blackbird mortality found within south pond enclosure. Report forthcoming.
Eric German	7/1/2013	Construction	Plant Site (incidental)	Injury	N/A	N/A	Bird appears hot, very lethargic. In shock possibly due to heat.	UTM Z11 NAD83 (m)	3726323	686968	Other (explain below)	Bird was in power block 2 area 15.	Red tailed hawk	Dark morph	Fem	Unk	NO	Partly Sunny	110	Calm	Other (note)	Compliance manager and db	7/1/2013	2:00:00 PM	Bird was brought to rehabilitation center in Blythe.	Rtha in power block proximate to person working. Beak open.

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_ Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Eric German	7/1/2013	Construction	Plant Site (incidental)	Injury	N/A	N/A	Not walking well. Did not flush.	UTM Z11 NAD83 (m)	3726927	685588	Other (explain below)	Near building, bare ground	Ruddy duck	Dark top of head whitish cheeks flattened blue grey bill	Fem	Unk	NO	Cloudy	90	Calm	Other (note)	Compliance manager and designated biologist.	7/1/2013	6:40:00 AM	Brought to Blythe rehabilitation.	Collected from assembly building area. Habitat construction staging by building: bare ground
Ron Walker	7/1/2013	Operations	Evaporation Pond Monitoring	Fatality	Intact Carcass	1-5 (fluid in eyes)	Yellow headed blackbird found on ground, intact	UTM Z11 NAD83 (m)	3727349	685776	Evaporation Pond	Eastern edge of southern evaporation pond, bird within two feet of netting, at top of pond berm	Yellow headed blackbird	Brown body, yellowish head	Fem	Unk	NO	Sunny	103	Calm	Bare Ground	Designated biologist	7/1/2013	10:07:00 AM	Removed carcass and buried outside of project site	N/A
Eric German	7/2/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Bird did not appear to have trauma	UTM Z11 NAD83 (m)	3726323	686968	Other (explain below)	Power block 2 pipe rack	Mourning dove	Grey	Unk	Adult	NO	Cloudy	95	Calm	Other (note)	Compliance manager and DB notified.	7/1/2013	1:30:00 PM	Bird removed and disposed by burial.	Bird was reported on July 1
Ron Walker	7/3/2013	Operations	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass appeared to be 2-3 days old	UTM Z11 NAD83 (m)	3726436	686891	Other (explain below)	Found at base of pipe rack in power block area of unit 2, next to dirt access road	Barn owl	White face, brown/tan back	Unk	Adult	NO	Sunny	104	Calm	Other (note)	Eric German	7/2/2013	3:30:00 PM	Retrieved owl and buried off site	N/A
Eric German	7/8/2013	Construction	Plant Site (incidental)	Injury	N/A	N/A	Bird was moving. Beak gaping. Allowed self to be captured.				Solar Trough	No utms taken. Unit 2 block 9 row 52. North end of mirrors.	Western Tanager	Greenish feathers. No orange/red head.	Fem	Adult	NO	Partly Sunny	100	Calm	Other (note)	Compliance and DB.	7/8/2013	11:00:00 AM	Bird collected and brought to Blythe rehabilitation center.	Bird brought to Blythe rehabilitation location. Found in mirrors by crew. Unit 2, block 9, row 52.
Eric German	7/8/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass located within electrical building (no doors).	UTM Z11 NAD83 (m)	3726323	686968	Other (explain below)	Electrical building power block 2.	Great Blue Heron	Greyish blue feathers	Unk	Adult	NO	Partly Sunny	102	Calm	Other (note)	Environmental Manager and DB.	7/8/2013	9:30:00 AM	Bird was removed and disposed by burial. Buried at NAD83 3720479 696323	N/A
Eric German	7/8/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass located in 5 gallon bucket with water. Bird may have drowned.	UTM Z11 NAD83 (m)	3726368	687059	Other (explain below)	Water bucket south of demineralization tank power block 2.	American kestrel		Unk	Adult	NO	Cloudy	100	Calm	Other (note)	Environmental Manager and DB	7/8/2013	9:00:00 AM	Bird removed and disposed, bucket emptied.	Power block 2, in 5 gallon bucket bird mortality reported by contractor.

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Michael Rathbun	7/8/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Intact, sunken eyes, some smell, no ants, maggots, etc.	UTM Z11 NAD83 (m)	3728049	684278	Solar Trough	20 feet north of solar trough next to a small shed on north side of Unit 1.	American coot	Dark grey body, black head, webbed feet	Unk	Adult	NO	Sunny	102	Calm	Creosote Bush Scrub	The Designated Biologist	7/8/2013	8:30:00 AM	Notified DB. Transferred off site and buried.	N/A
Michael Rathbun	7/8/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Intact, sunken eyes, no smell, some ants, no maggots	UTM Z11 NAD83 (m)	3727402	683446	Solar Trough	Unit 1, block 3, at the north end and below solar array on west side.	Yellow-headed black bird	Black bird, yellow head, white wing patch	Male	Adult	NO	Sunny	102	Calm	Creosote Bush Scrub	Designated Biologist	7/8/2013	8:35:00 AM	Notified DB, carried carcass off site and buried.	N/A
Michael Rathbun	7/8/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass perfectly intact as animal was alive earlier in day.	UTM Z11 NAD83 (m)	3726214	687909	Other (explain below)	Found in admin building entrance. It was moved to the permanent bridge on east side of unit 2 where it had later expired.	Western Pipestrelle? Myotis?	Tan fur, dark snout, ears, tail	Unk	Adult	NO	Sunny	110	Calm	Creosote Bush Scrub	Designated Biologist	7/8/2013	12:30:00 PM	Buried offsite after it was found deceased.	N/A
Eric German	7/9/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Drying out found on ground.				Other (explain below)	Located in power block 1. No utms provided.	Unknown (bat)	Black around edges less than two inches	Unk	Unk	NO	Partly Sunny	106	Calm	Other (note)	Compliance Manager and DB.	7/9/2013	10:00:00 AM	Animal originally not found. Contractor found later.	N/A
Michael Rathbun	7/9/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Intact and very dry, no ants or maggots	UTM Z11 NAD83 (m)	3726766	684402	Other (explain below)	Outside permanent fence but inside	Greater Roadrunner	Greenish feathers	Fem	Adult	NO	Sunny	98	Calm	Creosote Bush Scrub	DB	7/9/2013	12:41:00 PM	Buried carcass off site after notifying DB.	N/A
Michael Rathbun	7/9/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass was intact, animal was alive when found but expired within 10 minutes of moving.	UTM Z11 NAD83 (m)	3727607	685729	Other (explain below)	Found in fabrication tent near coolers	Western pipistrelle	Tan fur with dark nose, ears, and tail	Unk	Adult	NO	Cloudy	105	Calm	Creosote Bush Scrub	DB	7/9/2013	3:02:00 PM	Buried carcass off site	N/A

Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_Dat	Northing	Easting	Observation		Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Notification			Actions	Comments
											Location	Details										Who	Date	Time		
Eric German	7/10/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Bird had been seen at power block 2 at 1330 and was reported to be heat stressed. Observer saw bird fly nw at 1345. At 1515 report of bird mortality unit 1 block 5 mirror row 52. Carcass intact, no rigor, possible cervical dislocation noted when animal was removed.	UTM Z11 NAD83 (m)	3727672	685376	Solar Trough	Shaded side of solar mirror. No heat from mirrors in location of bird mortality.	Brown Pelican	Gray brown body. Gray feet.	Unk	Unk	NO	Partly Sunny	109	Calm	Other (note)	Compliance and DB notified.	7/10/2013	1:30:00 PM	Bird was searched for when reported alive. Bird not found. Remains collected and disposed of by burial.	Bird had been seen flying prior to discovery in solar field.
Eric German	7/16/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	6-30 (maggots)	Carcass was worn and located in an area of pipes and welding.	UTM Z11 NAD83 (m)	3727312	684746	Other (explain below)	East of power block near welding area and lunch area.	Lesser Nighthawk	White wing bars.	Unk	Adult	NO	Sunny	108	Calm	Other (note)	USFWS and CDFW	7/16/2013	1:30:00 PM	Contacted agencies at same time as 7/16 cliff swallow. CDFW representative collected 1730.	Bare ground near power block 1.
Eric German	7/16/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	When bird was first observed it was not moving and lying on stomach but some breathing. Expired before it could be taken to rehab.	UTM Z11 NAD83 (m)	3727287	684625	Other (explain below)	In power block on pipe stand.	Cliff swallow	Rufous neck	Unk	Adult	NO	Sunny	108	Calm	Other (note)	USFWS and CDFW	7/16/2013	1:30:00 PM	Contacted agencies. CDFW representative collected 1730.	Beneath power block structure.
Michael Rathbun	7/16/2013	Construction	Plant Site (incidental)	Injury	N/A	N/A	Still alive		33.6719	114.997	Other (explain below)	Found in structure alive but was taken to rehab off site.	Canyon Bat	Tan fur with dark ears, nose, and tail.	Unk	Unk	NO	Sunny	102	Calm	Creosote Bush Scrub	DB	7/16/2013	7:00:00 AM	Saw and identified and DB took action by notifying agencies.	N/A
Eric German	7/17/2013	Construction	Plant Site (incidental)	Injury	Intact Carcass	N/A	Bat was brought to 1400 meeting by construction personnel. The bat had been in assembly building. Inspected bat and brought to rehabilitation for release.	UTM Z11 NAD83 (m)	3726919	685583	Other (explain below)	Bat was in assembly building with workers present. Photo taken 7/18 of location.	Canyon bat	Greyish brown with dark edges.	Unk	Unk	NO	Sunny	108	Calm	Other (note)	CDFW notified.	7/17/2013	2:50:00 PM	Contacted CDFW, discussed releasing at day roost. Talked with rehab. Decision was made to bring bat to rehab.	Habitat was within building.

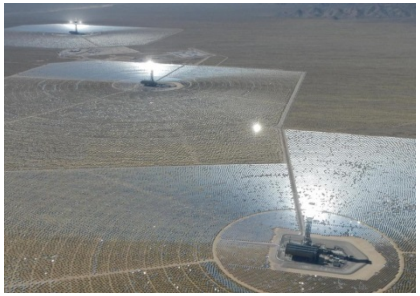
											Observation											Notification				
Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_ Dat	Northing	Easting	Location	Details	Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Who	Date	Time	Actions	Comments
Ron Walker	7/17/2013	Operations	Plant Site (incidental)	Injury	Intact Carcass	N/A	Injured bat, left wing appeared to be injured. Other than potentially injured wing, bat appeared healthy.	UTM Z11 NAD83 (m)	3726436	686957	Other (explain below)	Bat found in section 22W of power block in unit 2, bat on concrete floor of power block	Myotis sp.	Brown/grey	Unk	Unk	NO	Sunny	109	Calm	Other (note)	Eric German	7/17/2013	1:25:00 PM	Bat monitored during work hours and left in place	Small bat found in section 22W of unit 2 power block, bat on concrete foundation of power block, bat appeared to have injured left wing, bat left in place
Michael Rathbun	7/18/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass in intact condition	UTM Z11 NAD83 (m)	3728232	685067	Other (explain below)	North in Unit 1 near pipe laydown area.	Brown-headed cowbird	Black body with brown head	Male	Adult	NO	Sunny	95	Calm	Creosote Bush Scrub	I notified DB	7/18/2013	12:47:00 PM	Carcass left in place as instructed by DB	N/A
Michael Rathbun	7/18/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass is intact and good condition	UTM Z11 NAD83 (m)	3726436	686946	Other (explain below)	Power block 2, pipe structure 22 on west end	Cliff swallow	Tan throat and rump	Unk	Unk	NO	Sunny	102	Calm	Creosote Bush Scrub	DB notified me about a bird and I identified for him to pass along.	7/18/2013	11:27:00 AM	Left carcass in place as instructed by DB	N/A
Eric German	7/18/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Bat appeared to be fatality. Possibly some movement. Placed in air conditioned vehicle. No movement. Bat deceased.	UTM Z11 NAD83 (m)	3726351	687054	Other (explain below)	Bat located in power block area. Bat was in a box in the shade.	Canyon bat	Greyish brown with dark edges.	Unk	Unk	NO	Sunny	109	Calm	Other (note)	CDFW notified.	7/18/2013	2:45:00 PM	Contacted CDFW prior to removing from construction area and assessing mortality status.	Habitat was in power block.
Eric German	7/19/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass on bare ground in vicinity of power blocks.	UTM Z11 NAD83 (m)	3726362	687039	Other (explain below)	Located on bare ground in power block 2.	Unknown Bat	Brown	Unk	Unk	NO	Partly Sunny	102	Calm	Other (note)	CDFW	7/19/2013	12:15:00 PM	CDFW escorted to bat and bat was removed.	Habitat bare ground proximate to power block.
Ron Walker	7/24/2013	Operations	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass fairly dessicated, intact body	UTM Z11 NAD83 (m)	3726339	687007	Other (explain below)	Unit 2 power block area ACC, top floor of evaporation towers, bird on floor	Say's phoebe	Light buff color on breast, darker grey on neck	Unk	Unk	NO	Partly Sunny	105	Calm	Other (note)	Eric German, designated biologist	7/23/2013	1:57:00 PM	Called CDFW, on 7/24. Ms Kendra Peters came out to site and removed bird at 1:57 PM.	Bird picked up by CDFW Kendra Peters on 7/24/13

											Observation											Notification				
Bio-monitor	Date	Phase	Situation	Incident Type	Carcass Cond	Age of Remains	Carcass Details	UTM_Dat	Northing	Easting	Location	Details	Species	Markings	Sex	Age	Tag	Weather	Temp	Wind	Habitat	Who	Date	Time	Actions	Comments
Ron Walker	7/29/2013	Operations	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass intact, 2-3 days old	UTM Z11 NAD83 (m)	3727379	684601	Other (explain below)	Unit 1 power block section 17 on concrete floor	Cowbird	Brown	Fem	Unk	NO	Sunny	100	Calm	Other (note)	Ron Walker and Ed Nieves	7/29/2013	11:00:00 AM	Bird picked up, bagged and placed in freezer, Ed Nieves of USFWS was notified of collection	Ed Nieves of USFWS was notified and advised us to pick up carcass and label and put in freezer, female cowbird, photos sent to Amy Gardner and Eric German
Ron Walker	7/29/2013	Operations	Plant Site (incidental)	Fatality	Dismembered Carcass	30+ (bones)	Scattered remains of Great Blue Heron, cause of death unknown, very old carcass, totally desiccated	UTM Z11 NAD83 (m)	3727011	684699	Other (explain below)	Scattered remains found in unit 1 block 8 row 13, no mirrors in this area, just mirror pylons	Great blue heron	Bluish grey	Unk	Unk	NO	Sunny	106	Calm	Other (note)	Ron Walker and Ed Nieves	7/29/2013	3:02:00 PM	Carcass remains picked up and bagged and placed in freezer, Ed Nieves of USFWS was notified	Great Blue Heron remains discovered scattered over a 50 foot area, bird parts collected and bagged and placed in freezer
Eric German	7/30/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	1-5 (fluid in eyes)	Carcass on back and intact. No ants.	UTM Z11 NAD83 (m)	3726946	685610	Other (explain below)	located within the mirror assembly building, on	Brown-headed Cowbird	Large beak, paler than black feathers.	Fem	Unk	NO	Sunny	106	Calm	Other (note)	USFWS	7/30/2013	3:10:00 PM	Left in place. Contacted USFWS for guidance.	Salvaged and placed in freezer 0645, 07/31/2013.
Eric German	7/31/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	6-30 (maggots)	Carcass appears older, beginning to disarticulate. Feathers worn with matting.	UTM Z11 NAD83 (m)	3727395	685704	Evaporation Pond	North evaporation pond.	American Kestrel	Brownish red	Fem	Adult	NO	Sunny	106	Calm	Other (note)	USFWS	7/31/2013	10:30:00 AM	Left in place.	Mortality located within north evap pond. Location pictures taken 8/1/13.
Eric German	7/31/2013	Construction	Plant Site (incidental)	Fatality	Intact Carcass	6-30 (maggots)	Carcass worn. Intact.	UTM Z11 NAD83 (m)	3725858	685956	Other (explain below)	Beneath drain pipe unit 2 block 5 nw corner.	Great tailed grackle	Long tail black	Unk	Adult	NO	Sunny	109	Calm	Other (note)	USFWS law enforcement	8/1/2013	8:30:00 AM	Left in place. Could not be located for USFWS law enforcement collection.	Habitat. Rip rap beneath drain pipe. Bare ground around.

Evaluation of the Feasibility of Avian Vaporization from Concentrating Solar Power Towers

Exceptional service
in the national interest

Sandia
National
Laboratories



Clifford K. Ho
Sandia National Laboratories
Concentrating Solar Technologies Dept.
Albuquerque, New Mexico
ckho@sandia.gov, (505) 844-2384

SAND2015-1945 PE

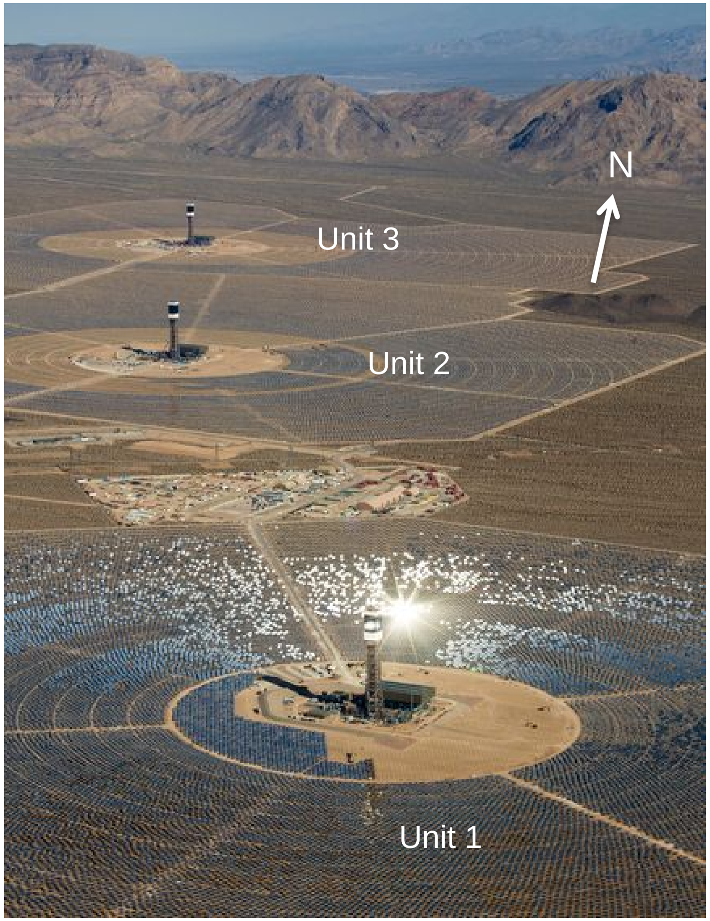
U.S. DEPARTMENT OF ENERGY

NNSA
National Nuclear Security Administration

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Ivanpah Solar Electric Generating System

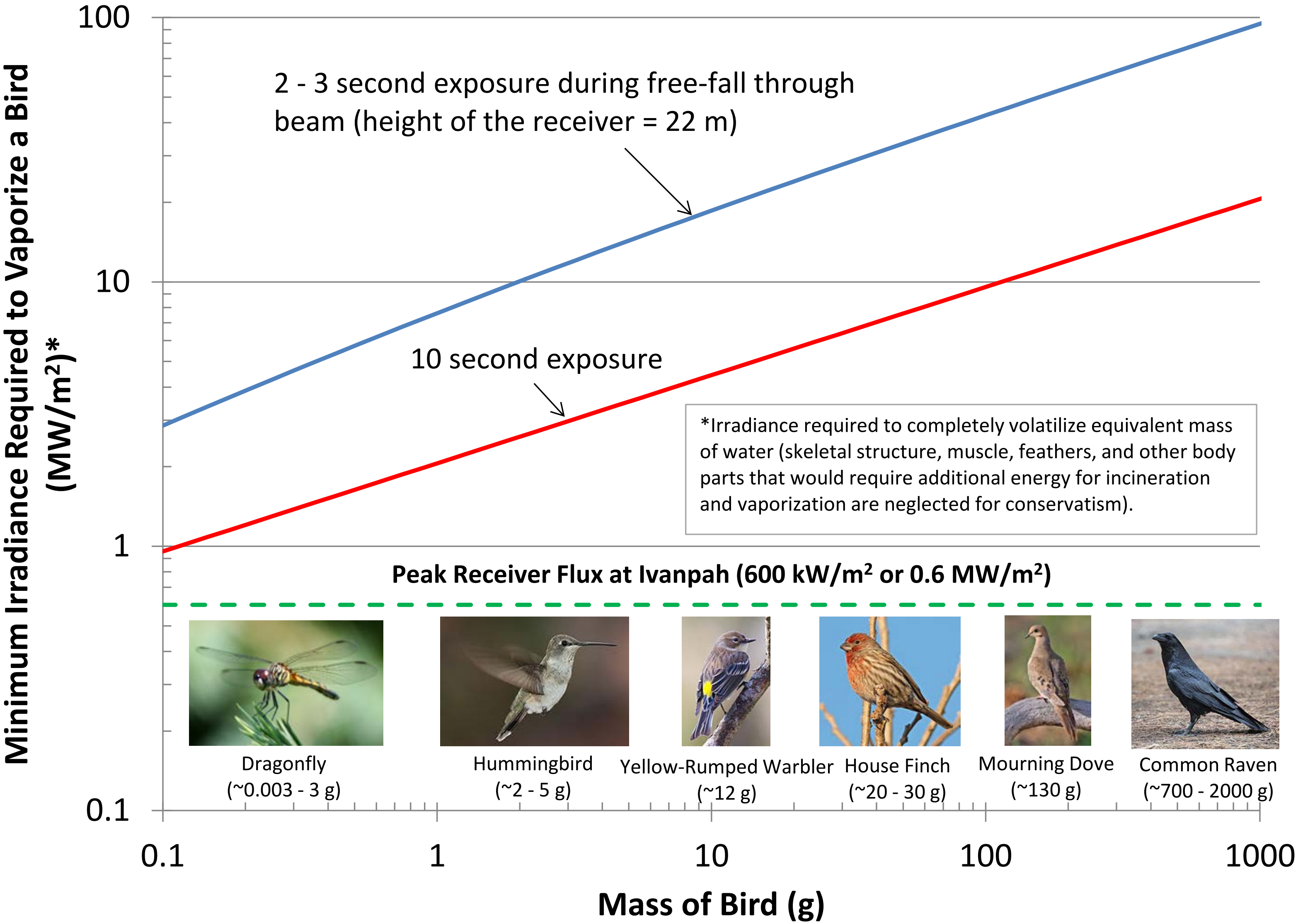
- Three power tower units (377 MW (net) / 392 MW (gross))
  - Unit 1: 126 MW
  - Unit 2: 133 MW
  - Unit 3: 133 MW
  - Each tower 140 m (459 ft) tall
- 173,500 heliostats
  - 2 mirrors/heliostat: 15.2 m^2
- Direct steam receiver (22 m tall x 17 m wide + ~16 m of white shielding)
- Dry-cooling
- 14.2 km^2 (3500 acres) on public desert land in southern California
- Owners: NRG Energy, Google, and Brightsource Energy



Vaporization Calculation

- Assume bird is composed entirely of water
- Determine energy required to volatilize equivalent mass of water (sensible heat plus latent heat)
    - Sensible (heating) energy to heat water from 40 C (average body temperature of bird) to 97 C (boiling point at elevation of Ivanpah)
    - Latent heat of vaporization to convert liquid water to vapor
- Convert energy (J) to irradiance (W/m^2) by dividing by exposure time (s) and cross-sectional area (m^2)
    - Two exposure times calculated
        - Free-fall through beam equivalent to height of receiver (22 m); ~2 – 3 sec
        - Fixed 10 sec exposure time
- Compare minimum irradiance required to volatilize a bird with prescribed mass to the peak available irradiance at Ivanpah

Irradiance Required to Vaporize a Bird


2 - 3 second exposure during free-fall through beam (height of the receiver = 22 m)

10 second exposure

*Irradiance required to completely volatilize equivalent mass of water (skeletal structure, muscle, feathers, and other body parts that would require additional energy for incineration and vaporization are neglected for conservatism).

Peak Receiver Flux at Ivanpah (600 kW/m² or 0.6 MW/m²)

Conclusions

- Complete vaporization of birds with concentrated solar flux less than 1 MW/m^2 is highly improbable
- For most common birds between 10 – 1000 g, the irradiance would need to be 4 – 20 MW/m^2 with an exposure time of 10 sec to volatilize equivalent mass of water
    - Peak irradiance (solar flux) at Ivanpah is only ~0.6 MW/m^2
    - Additional energy would be required to incinerate and vaporize bones, muscle, feather, and other body parts, which were neglected in this analysis

Appendices

- Free-fall and time of irradiance calculation
- Vaporization calculation
- References

Free-Fall Calculation

- Free-fall time over distance, H, is as follows:

$$t = \frac{v_\infty}{g}\cosh^{-1}\left(\exp\left(\frac{Hg}{v_\infty^2}\right)\right)$$

where $v_\infty = \text{terminal velocity} = 1.286 m^{1/6} \rho_w^{\ 1/3} \left(\frac{g}{\rho_a C_D}\right)^{1/2}$ assuming spherical body

g = gravitational accleration (9.81 m/s^2)
H = free-fall distance through beam = receiver height = 22 m
m = mass (kg)
ρ_a = density of ambient air = 1.2 kg/m^3
ρ_w = density of water = 992 kg/m^3 at 40 C
C_D = drag coefficient (~1 for passerine birds)*

⇨ Free-fall time through beam is ~2 – 3 sec, depending on mass

*Sum of three drag components: lift, profile, and parasite (Hedenstrom and Liechti, 2001)

Vaporization calculation

- Sensible (heating) energy:

$$E_{sensible} = mc_p \left(T_{boil} - T_{body}\right)$$

where

$E_{sensible}$ = sensible energy to bring water to boiling point (J)
m = mass (kg)
c_p = specific heat of water = 4200 J/kg-K (for T between 270 – 390 K)
T_{boil} = boiling point of water (= 97 C for atmospheric pressure at Ivanpah)
T_{body} = average body temperature of bird (= 40 C; Prinzinger et al., 1991)

Vaporization calculation

- Latent heating:

$$E_{latent} = mh_{fg}$$

where

E_{latent} = latent energy to volatilize liquid water (J)
m = mass (kg)
h_{fg} = latent heat of vaporization (=2.27e6 J/kg at 97 C)

Vaporization calculation

- Minimum irradiance required for vaporization

$$Q = \frac{E_{sensible} + E_{latent}}{At}$$

where

$$A = \frac{\pi^{1/3}}{4}\left(\frac{6m}{\rho_w}\right)^{2/3}$$

Q = irradiance (W/m^2)
$E_{sensible}$ = sensible energy to bring water to boiling point (J)
E_{latent} = latent energy to volatilize liquid water (J)
A = cross-sectional area of bird (m^2); assumed to be spherical in shape*
ρ_w = density of water = 992 kg/m^3 at 40 C
t = time of exposure (sec)

*Cross-sectional area of sphere is conservatively larger than estimates from Pennycuick (1989) for body frontal area, S_b: S_b=0.00813m$^{0.666}$

References

- Coles, B.H., 2007, *Essentials of avian medicine and surgery*, 3rd ed., Blackwell Pub., Oxford, UK ; Ames, Iowa, viii, 397 p.
- Hedenstrom, A. and F. Liechti, 2001, Field estimates of body drag coefficient on the basis of dives in passerine birds, *Journal of Experimental Biology*, **204**(6), p. 1167-1175.
- Pennycuick, C.J., 1989, *Bird flight performance : a practical calculation manual*, Oxford University Press, Oxford, England ; New York, x, 153 p.
- Prinzinger, R., A. Pressmar, and E. Schleucher, 1991, Body-Temperature in Birds, *Comparative Biochemistry and Physiology a-Physiology*, **99**(4), p. 499-506.

Avian Mortality at Solar Energy Facilities in Southern California: A Preliminary Analysis

Rebecca A. Kagan, Tabitha C. Viner, Pepper W. Trail, and Edgard O. Espinoza
National Fish and Wildlife Forensics Laboratory

Executive Summary

This report summarizes data on bird mortality at three solar energy facilities in southern California: Desert Sunlight, Genesis, and Ivanpah. These facilities use different solar technologies, but avian mortality was documented at each site. Desert Sunlight is a photovoltaic facility, Genesis employs a trough system with parabolic mirrors, and Ivanpah uses a power tower as a focal point for solar flux.

FINDINGS

Trauma was the leading cause of death documented for remains at the Desert Sunlight and Genesis sites. Trauma and solar flux injury were both major causes of mortality at the Ivanpah site. Exposure to solar flux caused singeing of feathers, which resulted in mortality in several ways. Severe singeing of flight feathers caused catastrophic loss of flying ability, leading to death by impact with the ground or other objects. Less severe singeing led to impairment of flight capability, reducing ability to forage and evade predators, leading to starvation or predation. Our examinations did not find evidence for significant tissue burns or eye damage caused by exposure to solar flux.

Cause of Death	Ivanpah	Genesis	Desert Sunlight	Total
Solar Flux	47	0	0	47
Impact trauma	24	6	19	49
Predation trauma	5	2	15	22
Trauma of undetermined cause	14	0	0	14
Electrocution	1	0	0	1
Emaciation	1	0	0	1
Undetermined (remains in poor condition)	46	17	22	85
No evident cause of death	3	6	5	14
Total	141	31	61	233

These solar facilities appear to represent “equal-opportunity” hazards for the bird species that encounter them. The remains of 71 species were identified, representing a broad range of ecological types. In body size, these ranged from hummingbirds to pelicans; in ecological type from strictly aerial feeders (swallows) to strictly aquatic feeders (grebes) to ground feeders (roadrunners) to raptors (hawks and owls). The species identified were equally divided among resident and non-resident species, and nocturnal as well as diurnal species were represented. Although not analyzed in detail, there was also significant bat and insect mortality at the Ivanpah site, including monarch butterflies. It appears that Ivanpah may act as a **"mega-trap,"** attracting insects which in turn attract insect-eating birds, which are incapacitated by solar flux injury, thus attracting predators and creating an entire food chain vulnerable to injury and death.

			Foraging Zone			**Residency Status**	
SITE	No. Remains	Identifiable Remains	Air	Terr	Water	Resident	Migrant
Ivanpah	141	127	28	85	14	63	64
Genesis	31	30	12	12	6	20	10
Desert Sun	61	56	7	22	27	18	38
TOTALS	233	213	47	119	47	101	112

CONCLUSIONS AND RECOMMENDATIONS

In summary, three main causes of avian mortality were identified at these facilities: impact trauma, solar flux, and predation. Birds at all three types of solar plants were susceptible to impact trauma and predators. Predation was documented mostly at the photovoltaic site, and in many cases appeared to be associated with stranding or nonfatal impact trauma with the panels, leaving birds vulnerable to resident predators. Solar flux injury, resulting from exposures to up to 800º F, was unique to the power tower facility. Our findings demonstrate that a broad ecological variety of birds are vulnerable to morbidity and mortality at solar facilities, though some differential mortality trends were evident, such as waterbirds at Desert Sunlight, where open water sources were present; and insectivores at Ivanpah, where insects are attracted to the solar tower.

Specific hazards were identified, including vertically-oriented mirrors or other smooth reflective panels; water-like reflective or polarizing panels; actively fluxing towers; open bodies of water; aggregations of insects that attracted insectivorous birds; and resident predators. Making towers, ponds and panels less attractive or accessible to birds may mitigate deaths. Specific actions should include:

Monitoring/detection measures:

1) Install video cameras sufficient to provide 360 degree coverage around each tower to record birds (and bats) entering and exiting the flux

2) For at least two years (and in addition to planned monitoring protocol), conduct daily surveys for birds (at all three facilities), as well as insects and bats (in the condenser building at Ivanpah) around each tower at the base of and immediately adjacent to the towers in the area cleared of vegetation. Timing of daily surveys can be adjusted to minimize scavenger removal of carcasses as recommended by the TAC. Surveys in the late afternoon might be optimal for bird carcasses, and first light for bat carcasses.

3) Use dogs for monitoring surveys to detect dead and injured birds that have hidden themselves in the brush, both inside and outside the perimeter of the facility

4) To decrease removal of carcasses, implement appropriate raven deterrent actions

Bird Mortality Avoidance Measures*:*

1) Increase cleared area around tower at Ivanpah to decrease attractive habitat; at least out to fence

2) Retrofit visual cues to existing panels at all three facilities and incorporate into new panel design. These cues should include UV-reflective or solid, contrasting bands spaced no further than 28 cm from each other

3) Suspend power tower operation during peak migration times for indicated species

4) Avoid vertical orientation of mirrors whenever possible, for example tilt mirrors during washing

5) Properly net or otherwise cover ponds

6) Place perch deterrent devices where indicated, eg. on tower railings near the flux field

7) Employ exclusionary measures to prevent bats from roosting in and around the condenser facility at Ivanpah.

It must be emphasized that we currently have a very incomplete knowledge of the scope of avian mortality at these solar facilities. Challenges to data collection include: large facilities which are difficult to efficiently search for carcasses; vegetation and panels obscuring ground visibility; carcass loss due to scavenging; rapid degradation of carcass quality hindering cause of death and species determination; and inconsistent documentation of carcass history.

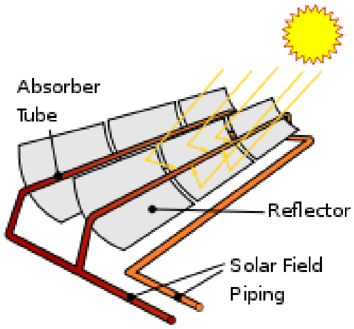
To rectify this problem, video cameras should be added to the solar towers to record bird mortality and daily surveys of the area at the base of and immediately adjacent to the towers should be conducted. At all the facilities, a protocol for systematic, statistically-rigorous searches for avian remains should be developed, emphasizing those areas where avian mortality is most likely to occur. Investigation into bat and insect mortalities at the power tower site should also be pursued.

Finally, there are presently little data available on how solar flux affects birds and insects. Studies of the temperatures experienced by objects in the flux; of the effects of high temperatures on feather structure and function; and of the behavior of insects and birds in response to the flux and related phenomena (e.g. "light clouds") are all essential if we are to understand the scope of solar facility effects on wildlife.

Introduction

The National Fish and Wildlife Forensics Laboratory was requested to determine cause of death for birds found at facilities that generate electricity from solar energy. Solar generating facilities can be classified into three major types: photovoltaic sites, trough systems and solar power towers. There is much written about these systems so this report will not include any technical details, but simply mention the differences and their potential impact on birds.

1) **Photovoltaic systems** directly convert the sun's light into electricity. The perceived threat to birds is associated with the presence of water ponds which attract birds and from traumatic impact with the photovoltaic cells. An example of this type of solar power plant is Desert Sunlight Solar Farm (AKA First Solar).



2) **Trough systems** are composed of parabolic mirrors which focus and reflect the sun to a tube that converts the heat from the sun into electricity. The perceived threat to birds is associated with the presence of water ponds which attract birds and from traumatic impact with the trough structures. An example of this type of solar power plant is Genesis Solar Energy Project.

3) **Solar power towers** use thousands of mirrors to reflect the solar energy to a tower, where water in a boiler is converted to steam, generating the electricity. The perceived threat to birds is associated traumatic impact with the mirrors and the danger associated with the heat produced by the mirrors. An example of this type of solar power plant is Ivanpah Solar Electric Generating System.

Methods

Carcasses were collected at the different solar power plant sites by either US Fish and Wildlife Service employees or by energy company staff. The collection of the carcasses was opportunistic; that is, not according to a pre-determined sampling schedule or protocol. There was no attempt to quantify the number of carcasses that scavengers or predators removed from the solar facilities' grounds, or to compare the distribution of carcasses inside and outside the boundaries of the solar facility sites.

Additionally, three USFWS/-OLE staff, including two Forensics Lab staff (EOE and RAK), visited the Ivanpah Solar plant from October 21 – 24, 2013. Their on-site observations are included in this report.

A total of 233 birds collected from three different facilities were examined; 141 from a solar thermal power tower site (Ivanpah, Bright Source Inc.), 31 from a parabolic trough site (Genesis, NextEra Energy Inc.) and 61 from a photovoltaic (PV) panel site (Desert Sunlight, First Solar Inc.). Nine of the Ivanpah birds were received fresh; 7 of those were necropsied during a site visit by a Forensics Laboratory pathologist (RAK). The rest of the birds were received frozen and allowed to thaw at room temperature prior to species identification and necropsy. Species determination was made by the Forensics Laboratory ornithologist (PWT) for all birds either prior to necropsy or, for those necropsied on-site, from photos and the formalin-fixed head. All data on carcass history (location of the carcass, date of collection and any additional observations) were transcribed, although these were not available for all carcasses.

As part of the gross pathological examination, whole carcasses were radiographed to help evaluate limb fractures and identify any metal foreign bodies. Alternate light source examination using an Omnichrome Spectrum 9000+ at 570 nm with a red filter helped rule in or out feather burns by highlighting subtle areas of feather charring (Viner et al., 2014). All birds or bird parts from Ivanpah without obvious burns were examined with the alternate light source, as well as any bird reportedly found near a power line and a random sub-sample of the remaining birds from Genesis and Desert Sunlight (Viner, T. C., R. A. Kagan, and J. L. Johnson, 2014, Using an alternate light source to detect electrically singed feathers and hair in a forensic setting. Forensic Science International, v. 234, p. e25-e29).

Carcass quality varied markedly. If carcasses were in good post mortem condition, representative sections of heart, lung, kidney, liver, brain and gastrointestinal tract as well as any tissues with gross lesions were collected and fixed in 10% buffered formalin. Full tissue sets were collected from the fresh specimens. Formalin-fixed tissues were routinely processed for histopathology, paraffin-embedded, cut at 4 µm and stained with hematoxylin and eosin. Tissues from 63 birds were examined microscopically: 41 from Ivanpah, 1 from Genesis and 21 from Desert Sunlight.

Birds with feather burns were graded based on the extent of the lesions. Grade 1 birds had curling of less than 50% of the flight feathers. Grade 2 birds had curling of 50% or more of the flight feathers. Grade 3 birds had curling and visible charring of contour feathers (Figure 1).

Figure 1: Three grades of flux injury based on extent and severity of burning. Grade 1 (top); Yellow-rumped Warbler with less than 50% of the flight feathers affected (note sparing of the yellow rump feathers). Grade 2 (middle); Northern Rough-winged Swallow initially found alive but unable to fly, with greater than 50% of the flight feathers affected. Grade 3 (bottom); MacGillivray's Warbler with charring of feathers around the head, neck, wings and tail.

Bird Species Recovered at Solar Power Facilities

Tables 1-4 and Appendix 1 summarize 211 identifiable bird remains recovered from the three solar facilities included in this study. These birds constitute a taxonomically diverse assemblage of 71 species, representing a broad range of ecological types. In body size, these species ranged from hummingbirds to pelicans; in ecological type from strictly aerial feeders (e.g. swifts and swallows) to strictly aquatic feeders (pelicans and cormorants) to ground feeders (roadrunners) to raptors (hawks and owls). The species identified were equally divided among resident and non-resident species. Nocturnal as well as diurnal species were represented.

In Tables 1-4 and Appendix 1, bird species are categorized into very general ecological types by foraging zone and residency status. Foraging Zones were "air" (a significant portion of foraging activity performed in the air), "terrestrial" (including foraging both in vegetation and on the ground), and "water" (foraging associated with water, including waders as well as aquatic birds). Residency Status was "resident" (for breeding or year-round residents) and "migrant" (for both passage migrants and non-breeding-season residents). For a number of species, the appropriate classification for residency status was uncertain, due to a lack of detailed knowledge of the sites. The present classification is based on published range maps, and is subject to revision as more information becomes available.

This dataset is not suitable for statistical analysis, due to the opportunistic and unstandardized collection of avian remains at the facilities, and the lack of baseline data on bird diversity and abundance at each site. Nevertheless, a few conclusions can be noted. First, these data do not support the idea that these solar facilities are attracting particular species. Of the 71 bird species identified in remains, only five species were recovered from all three sites. These five were American Coot, Mourning Dove, Lesser Nighthawk, Tree Swallow, and Brown-headed Cowbird, again emphasizing the ecological variety of birds vulnerable to mortality at the solar facilities. Over two-thirds (67%) of the species were found at only a single site

(Appendix 1). That being said, the Desert Sunlight facility had particularly high mortality among waterbirds, suggesting a need to render the ponds at that site inaccessible or unattractive to these species.

The diversity of birds dying at these solar facilities, and the differences among sites, suggest that there is no simple "fix" to reduce avian mortality. These sites appear to represent "equal-opportunity" mortality hazards for the bird species that encounter them. Actions to reduce or mitigate avian mortality at solar facilities will need to be designed on a site-specific basis, and will require much more data on the bird communities at each site, and on how mortality is occurring. Carefully-designed mortality studies might reveal significant patterns of vulnerability that are not evident in these data.

Table 1. Summary data on avian mortality at the three solar sites included in this study. See summary for discussion of Foraging Zone and Residency Status categories.

				Foraging Zone			**Residency Status**	
SITE	**No. Species**	**No. Remains**	**Identifiable Remains**	**Air**	**Terr**	**Water**	**Resident**	**Migrant**
Ivanpah	49	141	127	26	85	14	63	64
Genesis	15	31	30	12	12	6	20	10
Desert Sun	33	61	56	7	22	27	18	38
TOTALS	71	233	213	47	119	47	101	112

Table 2. Species identified from avian remains at the Desert Sunlight photovoltaic solar facility. MNI = minimum number of individuals of each species represented by the identifiable remains. In some cases (e.g. Cinnamon/Blue-winged Teal), closely related species could not be distinguished based on the available remains, but the Foraging Zone and Residency Status could still be coded, due to the ecological similarities of the species involved. Total identified birds = 56.

DESERT SUNLIGHT		Zone	Residency	MNI
Pied-billed Grebe	*Podilymbus podiceps*	water	migrant	1
Eared Grebe	*Podiceps nigricollis*	water	migrant	3
Sora	*Porzana carolina*	water	migrant	1
American Avocet	*Recurvirostra americana*	water	migrant	1
Cinnamon/Blue-winged Teal	*Anas discors/clypeata*	water	migrant	1
Western Grebe	*Aechmophorus occidentalis*	water	migrant	9
Brown Pelican	*Pelecanus occidentalis*	water	migrant	2
Double-crested Cormorant	*Phalacrocorax auritus*	water	migrant	2
Black-crowned Night-Heron	*Nycticorax nycticorax*	water	migrant	1
Yuma Clapper Rail	*Rallus longirostris*	water	resident	1
American Coot	*Fulica americana*	water	migrant	5
Mourning Dove	*Zenaida macroura*	terr	resident	3
White-winged Dove	*Zenaida asiatica*	terr	resident	1
Lesser Nighthawk	*Chordeiles acutipennis*	air	resident	2
Common Poorwill	*Phalaenoptilus nuttallii*	air	resident	1
Costa's Hummingbird	*Calypte costae*	air	resident	1
Ash-throated Flycatcher	*Myiarchus cinerascens*	air	resident	1
Black-throated/Sage Sparrow	*Amphispiza sp.*	terr	resident	1
Black Phoebe	*Sayornis nigricollis*	air	resident	1
Loggerhead Shrike	*Lanius ludovicianus*	terr	resident	2
Common Raven	*Corvus corax*	terr	resident	1
Horned Lark	*Eremophila alpestris*	terr	migrant	1
Tree Swallow	*Tachycineta bicolor*	air	migrant	1
Townsend's Warbler	*Setophaga townsendi*	terr	migrant	2
Common Yellowthroat	*Geothlypis trichas*	terr	migrant	1
Savannah Sparrow	*Passerculus sandwichensis*	terr	migrant	1
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	terr	migrant	1
Wilson's Warbler	*Cardellina pusilla*	terr	migrant	2
Western Tanager	*Piranga ludoviciana*	terr	migrant	2
Black-headed Grosbeak	*Pheucticus melanocephalus*	terr	migrant	1
Great-tailed Grackle	*Quiscalus mexicanus*	terr	resident	2
Brown-headed Cowbird	*Molothrus ater*	terr	resident	1

Table 3. Species identified from avian remains at the Genesis trough system solar facility. Total identified birds = 30.

GENESIS		Zone	Residency	MNI
Eared Grebe	*Podiceps nigricollis*	water	migrant	2
Great Blue Heron	*Ardea herodias*	water	migrant	1
American Kestrel	*Falco sparverius*	air	resident	1
Ring-billed Gull	*Larus delawarensis*	water	migrant	2
California Gull	*Larus californianus*	water	resident	1
White-winged Dove	*Zenaida asiatica*	terr	resident	1
Lesser Nighthawk	*Chordeiles acutipennis*	air	resident	2
Say's Phoebe	*Sayornis saya*	air	resident	2
Tree Swallow	*Tachycineta bicolor*	air	migrant	2
Cliff Swallow	*Petrochelidon pyrrhonota*	air	resident	5
Hermit Warbler	*Setophaga occidentalis*	terr	migrant	1
Black-headed Grosbeak	*Pheucticus melanocephalus*	terr	migrant	1
Chipping Sparrow	*Spizella passerina*	terr	resident	1
Bullock's Oriole	*Icterus bullockii*	terr	resident	2
Brown-headed Cowbird	*Molothrus ater*	terr	resident	6

Table 4. Species identified from avian remains at the Ivanpah power tower solar facility. Total identified birds = 127

IVANPAH		Zone	Residency	MNI
Cinnamon Teal	*Anas cyanoptera*	water	migrant	4
Cooper's Hawk	*Accipiter cooperii*	air	migrant	1
Red-shouldered Hawk	*Buteo lineatus*	terr	migrant	1
American Kestrel	*Falco sparverius*	air	resident	1
Peregrine Falcon	*Falco peregrinus*	air	resident	1
American Coot	*Fulica americana*	water	migrant	7
Sora	*Porzana carolina*	water	migrant	1
Spotted Sandpiper	*Actitis maculatus*	water	migrant	2
Greater Roadrunner	*Geococcyx californianus*	terr	resident	5
Yellow-billed Cuckoo	*Coccyzus americanus*	terr	migrant	1
Mourning Dove	*Zenaida macroura*	terr	resident	11
Barn Owl	*Tyto alba*	terr	resident	1
Lesser Nighthawk	*Chordeiles acutipennis*	air	resident	3
Common Poorwill	*Phalaenoptilus nuttallii*	air	resident	1
White-throated Swift	*Aeronautes saxatalis*	air	resident	1
Allen's/Rufous Hummingbird	*Selasphorus sp.*	air	migrant	1
Northern Flicker	*Colaptes auratus*	terr	resident	1
Ash-throated Flycatcher	*Myiarchus cinerascens*	air	resident	1
Loggerhead Shrike	*Lanius ludovicianus*	terr	resident	3
Warbling Vireo	*Vireo gilvus*	terr	migrant	1
Common Raven	*Corvus corax*	terr	resident	2
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	air	migrant	2
Tree Swallow	*Tachycineta bicolor*	air	migrant	2
Verdin	*Auriparus flaviceps*	terr	resident	3
Blue-gray Gnatcatcher	*Polioptila caerulea*	terr	resident	1
Northern Mockingbird	*Mimus polyglottos*	terr	resident	1
American Pipit	*Anthus rubescens*	terr	migrant	4
Orange-crowned Warbler	*Oreothlypis celata*	terr	migrant	1
Lucy's Warbler	*Oreothlypis luciae*	terr	resident	1
Black-throated Gray Warbler	*Setophaga nigrescens*	terr	migrant	1
Yellow-rumped Warbler	*Setophaga coronata*	air	migrant	14
Townsend's Warbler	*Setophaga townsendi*	terr	migrant	2
Yellow Warbler	*Setophaga petechia*	terr	migrant	1
Black-and-white Warbler	*Mniotilta varia*	terr	migrant	1
Wilson's Warbler	*Cardellina pusilla*	terr	migrant	2
MacGillivray's Warbler	*Oporornis tolmei*	terr	migrant	1
Western Tanager	*Piranga ludoviciana*	terr	migrant	2
Lazuli Bunting	*Passerina amoena*	terr	migrant	1
Blue Grosbeak	*Passerina caerulea*	terr	resident	1
Green-tailed Towhee	*Pipilo chlorurus*	terr	migrant	1
Brewer's Sparrow	*Spizella breweri*	terr	resident	3
Chipping Sparrow	*Spizella passerina*	terr	resident	3
Black-throated Sparrow	*Amphispiza bilineata*	terr	resident	3
Savannah Sparrow	*Passerculus sandwichensis*	terr	migrant	2
White-crowned Sparrow	*Zonotrichia leucophrys*	terr	migrant	6

IVANPAH		Zone	Residency	MNI
Pine Siskin	*Spinus pinus*	terr	migrant	1
House Finch	*Carpodacus mexicanus*	terr	resident	13
Brown-headed Cowbird	*Molothrus ater*	terr	resident	1
Great-tailed Grackle	*Quiscalus mexicanus*	terr	resident	3

Cause of Death of Birds Found at the Solar Power Plants

Photovoltaic facility (Desert Sunlight):

Sixty-one birds from 33 separate species were represented from Desert Sunlight. Due to desiccation and scavenging, a definitive cause of death could not be established for 22 of the 61 birds (see Table 5). Feathers could be examined in all cases, however, and none of the 61 bird remains submitted from the PV facility had visible evidence of feather singeing, a clear contrast with birds found at Ivanpah.

Blunt force impact trauma was determined to have been the cause of death for 19 Desert Sunlight birds including two Western Grebes (*Aechmophorus occidentalis*) and one each of 16 other species. Impact (blunt force) trauma is diagnosed by the presence of fractures and internal and/or external contusions. In particular, bruising around the legs, wings and chest are consistent with crash-landings while fractures of the head and/or neck are consistent with high-velocity, frontal impact (such as may result from impacting a mirror).

Predation was the immediate cause of death for 15 birds. Lesions supporting the finding of predation included decapitation or missing parts of the body with associated hemorrhage (9/15), and lacerations of the skin and pectoral muscles. Eight of the predated birds from Desert Sunlight were

Figure 2: Predation trauma (top) resulting in traumatic amputation of the head and neck (American Avocet) and impact trauma (bottom) causing bruising of the keel ridge of the sternum (Brown Pelican).

grebes, which are unable to easily take off from land. This suggests a link between predation and stranding and/or impact resulting from confusion of the solar panels with water (see Discussion).

Parabolic trough facility (Genesis):

Thirty-one birds were collected from this site. There were 15 species represented. Those found in the greatest numbers were Brown-headed Cowbirds and Cliff Swallows, though no more than 6 individuals from any given species were recovered. Overall, carcass quality was poor and precluded definitive cause of death determination in 17/31 birds (Table 5). Identifiable causes of death consisted of impact trauma (6/31) and predation trauma (2/31). Necropsy findings were similar to those at Desert Sunlight with fractures and hemorrhage noted grossly. Predation trauma was diagnosed in two birds, a Cliff Swallow and a Ring-billed Gull.

Power tower facility (Ivanpah):

Ivanpah is the only facility in this study that produces solar flux, which is intense radiant energy focused by the mirror array on the power-generating tower. Objects that pass through this flux, including insects and birds, encounter extreme heat, although the extent of heating depends on many variables, including the duration of exposure and the precise location in the flux beam.

From Ivanpah, 141 birds were collected and examined. Collection dates spanned a period of one year and five months (July 2012 to December 2013) and included at least seven months of construction during which time the towers were not actively fluxing (2013). There were 49 species represented (Table 4). Those found in the greatest numbers were Yellow-rumped Warblers (*Setophaga coronata;* 14), House Finches (*Carpodacus mexicanus*; 13), Mourning Doves (*Zenaida macroura*; 11) and American Coots (*Fulica americana*; 7). Yellow-rumped Warblers and House Finches were found exclusively at the power tower site.

Solar flux injury was identified as the cause of death in 47/141 birds. Solar flux burns manifested as feather curling, charring, melting and/or breakage and loss. Flight feathers of the tail and/or wings were invariably affected. Burns also tended to occur in one or more of the following areas; the sides of the body (axillae to pelvis), the dorsal coverts, the tops and/sides of the head and neck and the dorsal body wall (the back). Overlapping portions of feathers and light-colored feathers were often spared (Figures 3 and 4).

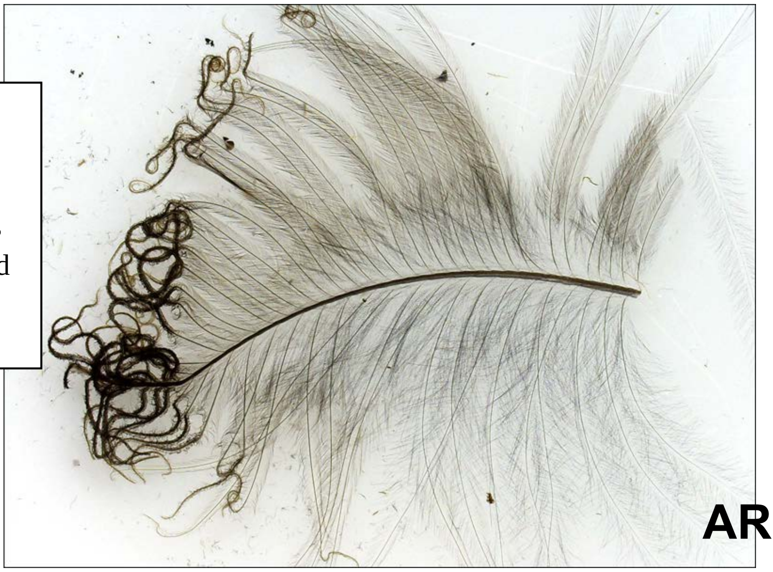


Figure 3: contour feather from the back of a House Finch with Grade 3 solar flux injury. The feather has curling and charring limited to the exposed tip.

Figure 4: Feather from a Peregrine Falcon with Grade 2 solar flux injury. Note burning of dark feather bands with relative sparing of light bands.

The yellow and red rumps of Yellow-rumped Warblers and House Finches respectively remained strikingly unaffected (See Figure 1). Charring of head feathers, in contrast, was generally diffuse across all color patterns. A pattern of spiraling bands of curled feathers across or around the body and wings was often apparent.

Table 5. Cause of death (COD) data

Cause of Death	Ivanpah	Genesis	Desert Sunlight	Total
Solar Flux	47	0	0	47
Impact trauma	24	6	19	49
Predation trauma	5	2	15	22
Trauma of undetermined cause	14	0	0	14
Electrocution	1	0	0	1
Emaciation	1	0	0	1
Undetermined (remains in poor condition)	46	17	22	85
No evident cause of death	3	6	5	14
Total	141	31	61	233

Eight birds were assigned a feather damage Grade of 1 with curling of less than 50% of the flight feathers. Six of these had other evidence of acute trauma (75%). Five birds were Grade 2, including three birds that were found alive and died shortly afterwards. Of these birds, 2 (the birds found dead) also had evidence of acute trauma. Twenty-eight birds were Grade 3; with charring of body feathers. Of these birds, 21/28

(28%) had other evidence of acute trauma. Remaining carcasses (6) were incomplete and a grade could not be assigned.

Twenty-nine birds with solar flux burns also had evidence of impact trauma. Trauma consisted of skull fractures or indentations (8), sternum fractures (4), one or more rib fractures (4), vertebral fractures (1), leg fracture (3), wing fracture (1) and/or mandible fracture (1). Other signs of trauma included acute macroscopic and/or microscopic internal hemorrhage. Location found was reported for 39 of these birds; most of the intact carcasses were found near or in a tower. One was found in the inner heliostat ring and one was found (alive) on a road between tower sites. The date of carcass collection was provided for 42/47. None were found prior to the reported first flux (2013).

Figure 5: The dorsal aspect of the wing from a Peregrine Falcon (the same bird as shown in Figure 4) with Grade 2 lesions. Note extensive curling of feathers without visible charring. This bird was found alive, unable to fly, emaciated and died shortly thereafter. These findings demonstrate fatal loss of function due to solar flux exposure in the absence of skin or other soft tissue burns.

Among the solar flux cases, a variety of bird species were affected though all but one (a raptor) was a passerine (Appendix 2). House Finches and yellow-rumped Warblers were most often represented (10/47 and 12/47 respectively). For the birds in which species could be determined (41/47), insects were a major dietary component in all but two species. These were an unidentified hummingbird (*Selasphorus*) species (known to include insects in the diet) and a Peregrine Falcon (a species that feeds on small birds).

Four birds were reportedly found alive and taken to a wildlife rehabilitation center where they died one to a few days later (exact dates were not consistently provided). Three had Grade 2 feather burns and one had Grade 3 feather burns. None had other evidence of trauma. Body condition was reduced in all of the birds (two considered thin and two emaciated) based on a paucity of fat stores and depletion of skeletal muscling. The four birds were of four different species and consisted of three passerines and one raptor.

The second most commonly diagnosed cause of death at the Ivanpah facility was impact (or blunt force) trauma (24/141 birds). Necropsy findings were as previously described at the Desert Sunlight facility. Impact marks were reported on heliostat mirrors adjacent to the carcasses in 5 cases and mirrors were described as being vertically-oriented in 5 cases. Specific carcass locations were reported for 18 of the birds. Those birds were found in a variety of areas; below heliostats (8/18), in or near tower and powerblock buildings (4/18), on roads (2/18), below power lines (2/18), in the open (1/18) and by a desert tortoise pen (1/18).

Predation was determined to be the cause of death for five of the birds. A coot and a Mourning Dove were found with extensive trauma and hemorrhage to the head and upper body consisting of lacerations, crush trauma and/or decapitation. One of the birds (an American Coot) was found near a kit fox shelter site. One bird (Northern Mockingbird) was found near the fence line and the third (a Mourning Dove) in an alley way. Two more birds (an unidentified sparrow and an American Pipit) were observed being eaten by one of the resident Common Ravens.

Discussion of Cause of Death of Birds Found at the Solar Power Plants

Impact trauma:

Sheet glass used in commercial and residential buildings has been well-established as a hazard for birds, especially passerines (Klem 1990, 2004, 2006; Loss et al. 2014). A recent comprehensive review estimated that between 365-988 million birds die annually by impacting glass panels in the United States alone (median estimate 599 million; Loss et al. 2014). Conditions that precipitate window strike events include the positioning of vegetation on either side of the glass and the reflective properties of the window. Glass panels that reflect trees and other attractive habitat are involved in a higher number of bird collisions.

The mirrors and photovoltaic panels used at all three facilities are movable and generally directed upwardly, reflecting the sky. At the Ivanpah facility, when heliostats are oriented vertically (typically for washing or installation, personal communication, RAK) they appear to pose a greater risk for birds. Of the eight birds reported found under a heliostat, heliostats were vertically-oriented in at least 5 cases. (D Klem Jr., DC Keck, KL Marty, AJ Miller Ball, EE Niciu, and CT Platt. 2004. Effects of window angling, feeder placement, and scavengers on avian mortality at plate glass. Wilson Bulletin, 116(1):69-73; D Klem Jr. 2006. Glass: A deadly conservation issue for birds. Bird Observer 34(2):73-81; D Klem Jr. 1990.

Collisions between birds and windows: mortality and prevention. Journal of Field Ornithology 61:120–128; Loss, S.R., T. Will, S.S.Loss, and P.P. Marra. 2014. Bird-building collisions in the United States: Estimates of annual mortality and species vulnerability. Condor 116: 8-23). Studies with aquatic insects have found that vertically-oriented black glass surfaces (similar to solar panels) produced highly polarized reflected light, making them highly attractive (Kriska, G., P. Makik, I. Szivak, and G. Horvath. 2008. Glass buildings on river banks as “polarized light traps” for mass-swarming polarotactic caddis flies. Naturwissenschaften 95: 461-467).

A desert environment punctuated by a large expanse of reflective, blue panels may be reminiscent of a large body of water. Birds for which the primary habitat is water, including coots, grebes, and cormorants, were over-represented in mortalities at the Desert Sunlight facility (44%) compared to Genesis (19%) and Ivanpah (10%). Several factors may inform these observations. First, the size and continuity of the panels differs between facilities. Mirrors at Ivanpah are individual, 4 x 8’ panels that appear from above as stippling in a desert background (Figure 6). Photovoltaic panels at Desert Sunlight are long banks of adjacent 27.72 x 47.25” panels (70 x 120 cm), providing a more continuous, sky/water appearance. Similarly, troughs at Genesis are banks of 5 x 5.5’ panels that are up to 49-65 meters long.

Figure 6: The Ivanpah Solar Electric Generating System as seen via satellite. The mirrored panels are 5 x 8 feet.

There is growing concern about "polarized light pollution" as a source of mortality for wildlife, with evidence that photovoltaic panels may be particularly effective sources of polarized light in the environment (see Horvath et al. 2010. Reducing the maladaptive attractiveness of solar panels to polarotactic insects. Conservation Biology 24: 1644-1653, and ParkScience, Vol. 27, Number 1, 2010; available online at: http://www.nature.nps.gov/parkscience/index.cfm?ArticleID=386&ArticleTypeID=5; as well as discussion of this issue in the Desert Sunlight Final Environmental Impact Statement, Chapter 4, pp. 14-15).

Variables that may affect the illusory characteristics of solar panels are structural elements or markings that may break up the reflection. Visual markers spaced at a distance of 28 cm or less have been shown to reduce the number of window strike events on large commercial buildings (City of Toronto Green Development Standard; Bird-friendly development guidelines. March 2007). Mirrors at the Ivanpah facility are unobscured by structures or markings and present a diffuse, reflective surface. Photovoltaic panels at Desert Sunlight are arranged as large banks of small units that are 60 x 90 cm. The visually uninterrupted expanse of both these types of heliostat is larger than that which provides a solid structure visual cue to passerines. Parabolic troughs at Genesis have large, diffusely reflective surfaces between seams that periodically transect the bank of panels at 5.5' intervals. Structures within the near field, including the linear concentrator and support arms, and their reflection in the panels and may provide a visual cue to differentiate the panel as a solid structure.

The paper by Horvath et al cited above provides experimental evidence that placing a white outline and/or white grid lines on solar panels significantly reduced the attractiveness of these panels to aquatic insects, with a loss of only 1.8% in energy-producing surface area (p. 1651). While similar detailed studies have yet to be carried out with birds, this work, combined with the window strike results, suggest that significant reductions in avian mortality at solar facilities could be achieved by relatively minor modifications of panel and mirror design. This should be a priority for further research.

Finally, ponds are present on the property of the Desert Sunlight and Genesis facilities. The pond at Genesis is netted, reducing access by migratory birds, while the pond at Desert Sunlight is open to flighted wildlife. Thus, birds are both attracted to the water feature at Desert Sunlight and habituated to the presence of an accessible aquatic environment in the area. This may translate into the misinterpretation of a diffusely reflected sky or horizonal polarized light source as a body of water.

Stranding and Predation:

Predation is likely linked to panel-related impact trauma and stranding. Water birds were heavily over-represented in predation mortalities at Desert Sunlight. Of the 15 birds that died due to predation, 14 make their primary habitat on water (coots, grebes, a cormorant, and an avocet). A single White-winged Dove was the only terrestrial-based predation mortality in the submitted specimens. This is in contrast to blunt trauma mortalities at Desert Sunlight in which 8 of the 19 birds determined to have died of impact trauma were water species.

Locations of the birds when found dead were noted on several submissions. Of the birds that died of predation for which locations were known, none were located near ponds. The physiology of several of these water birds is such that locomotion on land is difficult or impossible. Grebes in particular have very limited mobility on land and require a run across water in order to take off (Jehl, J. R., 1996. Mass mortality events of Eared Grebes in North America. Journal of Field Ornithology 67: 471-476). Thus, these birds likely did not reach their final location intentionally. Ponds at the PV and trough sites are fenced, prohibiting terrestrial access by predators. Birds on the water or banks of the pond are inaccessible to resident predators. Therefore, it is unlikely that the birds were captured at the pond and transported by a predator into the area of the panels. Attempts to land or feed on the panels because of their deceptive appearance may have injured the birds to the point that they could not escape to safety, or inadvertently stranded the birds on a substrate from which they could not take flight. We believe that an inability to quickly flee after striking the panels and stranding on the ground left these birds vulnerable to opportunistic predators. At least two types of predators, kit foxes and ravens, have been observed in residence at the power tower and PV facilities and ravens have been reported at the trough site (personal communication and observation, RAK). Additionally, histories for multiple birds found at the tower site document carcasses found near kit fox shelters or being eaten or carried by a raven.

Solar Flux:

Avian mortality due to exposure to solar flux has been previously explored and documented (McCrary, M. D., McKernan, R. L., Schreiber, R. W., Wagner, W. D., and Sciarrotta, T. C. Avian mortality at a solar energy power plant. Journal of Field Ornithology, 57(2): 135-141). Solar flux injury to the birds of this report, as expected, occurred only at the power tower facility. Flux injury grossly differed from other sources of heat injury, such as electrocution or fire. Electrocution injury requires the bridging of two contact points and is, therefore, seen almost exclusively in larger birds such as raptors. Contact points tend to be on the feet, carpi and/or head and burns are often found in these areas. Electrocution causes deep tissue damage as opposed to the surface damage of fire or solar flux. Other sequelae include amputation of limbs with burn marks on bone, blood vessel tears and pericardial hemorrhage. Burns from fires cause widespread charring and melting of feathers and soft tissues and histopathologic findings of soot inhalation or heat damage to the respiratory mucosa. None of these were characteristics of flux injury. In the flux cases small birds were over-represented, had burns generally limited to the feathers and internal injuries attributable to impact. Flux injury inconsistently resulted in charring, tended to affect feathers along the dorsal aspects of the wings and tail, and formed band-like patterns across the body (Divincenti, F. C., J. A. Moncrief, and B. A. Pruitt. 1969. Electrical injuries: a review of 65 cases. The Journal of Trauma 9: 497-507).

Proposed mechanisms of solar flux-related death follow one or a combination of the following pathways:

- impact trauma following direct heat damage to feathers and subsequent loss of flight ability
- starvation and/or thermoregulatory dysfunction following direct heat damage to feathers
- shock
- soft tissue damage following whole-body exposure to high heat
- ocular damage following exposure to bright light.

Necropsy findings from this study are most supportive of the first three mechanisms.

Loss of feather integrity has effects on a bird's ability to take off, land, sustain flight and maneuver. Tail feathers are needed for lift production and maneuverability, remiges are needed for thrust and lift and feathers along the propatagium and coverts confer smoothness to the avian airfoil. Shortening of primary flight feathers by as little as 1.6 cm with loss of secondary and tertiary remiges has been shown to eliminate take-off ability in house sparrows further demonstrating the importance of these feathers (Brown, R. E., and A. C. Cogley, 1996. Contributions of the propatagium to avian flight: Journal of Experimental Zoology 276: 112-124). Loss of relatively few flight feathers can, therefore, render a bird unable or poorly-able to fly. Birds encountering the flux field at Ivanpah may fall as far as 400 feet after feather singeing. Signs of impact trauma were often observed in birds with feather burns and are supportive of sudden loss of function (Beaufrere, H., 2009. A review of biomechanic and aerodynamic considerations of the avian thoracic limb. Journal of Avian Medicine and Surgery 23: 173-185).

Birds appear to be able to survive flux burns in the short term, as evidenced by the collection of several live birds with singed feathers. Additionally, Forensic Lab staff observed a falcon or falcon-like bird with a plume of smoke arising from the tail as it passed through the flux field. Immediately after encountering the flux, the bird exhibited a controlled loss of stability and altitude but was able to cross the perimeter fence before landing. The bird could not be further located following a brief search (personal observation, RAK and EOE). Birds that initially survive the flux exposure and are able to glide to the ground or a perch may be disabled to the point that they cannot efficiently acquire food, escape predators or thermoregulate. Observations of emaciation in association with feather burns in birds found alive is supportive of debilitation subsequent to flux exposure. More observational studies and follow-up are required to understand how many birds survive flux exposure and whether survival is always merely short-term. As demonstrated by the falcon, injured birds (particulary larger birds), may be ambulatory enough to glide or walk over the property line indicating a need to include adjacent land in carcass searches.

There was evidence of acute skin burns on the heads of some of the Grade 3 birds that were found dead. But interestingly, tissue burn effects could not be demonstrated in birds known to have survived short periods after being burned. Hyperthermia causing instantaneous death manifests as rapid burning of tissue, but when death occurs a day or later there will be signs of tissue loss, inflammation, proteinic exudate and/or cellular death leading to multisystemic organ failure. The beginnings of an inflammatory response to injury can be microscopically observed within one to a few hours after the insult and would have been expected in any of the four birds found alive. Signs of heat stroke or inhalation of hot air should have been observable a day or more after the incident. Rather, in these cases extensive feather burns on the body largely appeared to be limited to the tips of the feathers with the overlapping portions insulating the body as designed. This, in conjunction with what is likely only a few seconds or less spent in the flux, suggests that skin or internal organ damage from exposure to high temperatures in solar flux may not be a major cause of the observed mortality.

Ocular damage following light exposure was also considered but could not be demonstrated in the submitted birds. In the four birds that initially survived, there were no signs of retinal damage, inflammation or other ocular trauma. Given the small sample size, this does not preclude sight impairment as a possible sequela but clinical monitoring of survivors would be needed to draw more definitive conclusions.

Other/Undetermined:

Powerline electrocution was the cause of death for one bird (a juvenile Common Raven) at the Ivanpah facility. Electrocution at these solar facilities is a potential hazard but, thus far, appears to be an uncommon cause of death.

Smashed birds (13/233) were found at all three locations. Detailed carcass collection information was provided for 6; all were found on roads. Though poor carcass quality in all cases precluded definitive cause death determination, circumstances and carcass condition suggest vehicle trauma as the cause of deaths. The relatively low numbers of vehicle collisions may be attributed to slow on-site vehicle speeds and light traffic. Vehicle collisions, therefore, do not appear to be a major source of mortality and would be expected to decrease as construction ends.

There was a large number of birds (85/233) for which a cause of death could not be determined due to poor carcass condition. The arid, hot environment at these facilities leads to rapid carcass degradation which greatly hinders pathology examination. Results were especially poor for birds from the Genesis facility, where the cause of death(s) for 23/31 (74%) could not be determined. These results underscore the need for carcasses to be collected soon after death. More frequent, concerted carcass sweeps are advised.

Insect mortality and solar facilities as “mega-traps”

An ecological trap is a situation that results in an animal selecting a habitat that reduces its fitness relative to other available habitats (Robertson, B.A. and R.L. Hutto. 2006. A framework for understanding ecological traps and an evaluation of existing evidence. Ecology 87: 1075-1085; Robertson, B.A., J.S. Rehage, and Sih, A. 2013. Ecological novelty and the emergence of evolutionary traps. Trends in Ecology and Evolution 28: 552-560).

A wide variety of circumstances may create ecological traps, ranging from subtle (songbirds attracted to food resources in city parks, where they are vulnerable to unnaturally high populations of predators) to direct (birds are attracted to oil-filled ponds, believing it to be water, and become trapped). It appears that solar flux facilities may act as **“mega-traps,”** which we define as artificial features that attract and kill species of multiple trophic layers. The strong light emitted by these facilities attract insects, which in turn attract insect-eating birds, which are incapacitated by solar flux injury, thus attracting predators and creating an entire food chain vulnerable to injury and death.

OLE staff observed large numbers of insect carcasses throughout the Ivanpah site during their visit. In some places there were hundreds upon hundreds of butterflies (including monarchs, *Danaus plexippus*) and dragonfly carcasses. Some showed singeing, and many appeared to have just fallen from the sky. Careful observation with binoculars showed the insects were active in the bright area around the boiler at the top of the tower. It was deduced that the solar flux creates such a bright light that it is brighter than the surrounding daylight. Insects were attracted to the light and could be seen actively flying the height of the tower. Birds were also observed feeding on the insects. At times birds flew into the solar flux and ignited. Bird carcasses recovered from the site showed the typical singed feathers. The large populations of insects may also attract indigenous bat species, which were seen roosting in structures at the base of the power tower.

Monarch butterflies in North America – both east and west of the Rocky Mountains – have been documented to be in decline (see the North American Monarch Conservation Plan, available at: http://www.mlmp.org/Resources/pdf/5431_Monarch_en.pdf). Proposed causes include general habitat loss and specific loss of milkweed, upon which the butterflies feed and reproduce. Considering the numerous monarch butterfly carcasses seen at the Ivanpah facility, it appears that solar power towers could have a significant impact on monarch populations in the desert southwest. Analysis of the insect mortality at Ivanpah, and systematic observations of bird/insect interactions around the power tower, is clearly needed.

Bird species affected by solar flux include both insectivores (e.g. swallows, swifts, flycatchers, and warblers) and raptors that prey on insect-feeding birds. Based on observations of the tower in flux and the finding of large numbers of butterflies, dragonflies and other insects at the base of the tower and in adjacent buildings it is suspected that the bright light generated by solar flux attracts insects, which in turn attracts insectivores and predators of insectivores. Waterbirds and other birds that feed on vegetation were not found to have solar flux burns. Birds were observed perching and feeding on railings at the top of the tower, apparently in response to the insect aggregations there.

Further, dead bats found at the Ivanpah site could be attracted to the large numbers of insects in the area. Nineteen bats from the condenser area of the power tower facility have been submitted to NFWFL for further evaluation. These bats belong to the Vespertilionidae and Molossidae families, which contain species considered by the Bureau of Land Management to be sensitive species in California. Preliminary evaluation revealed no apparent singing of the hair, and analysis is ongoing.

Solar flux and heat associated with solar power tower facilities

Figure 7 Ivanpah solar power facilities
http://ivanpahsolar.com/about

Despite repeated requests, we have been unsuccessful in obtaining technical data relating to the temperature associated with solar flux at the Ivanpah facility. The following summarizes the information we have gathered from other sources.

The Ivanpah solar energy generating facility consists of mirrors that reflect sunlight to a tower. In the tower sits a boiler that generates steam which then powers a turbine.

At the top of a 459 foot tall tower sits a boiler (solar receiver) that is heated by the sun rays reflected by 300,000 mirrors, called solar heliostats. When the concentrated sunlight strikes the boiler tubes, it heats the water to create superheated steam. The high temperature steam is then piped from the boiler to a turbine where electricity is generated (http://ivanpahsolar.com/about visited on 01/20/2014).

Figure 8: Seville solar power facility (http://inhabitat.com/sevilles-solar-power-tower)

If all the solar heliostats are focused on the solar tower the beams multiply the strength of sunlight by 5000 times, and this generates temperatures at the solar tower in excess of 3600° Fahrenheit (> 1982° Celsius). Since steel melts at 2750° Fahrenheit (1510° Celsius), only a percentage of heliostats are focused on the solar receiver so that) the optimal temperature at the tower is approximately 900° Fahrenheit (~482° Celsius) ("How do they do it" Wag TV for Discovery Channel, Season 3, Episode 15, "Design Airplane Parachutes, Create Solar Power, Make Sunglasses" Aired August 25, 2009).

A solar steam plant in Coalinga that also uses heliostat technology for extracting oil is on record stating that the steam generator is set to about 500° Celsius. (http://abclocal.go.com/kDSn/story?section=news%2Fbusiness&id=8377469 Viewed Jan 21, 2013)

Temperatures measured by the authors at the edge of the solar complex on the surface of a heliostat were approximately 200° Fahrenheit (~93° Celsius). Therefore, there is a gradient of temperature from the edge of the solar field to the tower that ranges from 200° to 900° Fahrenheit.

There is a phenomenon that occurs when the heliostats are focused on the tower and electricity is being generated. The phenomenon can be described as either a circle of clouds around the tower or, at times, a cloud formed on the side that is receiving the solar reflection. It appears as though the tower is creating clouds. Currently we propose two hypotheses of why this "cloud" is formed. The first hypothesis is simply the presumption that the high heat associated with towers is condensing the air, and forming the

Figure 9: Tower 1 (bright white) is shown under power. Tower 2 (black) is not operating.

clouds. The second hypothesis is that this phenomenon does not represent clouds at all rather it is a place in space where the heliostats that are not being used to generate heat are focused. Under this scenario, it is a place where the mirrors focus the excess energy not being used to generate electricity.

Ivanpah employees and OLE staff noticed that close to the periphery of the tower and within the reflected solar field area, streams of smoke rise when an object crosses the solar flux fields aimed at the tower. Ivanpah employees used the term “streamers” to characterize this occurrence.

When OLE staff visited the Ivanpah Solar plant, we observed many streamer events. It is claimed that these events represent the combustion of loose debris, or insects. Although some of the events are likely that, there were instances in which the amount of smoke produced by the ignition could only be explained by a larger flammable biomass such as a bird. Indeed OLE staff observed birds entering the solar flux and igniting, consequently becoming a streamer.

OLE staff observed an average of one streamer event every two minutes. It appeared that the streamer events occurred more frequently within the “cloud” area adjacent to the tower. Therefore we hypothesize that the “cloud” has a very high temperature that is igniting all material that traverses its field.
One possible explanation of this this phenomenon is that the “cloud” is a convergent location where heliostats are “parked” when not in use. Conversely it undermines the condensation hypothesis, given that birds flying through condensation clouds will not spontaneously ignite.

Temperatures required to burn feathers

Many of the carcasses recovered from the Ivanpah Solar plant after the plant became operational showed singing of feathers as shown in Figure 10.

Figure 10: Singed feathers from a Northern Rough-winged Swallow

In order to investigate at what temperature feathers burn/singe, we exposed feathers to different air temperatures. Each feather was exposed to a stream of helium and air for 30 seconds. The results indicate that at 400° Celsius (752° Fahrenheit) after 30 seconds the feather begins to degrade. But at 450° and

500° Celsius (842° and 932° Fahrenheit respectively) the feathers singed as soon as they made contact with the superheated air (Figure 11). Therefore, when singed birds are found, it can be inferred that the temperatures in the solar flux at the time a bird flew through it was at least 400° Celsius (752° Fahrenheit). This inference is consistent with the desired operating temperature of a power tower solar boiler (482° Celsius).

The fact that a bird will catch on fire as it flies through the solar flux has been confirmed by a Chevron engineer who works at the Coalinga Chevron Steam plant, a joint venture of Chevron and BrightSource Solar. (http://abclocal.go.com/kDSn/story?section=news%2Fbusiness&id=8377469 Viewed Jan 21, 2013)

Figure 11: Results of exposing feathers to different temperatures (in degrees Celsius)

Conclusions and Recommendations

In summary, three main causes of avian mortality were identified at these facilities; impact trauma, predation and solar flux. Birds at all three types of solar plants were susceptible to impact trauma and predators. Solar flux injury was unique to the power tower facility. Solar facilities, in general, do not appear to attract particular species, rather an ecological variety of birds are vulnerable. That said, certain mortality and species trends were evident, such as waterbirds at Desert Sunlight, where open water sources were present.

Specific hazards were identified, including vertically-oriented mirrors or other smooth reflective panels; water-like reflective or polarizing panels; actively fluxing towers; open bodies of water; aggregations of insects that attracted insectivorous birds; and resident predators. Making towers, ponds and panels less attractive or accessible to birds may mitigate deaths. Specific actions include placing perch-guards on power tower railings near the flux field, properly netting or otherwise covering ponds, tilting heliostat mirrors during washing and suspending power tower operation at peak migration times.

Visual cues should be retrofitted to existing panels and incorporated into new panel design. These cues may include UV-reflective or solid, contrasting bands spaced no further than 28 cm from each other. This arrangement has been shown to significantly reduce the number of passerines hitting expanses of windows on commercial buildings. Spacing of 10 cm eliminates window strikes altogether. Further exploration of panel design and orientation should be undertaken with researchers experienced in the field (Daneil Klem Jr. of Muhlenberg College) to determine causes for the high rate of impact trauma, and designs optimized to reduce these mortalities.

Challenges to data collection included rapid degradation of carcass quality hindering cause of death and species determination; large facilities which are difficult to efficiently search for carcasses; vegetation and panels obscuring ground visibility; carcass loss due to scavenging; and inconsistent documentation of carcass history. Searcher efficiency has been shown to have varying influences on carcass recovery with anywhere from 30% to 90% detection of small birds achieved in studies done at wind plants (Erickson et al., 2005). Scavengers may also remove substantial numbers of carcasses. In studies done on agricultural fields, up to 90% of small bird carcasses were lost within 24 hours (Balcomb, 1986; Wobeser and Wobeser, 1992). OLE staff observed apparently resident ravens at the Ivanpah power tower. Ravens are efficient scavengers, and could remove large numbers of small bird carcasses from the tower vicinity. (Erickson, W. P., G. D. Johnson, and D. P. Young, Jr., 2005, A summary and comparison of bird mortality from anthropogenic causes with an emphasis on collisions: U S Forest Service General Technical Report PSW, v. 191, p. 1029-1042; Balcomb, R., 1986, Songbird carcasses disappear rapidly from agricultural fields: Auk, v. 103, p. 817-820; Wobeser, G., and A. G. Wobeser, 1992, Carcass disappearance and estimation of mortality in a simulated die-off of small birds: Journal of Wildlife Diseases, v. 28, p. 548-554.)

Given these variables it is difficult to know the true scope of avian mortality at these facilities. The numbers of dead birds are likely underrepresented, perhaps vastly so. Observational and statistical studies to account for carcass loss may help us to gain a better sense of how many birds are being killed. Complete histories would help us to identify factors (such as vertical placement of mirrors) leading to mortalities. Continued monitoring is also advised as these facilities transition from construction to full operation. Of especial concern is the Ivanpah facility which was not fully-functioning at the time of the latest carcass submissions. In fact, all but 7 of the carcasses with solar flux injury and reported dates of collection were found at or prior to the USFWS site visit (October 21-24, 2013) and, therefore, represent flux mortality from a facility operating at only 33% capacity. Investigation into bat and insect mortalities at the power tower site should also be pursued.

ACKNOWLEDGMENTS

We wish to acknowledge the invaluable assistance and insights of S.A. Michael Clark and S.A. Ed Nieves.

Appendix 1. List of all 71 species recovered from the three solar energy sites. In this table, remains of closely related taxa that could not be definitively identified (e.g. Cinnamon/Blue-winged Teal and Black-throated/Sage Sparrow) are assigned to the biogeographically more likely taxon. In all such cases, the possible taxa are ecologically similar. All of these species are MBTA-listed.

SPECIES		**Zone**	**Residency**	**Sites**	**MNI**
Cinnamon Teal	*Anas cyanoptera*	water	migrant	DS,IV	5
Pied-billed Grebe	*Podilymbus podiceps*	water	migrant	DS	1
Western Grebe	*Aechmorphorus occidentalis*	water	migrant	DS	9
Eared Grebe	*Podiceps nigricollis*	water	migrant	DS,GN	5
Brown Pelican	*Pelecanus occidentalis*	water	migrant	DS	2
Double-crested Cormorant	*Phalacrocorax auritus*	water	migrant	DS	2
Great Blue Heron	*Ardea herodias*	water	migrant	GN	1
Black-crowned Night-Heron	*Nycticorax nycticorax*	water	migrant	DS	1
Cooper's Hawk	*Accipiter cooperii*	air	migrant	IV	1
Red-shouldered Hawk	*Buteo lineatus*	terr	migrant	IV	1
American Kestrel	*Falco sparverius*	air	resident	GN,IV	2
Peregrine Falcon	*Falco peregrinus*	air	resident	IV	1
American Coot	*Fulica americana*	water	migrant	DS, IV	12
Yuma Clapper Rail	*Rallus longirostris yumanensis*	water	resident	DS	1
Sora	*Porzana carolina*	water	migrant	DS,IV	2
American Avocet	*Recurvirostra americana*	water	migrant	DS	1
Spotted Sandpiper	*Actitis maculatus*	water	migrant	IV	2
Ring-billed Gull	*Larus delawarensis*	water	migrant	GN	2
California Gull	*Larus californianus*	water	resident	GN	1
Greater Roadrunner	*Geococcyx californianus*	terr	resident	IV	5
Yellow-billed Cuckoo	*Coccyzus americanus*	terr	migrant	IV	1
Mourning Dove	*Zenaida macroura*	terr	resident	DS, IV	14
White-winged Dove	*Zenaida asiatica*	terr	resident	DS,GN	2
Barn Owl	*Tyto alba*	terr	resident	IV	1
Lesser nighthawk	*Chordeiles acutipennis*	air	resident	DS,GN,IV	7
Common Poorwill	*Phalaenoptilus nuttallii*	air	resident	DS,IV	2
White-throated Swift	*Aeronautes saxatalis*	air	resident	IV	1
Costa's Hummingbird	*Calypte costae*	air	resident	DS	1
Allen's/Rufous Hummingbird	*Selasphorus sp.*	air	migrant	IV	1
Northern Flicker	*Colaptes auratus*	terr	resident	IV	1
Ash-throated Flycatcher	*Myiarchus cinerascens*	air	resident	DS,IV	2
Say's Phoebe	*Sayornis saya*	air	resident	GN	2
Black Phoebe	*Sayornis nigricollis*	air	resident	DS	1
Loggerhead shrike	*Lanius ludovicianus*	terr	resident	DS,IV	5
Warbling Vireo	*Vireo gilvus*	terr	migrant	IV	1
Common Raven	*Corvus corax*	terr	resident	DS,IV	3
Horned Lark	*Eremophila alpestris*	terr	migrant	DS	1
Tree Swallow	*Tachycineta bicolor*	air	migrant	DS,GN,IV	5

SPECIES		Zone	Residency	Sites	MNI
Cliff Swallow	*Petrochelidon pyrrhonota*	air	resident	GN	5
No. Rough-winged Swallow	*Stelgidopteryx serripennis*	air	migrant	IV	2
Verdin	*Auriparus flaviceps*	terr	resident	IV	3
Blue-gray Gnatcatcher	*Polioptila caerulea*	terr	resident	IV	1
Northern Mockingbird	*Mimus polyglottos*	terr	resident	IV	1
American Pipit	*Anthus rubescens*	terr	migrant	IV	4
Orange-crowned Warbler	*Oreothlypis celata*	terr	migrant	IV	1
Lucy's Warbler	*Oreothlypis luciae*	terr	resident	IV	1
Yellow-rumped Warbler	*Setophaga coronata*	air	migrant	IV	14
Black-throated Gray Warbler	*Setophaga nigrescens*	terr	migrant	IV	1
Hermit Warbler	*Setophaga occidentalis*	terr	migrant	GN	1
Townsend's warbler	*Setophaga townsendi*	terr	migrant	DS,IV	4
Yellow Warbler	*Setophaga petechia*	terr	migrant	IV	1
Black-and-white Warbler	*Mniotilta varia*	terr	migrant	IV	1
MacGillivray's Warbler	*Oporornis tolmei*	terr	migrant	IV	1
Wilson's Warbler	*Cardellina pusilla*	terr	migrant	DS,IV	4
Common Yellowthroat	*Geothlypis trichas*	terr	migrant	DS	1
Western Tanager	*Piranga ludoviciana*	terr	migrant	DS,IV	4
Black-headed Grosbeak	*Pheucticus melanocephalus*	terr	migrant	DS,GN	2
Lazuli Bunting	*Passerina caerulea*	terr	migrant	IV	1
Blue Grosbeak	*Passerina caerulea*	terr	resident	IV	1
Green-tailed Towhee	*Pipilo chlorurus*	terr	migrant	IV	1
Brewer's Sparrow	*Spizella breweri*	terr	resident	IV	3
Chipping Sparrow	*Spizella passerina*	terr	resident	GN,IV	4
Black-throated Sparrow	*Amphispiza bilineata*	terr	resident	DS,IV	4
Savannah Sparrow	*Passerculus sandwichensis*	terr	migrant	DS,IV	3
White-crowned Sparrow	*Zonotrichia leucophrys*	terr	migrant	IV	6
Pine Siskin	*Spinus pinus*	terr	migrant	IV	1
House Finch	*Carpodacus mexicanus*	terr	resident	IV	13
Great-tailed Grackle	*Quiscalus mexicanus*	terr	resident	DS,IV	5
Brown-headed Cowbird	*Molothrus ater*	terr	resident	DS,GN,IV	8
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	terr	migrant	DS	1
Bullock's Oriole	*Icterus bullockii*	terr	resident	GN	2

Species recovered from one site: 47
two sites: 18
three sites: 5

Appendix 2. Species with solar flux burns

Common Name	Scientific name	
Yellow-rumped warbler	*Setophaga coronata*	12
House finch	*Carpodacus mexicanus*	10
Chipping sparrow	*Spizella passerina*	2
Unidentified warbler	*Parulidae*	2
Verdin	*Auriparus flaviceps*	2
Great-tailed grackle	*Quiscalus mexicanus*	2
Lucy’s warbler	*Oreothlypis luciae*	1
Wilson's warbler	*Cardellina pusilla*	1
MacGillivray's warbler	*Oporornis tolmei*	1
Black-throated gray warbler	*Setophaga nigrescens*	1
Townsend's warbler	*Setophaga townsendi*	1
Orange-crowned warbler	*Oreothlypis celata*	1
Blue-gray gnatcatcher	*Polioptila caerulea*	1
Unidentified swallow	*Hirundinidae*	1
Northern rough-winged swallow	*Stelgidopteryx serripennis*	1
Warbling vireo	*Vireo gilvus*	1
Unidentified hummingbird	*Selasphorus sp.*	1
Unidentified passerine	Passeriformes	1
Unidentified finch	*Carpodacus sp.*	1
Lazuli bunting	*Passerina caerulea*	1
Unidentified sparrow	*Spizella species*	1
Unidentified blackbird	*Icteridae*	1
Peregrine falcon	*Falco peregrinus*	1

Additional Documentation Attachment to Comment 2-F1
Attachment I-4

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Ecological Services
Palm Springs Fish and Wildlife Office
777 East Tahquitz Canyon Way, Suite 208
Palm Springs, California 92262

In Reply Refer To:
FWS-ERIV-08B0789-15TA0228

MAR 10 2015

Memorandum

To: Deputy State Director, California State Office, Bureau of Land Management
Sacramento, California
Attention: Amy Fesnock

From: Assistant Field Supervisor, Palm Springs Fish and Wildlife Office
Palm Springs, California

Subject: Bird and Bat Conservation Strategy for the Desert Sunlight Solar Project in Riverside County, California

The U.S. Fish and Wildlife Service (Service) appreciates the continued coordination among the Renewable Energy Action Team (REAT) agencies on project-specific planning, environmental review, and development of compliance plans, including Bird and Bat Conservation Strategies (BBCS). The Bureau of Land Management (BLM) recently approved the BBCS for the Desert Sunlight Solar Project. We have provided substantive comments on several iterations of the draft BBCS that were not incorporated into the accepted version, and would like to highlight the importance of the monitoring program within the adaptive management[1] framework as a means of addressing and evaluating our stated concerns. As we learn more about the relationship between solar facilities and avian impacts, we anticipate the need for further refinement of this and other project-level BBCSs, as monitoring results and changing agency policy may warrant.

Because utility-scale solar development is a relatively nascent industry, systematic monitoring designed to assess the impacts associated with construction and operation of these types of facilities has not been conducted. Consequently, our current scientific understanding of the effects of all aspects of facility operations (e.g., noise, lighting, panels, utility lines, etc.) on bird and bat impacts, such as differential effects on behaviors and mortality rates of resident and migratory species, and changes in population status of those groups, is limited.

---

[1] Adaptive management is an iterative, science-based process that involves: (a) formulating alternative actions to meet measurable objectives; (b) predicting the outcomes of alternatives based on current knowledge; (c) monitoring to test the assumptions underlying those predictions; (d) implementing alternatives; (e), monitoring the results; and (f) using the monitoring results to improve knowledge and adjust actions and objectives accordingly.

The Service will participate in the Technical Advisory Group (TAG) that has been established for this project. Therefore, in preparation for the TAG process, we offer the following key components of the BBCS that will best help the REAT agencies better understand the risks to avian communities and how best to avoid and minimize impacts to migratory birds on this and other solar energy projects. Among other issues, we will ask that the TAG address the topics below as part of their responsibilities.

- The Desert Sunlight Solar Project will be one of the first utility-scale solar projects where systematic mortality monitoring will be conducted. Accordingly, the adaptive management section of the BBCS focuses on the mortality monitoring component of the plan; however, discussions regarding effectiveness monitoring of existing conservation measures and the identification of metrics or thresholds necessary to trigger implementation of additional conservation measures should be articulated in the plan. These types of metrics will be useful in addressing impacts that may not have been accounted for during the permitting process. We believe it will be important for the TAG to consider effectiveness monitoring in the adaptive management process to minimize adverse effects to the extent feasible.

- To our knowledge, distance sampling has never been used for this application (mortality monitoring on wind and solar projects). Due to site-specific conditions (obstructed visibility inherent to the project panel configuration), 100 percent of the proposed search area may not be adequately observed. Therefore, additional survey area may be needed to meet the stated objective to survey 30 percent of the solar field. The TAG should evaluate the results after each monitoring season and make recommendations to BLM to modify the methodology, if warranted.

- The BBCS establishes mixed monitoring intervals (7 and 21 days) for different seasons. Longer monitoring intervals are not supported by the Corvus carcass persistence trials performed on the Desert Sunlight site to date, HT Harvey's detectability study, and much of the available literature from the Mojave region. Longer survey intervals could introduce a bias toward larger bodied species, with medium and smaller sized species being under-represented. This bias could be further complicated by sampling only a subset of the fall and spring migration periods. Consequently, these intervals coupled with the distance sampling method as proposed, could result in statistically significant under-sampling, which cannot be corrected for using estimators. We suggest the TAG evaluate the methods and results in accordance with an agreed upon schedule as discussed below.

- There are over 400 species of resident and migratory birds known to occur in this region (Rosenberg et al. 1991, Patten et al. 2003). The migration periods specified in the BBCS are inadequate to cover the suite of species that have been documented in the area. We will work within the framework of the TAG to review a subset of avian species migratory patterns and make recommendations to adjust the migration monitoring periods, as appropriate, to avoid bias where possible, in the mortality monitoring results.

- Mortalities of rare species have been documented at this and other solar facilities in the California desert. Currently, the BBCS includes systematic monitoring of 30 percent of the solar field; however, this level of survey effort may not be sufficient to detect rare mortality events of uncommon and/or listed species, such as Yuma Ridgway's rail. New modeling tools, such as the Evidence of Absence tool (Huso *et al.* in press), have recently become available and can be used to inform what level of monitoring will be needed to increase the level of confidence that a rare mortality event has not occurred during the monitoring period. We recommend that the TAG assess whether the use of this tool should be used to inform future monitoring efforts.

- The BBCS allows the use of monitoring personnel who do not have academic ornithological and field ecology/biology background or personnel with limited experience in the desert Southwest. While training will be conducted, locating carcasses can be quite difficult, especially for surveyors unfamiliar with scientific principles, and measurements for distance sampling will need to be precise to support a robust analysis. An assessment of searcher efficiency rates and a complete description of methods [i.e., the number, size (weight), and species of trial carcasses used, exact time and location of carcass placement, surveyor detectability thresholds, etc.] should be reviewed periodically by the TAG to determine if modifications are warranted.

  Accurate identification of species is critical to understanding which species/taxa may be at risk from the project. We appreciate that an Authorized Avian Biologist will be available to ensure proper identification of carcasses and implementation of collection protocols and that a biologist will be on-site during monitoring periods to provide oversight. However, for carcasses and feathers that the Authorized Avian Biologist cannot identify, we would like to establish a process to have these items identified by a federally permitted natural history museum, ornithological research institution, or public wildlife forensic laboratory approved by the Service.

- As part of our efforts to gain a better understanding of cumulative impacts associated with solar projects throughout the desert region, biological samples from bird carcasses need to be collected. Identification of affected sub-populations of priority species is needed to help determine the significance of demographic impacts. Determination of the sub-species and regional populations affected require the collection of morphometric, genetic, and isotope data from collected carcasses (including those currently in storage on the project site).

One of the primary functions of an effective mortality monitoring program is to obtain the data necessary for the TAG to make informed decisions on the implementation and/or modification of conservation actions needed to reduce the impacts of mortality. Data are also needed to assist the TAG in determining the effectiveness of those conservation actions once they are adopted. We recommend that the TAG review the site-specific avoidance and minimization measures implemented to date by the project proponent, and assess whether effectiveness monitoring data could be collected to determine the utility of these and any future conservation actions.

The BBCS for Desert Sunlight states that the TAG meets subsequent to each monitoring season to review results of the carcass persistence, searcher efficiency, and mortality monitoring surveys. Seasonal meetings will allow the TAG to evaluate the concerns listed above and recommend any necessary adjustments to the monitoring methods prior to the next seasonal survey, if warranted and the meeting schedules allow.

We also recommend that an annual comprehensive report that includes mortality estimates for all birds and key taxa identified by the TAG, an analysis of meteorological data, taxa-specific migration information that may affect avian presence on and around the project site during the monitoring period, be submitted to the TAG after each full year of monitoring. The report should analyze the assumptions associated with the protocol, monitoring methods employed, and results that inform any conclusions. Based on a review of the report, the TAG may recommend continuation of the current protocol or recommend modifications to the methods to better achieve the monitoring goals and objectives.

We look forward to participating in the TAG and working together to develop and implement a meaningful adaptive management strategy that will facilitate conservation of our shared trust resources. If you have any questions regarding these comments or our recommendations, please contact Thomas Dietsch in our Division of Migratory Birds at thomas_dietsch@fws.gov; (760) 431-9440, extension 214 or Jody Fraser in the Palm Springs Fish and Wildlife Office at jody_fraser@fws.gov; (760) 322-2070, extension 207.

cc:
Magdalena Rodriguez, California Department of Fish and Wildlife, Ontario, California

LITERATURE CITED

Huso, M.M.P., D. Dalthorp, D. Dail, L. Madsen. In press. Estimating wind-turbine caused bird and bat fatality when zero carcasses are observed. Ecological Applications.

Patten, M.A., G. McCaskie, and P. Unitt. 2003. Birds of the Salton Sea. University of California Press. Berkeley, CA, 363 p.

Rosenberg, K.V., R.D. Ohmart, W.C. Hunter, and B.W. Anderson. 1991. Birds of the Lower Colorado River Valley. University of Arizona Press. Tuscon, AZ, 416 p.

Avian Mortality at Solar Energy Facilities in Southern California: A Preliminary Analysis

Rebecca A. Kagan, Tabitha C. Viner, Pepper W. Trail, and Edgard O. Espinoza
National Fish and Wildlife Forensics Laboratory

Executive Summary

This report summarizes data on bird mortality at three solar energy facilities in southern California: Desert Sunlight, Genesis, and Ivanpah. These facilities use different solar technologies, but avian mortality was documented at each site. Desert Sunlight is a photovoltaic facility, Genesis employs a trough system with parabolic mirrors, and Ivanpah uses a power tower as a focal point for solar flux.

FINDINGS

Trauma was the leading cause of death documented for remains at the Desert Sunlight and Genesis sites. Trauma and solar flux injury were both major causes of mortality at the Ivanpah site. Exposure to solar flux caused singeing of feathers, which resulted in mortality in several ways. Severe singeing of flight feathers caused catastrophic loss of flying ability, leading to death by impact with the ground or other objects. Less severe singeing led to impairment of flight capability, reducing ability to forage and evade predators, leading to starvation or predation. Our examinations did not find evidence for significant tissue burns or eye damage caused by exposure to solar flux.

Cause of Death	Ivanpah	Genesis	Desert Sunlight	Total
Solar Flux	47	0	0	47
Impact trauma	24	6	19	49
Predation trauma	5	2	15	22
Trauma of undetermined cause	14	0	0	14
Electrocution	1	0	0	1
Emaciation	1	0	0	1
Undetermined (remains in poor condition)	46	17	22	85
No evident cause of death	3	6	5	14
Total	141	31	61	233

These solar facilities appear to represent "equal-opportunity" hazards for the bird species that encounter them. The remains of 71 species were identified, representing a broad range of ecological types. In body size, these ranged from hummingbirds to pelicans; in ecological type from strictly aerial feeders (swallows) to strictly aquatic feeders (grebes) to ground feeders (roadrunners) to raptors (hawks and owls). The species identified were equally divided among resident and non-resident species, and nocturnal as well as diurnal species were represented. Although not analyzed in detail, there was also significant bat and insect mortality at the Ivanpah site, including monarch butterflies. It appears that Ivanpah may act as a **"mega-trap,"** attracting insects which in turn attract insect-eating birds, which are incapacitated by solar flux injury, thus attracting predators and creating an entire food chain vulnerable to injury and death.

			Foraging Zone			**Residency Status**	
SITE	No. Remains	Identifiable Remains	Air	Terr	Water	Resident	Migrant
Ivanpah	141	127	28	85	14	63	64
Genesis	31	30	12	12	6	20	10
Desert Sun	61	56	7	22	27	18	38
TOTALS	233	213	47	119	47	101	112

CONCLUSIONS AND RECOMMENDATIONS

In summary, three main causes of avian mortality were identified at these facilities: impact trauma, solar flux, and predation. Birds at all three types of solar plants were susceptible to impact trauma and predators. Predation was documented mostly at the photovoltaic site, and in many cases appeared to be associated with stranding or nonfatal impact trauma with the panels, leaving birds vulnerable to resident predators. Solar flux injury, resulting from exposures to up to 800º F, was unique to the power tower facility. Our findings demonstrate that a broad ecological variety of birds are vulnerable to morbidity and mortality at solar facilities, though some differential mortality trends were evident, such as waterbirds at Desert Sunlight, where open water sources were present; and insectivores at Ivanpah, where insects are attracted to the solar tower.

Specific hazards were identified, including vertically-oriented mirrors or other smooth reflective panels; water-like reflective or polarizing panels; actively fluxing towers; open bodies of water; aggregations of insects that attracted insectivorous birds; and resident predators. Making towers, ponds and panels less attractive or accessible to birds may mitigate deaths. Specific actions should include:

Monitoring/detection measures:

1) Install video cameras sufficient to provide 360 degree coverage around each tower to record birds (and bats) entering and exiting the flux

2) For at least two years (and in addition to planned monitoring protocol), conduct daily surveys for birds (at all three facilities), as well as insects and bats (in the condenser building at Ivanpah) around each tower at the base of and immediately adjacent to the towers in the area cleared of vegetation. Timing of daily surveys can be adjusted to minimize scavenger removal of carcasses as recommended by the TAC. Surveys in the late afternoon might be optimal for bird carcasses, and first light for bat carcasses.

3) Use dogs for monitoring surveys to detect dead and injured birds that have hidden themselves in the brush, both inside and outside the perimeter of the facility

4) To decrease removal of carcasses, implement appropriate raven deterrent actions

Bird Mortality Avoidance Measures*:*

1) Increase cleared area around tower at Ivanpah to decrease attractive habitat; at least out to fence

2) Retrofit visual cues to existing panels at all three facilities and incorporate into new panel design. These cues should include UV-reflective or solid, contrasting bands spaced no further than 28 cm from each other

3) Suspend power tower operation during peak migration times for indicated species

4) Avoid vertical orientation of mirrors whenever possible, for example tilt mirrors during washing

5) Properly net or otherwise cover ponds

6) Place perch deterrent devices where indicated, eg. on tower railings near the flux field

7) Employ exclusionary measures to prevent bats from roosting in and around the condenser facility at Ivanpah.

It must be emphasized that we currently have a very incomplete knowledge of the scope of avian mortality at these solar facilities. Challenges to data collection include: large facilities which are difficult to efficiently search for carcasses; vegetation and panels obscuring ground visibility; carcass loss due to scavenging; rapid degradation of carcass quality hindering cause of death and species determination; and inconsistent documentation of carcass history.

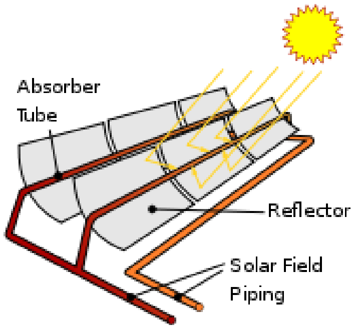
To rectify this problem, video cameras should be added to the solar towers to record bird mortality and daily surveys of the area at the base of and immediately adjacent to the towers should be conducted. At all the facilities, a protocol for systematic, statistically-rigorous searches for avian remains should be developed, emphasizing those areas where avian mortality is most likely to occur. Investigation into bat and insect mortalities at the power tower site should also be pursued.

Finally, there are presently little data available on how solar flux affects birds and insects. Studies of the temperatures experienced by objects in the flux; of the effects of high temperatures on feather structure and function; and of the behavior of insects and birds in response to the flux and related phenomena (e.g. “light clouds”) are all essential if we are to understand the scope of solar facility effects on wildlife.

Introduction

The National Fish and Wildlife Forensics Laboratory was requested to determine cause of death for birds found at facilities that generate electricity from solar energy. Solar generating facilities can be classified into three major types: photovoltaic sites, trough systems and solar power towers. There is much written about these systems so this report will not include any technical details, but simply mention the differences and their potential impact on birds.

1) **Photovoltaic systems** directly convert the sun's light into electricity. The perceived threat to birds is associated with the presence of water ponds which attract birds and from traumatic impact with the photovoltaic cells. An example of this type of solar power plant is Desert Sunlight Solar Farm (AKA First Solar).



2) **Trough systems** are composed of parabolic mirrors which focus and reflect the sun to a tube that converts the heat from the sun into electricity. The perceived threat to birds is associated with the presence of water ponds which attract birds and from traumatic impact with the trough structures. An example of this type of solar power plant is Genesis Solar Energy Project.

3) **Solar power towers** use thousands of mirrors to reflect the solar energy to a tower, where water in a boiler is converted to steam, generating the electricity. The perceived threat to birds is associated traumatic impact with the mirrors and the danger associated with the heat produced by the mirrors. An example of this type of solar power plant is Ivanpah Solar Electric Generating System.

Methods

Carcasses were collected at the different solar power plant sites by either US Fish and Wildlife Service employees or by energy company staff. The collection of the carcasses was opportunistic; that is, not according to a pre-determined sampling schedule or protocol. There was no attempt to quantify the number of carcasses that scavengers or predators removed from the solar facilities' grounds, or to compare the distribution of carcasses inside and outside the boundaries of the solar facility sites.

Additionally, three USFWS/-OLE staff, including two Forensics Lab staff (EOE and RAK), visited the Ivanpah Solar plant from October 21 – 24, 2013. Their on-site observations are included in this report.

A total of 233 birds collected from three different facilities were examined; 141 from a solar thermal power tower site (Ivanpah, Bright Source Inc.), 31 from a parabolic trough site (Genesis, NextEra Energy Inc.) and 61 from a photovoltaic (PV) panel site (Desert Sunlight, First Solar Inc.). Nine of the Ivanpah birds were received fresh; 7 of those were necropsied during a site visit by a Forensics Laboratory pathologist (RAK). The rest of the birds were received frozen and allowed to thaw at room temperature prior to species identification and necropsy. Species determination was made by the Forensics Laboratory ornithologist (PWT) for all birds either prior to necropsy or, for those necropsied on-site, from photos and the formalin-fixed head. All data on carcass history (location of the carcass, date of collection and any additional observations) were transcribed, although these were not available for all carcasses.

As part of the gross pathological examination, whole carcasses were radiographed to help evaluate limb fractures and identify any metal foreign bodies. Alternate light source examination using an Omnichrome Spectrum 9000+ at 570 nm with a red filter helped rule in or out feather burns by highlighting subtle areas of feather charring (Viner et al., 2014). All birds or bird parts from Ivanpah without obvious burns were examined with the alternate light source, as well as any bird reportedly found near a power line and a random sub-sample of the remaining birds from Genesis and Desert Sunlight (Viner, T. C., R. A. Kagan, and J. L. Johnson, 2014, Using an alternate light source to detect electrically singed feathers and hair in a forensic setting. Forensic Science International, v. 234, p. e25-e29).

Carcass quality varied markedly. If carcasses were in good post mortem condition, representative sections of heart, lung, kidney, liver, brain and gastrointestinal tract as well as any tissues with gross lesions were collected and fixed in 10% buffered formalin. Full tissue sets were collected from the fresh specimens. Formalin-fixed tissues were routinely processed for histopathology, paraffin-embedded, cut at 4 µm and stained with hematoxylin and eosin. Tissues from 63 birds were examined microscopically: 41 from Ivanpah, 1 from Genesis and 21 from Desert Sunlight.

Birds with feather burns were graded based on the extent of the lesions. Grade 1 birds had curling of less than 50% of the flight feathers. Grade 2 birds had curling of 50% or more of the flight feathers. Grade 3 birds had curling and visible charring of contour feathers (Figure 1).

Figure 1: Three grades of flux injury based on extent and severity of burning. Grade 1 (top); Yellow-rumped Warbler with less than 50% of the flight feathers affected (note sparing of the yellow rump feathers). Grade 2 (middle); Northern Rough-winged Swallow initially found alive but unable to fly, with greater than 50% of the flight feathers affected. Grade 3 (bottom); MacGillivray's Warbler with charring of feathers around the head, neck, wings and tail.

Bird Species Recovered at Solar Power Facilities

Tables 1-4 and Appendix 1 summarize 211 identifiable bird remains recovered from the three solar facilities included in this study. These birds constitute a taxonomically diverse assemblage of 71 species, representing a broad range of ecological types. In body size, these species ranged from hummingbirds to pelicans; in ecological type from strictly aerial feeders (e.g. swifts and swallows) to strictly aquatic feeders (pelicans and cormorants) to ground feeders (roadrunners) to raptors (hawks and owls). The species identified were equally divided among resident and non-resident species. Nocturnal as well as diurnal species were represented.

In Tables 1-4 and Appendix 1, bird species are categorized into very general ecological types by foraging zone and residency status. Foraging Zones were "air" (a significant portion of foraging activity performed in the air), "terrestrial" (including foraging both in vegetation and on the ground), and "water" (foraging associated with water, including waders as well as aquatic birds). Residency Status was "resident" (for breeding or year-round residents) and "migrant" (for both passage migrants and non-breeding-season residents). For a number of species, the appropriate classification for residency status was uncertain, due to a lack of detailed knowledge of the sites. The present classification is based on published range maps, and is subject to revision as more information becomes available.

This dataset is not suitable for statistical analysis, due to the opportunistic and unstandardized collection of avian remains at the facilities, and the lack of baseline data on bird diversity and abundance at each site. Nevertheless, a few conclusions can be noted. First, these data do not support the idea that these solar facilities are attracting particular species. Of the 71 bird species identified in remains, only five species were recovered from all three sites. These five were American Coot, Mourning Dove, Lesser Nighthawk, Tree Swallow, and Brown-headed Cowbird, again emphasizing the ecological variety of birds vulnerable to mortality at the solar facilities. Over two-thirds (67%) of the species were found at only a single site

(Appendix 1). That being said, the Desert Sunlight facility had particularly high mortality among waterbirds, suggesting a need to render the ponds at that site inaccessible or unattractive to these species.

The diversity of birds dying at these solar facilities, and the differences among sites, suggest that there is no simple "fix" to reduce avian mortality. These sites appear to represent "equal-opportunity" mortality hazards for the bird species that encounter them. Actions to reduce or mitigate avian mortality at solar facilities will need to be designed on a site-specific basis, and will require much more data on the bird communities at each site, and on how mortality is occurring. Carefully-designed mortality studies might reveal significant patterns of vulnerability that are not evident in these data.

Table 1. Summary data on avian mortality at the three solar sites included in this study. See summary for discussion of Foraging Zone and Residency Status categories.

				Foraging Zone			**Residency Status**	
SITE	**No. Species**	**No. Remains**	**Identifiable Remains**	**Air**	**Terr**	**Water**	**Resident**	**Migrant**
Ivanpah	49	141	127	26	85	14	63	64
Genesis	15	31	30	12	12	6	20	10
Desert Sun	33	61	56	7	22	27	18	38
TOTALS	71	233	213	47	119	47	101	112

Table 2. Species identified from avian remains at the Desert Sunlight photovoltaic solar facility. MNI = minimum number of individuals of each species represented by the identifiable remains. In some cases (e.g. Cinnamon/Blue-winged Teal), closely related species could not be distinguished based on the available remains, but the Foraging Zone and Residency Status could still be coded, due to the ecological similarities of the species involved. Total identified birds = 56.

DESERT SUNLIGHT		Zone	Residency	MNI
Pied-billed Grebe	*Podilymbus podiceps*	water	migrant	1
Eared Grebe	*Podiceps nigricollis*	water	migrant	3
Sora	*Porzana carolina*	water	migrant	1
American Avocet	*Recurvirostra americana*	water	migrant	1
Cinnamon/Blue-winged Teal	*Anas discors/clypeata*	water	migrant	1
Western Grebe	*Aechmophorus occidentalis*	water	migrant	9
Brown Pelican	*Pelecanus occidentalis*	water	migrant	2
Double-crested Cormorant	*Phalacrocorax auritus*	water	migrant	2
Black-crowned Night-Heron	*Nycticorax nycticorax*	water	migrant	1
Yuma Clapper Rail	*Rallus longirostris*	water	resident	1
American Coot	*Fulica americana*	water	migrant	5
Mourning Dove	*Zenaida macroura*	terr	resident	3
White-winged Dove	*Zenaida asiatica*	terr	resident	1
Lesser Nighthawk	*Chordeiles acutipennis*	air	resident	2
Common Poorwill	*Phalaenoptilus nuttallii*	air	resident	1
Costa's Hummingbird	*Calypte costae*	air	resident	1
Ash-throated Flycatcher	*Myiarchus cinerascens*	air	resident	1
Black-throated/Sage Sparrow	*Amphispiza sp.*	terr	resident	1
Black Phoebe	*Sayornis nigricollis*	air	resident	1
Loggerhead Shrike	*Lanius ludovicianus*	terr	resident	2
Common Raven	*Corvus corax*	terr	resident	1
Horned Lark	*Eremophila alpestris*	terr	migrant	1
Tree Swallow	*Tachycineta bicolor*	air	migrant	1
Townsend's Warbler	*Setophaga townsendi*	terr	migrant	2
Common Yellowthroat	*Geothlypis trichas*	terr	migrant	1
Savannah Sparrow	*Passerculus sandwichensis*	terr	migrant	1
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	terr	migrant	1
Wilson's Warbler	*Cardellina pusilla*	terr	migrant	2
Western Tanager	*Piranga ludoviciana*	terr	migrant	2
Black-headed Grosbeak	*Pheucticus melanocephalus*	terr	migrant	1
Great-tailed Grackle	*Quiscalus mexicanus*	terr	resident	2
Brown-headed Cowbird	*Molothrus ater*	terr	resident	1

Table 3. Species identified from avian remains at the Genesis trough system solar facility. Total identified birds = 30.

GENESIS		Zone	Residency	MNI
Eared Grebe	*Podiceps nigricollis*	water	migrant	2
Great Blue Heron	*Ardea herodias*	water	migrant	1
American Kestrel	*Falco sparverius*	air	resident	1
Ring-billed Gull	*Larus delawarensis*	water	migrant	2
California Gull	*Larus californianus*	water	resident	1
White-winged Dove	*Zenaida asiatica*	terr	resident	1
Lesser Nighthawk	*Chordeiles acutipennis*	air	resident	2
Say's Phoebe	*Sayornis saya*	air	resident	2
Tree Swallow	*Tachycineta bicolor*	air	migrant	2
Cliff Swallow	*Petrochelidon pyrrhonota*	air	resident	5
Hermit Warbler	*Setophaga occidentalis*	terr	migrant	1
Black-headed Grosbeak	*Pheucticus melanocephalus*	terr	migrant	1
Chipping Sparrow	*Spizella passerina*	terr	resident	1
Bullock's Oriole	*Icterus bullockii*	terr	resident	2
Brown-headed Cowbird	*Molothrus ater*	terr	resident	6

Table 4. Species identified from avian remains at the Ivanpah power tower solar facility. Total identified birds = 127

IVANPAH		Zone	Residency	MNI
Cinnamon Teal	*Anas cyanoptera*	water	migrant	4
Cooper's Hawk	*Accipiter cooperii*	air	migrant	1
Red-shouldered Hawk	*Buteo lineatus*	terr	migrant	1
American Kestrel	*Falco sparverius*	air	resident	1
Peregrine Falcon	*Falco peregrinus*	air	resident	1
American Coot	*Fulica americana*	water	migrant	7
Sora	*Porzana carolina*	water	migrant	1
Spotted Sandpiper	*Actitis maculatus*	water	migrant	2
Greater Roadrunner	*Geococcyx californianus*	terr	resident	5
Yellow-billed Cuckoo	*Coccyzus americanus*	terr	migrant	1
Mourning Dove	*Zenaida macroura*	terr	resident	11
Barn Owl	*Tyto alba*	terr	resident	1
Lesser Nighthawk	*Chordeiles acutipennis*	air	resident	3
Common Poorwill	*Phalaenoptilus nuttallii*	air	resident	1
White-throated Swift	*Aeronautes saxatalis*	air	resident	1
Allen’s/Rufous Hummingbird	*Selasphorus sp.*	air	migrant	1
Northern Flicker	*Colaptes auratus*	terr	resident	1
Ash-throated Flycatcher	*Myiarchus cinerascens*	air	resident	1
Loggerhead Shrike	*Lanius ludovicianus*	terr	resident	3
Warbling Vireo	*Vireo gilvus*	terr	migrant	1
Common Raven	*Corvus corax*	terr	resident	2
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	air	migrant	2
Tree Swallow	*Tachycineta bicolor*	air	migrant	2
Verdin	*Auriparus flaviceps*	terr	resident	3
Blue-gray Gnatcatcher	*Polioptila caerulea*	terr	resident	1
Northern Mockingbird	*Mimus polyglottos*	terr	resident	1
American Pipit	*Anthus rubescens*	terr	migrant	4
Orange-crowned Warbler	*Oreothlypis celata*	terr	migrant	1
Lucy's Warbler	*Oreothlypis luciae*	terr	resident	1
Black-throated Gray Warbler	*Setophaga nigrescens*	terr	migrant	1
Yellow-rumped Warbler	*Setophaga coronata*	air	migrant	14
Townsend's Warbler	*Setophaga townsendi*	terr	migrant	2
Yellow Warbler	*Setophaga petechia*	terr	migrant	1
Black-and-white Warbler	*Mniotilta varia*	terr	migrant	1
Wilson's Warbler	*Cardellina pusilla*	terr	migrant	2
MacGillivray's Warbler	*Oporornis tolmei*	terr	migrant	1
Western Tanager	*Piranga ludoviciana*	terr	migrant	2
Lazuli Bunting	*Passerina amoena*	terr	migrant	1
Blue Grosbeak	*Passerina caerulea*	terr	resident	1
Green-tailed Towhee	*Pipilo chlorurus*	terr	migrant	1
Brewer's Sparrow	*Spizella breweri*	terr	resident	3
Chipping Sparrow	*Spizella passerina*	terr	resident	3
Black-throated Sparrow	*Amphispiza bilineata*	terr	resident	3
Savannah Sparrow	*Passerculus sandwichensis*	terr	migrant	2
White-crowned Sparrow	*Zonotrichia leucophrys*	terr	migrant	6

IVANPAH		Zone	Residency	MNI
Pine Siskin	*Spinus pinus*	terr	migrant	1
House Finch	*Carpodacus mexicanus*	terr	resident	13
Brown-headed Cowbird	*Molothrus ater*	terr	resident	1
Great-tailed Grackle	*Quiscalus mexicanus*	terr	resident	3

Cause of Death of Birds Found at the Solar Power Plants

Photovoltaic facility (Desert Sunlight):

Sixty-one birds from 33 separate species were represented from Desert Sunlight. Due to desiccation and scavenging, a definitive cause of death could not be established for 22 of the 61 birds (see Table 5). Feathers could be examined in all cases, however, and none of the 61 bird remains submitted from the PV facility had visible evidence of feather singeing, a clear contrast with birds found at Ivanpah.

Blunt force impact trauma was determined to have been the cause of death for 19 Desert Sunlight birds including two Western Grebes (*Aechmophorus occidentalis*) and one each of 16 other species. Impact (blunt force) trauma is diagnosed by the presence of fractures and internal and/or external contusions. In particular, bruising around the legs, wings and chest are consistent with crash-landings while fractures of the head and/or neck are consistent with high-velocity, frontal impact (such as may result from impacting a mirror).

Figure 2: Predation trauma (top) resulting in traumatic amputation of the head and neck (American Avocet) and impact trauma (bottom) causing bruising of the keel ridge of the sternum (Brown Pelican).

Predation was the immediate cause of death for 15 birds. Lesions supporting the finding of predation included decapitation or missing parts of the body with associated hemorrhage (9/15), and lacerations of the skin and pectoral muscles. Eight of the predated birds from Desert Sunlight were grebes, which are unable to easily take off from land. This suggests a link between predation and stranding and/or impact resulting from confusion of the solar panels with water (see Discussion).

Parabolic trough facility (Genesis):

Thirty-one birds were collected from this site. There were 15 species represented. Those found in the greatest numbers were Brown-headed Cowbirds and Cliff Swallows, though no more than 6 individuals from any given species were recovered. Overall, carcass quality was poor and precluded definitive cause of death determination in 17/31 birds (Table 5). Identifiable causes of death consisted of impact trauma (6/31) and predation trauma (2/31). Necropsy findings were similar to those at Desert Sunlight with fractures and hemorrhage noted grossly. Predation trauma was diagnosed in two birds, a Cliff Swallow and a Ring-billed Gull.

Power tower facility (Ivanpah):

Ivanpah is the only facility in this study that produces solar flux, which is intense radiant energy focused by the mirror array on the power-generating tower. Objects that pass through this flux, including insects and birds, encounter extreme heat, although the extent of heating depends on many variables, including the duration of exposure and the precise location in the flux beam.

From Ivanpah, 141 birds were collected and examined. Collection dates spanned a period of one year and five months (July 2012 to December 2013) and included at least seven months of construction during which time the towers were not actively fluxing (2013). There were 49 species represented (Table 4). Those found in the greatest numbers were Yellow-rumped Warblers (*Setophaga coronata;* 14), House Finches (*Carpodacus mexicanus*; 13), Mourning Doves (*Zenaida macroura*; 11) and American Coots (*Fulica americana*; 7). Yellow-rumped Warblers and House Finches were found exclusively at the power tower site.

Solar flux injury was identified as the cause of death in 47/141 birds. Solar flux burns manifested as feather curling, charring, melting and/or breakage and loss. Flight feathers of the tail and/or wings were invariably affected. Burns also tended to occur in one or more of the following areas; the sides of the body (axillae to pelvis), the dorsal coverts, the tops and/sides of the head and neck and the dorsal body wall (the back). Overlapping portions of feathers and light-colored feathers were often spared (Figures 3 and 4).

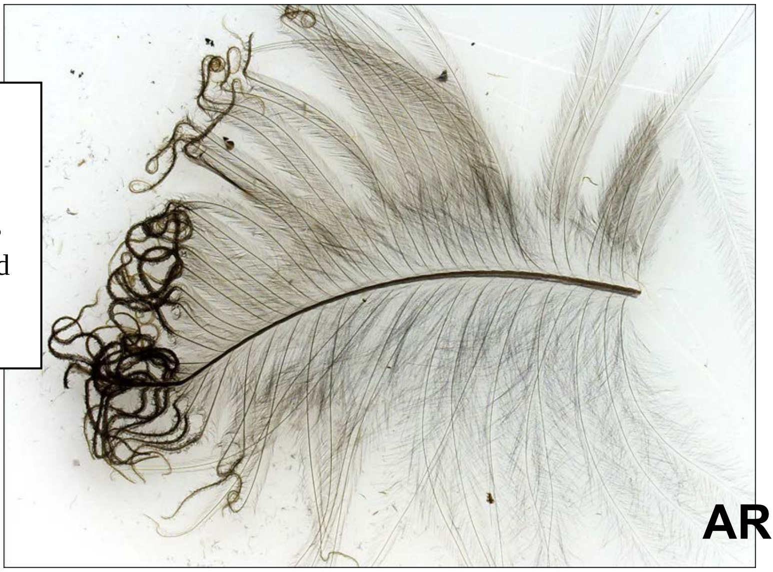


Figure 3: contour feather from the back of a House Finch with Grade 3 solar flux injury. The feather has curling and charring limited to the exposed tip.

Figure 4: Feather from a Peregrine Falcon with Grade 2 solar flux injury. Note burning of dark feather bands with relative sparing of light bands.

The yellow and red rumps of Yellow-rumped Warblers and House Finches respectively remained strikingly unaffected (See Figure 1). Charring of head feathers, in contrast, was generally diffuse across all color patterns. A pattern of spiraling bands of curled feathers across or around the body and wings was often apparent.

Table 5. Cause of death (COD) data

Cause of Death	Ivanpah	Genesis	Desert Sunlight	Total
Solar Flux	47	0	0	47
Impact trauma	24	6	19	49
Predation trauma	5	2	15	22
Trauma of undetermined cause	14	0	0	14
Electrocution	1	0	0	1
Emaciation	1	0	0	1
Undetermined (remains in poor condition)	46	17	22	85
No evident cause of death	3	6	5	14
Total	141	31	61	233

Eight birds were assigned a feather damage Grade of 1 with curling of less than 50% of the flight feathers. Six of these had other evidence of acute trauma (75%). Five birds were Grade 2, including three birds that were found alive and died shortly afterwards. Of these birds, 2 (the birds found dead) also had evidence of acute trauma. Twenty-eight birds were Grade 3; with charring of body feathers. Of these birds, 21/28

(28%) had other evidence of acute trauma. Remaining carcasses (6) were incomplete and a grade could not be assigned.

Twenty-nine birds with solar flux burns also had evidence of impact trauma. Trauma consisted of skull fractures or indentations (8), sternum fractures (4), one or more rib fractures (4), vertebral fractures (1), leg fracture (3), wing fracture (1) and/or mandible fracture (1). Other signs of trauma included acute macroscopic and/or microscopic internal hemorrhage. Location found was reported for 39 of these birds; most of the intact carcasses were found near or in a tower. One was found in the inner heliostat ring and one was found (alive) on a road between tower sites. The date of carcass collection was provided for 42/47. None were found prior to the reported first flux (2013).

Figure 5: The dorsal aspect of the wing from a Peregrine Falcon (the same bird as shown in Figure 4) with Grade 2 lesions. Note extensive curling of feathers without visible charring. This bird was found alive, unable to fly, emaciated and died shortly thereafter. These findings demonstrate fatal loss of function due to solar flux exposure in the absence of skin or other soft tissue burns.

Among the solar flux cases, a variety of bird species were affected though all but one (a raptor) was a passerine (Appendix 2). House Finches and yellow-rumped Warblers were most often represented (10/47 and 12/47 respectively). For the birds in which species could be determined (41/47), insects were a major dietary component in all but two species. These were an unidentified hummingbird (*Selasphorus*) species (known to include insects in the diet) and a Peregrine Falcon (a species that feeds on small birds).

Four birds were reportedly found alive and taken to a wildlife rehabilitation center where they died one to a few days later (exact dates were not consistently provided). Three had Grade 2 feather burns and one had Grade 3 feather burns. None had other evidence of trauma. Body condition was reduced in all of the birds (two considered thin and two emaciated) based on a paucity of fat stores and depletion of skeletal muscling. The four birds were of four different species and consisted of three passerines and one raptor.

The second most commonly diagnosed cause of death at the Ivanpah facility was impact (or blunt force) trauma (24/141 birds). Necropsy findings were as previously described at the Desert Sunlight facility. Impact marks were reported on heliostat mirrors adjacent to the carcasses in 5 cases and mirrors were described as being vertically-oriented in 5 cases. Specific carcass locations were reported for 18 of the birds. Those birds were found in a variety of areas; below heliostats (8/18), in or near tower and powerblock buildings (4/18), on roads (2/18), below power lines (2/18), in the open (1/18) and by a desert tortoise pen (1/18).

Predation was determined to be the cause of death for five of the birds. A coot and a Mourning Dove were found with extensive trauma and hemorrhage to the head and upper body consisting of lacerations, crush trauma and/or decapitation. One of the birds (an American Coot) was found near a kit fox shelter site. One bird (Northern Mockingbird) was found near the fence line and the third (a Mourning Dove) in an alley way. Two more birds (an unidentified sparrow and an American Pipit) were observed being eaten by one of the resident Common Ravens.

Discussion of Cause of Death of Birds Found at the Solar Power Plants

Impact trauma:

Sheet glass used in commercial and residential buildings has been well-established as a hazard for birds, especially passerines (Klem 1990, 2004, 2006; Loss et al. 2014). A recent comprehensive review estimated that between 365-988 million birds die annually by impacting glass panels in the United States alone (median estimate 599 million; Loss et al. 2014). Conditions that precipitate window strike events include the positioning of vegetation on either side of the glass and the reflective properties of the window. Glass panels that reflect trees and other attractive habitat are involved in a higher number of bird collisions.

The mirrors and photovoltaic panels used at all three facilities are movable and generally directed upwardly, reflecting the sky. At the Ivanpah facility, when heliostats are oriented vertically (typically for washing or installation, personal communication, RAK) they appear to pose a greater risk for birds. Of the eight birds reported found under a heliostat, heliostats were vertically-oriented in at least 5 cases. (D Klem Jr., DC Keck, KL Marty, AJ Miller Ball, EE Niciu, and CT Platt. 2004. Effects of window angling, feeder placement, and scavengers on avian mortality at plate glass. Wilson Bulletin, 116(1):69-73; D Klem Jr. 2006. Glass: A deadly conservation issue for birds. Bird Observer 34(2):73-81; D Klem Jr. 1990.

Collisions between birds and windows: mortality and prevention. Journal of Field Ornithology 61:120–128; Loss, S.R., T. Will, S.S.Loss, and P.P. Marra. 2014. Bird-building collisions in the United States: Estimates of annual mortality and species vulnerability. Condor 116: 8-23). Studies with aquatic insects have found that vertically-oriented black glass surfaces (similar to solar panels) produced highly polarized reflected light, making them highly attractive (Kriska, G., P. Makik, I. Szivak, and G. Horvath. 2008. Glass buildings on river banks as “polarized light traps” for mass-swarming polarotactic caddis flies. Naturwissenschaften 95: 461-467).

A desert environment punctuated by a large expanse of reflective, blue panels may be reminiscent of a large body of water. Birds for which the primary habitat is water, including coots, grebes, and cormorants, were over-represented in mortalities at the Desert Sunlight facility (44%) compared to Genesis (19%) and Ivanpah (10%). Several factors may inform these observations. First, the size and continuity of the panels differs between facilities. Mirrors at Ivanpah are individual, 4 x 8’ panels that appear from above as stippling in a desert background (Figure 6). Photovoltaic panels at Desert Sunlight are long banks of adjacent 27.72 x 47.25” panels (70 x 120 cm), providing a more continuous, sky/water appearance. Similarly, troughs at Genesis are banks of 5 x 5.5’ panels that are up to 49-65 meters long.

Figure 6: The Ivanpah Solar Electric Generating System as seen via satellite. The mirrored panels are 5 x 8 feet.

There is growing concern about “polarized light pollution” as a source of mortality for wildlife, with evidence that photovoltaic panels may be particularly effective sources of polarized light in the environment (see Horvath et al. 2010. Reducing the maladaptive attractiveness of solar panels to polarotactic insects. Conservation Biology 24: 1644-1653, and ParkScience, Vol. 27, Number 1, 2010; available online at: http://www.nature.nps.gov/parkscience/index.cfm?ArticleID=386&ArticleTypeID=5; as well as discussion of this issue in the Desert Sunlight Final Environmental Impact Statement, Chapter 4, pp. 14-15).

Variables that may affect the illusory characteristics of solar panels are structural elements or markings that may break up the reflection. Visual markers spaced at a distance of 28 cm or less have been shown to reduce the number of window strike events on large commercial buildings (City of Toronto Green Development Standard; Bird-friendly development guidelines. March 2007). Mirrors at the Ivanpah facility are unobscured by structures or markings and present a diffuse, reflective surface. Photovoltaic panels at Desert Sunlight are arranged as large banks of small units that are 60 x 90 cm. The visually uninterrupted expanse of both these types of heliostat is larger than that which provides a solid structure visual cue to passerines. Parabolic troughs at Genesis have large, diffusely reflective surfaces between seams that periodically transect the bank of panels at 5.5’ intervals. Structures within the near field, including the linear concentrator and support arms, and their reflection in the panels and may provide a visual cue to differentiate the panel as a solid structure.

The paper by Horvath et al cited above provides experimental evidence that placing a white outline and/or white grid lines on solar panels significantly reduced the attractiveness of these panels to aquatic insects, with a loss of only 1.8% in energy-producing surface area (p. 1651). While similar detailed studies have yet to be carried out with birds, this work, combined with the window strike results, suggest that significant reductions in avian mortality at solar facilities could be achieved by relatively minor modifications of panel and mirror design. This should be a priority for further research.

Finally, ponds are present on the property of the Desert Sunlight and Genesis facilities. The pond at Genesis is netted, reducing access by migratory birds, while the pond at Desert Sunlight is open to flighted wildlife. Thus, birds are both attracted to the water feature at Desert Sunlight and habituated to the presence of an accessible aquatic environment in the area. This may translate into the misinterpretation of a diffusely reflected sky or horizonal polarized light source as a body of water.

Stranding and Predation:

Predation is likely linked to panel-related impact trauma and stranding. Water birds were heavily over-represented in predation mortalities at Desert Sunlight. Of the 15 birds that died due to predation, 14 make their primary habitat on water (coots, grebes, a cormorant, and an avocet). A single White-winged Dove was the only terrestrial-based predation mortality in the submitted specimens. This is in contrast to blunt trauma mortalities at Desert Sunlight in which 8 of the 19 birds determined to have died of impact trauma were water species.

Locations of the birds when found dead were noted on several submissions. Of the birds that died of predation for which locations were known, none were located near ponds. The physiology of several of these water birds is such that locomotion on land is difficult or impossible. Grebes in particular have very limited mobility on land and require a run across water in order to take off (Jehl, J. R., 1996. Mass mortality events of Eared Grebes in North America. Journal of Field Ornithology 67: 471-476). Thus, these birds likely did not reach their final location intentionally. Ponds at the PV and trough sites are fenced, prohibiting terrestrial access by predators. Birds on the water or banks of the pond are inaccessible to resident predators. Therefore, it is unlikely that the birds were captured at the pond and transported by a predator into the area of the panels. Attempts to land or feed on the panels because of their deceptive appearance may have injured the birds to the point that they could not escape to safety, or inadvertently stranded the birds on a substrate from which they could not take flight. We believe that an inability to quickly flee after striking the panels and stranding on the ground left these birds vulnerable to opportunistic predators. At least two types of predators, kit foxes and ravens, have been observed in residence at the power tower and PV facilities and ravens have been reported at the trough site (personal communication and observation, RAK). Additionally, histories for multiple birds found at the tower site document carcasses found near kit fox shelters or being eaten or carried by a raven.

Solar Flux:

Avian mortality due to exposure to solar flux has been previously explored and documented (McCrary, M. D., McKernan, R. L., Schreiber, R. W., Wagner, W. D., and Sciarrotta, T. C. Avian mortality at a solar energy power plant. Journal of Field Ornithology, 57(2): 135-141). Solar flux injury to the birds of this report, as expected, occurred only at the power tower facility. Flux injury grossly differed from other sources of heat injury, such as electrocution or fire. Electrocution injury requires the bridging of two contact points and is, therefore, seen almost exclusively in larger birds such as raptors. Contact points tend to be on the feet, carpi and/or head and burns are often found in these areas. Electrocution causes deep tissue damage as opposed to the surface damage of fire or solar flux. Other sequelae include amputation of limbs with burn marks on bone, blood vessel tears and pericardial hemorrhage. Burns from fires cause widespread charring and melting of feathers and soft tissues and histopathologic findings of soot inhalation or heat damage to the respiratory mucosa. None of these were characteristics of flux injury. In the flux cases small birds were over-represented, had burns generally limited to the feathers and internal injuries attributable to impact. Flux injury inconsistently resulted in charring, tended to affect feathers along the dorsal aspects of the wings and tail, and formed band-like patterns across the body (Divincenti, F. C., J. A. Moncrief, and B. A. Pruitt. 1969. Electrical injuries: a review of 65 cases. The Journal of Trauma 9: 497-507).

Proposed mechanisms of solar flux-related death follow one or a combination of the following pathways:

- impact trauma following direct heat damage to feathers and subsequent loss of flight ability
- starvation and/or thermoregulatory dysfunction following direct heat damage to feathers
- shock
- soft tissue damage following whole-body exposure to high heat
- ocular damage following exposure to bright light.

Necropsy findings from this study are most supportive of the first three mechanisms.

Loss of feather integrity has effects on a bird's ability to take off, land, sustain flight and maneuver. Tail feathers are needed for lift production and maneuverability, remiges are needed for thrust and lift and feathers along the propatagium and coverts confer smoothness to the avian airfoil. Shortening of primary flight feathers by as little as 1.6 cm with loss of secondary and tertiary remiges has been shown to eliminate take-off ability in house sparrows further demonstrating the importance of these feathers (Brown, R. E., and A. C. Cogley, 1996. Contributions of the propatagium to avian flight: Journal of Experimental Zoology 276: 112-124). Loss of relatively few flight feathers can, therefore, render a bird unable or poorly-able to fly. Birds encountering the flux field at Ivanpah may fall as far as 400 feet after feather singeing. Signs of impact trauma were often observed in birds with feather burns and are supportive of sudden loss of function (Beaufrere, H., 2009. A review of biomechanic and aerodynamic considerations of the avian thoracic limb. Journal of Avian Medicine and Surgery 23: 173-185).

Birds appear to be able to survive flux burns in the short term, as evidenced by the collection of several live birds with singed feathers. Additionally, Forensic Lab staff observed a falcon or falcon-like bird with a plume of smoke arising from the tail as it passed through the flux field. Immediately after encountering the flux, the bird exhibited a controlled loss of stability and altitude but was able to cross the perimeter fence before landing. The bird could not be further located following a brief search (personal observation, RAK and EOE). Birds that initially survive the flux exposure and are able to glide to the ground or a perch may be disabled to the point that they cannot efficiently acquire food, escape predators or thermoregulate. Observations of emaciation in association with feather burns in birds found alive is supportive of debilitation subsequent to flux exposure. More observational studies and follow-up are required to understand how many birds survive flux exposure and whether survival is always merely short-term. As demonstrated by the falcon, injured birds (particulary larger birds), may be ambulatory enough to glide or walk over the property line indicating a need to include adjacent land in carcass searches.

There was evidence of acute skin burns on the heads of some of the Grade 3 birds that were found dead. But interestingly, tissue burn effects could not be demonstrated in birds known to have survived short periods after being burned. Hyperthermia causing instantaneous death manifests as rapid burning of tissue, but when death occurs a day or later there will be signs of tissue loss, inflammation, proteinic exudate and/or cellular death leading to multisystemic organ failure. The beginnings of an inflammatory response to injury can be microscopically observed within one to a few hours after the insult and would have been expected in any of the four birds found alive. Signs of heat stroke or inhalation of hot air should have been observable a day or more after the incident. Rather, in these cases extensive feather burns on the body largely appeared to be limited to the tips of the feathers with the overlapping portions insulating the body as designed. This, in conjunction with what is likely only a few seconds or less spent in the flux, suggests that skin or internal organ damage from exposure to high temperatures in solar flux may not be a major cause of the observed mortality.

Ocular damage following light exposure was also considered but could not be demonstrated in the submitted birds. In the four birds that initially survived, there were no signs of retinal damage, inflammation or other ocular trauma. Given the small sample size, this does not preclude sight impairment as a possible sequela but clinical monitoring of survivors would be needed to draw more definitive conclusions.

Other/Undetermined:

Powerline electrocution was the cause of death for one bird (a juvenile Common Raven) at the Ivanpah facility. Electrocution at these solar facilities is a potential hazard but, thus far, appears to be an uncommon cause of death.

Smashed birds (13/233) were found at all three locations. Detailed carcass collection information was provided for 6; all were found on roads. Though poor carcass quality in all cases precluded definitive cause death determination, circumstances and carcass condition suggest vehicle trauma as the cause of deaths. The relatively low numbers of vehicle collisions may be attributed to slow on-site vehicle speeds and light traffic. Vehicle collisions, therefore, do not appear to be a major source of mortality and would be expected to decrease as construction ends.

There was a large number of birds (85/233) for which a cause of death could not be determined due to poor carcass condition. The arid, hot environment at these facilities leads to rapid carcass degradation which greatly hinders pathology examination. Results were especially poor for birds from the Genesis facility, where the cause of death(s) for 23/31 (74%) could not be determined. These results underscore the need for carcasses to be collected soon after death. More frequent, concerted carcass sweeps are advised.

Insect mortality and solar facilities as “mega-traps”

An ecological trap is a situation that results in an animal selecting a habitat that reduces its fitness relative to other available habitats (Robertson, B.A. and R.L. Hutto. 2006. A framework for understanding ecological traps and an evaluation of existing evidence. Ecology 87: 1075-1085; Robertson, B.A., J.S. Rehage, and Sih, A. 2013. Ecological novelty and the emergence of evolutionary traps. Trends in Ecology and Evolution 28: 552-560).

A wide variety of circumstances may create ecological traps, ranging from subtle (songbirds attracted to food resources in city parks, where they are vulnerable to unnaturally high populations of predators) to direct (birds are attracted to oil-filled ponds, believing it to be water, and become trapped). It appears that solar flux facilities may act as **“mega-traps,”** which we define as artificial features that attract and kill species of multiple trophic layers. The strong light emitted by these facilities attract insects, which in turn attract insect-eating birds, which are incapacitated by solar flux injury, thus attracting predators and creating an entire food chain vulnerable to injury and death.

OLE staff observed large numbers of insect carcasses throughout the Ivanpah site during their visit. In some places there were hundreds upon hundreds of butterflies (including monarchs, *Danaus plexippus*) and dragonfly carcasses. Some showed singeing, and many appeared to have just fallen from the sky. Careful observation with binoculars showed the insects were active in the bright area around the boiler at the top of the tower. It was deduced that the solar flux creates such a bright light that it is brighter than the surrounding daylight. Insects were attracted to the light and could be seen actively flying the height of the tower. Birds were also observed feeding on the insects. At times birds flew into the solar flux and ignited. Bird carcasses recovered from the site showed the typical singed feathers. The large populations of insects may also attract indigenous bat species, which were seen roosting in structures at the base of the power tower.

Monarch butterflies in North America – both east and west of the Rocky Mountains – have been documented to be in decline (see the North American Monarch Conservation Plan, available at: http://www.mlmp.org/Resources/pdf/5431_Monarch_en.pdf). Proposed causes include general habitat loss and specific loss of milkweed, upon which the butterflies feed and reproduce. Considering the numerous monarch butterfly carcasses seen at the Ivanpah facility, it appears that solar power towers could have a significant impact on monarch populations in the desert southwest. Analysis of the insect mortality at Ivanpah, and systematic observations of bird/insect interactions around the power tower, is clearly needed.

Bird species affected by solar flux include both insectivores (e.g. swallows, swifts, flycatchers, and warblers) and raptors that prey on insect-feeding birds. Based on observations of the tower in flux and the finding of large numbers of butterflies, dragonflies and other insects at the base of the tower and in adjacent buildings it is suspected that the bright light generated by solar flux attracts insects, which in turn attracts insectivores and predators of insectivores. Waterbirds and other birds that feed on vegetation were not found to have solar flux burns. Birds were observed perching and feeding on railings at the top of the tower, apparently in response to the insect aggregations there.

Further, dead bats found at the Ivanpah site could be attracted to the large numbers of insects in the area. Nineteen bats from the condenser area of the power tower facility have been submitted to NFWFL for further evaluation. These bats belong to the Vespertilionidae and Molossidae families, which contain species considered by the Bureau of Land Management to be sensitive species in California. Preliminary evaluation revealed no apparent singing of the hair, and analysis is ongoing.

Solar flux and heat associated with solar power tower facilities

Despite repeated requests, we have been unsuccessful in obtaining technical data relating to the temperature associated with solar flux at the Ivanpah facility. The following summarizes the information we have gathered from other sources.

The Ivanpah solar energy generating facility consists of mirrors that reflect sunlight to a tower. In the tower sits a boiler that generates steam which then powers a turbine.

Figure 7 Ivanpah solar power facilities
http://ivanpahsolar.com/about

At the top of a 459 foot tall tower sits a boiler (solar receiver) that is heated by the sun rays reflected by 300,000 mirrors, called solar heliostats. When the concentrated sunlight strikes the boiler tubes, it heats the water to create superheated steam. The high temperature steam is then piped from the boiler to a turbine where electricity is generated (http://ivanpahsolar.com/about visited on 01/20/2014).

Figure 8: Seville solar power facility (http://inhabitat.com/sevilles-solar-power-tower)

If all the solar heliostats are focused on the solar tower the beams multiply the strength of sunlight by 5000 times, and this generates temperatures at the solar tower in excess of 3600° Fahrenheit (> 1982° Celsius). Since steel melts at 2750° Fahrenheit (1510° Celsius), only a percentage of heliostats are focused on the solar receiver so that) the optimal temperature at the tower is approximately 900° Fahrenheit (~482° Celsius) ("How do they do it" Wag TV for Discovery Channel, Season 3, Episode 15, "Design Airplane Parachutes, Create Solar Power, Make Sunglasses" Aired August 25, 2009).

A solar steam plant in Coalinga that also uses heliostat technology for extracting oil is on record stating that the steam generator is set to about 500° Celsius. (http://abclocal.go.com/kDSn/story?section=news%2Fbusiness&id=8377469 Viewed Jan 21, 2013)

Temperatures measured by the authors at the edge of the solar complex on the surface of a heliostat were approximately 200° Fahrenheit (~93° Celsius). Therefore, there is a gradient of temperature from the edge of the solar field to the tower that ranges from 200° to 900° Fahrenheit.

There is a phenomenon that occurs when the heliostats are focused on the tower and electricity is being generated. The phenomenon can be described as either a circle of clouds around the tower or, at times, a cloud formed on the side that is receiving the solar reflection. It appears as though the tower is creating clouds. Currently we propose two hypotheses of why this "cloud" is formed. The first hypothesis is simply the presumption that the high heat associated with towers is condensing the air, and forming the

Figure 9: Tower 1 (bright white) is shown under power. Tower 2 (black) is not operating.

clouds. The second hypothesis is that this phenomenon does not represent clouds at all rather it is a place in space where the heliostats that are not being used to generate heat are focused. Under this scenario, it is a place where the mirrors focus the excess energy not being used to generate electricity.

Ivanpah employees and OLE staff noticed that close to the periphery of the tower and within the reflected solar field area, streams of smoke rise when an object crosses the solar flux fields aimed at the tower. Ivanpah employees used the term “streamers” to characterize this occurrence.

When OLE staff visited the Ivanpah Solar plant, we observed many streamer events. It is claimed that these events represent the combustion of loose debris, or insects. Although some of the events are likely that, there were instances in which the amount of smoke produced by the ignition could only be explained by a larger flammable biomass such as a bird. Indeed OLE staff observed birds entering the solar flux and igniting, consequently becoming a streamer.

OLE staff observed an average of one streamer event every two minutes. It appeared that the streamer events occurred more frequently within the “cloud” area adjacent to the tower. Therefore we hypothesize that the “cloud” has a very high temperature that is igniting all material that traverses its field.
One possible explanation of this this phenomenon is that the “cloud” is a convergent location where heliostats are “parked” when not in use. Conversely it undermines the condensation hypothesis, given that birds flying through condensation clouds will not spontaneously ignite.

Temperatures required to burn feathers

Many of the carcasses recovered from the Ivanpah Solar plant after the plant became operational showed singing of feathers as shown in Figure 10.

Figure 10: Singed feathers from a Northern Rough-winged Swallow

In order to investigate at what temperature feathers burn/singe, we exposed feathers to different air temperatures. Each feather was exposed to a stream of helium and air for 30 seconds. The results indicate that at 400° Celsius (752° Fahrenheit) after 30 seconds the feather begins to degrade. But at 450° and

500° Celsius (842° and 932° Fahrenheit respectively) the feathers singed as soon as they made contact with the superheated air (Figure 11). Therefore, when singed birds are found, it can be inferred that the temperatures in the solar flux at the time a bird flew through it was at least 400° Celsius (752° Fahrenheit). This inference is consistent with the desired operating temperature of a power tower solar boiler (482° Celsius).

The fact that a bird will catch on fire as it flies through the solar flux has been confirmed by a Chevron engineer who works at the Coalinga Chevron Steam plant, a joint venture of Chevron and BrightSource Solar. (http://abclocal.go.com/kDSn/story?section=news%2Fbusiness&id=8377469 Viewed Jan 21, 2013)

Figure 11: Results of exposing feathers to different temperatures (in degrees Celsius)

Conclusions and Recommendations

In summary, three main causes of avian mortality were identified at these facilities; impact trauma, predation and solar flux. Birds at all three types of solar plants were susceptible to impact trauma and predators. Solar flux injury was unique to the power tower facility. Solar facilities, in general, do not appear to attract particular species, rather an ecological variety of birds are vulnerable. That said, certain mortality and species trends were evident, such as waterbirds at Desert Sunlight, where open water sources were present.

Specific hazards were identified, including vertically-oriented mirrors or other smooth reflective panels; water-like reflective or polarizing panels; actively fluxing towers; open bodies of water; aggregations of insects that attracted insectivorous birds; and resident predators. Making towers, ponds and panels less attractive or accessible to birds may mitigate deaths. Specific actions include placing perch-guards on power tower railings near the flux field, properly netting or otherwise covering ponds, tilting heliostat mirrors during washing and suspending power tower operation at peak migration times.

Visual cues should be retrofitted to existing panels and incorporated into new panel design. These cues may include UV-reflective or solid, contrasting bands spaced no further than 28 cm from each other. This arrangement has been shown to significantly reduce the number of passerines hitting expanses of windows on commercial buildings. Spacing of 10 cm eliminates window strikes altogether. Further exploration of panel design and orientation should be undertaken with researchers experienced in the field (Daneil Klem Jr. of Muhlenberg College) to determine causes for the high rate of impact trauma, and designs optimized to reduce these mortalities.

Challenges to data collection included rapid degradation of carcass quality hindering cause of death and species determination; large facilities which are difficult to efficiently search for carcasses; vegetation and panels obscuring ground visibility; carcass loss due to scavenging; and inconsistent documentation of carcass history. Searcher efficiency has been shown to have varying influences on carcass recovery with anywhere from 30% to 90% detection of small birds achieved in studies done at wind plants (Erickson et al., 2005). Scavengers may also remove substantial numbers of carcasses. In studies done on agricultural fields, up to 90% of small bird carcasses were lost within 24 hours (Balcomb, 1986; Wobeser and Wobeser, 1992). OLE staff observed apparently resident ravens at the Ivanpah power tower. Ravens are efficient scavengers, and could remove large numbers of small bird carcasses from the tower vicinity. (Erickson, W. P., G. D. Johnson, and D. P. Young, Jr., 2005, A summary and comparison of bird mortality from anthropogenic causes with an emphasis on collisions: U S Forest Service General Technical Report PSW, v. 191, p. 1029-1042; Balcomb, R., 1986, Songbird carcasses disappear rapidly from agricultural fields: Auk, v. 103, p. 817-820; Wobeser, G., and A. G. Wobeser, 1992, Carcass disappearance and estimation of mortality in a simulated die-off of small birds: Journal of Wildlife Diseases, v. 28, p. 548-554.)

Given these variables it is difficult to know the true scope of avian mortality at these facilities. The numbers of dead birds are likely underrepresented, perhaps vastly so. Observational and statistical studies to account for carcass loss may help us to gain a better sense of how many birds are being killed. Complete histories would help us to identify factors (such as vertical placement of mirrors) leading to mortalities. Continued monitoring is also advised as these facilities transition from construction to full operation. Of especial concern is the Ivanpah facility which was not fully-functioning at the time of the latest carcass submissions. In fact, all but 7 of the carcasses with solar flux injury and reported dates of collection were found at or prior to the USFWS site visit (October 21-24, 2013) and, therefore, represent flux mortality from a facility operating at only 33% capacity. Investigation into bat and insect mortalities at the power tower site should also be pursued.

ACKNOWLEDGMENTS

We wish to acknowledge the invaluable assistance and insights of S.A. Michael Clark and S.A. Ed Nieves.

Appendix 1. List of all 71 species recovered from the three solar energy sites. In this table, remains of closely related taxa that could not be definitively identified (e.g. Cinnamon/Blue-winged Teal and Black-throated/Sage Sparrow) are assigned to the biogeographically more likely taxon. In all such cases, the possible taxa are ecologically similar. All of these species are MBTA-listed.

SPECIES		**Zone**	**Residency**	**Sites**	**MNI**
Cinnamon Teal	*Anas cyanoptera*	water	migrant	DS,IV	5
Pied-billed Grebe	*Podilymbus podiceps*	water	migrant	DS	1
Western Grebe	*Aechmorphorus occidentalis*	water	migrant	DS	9
Eared Grebe	*Podiceps nigricollis*	water	migrant	DS,GN	5
Brown Pelican	*Pelecanus occidentalis*	water	migrant	DS	2
Double-crested Cormorant	*Phalacrocorax auritus*	water	migrant	DS	2
Great Blue Heron	*Ardea herodias*	water	migrant	GN	1
Black-crowned Night-Heron	*Nycticorax nycticorax*	water	migrant	DS	1
Cooper's Hawk	*Accipiter cooperii*	air	migrant	IV	1
Red-shouldered Hawk	*Buteo lineatus*	terr	migrant	IV	1
American Kestrel	*Falco sparverius*	air	resident	GN,IV	2
Peregrine Falcon	*Falco peregrinus*	air	resident	IV	1
American Coot	*Fulica americana*	water	migrant	DS, IV	12
Yuma Clapper Rail	*Rallus longirostris yumanensis*	water	resident	DS	1
Sora	*Porzana carolina*	water	migrant	DS,IV	2
American Avocet	*Recurvirostra americana*	water	migrant	DS	1
Spotted Sandpiper	*Actitis maculatus*	water	migrant	IV	2
Ring-billed Gull	*Larus delawarensis*	water	migrant	GN	2
California Gull	*Larus californianus*	water	resident	GN	1
Greater Roadrunner	*Geococcyx californianus*	terr	resident	IV	5
Yellow-billed Cuckoo	*Coccyzus americanus*	terr	migrant	IV	1
Mourning Dove	*Zenaida macroura*	terr	resident	DS, IV	14
White-winged Dove	*Zenaida asiatica*	terr	resident	DS,GN	2
Barn Owl	*Tyto alba*	terr	resident	IV	1
Lesser nighthawk	*Chordeiles acutipennis*	air	resident	DS,GN,IV	7
Common Poorwill	*Phalaenoptilus nuttallii*	air	resident	DS,IV	2
White-throated Swift	*Aeronautes saxatalis*	air	resident	IV	1
Costa's Hummingbird	*Calypte costae*	air	resident	DS	1
Allen's/Rufous Hummingbird	*Selasphorus sp.*	air	migrant	IV	1
Northern Flicker	*Colaptes auratus*	terr	resident	IV	1
Ash-throated Flycatcher	*Myiarchus cinerascens*	air	resident	DS,IV	2
Say's Phoebe	*Sayornis saya*	air	resident	GN	2
Black Phoebe	*Sayornis nigricollis*	air	resident	DS	1
Loggerhead shrike	*Lanius ludovicianus*	terr	resident	DS,IV	5
Warbling Vireo	*Vireo gilvus*	terr	migrant	IV	1
Common Raven	*Corvus corax*	terr	resident	DS,IV	3
Horned Lark	*Eremophila alpestris*	terr	migrant	DS	1
Tree Swallow	*Tachycineta bicolor*	air	migrant	DS,GN,IV	5

SPECIES		**Zone**	**Residency**	**Sites**	**MNI**
Cliff Swallow	*Petrochelidon pyrrhonota*	air	resident	GN	5
No. Rough-winged Swallow	*Stelgidopteryx serripennis*	air	migrant	IV	2
Verdin	*Auriparus flaviceps*	terr	resident	IV	3
Blue-gray Gnatcatcher	*Polioptila caerulea*	terr	resident	IV	1
Northern Mockingbird	*Mimus polyglottos*	terr	resident	IV	1
American Pipit	*Anthus rubescens*	terr	migrant	IV	4
Orange-crowned Warbler	*Oreothlypis celata*	terr	migrant	IV	1
Lucy's Warbler	*Oreothlypis luciae*	terr	resident	IV	1
Yellow-rumped Warbler	*Setophaga coronata*	air	migrant	IV	14
Black-throated Gray Warbler	*Setophaga nigrescens*	terr	migrant	IV	1
Hermit Warbler	*Setophaga occidentalis*	terr	migrant	GN	1
Townsend's warbler	*Setophaga townsendi*	terr	migrant	DS,IV	4
Yellow Warbler	*Setophaga petechia*	terr	migrant	IV	1
Black-and-white Warbler	*Mniotilta varia*	terr	migrant	IV	1
MacGillivray's Warbler	*Oporornis tolmei*	terr	migrant	IV	1
Wilson's Warbler	*Cardellina pusilla*	terr	migrant	DS,IV	4
Common Yellowthroat	*Geothlypis trichas*	terr	migrant	DS	1
Western Tanager	*Piranga ludoviciana*	terr	migrant	DS,IV	4
Black-headed Grosbeak	*Pheucticus melanocephalus*	terr	migrant	DS,GN	2
Lazuli Bunting	*Passerina caerulea*	terr	migrant	IV	1
Blue Grosbeak	*Passerina caerulea*	terr	resident	IV	1
Green-tailed Towhee	*Pipilo chlorurus*	terr	migrant	IV	1
Brewer's Sparrow	*Spizella breweri*	terr	resident	IV	3
Chipping Sparrow	*Spizella passerina*	terr	resident	GN,IV	4
Black-throated Sparrow	*Amphispiza bilineata*	terr	resident	DS,IV	4
Savannah Sparrow	*Passerculus sandwichensis*	terr	migrant	DS,IV	3
White-crowned Sparrow	*Zonotrichia leucophrys*	terr	migrant	IV	6
Pine Siskin	*Spinus pinus*	terr	migrant	IV	1
House Finch	*Carpodacus mexicanus*	terr	resident	IV	13
Great-tailed Grackle	*Quiscalus mexicanus*	terr	resident	DS,IV	5
Brown-headed Cowbird	*Molothrus ater*	terr	resident	DS,GN,IV	8
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	terr	migrant	DS	1
Bullock's Oriole	*Icterus bullockii*	terr	resident	GN	2

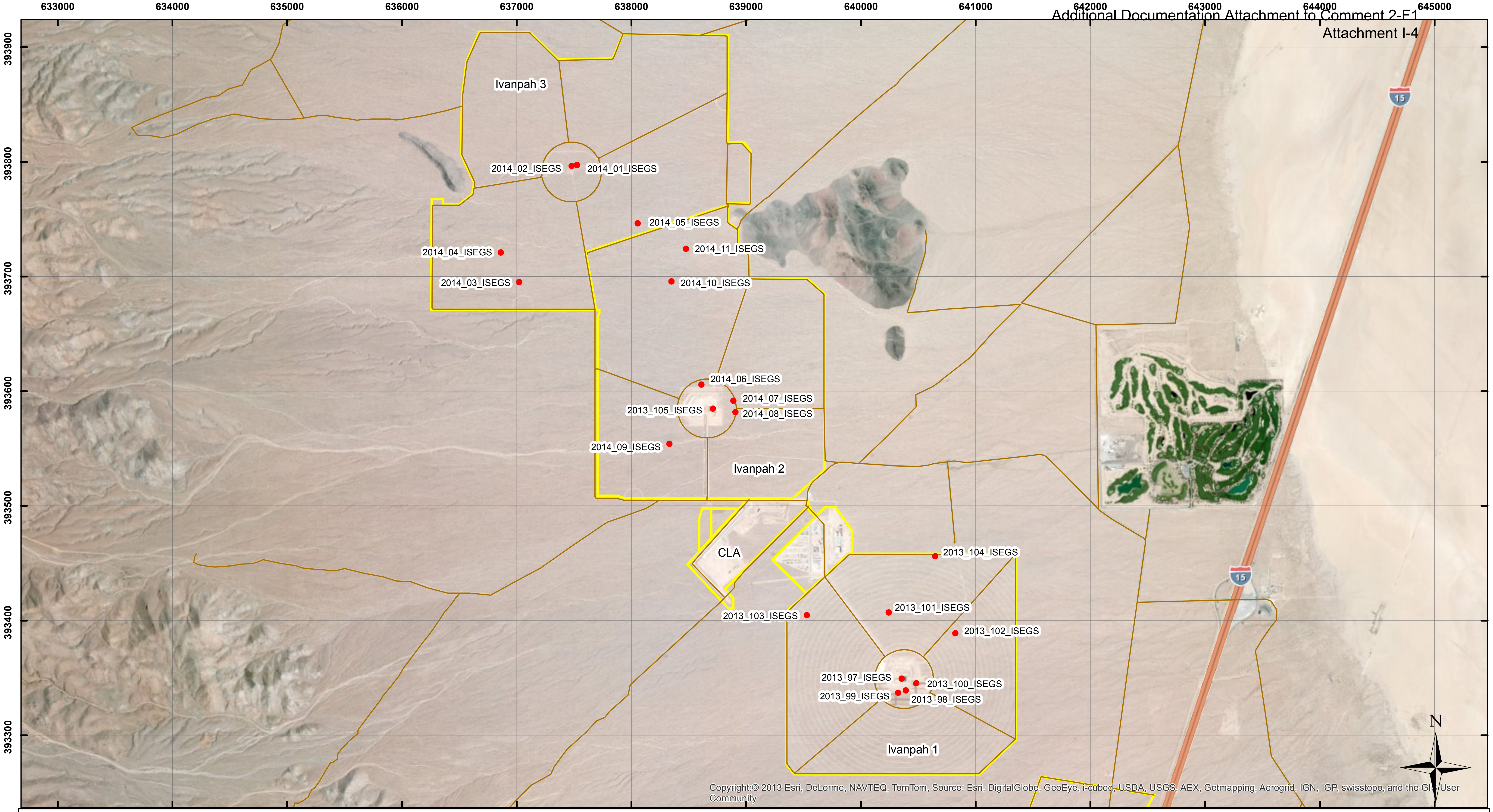
Species recovered from one site: 47
two sites: 18
three sites: 5

Appendix 2. Species with solar flux burns

Common Name	Scientific name	
Yellow-rumped warbler	*Setophaga coronata*	12
House finch	*Carpodacus mexicanus*	10
Chipping sparrow	*Spizella passerina*	2
Unidentified warbler	*Parulidae*	2
Verdin	*Auriparus flaviceps*	2
Great-tailed grackle	*Quiscalus mexicanus*	2
Lucy’s warbler	*Oreothlypis luciae*	1
Wilson's warbler	*Cardellina pusilla*	1
MacGillivray's warbler	*Oporornis tolmei*	1
Black-throated gray warbler	*Setophaga nigrescens*	1
Townsend's warbler	*Setophaga townsendi*	1
Orange-crowned warbler	*Oreothlypis celata*	1
Blue-gray gnatcatcher	*Polioptila caerulea*	1
Unidentified swallow	*Hirundinidae*	1
Northern rough-winged swallow	*Stelgidopteryx serripennis*	1
Warbling vireo	*Vireo gilvus*	1
Unidentified hummingbird	*Selasphorus sp.*	1
Unidentified passerine	Passeriformes	1
Unidentified finch	*Carpodacus sp.*	1
Lazuli bunting	*Passerina caerulea*	1
Unidentified sparrow	*Spizella species*	1
Unidentified blackbird	*Icteridae*	1
Peregrine falcon	*Falco peregrinus*	1

Additional Documentation Attachment to Comment 2-E1

Attachment I-4



Copyright:© 2013 Esri, DeLorme, NAVTEQ, TomTom, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

● *Avian Mortality*

▭ *Site Boundary*

— *Accessible Roads*

0 0.5 1 Kilometers

This map should not be used for site specific purposes.
Proprietary and confidential.
For use by Solar Partners I, II, and VIII only.

Avian Mortalities
Dec 15, 2013 - Jan 15, 2014
Combined Unit Map: Ivanpah 1, 2 & 3
Ivanpah Solar Electric Generating System

6 Jan, 2014

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE
Migratory Bird Permit Office
2800 Cottage Way - Room W-2606 - Sacramento, CA 95825
Tel: 916-978-6183 Fax: 916-978-6183
Email: permitsR8MB@fws.gov

FEDERAL FISH AND WILDLIFE PERMIT

1. PERMITTEE

NEXTERA BLYTHE SOLAR ENERGY CENTER, LLC
700 UNIVERSE BLVD
JUNO BEACH, FL 33408
U.S.A.

2. AUTHORITY-STATUTES
16 USC 703-712

REGULATIONS
50 CFR Part 13
50 CFR 21.27

3. NUMBER
MB58483B-0

4. RENEWABLE
☒ YES
☐ NO

5. MAY COPY
☒ YES
☐ NO

6. EFFECTIVE
03/25/2015

7. EXPIRES
03/25/2017

8. NAME AND TITLE OF PRINCIPAL OFFICER *(If # 1 is a business)*
GREGORY P. SCHNECK
VICE PRESIDENT

9. TYPE OF PERMIT
MIGRATORY BIRD SPECIAL PURPOSE UTILITY PERMIT - SOLAR

10. LOCATION WHERE AUTHORIZED ACTIVITY MAY BE CONDUCTED

Records location: 1000 Draker Drive, Blythe, CA 92225, Riverside County, CA
Collection location: 1000 Draker Drive, Blythe, CA 92225, Riverside County, CA
Freezer location: 1000 Draker Drive, Blythe, CA 92225, Riverside County, CA

11. CONDITIONS AND AUTHORIZATIONS:

A. GENERAL CONDITIONS SET OUT IN SUBPART D OF 50 CFR 13, AND SPECIFIC CONDITIONS CONTAINED IN FEDERAL REGULATIONS CITED IN BLOCK #2 ABOVE, ARE HEREBY MADE A PART OF THIS PERMIT. ALL ACTIVITIES AUTHORIZED HEREIN MUST BE CARRIED OUT IN ACCORD WITH AND FOR THE PURPOSES DESCRIBED IN THE APPLICATION SUBMITTED. CONTINUED VALIDITY, OR RENEWAL, OF THIS PERMIT IS SUBJECT TO COMPLETE AND TIMELY COMPLIANCE WITH ALL APPLICABLE CONDITIONS, INCLUDING THE FILING OF ALL REQUIRED INFORMATION AND REPORTS.

B. THE VALIDITY OF THIS PERMIT IS ALSO CONDITIONED UPON STRICT OBSERVANCE OF ALL APPLICABLE FOREIGN, STATE, LOCAL, TRIBAL, OR OTHER FEDERAL LAW.

C. VALID FOR USE BY PERMITTEE NAMED ABOVE.

This permit does not supersede any State Requirements. You are responsible for ensuring that you are in compliance with all State laws, including but not limited to California Fish and Game Code 3511 (fully protected species) 3503.5 and 3513. For additional information on State requirements please contact: California Department of Fish and Wildlife, Magdalena Rodriguez, 909-945-3294.

D. **Possession and transport.**

1) You and subpermittees are authorized to handle, collect, transport and temporarily possess carcasses and partial remains of birds protected under the Migratory Bird Treaty Act, **except Bald Eagles and Golden Eagles (Eagles)** and species listed as **Threatened or Endangered** under the U.S Endangered Species Act (see 50 CFR § 17.11), found at the location/property specified in Block 10 for monitoring bird mortality associated with operation of the solar facility. To accurately determine species fatality rates, the monitoring study must include standardized carcass searches, searcher efficiency trials, and carcass removal by scavenger trials. For **Eagles and federally listed Threatened or Endangered Species** you must call a U.S. Fish and Wildlife Service (Service), Office of Law Enforcement (OLE) special agent for instructions and approval before collecting or moving the carcass or its parts. It may be necessary to preserve the carcass or its parts onsite until an agent or other Service or State representative arrives to collect it. **Your OLE point-of-contact is Resident Agent Erin Dean, email: erin_dean@fws.gov ,**

☒ ADDITIONAL CONDITIONS AND AUTHORIZATIONS ALSO APPLY

12. REPORTING REQUIREMENTS

ANNUAL REPORT DUE: 01/31
You must submit an annual report to your Regional Migratory Bird Permit Office each year, even if you had no activity. Form: www.fws.gov/forms/3-202-17.pdf.

ISSUED BY

TITLE
MIGRATORY BIRD PERMIT SPECIALIST

DATE
03/25/2015

phone: 310-328-1516

2) Except for take caused by your infrastructure and operations, you may not collect or disturb and must immediately report to OLE any dead migratory birds that appear to have been poisoned, shot, or otherwise killed or injured as the result of potential criminal activity.

3) As a condition of this permit, you are required to complete an avian mortality monitoring plan for the solar facility as part of a Bird and Bat Conservation Strategy (BBCS, previously referred to as Avian and Bat Protection Plans) prior to the expiration of this permit. The BBCS should include measures to avoid and minimize take of migratory birds during construction, as appropriate, and operation of the solar facility, as well as adaptive management actions and a monitoring plan to quantify avian mortality and evaluate the effectiveness of any avoidance and minimization measures. Upon determination by the Service that the BBCS and monitoring plan are acceptable, you will need to complete a new application form for a three-year operational Special Purpose - Utility permit (Form 3-200-81).

E. **Data Collection.**

Mortality data should be compiled in the attached Excel spreadsheet and submitted to the Service on a monthly basis until directed differently by permit official. It includes but is not limited to the collection of the following information:

1) All relevant and applicable data associated with each carcass or part collection, or injured bird, should be recorded, including the information below. Required data are designated with an asterisk (*).

   a) discovery date*
   b) collection date*
   c) species*
   d) sex and age (juvenile/adult), if known
   e) condition of bird (alive or dead) *
   f) condition of carcass (entire, partial, scavenged)*
   g) description of carcass (e.g., intact, feather spot, headless, wing sheared, blood in mouth, entanglement)*
   h) interval since last search*
   i) observer*
   j) search method used, including opportunistic discovery of carcasses*
   k) weather conditions at likely time of death, if known*
   l) identifying information for the infrastructure element, e.g. solar panel, evaporation pond, fencing, building
   m) the GPS coordinates in decimal degrees for the location where carcass/part found*
   n) ground distance of carcass from pole, line, panel, or other structure (e.g pond or building)
   o) azimuth of carcass from solar panel or infrastructure (including GPS coordinates in decimal degrees), if known
   p) apparent cause of mortality/injury (collision, electrocution, drowned, other) *
   q) estimated date of mortality or estimate of time since death (e.g., <1 day, 1 day, 2-3 days)*
   r) habitat surrounding carcass (*e.g.*, desert, grassland, rural, urban, cropland, bare ground, tall grass)
   s) information on carcass or injured bird disposition*
   t) any special notes or additional information
   u)

2) All carcasses and partial remains that are collected should be digitally photographed, bagged, and labeled with the following information:

   a) date collected
   b) a unique specimen number
   c) the information listed in E(1)(l and m) above
   d) facility name

F. **Injured birds.** Injured migratory birds, including **eagles and federally listed threatened or endangered species,** must be transferred to a federally permitted migratory bird rehabilitator or a licensed veterinarian for care. Rehabilitation and/or veterinary costs are the utility's responsibility. See condition H for reporting instructions.

G. **Take and collection of live, non-injured migratory birds, eggs, or nests is not authorized by this permit.** In addition, this permit does not authorize the take, capture, harassment or disturbance of **eagles or federally listed endangered or threatened species** (see 50 CFR 17.11).

H. **Reporting.**

1) You must report bird injuries and deaths in accordance with the time frames specified below (a-c).

a. You must submit a written report of avian mortality and injury **monthly** to OLE, the Regional Migratory Bird Permit Office (RMBPO), the Ecological Service's Field Office (Field Office) and California Department of Fish and Wildlife (CDFW). Your report must include as much of the data listed in condition E above that is available for each incident. In addition, we request that you voluntarily report bat injury and mortality information.

- OLE SA: Your OLE point-of-contact is Resident Agent Erin Dean, (erin_dean@fws.gov , phone 310-328-1516)
- RMBPO: Heather Beeler (heather_beeler@fws.gov, phone: 916-414-6651)
- Field Office- Palm Springs: Pete Sorensen (pete_Sorensen@fws.gov, phone: 760-431-9440 x293)
- CDFW: Email to Armand Gonzales (Armand.Gonzales@wildlife.ca.gov) and Magdalena Rodriguez, Magdalena.Rodriguez@wildlife.ca.gov)

b. *Eagles and T/E Species*: In addition to the monthly reports, you must report any **bald eagle or golden eagle or threatened or endangered species** found dead or injured to the OLE and each contact listed in H (1)(a) immediately if possible, but no later than **24 hours after discovery.** Your report must include as much of the information from condition E that is available for each incident. A written mortality or injury report specific to the eagle or listed species must be submitted to all contacts listed in condition H(1)(a), to include the data in condition E, no later than **one week (7 days)** from the date of discovery of the carcass.

A list of Threatened and Endangered species by State may be found in the Service's Threatened and Endangered Species System (TESS) database at: <http://www.fws.gov/endangered>.

c. *Significant Mortality Events*: In the event that you discover 6 or more migratory birds that have been injured or killed within a 24 hour period, you must report the event to RMBPO and the Field Office listed in condition H(1)(a) above immediately if possible, but no later than the **next business day**. This summary must list the number of events by species. Within 14 days of carcass/injury discovery, a written mortality or injury report specific to the incident must be submitted to your FWS contacts, and should include as much of the data in E above as possible. This reporting requirement is intended to inform the Service of events or other variables that may have contributed to the mortality event.

2) *Annual Report:* You must submit a cumulative annual report of all activities authorized under this permit to your migratory bird permit issuing office by **January 31** following each calendar year in which the permit is in effect, including:

a. All dead and injured birds, including **Eagles and T/E Species**, discovered or collected, your report must include at a minimum the information required in Condition F.

3) *Submitting Reports:* This permit has an electronic annual report. The spreadsheet report form can be downloaded from: http://www.fws.gov/forms/3-202-17.xlsm. Instructions are available on Tab 1 of the spreadsheet. Complete Tab 2, and if appropriate Tab 3. Email your monthly reports as described above in condition 1(a-c) above. Email your Annual Report by January 31 to **|Heather_Beeler@fws.gov|** **AND** **MigBirdReports@fws.gov** with the subject line "SPUT Solar - McCoy Solar Project|". You may submit an Excel spreadsheet from your own database, provided all of the "required" information is included in exact format.

I. Disposition of Carcasses and Parts.

1) In accordance with Condition D(1) above, the Service will advise you on disposition of **Eagles and federally listed Threatened or Endangered Species** specimens. The special agent will advise if they will recover an eagle carcass or if you need to ship the carcass to the Service. With PRIOR written authorization from an OLE special agent, you may contact the U.S. Fish and Wildlife Service, National Eagle and Wildlife Property Repository (NER) at (303) 287-2110 for shipping instructions. The written authorization from the special agent must accompany the Eagle if it is shipped to the NER. Disposition must be reported in your annual report to your migratory bird permit issuing office.

2) Migratory birds, other than Eagles and federally listed Threatened or Endangered Species, may be used for searcher efficiency trials and carcass removal trials AFTER a mortality report has been submitted to Regional Migratory Bird Permit Office per condition H(1)(e) documenting their death, all data collected in condition E(2), and the unique specimen number assigned to that carcass in condition E(3) above.

3) Unless otherwise specified in this permit, **Migratory Bird carcasses** and parts (**other than Eagles and federally listed Threatened or Endangered Species**) collected during the calendar year (ending Dec 31) that have been documented in your records must be stored in the freezer at the facilities at the location specified in Block 10. **AFTER** a mortality report has been submitted to Regional Migratory Bird Permit Office per condition H(1)(e) documenting their death, all data collected in condition E(2), and the unique specimen number assigned to that carcass in condition E(3), carcasses maybe:

(a) used for searcher efficiency and scavenger removal trials; provided carcasses used in trials have been reported to the Service prior to use,

(b) turned over to the State wildlife agency for official purposes, or,

(c) donated to a public scientific or educational institution or to an individual or entity authorized by Federal permit to acquire and possess migratory bird specimens.

After all permit requirements have been met, carcasses and parts (**except Eagles and federally listed Threatened or Endangered species**) that you do not transfer to another authorized party must be disposed of by burial or incineration.

J. **Construction Only Authorization.** This permit authorizes you and your subpermittees to pick up Migratory Bird carcasses and parts (**other than Eagles and federally listed Threatened or Endangered Species**) during project construction only as required for compliance with your Raven Management Plan.

K. **Renewal**. A one year extension, of this construction phase permit maybe granted with a written request and consensus from the U.S. Fish and Wildlife Service's Palm Springs Ecological Service's Field Office. A new permit application is required to obtain authorization to handle migratory bird carcasses during the operational phase of the project once a mortality monitoring plan is approved. Upon determination by the Service that the BBCS and monitoring plan are acceptable, you will need to complete a new application form for a three-year operational Special Purpose - Utility permit (Form 3-200-81).

L. **Subpermittees.** Any person who is employed by or under contract to the permittee for the activities specified in this permit, or is otherwise designated as a subpermittee in writing by the permittee may exercise the authority of this permit.

M. **Standard Conditions.** You and any subpermittees must comply with the attached **Standard Conditions for Migratory Bird Special Purpose Utility Salvage Permits. These standard conditions are a continuation of your permit conditions and must remain with your permit.**

This permit does not supersede any State Requirements. You are responsible for ensuring that you are in compliance with all State laws, including but not limited to California Fish and Game Code 3511 (fully protected species) 3503.5 and 3513. For additional information on State requirements please contact: California Department of Fish and Wildlife, Deborah Hawk, 760-872-1126.

This permit does not, nor shall it be construed to, authorize lethal take or injury of migratory birds or limit or preclude the U.S. Fish and Wildlife Service from exercising its authority under any law, statute, or regulation, or from taking enforcement action against any individual, company, or agency. This permit is not intended to relieve any individual, company, or agency of its obligations to comply with any applicable Federal, State, Tribal, or local law, statute, or regulation.

This permit may be amended at any time in response to changes in national guidance or take reported.

Avian and Wildlife Reporting Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Observation Made During (circle one):

Evaporation Pond Monitoring / Scheduled Mortality Survey / [✓ Incidental]

Date: 6/10/2013 Observer: Ron Walker

Type of Incident (circle one): [✓ Injury] / Fatality / Nest

Condition (circle one): Intact Carcass / Dismembered Carcass / Feathers Only

Age of Remains (circle one): 1-5 (fluid filled eyes) / 6-30 (maggots) / 30+ (bones)

Photo No.

Carcass Condition Details, Behavior of Injured Animal or Nest Details: Injured brown pelican found in unit 2 in power block area under HTF overhead pipes, above power block access road. Pelican appeared to be suffering from heat stress. Pelican transported to wildlife rehabilitation center in Blythe, CA. It was reported later that the pelican recovered and was released uninjured.

LOCATION

DATUM: UTM Z11 NAD83 (m) UTM N: 3726434 UTM E: 686893

Found Near (circle one):

Solar Trough / Evaporation Pond / Road / Power Line / [✓ Other (explain below)]

Location Details: Unit 2, west side of power block, under HTF pipe overhead crossing

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)

Species (if unknown, write 'unknown'): Brown Pelican

Color/Markings: Brown, light underbelly

Sex (circle one): Male / Female / [✓ Unknown] Age (circle one): Adult / Juvenile / [✓ Unknown]

Is Animal Tagged? (circle one): Yes / [✓ No]

Identification Remarks: N/A

ENVIRONMENTAL CONDITION

Weather (circle one): [✓ Clear] / Fog / Cloudy / Rain

Approx. Temperature (circle one): [✓ °F] / °C: 109

Wind (circle one): Calm / [✓ Gusty] / Storm / Violent Storm

Habitat (circle all that apply):

Bare Ground / Creosote Bush Scrub / Sand Dunes

Sand Drifts over Playa / Ephemeral Wash / Desert Pavement

NOTIFICATION

Who was notified, and When? Designated biologist on 6/10/2013 4:30:00 PM

Actions Taken (e.g., left in place, taken to rehab): Brown pelican picked up and transported to wildlife rehabilitation center in Blythe CA

COMMENTS:

Injured brown pelican found in unit 2 in power block area under HTF overhead pipes, above power block access road. Pelican appeared to be suffering from heat stress. Pelican transported to wildlife rehabilitation center in Blythe, CA. It was reported later that the pelican recovered and was released uninjured.

* Turn in completed form and incident photos to the on-site Environmental Manager.

* Report any incidental observations of dead birds or other wildlife at the evaporation ponds to the Designated Biologist within one day of the detection of the carcass.

* Report any nests immediately to the on-site Environmental Manager.

Avian and Wildlife Reporting Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Observation Made During (circle one):

Evaporation Pond Monitoring / Scheduled Mortality Survey / [✓ Incidental]

Date: 7/10/2013 Observer: Eric German

Type of Incident (circle one): Injury / [✓ Fatality] / Nest

Condition (circle one): [✓ Intact Carcass] / Dismembered Carcass / Feathers Only

Age of Remains (circle one): [✓ 1-5 (fluid filled eyes)] / 6-30 (maggots) / 30+ (bones)

Photo No. ______

Carcass Condition Details, Behavior of Injured Animal or Nest Details: Bird had been seen at power block 2 at 1330 and was reported to be heat stressed. Observer saw bird fly nw at 1345. At 1515 report of bird mortality unit 1 block 5 mirror row 52. Carcass intact, no rigor, possible cervical dislocation noted when animal was removed.

LOCATION

DATUM: UTM Z11 NAD83 (m) UTM N: 3727672 UTM E: 685376

Found Near (circle one):

[✓ Solar Trough] / Evaporation Pond / Road / Power Line / Other (explain below)

Location Details: Shaded side of solar mirror. No heat from mirrors in location of bird mortality.

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)

Species (if unknown, write 'unknown'): Brown Pelican

Color/Markings: Gray brown body. Gray feet.

Sex (circle one): Male / Female / [✓ Unknown] Age (circle one): Adult / Juvenile / [✓ Unknown]

Is Animal Tagged? (circle one): Yes / [✓ No]

Identification Remarks: N/A

ENVIRONMENTAL CONDITION

Weather (circle one): Clear / Fog / [✓ Cloudy] / Rain

Approx. Temperature (circle one): [✓ °F] / °C: 109

Wind (circle one): [✓ Calm] / Gusty / Storm / Violent Storm

Habitat (circle all that apply):

Bare Ground / Creosote Bush Scrub / Sand Dunes
Sand Drifts over Playa / Ephemeral Wash / Desert Pavement

NOTIFICATION

Who was notified, and When? Compliance and DB notified. on 7/10/2013 1:30:00 PM

Actions Taken (e.g., left in place, taken to rehab): Bird was searched for when reported alive. Bird not found. Remains collected and disposed of by burial.

COMMENTS:

Bird had been seen flying prior to discovery in solar field.

* Turn in completed form and incident photos to the on-site Environmental Manager.

* Report any incidental observations of dead birds or other wildlife at the evaporation ponds to the Designated Biologist within one day of the detection of the carcass.

* Report any nests immediately to the on-site Environmental Manager.


Date & Time: Wed Jul 10 15:36:18 PDT 2013
Position: 11 N 685376 3727972
Altitude: 418ft
Azimuth/Bearing: 230° S50W 4089mils (True)
Elevation Angle: -67.3°
Horizon Angle: +14.5°
Zoom: 1X
pelican mortality


Date & Time: Wed Jul 10 15:38:33 PDT 2013
Position: 11 N 685377 3727970
Altitude: 432ft
Azimuth/Bearing: 253° S73W 4498mils (True)
Elevation Angle: -88.1°
Horizon Angle: -88.5°
Zoom: 1X
pelican mortality


Date & Time: Wed Jul 10 16:01:09 PDT 2013
Position: 11 N [illegible]
Altitude: 280ft
Azimuth/Bearing: 356° N04W 6329mils (True)
Elevation Angle: -65.6°
Horizon Angle: +02.9°
Zoom: 1X
pelican mortality

DUDEK

MAIN OFFICE
605 THIRD STREET
ENCINITAS, CALIFORNIA 92024
T 760.942.5147 T 800.450.1818 F 760.632.0164

MEMORANDUM

To: Esther Burkett, CDFW (esther.burkett@wildlife.ca.gov)
Carie Battistone, CDFW (carie.battistone@wildlife.ca.gov)
Magdalena Rodriguez, CDFW (Magdalena.rodriguez@wildlife.ca.gov)
From: Brock Ortega, Dudek
Subject: 2015 Annual Report for the Blythe Solar Power Project (BSPP) Scientific Collecting Permit (SCP) SC-002067
Date: February 16, 2016
cc: Dave Hochart, Dudek
Bobby Hall, NextEra Energy Resources
Adrienne Charbonneau, NextEra Energy Resources
Att: Attachment A – Avian Mortality Monitoring Spreadsheet / Special Purpose Utility Excel Data Sheet

---

Introduction

This memorandum provides a summary of avian carcasses collected and documented under Scientific Collecting Permit (SCP) No. SC-002067 at the Blythe Solar Power Project (BSPP) from October 14, 2015 (date the permit was issued) through the end of the reporting year (December 31, 2015). This report serves as the "Annual Report" required in accordance with section "10. Reporting" of SCP Permit No. SC-002067.

In addition, it should be noted that in accordance with section "10. Reporting" of SC-002067, it is acceptable to present a summary of avian carcasses collected during this reporting period through the use of the Service's excel file, which is being used in accordance with federal permit MB5843B-0:

> "A current version of the Service's "Avian Mortality Monitoring Spreadsheet/Special Purpose Utility Excel Data Sheet" (Excel file) shall be used to tabulate the salvaged and injured birds, quarterly and annually, unless otherwise instructed by the Department contact. The spreadsheet shall be submitted electronically along with the quarterly and annual reports."

Summary

During the reporting period indicated above (October 14, 2015 through December 31, 2015), three (3) avian carcasses were collected, documented, and placed in an on-site freezer, in accordance with federal permit MB5843B-0. Details about the carcasses collected during this reporting period are included in **Attachment A.**

Adjusted Annual Mortality Estimates

In accordance with section "10. Reporting" of SC-0022067, annual reports should include:

> "adjusted annual mortality estimates for all birds (including additional mortality estimates for small birds, large birds, and raptors) whose death appears related to the operation of the Blythe Solar Power Project."

It is Dudek's understanding that since no avian mortalities during this reporting period appeared to be the result of project-related activities, it is not feasible to adequately estimate the number of mortalities estimated for the next reporting period (2016). SC-002067 requires another annual report to be submitted in January 2017, and at that time, after a full year of data is collected under this SCP permit, an annual mortality estimate will be made.

Please feel free to contact me at bortega@dudek.com or 760.479.4254 if you have any questions regarding the contents of this memorandum.

Brock Ortega
Project Biologist

Attachment A

***Report Year** Please make sure this column reflects the current reporting year. If not, please go to tab 2: CORE INFORMATION and change the report year to the correct year.	**UNIQUE RECORD ID#** (will autopopulate upon species selection) NOTE: FOR EAGLE and T&E REPORTS THIS UNIQUE ID IS IMPORTANT. Please read instruction in tab 1 (Step #3 of "If you discover an eagle or T&E species") for specific instructions on what to do with this unique ID#.	***Species** (Common Name)	***How Identified** For assistance with identification of birds, please refer to the suggested bird identification guides in the REFERENCE MATERIALS tab.	***Number of Individuals**	***Condition of Animal** (Alive or Dead)	***Description of Animal** If Alive, indicate if injured or sick; If Dead, indicate if carcass is intact, freshly killed [eyes moist], semi-fresh [stiff], partially decomposed, feathers and/or bones, other	***Discovery Date** (mm/dd/yyyy)
2015	FWSIMR2015MB58483B-028	Northern Flicker	Expert Opinion	1	Dead	Partial carcass; carcass 2-4 days old (maggots)	10/23/2015
2015	FWSIMR2015MB58483B-029	Brewer's Sparrow	Expert Opinion	1	Dead	Carcass intact; carcass 1-2 days old (fluid filled eyes)	11/10/2015
2015	FWSIMR2015MB58483B-030	Other Bird - Unknown passerine	Expert Opinion	1	Dead	Partial carcass; carcass 1-2 days old/freshly killed (fluid filled eyes)	12/28/2015

Attachment A

***Collection Date** (mm/dd/yyyy) (If specimen was not collected, enter "NA")	***How found?** Was this eagle an incidental find or was it found during a planned carcass survey?	***Age** For assistance with ageing of eagles, please refer to the US Fish and Wildlife Service Feather Atlas and Bloom and Clark (2001) paper in the REFERENCE MATERIALS tab.	**How Aged**	***Sex**	***Suspected cause of injury/mortality (field determination)**	***Did you see the injury or mortality event?**	***Additional details on suspected cause of injury/mortality** If suspected cause is "Other" or includes "Other", or you have additional details about the option selected, please use this field to add more information
10/23/2015	Other - Found during routine construction monitoring of the gen-tie (not a focused survey). The Blythe Solar Power Project is currently under construction.	Unknown	Expert Opinion	Unknown	Possible Predated	No	Missing head and appears to have predation marks on breast
11/10/2015	Other - Found during routine construction monitoring of the gen-tie (not a focused survey). The Blythe Solar Power Project is currently under construction.	Unknown	Expert Opinion	Unknown	Dehydration/Exhaustion	No	Fully intact carcass. No wounds visable.
12/28/2015	Other - Found during routine construction monitoring of the gen-tie (not a focused survey). The Blythe Solar Power Project is currently under construction.	Adult	Expert Opinion	Unknown	Predated	Yes	Head and most primaries/secondaries missing. Small, approx 3.5". Unknown passerine was preyed upon and placed in bush by American Kestrel.

Attachment A

***Feature near where dead/injured animal was found**	***Feature 2 (use if more than one feature found)**	***Feature 3**	***Describe any additional information or details about nearby hazards or attractants here, including any structure configuration or nameplate details and the distance the animal was found from the feature.**	***County** (Note: Please list only primary name e.g. Grant Parish would be "Grant", and Alameda County would be "Alameda")	***State**	***Latitude** (decimal degrees, e.g. 38.88266)	***Longitude** (decimal degrees, e.g. -77.11504)
G21, during pile driving activities	Array	N/A	N/A	Riverside	CA	33.670802	-114.746537
Trench in Block H5	Array	N/A	N/A	Riverside	CA	33.685782	-114.743877
Southwest corner of array Unit 1	Array	N/A	N/A	Riverside	CA	33.668475	-114.752372

Attachment A

***Nearest cross street**	**Surrounding Habitat**	**Estimated weather conditions at time of mortality/injury**	***Animal Disposition**	**PHOTOS:** If you have photos of the incident/specimen, please select and "X" in the box below and store the photos with a copy of your spreadsheet. NOTE: Please reference the Unique Record ID# assigned to the associated record (column "L") in the photo file name.	**Unique Specimen** (non-USFWS) ID# (e.g. state, local, laboratory ID #). If not applicable, enter "NA".	**USGS Band Number** (if present)	**Transmitter or other markers**	**Any Additional Information or Notes**
	Bare Ground	Clear	Other (baged and stored in on-site freezer)	X	N/A			
	Bare Ground	Clear	Other (baged and stored in on-site freezer)	X	N/A			
	Bush	Clear	Other (baged and stored in on-site freezer)	X	N/A			

FWSIMR2015MB58483B-028

FWSIMR2015MB58483B-029

FWSIMR2015MB58483B-030

CORE INFORMATION ***Required Fields**

***Report Year (yyyy)**	2015
***Permittee Name**	NextEra Blythe Solar Energy Center, LLC
***FWS Permit Number**	MB58483B-0
***Project Type**	Solar PV
***If Project Type selected is "Other", please enter more details**	
***Principal Officer Name, Phone, and E-mail Address**	Greogry Schneck, (561) 691-7510, gregoryschneck@nee.com
***Primary Contact Name**	Brock Ortega
***Primary Contact Title**	Senior Wildlife Biologist
***Primary Contact Business Phone Number (xxx-xxx-xxxx)**	(760) 479-4254

Form 3-202-17, Rev. 2/2014

OMB Control No. 1018-0022, Expires 5/31/2017

If you do not have any mortality/injury information to report for the current reporting cycle, please indicate this by checking the box in the cell to the right. ☐

I certify that the information in this report is true and correct to the best of my knowledge. I understand that any false statement herein may subject me to the criminal penalties of 18 U.S. C. 1001.

Official Representative Signature : ***X*** Brock Ortega

Please type name in box above

Date of Signature: 10/9/2015

Please type date (mm/dd/yyyy) of signature in box above

Additional Documentation Attachment to Comment 2-F1
Attachment I-4

*Required Fields

*Requested Fields

Please make sure you have filled out CORE INFORMATION (TAB 2) before entering mortality/injury information.

Specimen Information

OMB Control No. 1018-0022, Expires 5/31/2017
Form 3-202-17, Rev. 2/2014

PLEASE READ TAB 1 OF THIS WORKBOOK if you have not yet done so before entering any injury and mortality records. Tab 1 contains important information about the meaning of Required and Priority fields, the level of information you should be providing if you are a permittee, and how to proceed upon discovery of an eagle or T&E species.

***Report Year** *Please make sure this column reflects the current reporting year. If not, please go to tab 2: CORE INFORMATION and change the report year to the correct year*.	**UNIQUE RECORD ID#** *(will autopopulate upon species selection)* ***NOTE: FOR EAGLE and T&E REPORTS THIS UNIQUE ID IS IMPORTANT. Please read instruction in tab 1 (Step #3 of "If you discover an eagle or T&E species") for specific instructions on what to do with this unique ID#.***	***Species (Common Name)**	***How Identified** *For assistance with identification of birds, please refer to the suggested bird identification guides in the REFERENCE MATERIALS tab.*	***Number of Individuals**	***Condition of Animal (Alive or Dead)**	***Description of Animal** *If Alive, indicate if injured or sick; If Dead, indicate if carcass is intact, freshly killed [eyes moist], semi-fresh [stiff], partially decomposed, feathers and/or bones, other*	***Discovery Date (mm/dd/yyyy)**
2015	FWSIMR2015MB58483B-016	Loggerhead Shrike	Expert Opinion	1	Dead	Carcass intact; carcass 1-2 days old (fluid filled eyes)	9/3/2015
2015	FWSIMR2015MB58483B-017	Lesser Nighthawk	Expert Opinion	1	Dead	Carcass intact; carcass 1-2 days old (fluid filled eyes)	9/11/2015
2015	FWSIMR2015MB58483B-018	Lesser Nighthawk	Expert Opinion	1	Dead	Partial carcass; carcass 1-2 days old/freshly killed (fluid	9/17/2015
2015	FWSIMR2015MB58483B-019	American Coot	Expert Opinion	1	Dead	Carcass intact; carcass 1-2 days old (fluid filled eyes)	9/24/2015
2015	FWSIMR2015MB58483B-020	MacGillivray's Warbler	Expert Opinion	1	Dead	Carcass intact; carcass 2-4 days old (maggots)	9/28/2015
2015	FWSIMR2015MB58483B-021	House Wren	Expert Opinion	1	Dead	Carcass intact; carcass 2-4 days old (maggots)	9/28/2015
2015	FWSIMR2015MB58483B-022	Savannah Sparrow	Expert Opinion	1	Dead	Carcass intact; carcass 2-4 days old (maggots)	9/30/2015

					Suspected Cause of Injury/Mortality Details		
***Collection Date (mm/dd/yyyy) (If specimen was not collected, enter "NA")**	***How found?** *Was this eagle an incidental find or was it found during a planned carcass survey?*	***Age** *For assistance with ageing of eagles, please refer to the US Fish and Wildlife Service Feather Atlas and Bloom and Clark (2001) paper in the REFERENCE MATERIALS tab.*	**How Aged**	***Sex**	***Suspected cause of injury/mortality (field determination)**	***Did you see the injury or mortality event?**	***Additional details on suspected cause of injury/mortality** *If suspected cause is "Other" or includes "Other", or you have additional details about the option selected, please use this field to add more information*
9/3/2015	Other - Found during routine construction monitoring of the gen-tie (not a focused survey). The Blythe Solar Power Project is currently under construction.	Adult	Expert Opinion	Unknown	Possible Heat Stress/Dehydration	No	Found beneath inverter
9/11/2015	Other - Found during routine construction monitoring of the gen-tie (not a focused survey). The Blythe Solar Power Project is currently under construction.	Adult	Expert Opinion	Unknown	Possible Vehicle Strike	No	Observed external injuries include damage to the head and ventral area of body including entrails being exposed.
9/17/2015	Other - Found during routine construction monitoring of the gen-tie (not a focused survey). The Blythe Solar Power Project is currently under construction.	Adult	Expert Opinion	Unknown	Possible Vehicle Strike	No	N/A
9/24/2015	Other - Found during routine construction monitoring of the gen-tie (not a focused survey). The Blythe Solar Power Project is currently under construction.	Adult	Expert Opinion	Unknown	Possible collision with non-project-related wire but not able to rule out other possible causes of death (> 50%)	No	Found on road in good condition
9/28/2015	Other - Found during routine construction monitoring of the gen-tie (not a focused survey). The Blythe Solar Power Project is currently under construction.	Adult	Expert Opinion	Male	Possible collision with non-project related wire but not able to rule out other possible causes of death (>50%)	No	Broken beak and dehydrated
9/28/2015	Other - Found during routine construction monitoring of the gen-tie (not a focused survey). The Blythe Solar Power Project is currently under construction.	Adult	Expert Opinion	Unknown	Possible collision with non-project related wire but not able to rule out other possible causes of death (>50%)	No	Dehydrated
9/30/2015	Other - Found during routine construction monitoring of the gen-tie (not a focused survey). The Blythe Solar Power Project is currently under construction.	Adult	Expert Opinion	Male	Posible Heat Stress/Dehydration	No	Dehydrated

				Location Information		**Click here to identify the nearest La Datum) for** If you can not provide the Lat./Long., please p fields. If known, please also provide informati
***Feature near where dead/injured animal was found**	***Feature 2** *(use if more than one feature found)*	***Feature 3**	***Describe any additional information or details about nearby hazards or attractants here, including any structure configuration or nameplate details and the distance the animal was found from the feature.**	***County** *(Note: Please list only primary name e.g. Grant Parish would be "Grant", and Alameda County would be "Alameda")*	***State**	***Latitude (decimal degrees, e.g. 38.88266)**
Other - Array	N/A	N/A	N/A	Riverside	CA	33.64528
Road	Northward lane on Dracker Drive	N/A	N/A	Riverside	CA	33.621873
Road	Dracker Drive	N/A	N/A	Riverside	CA	33.656962
Road	Drack Drive near Blythe Unit 1 north gate	N/A	N/A	Riverside	CA	33.683264
Road	On Blythe solar array on North central area near McCoy fence.	Gravel (access road)	N/A	Riverside	CA	33.690007
Road	On Blythe solar access road on north central end	Gravel (access road)	N/A	Riverside	CA	33.689983
Other - Array	In DC trench near sub array E	N/A	N/A	Riverside	CA	33.671303

t./Long. in Decimal Degrees (WGS 84 the incident. populate **at a minimum** the **County** and **State** ion on the **nearest cross street.**			Weather conditions	Animal Disposition	Additional Information	
*Longitude (decimal degrees, e.g. -77.11504)	*Nearest cross street	Surrounding Habitat	Estimated weather conditions at time of mortality/injury	*Animal Disposition	**PHOTOS:** *If you have photos of the incident/specimen, please select and "X" in the box below and store the photos with a copy of your spreadsheet. NOTE: Please reference the Unique Record ID# assigned to the associated record (column "L") in the photo file name.*	**Unique Specimen (non-USFWS) ID#** *(e.g. state, local, laboratory ID #). If not applicable, enter "NA".*
-114.554621		Creosote Scrub Brush	Clear	Other (bagged and stored in on-site freezer)	**X**	N/A
-114.752511		Pavement	Clear	Other (bagged and stored in on-site freezer)	**X**	N/A
-114.754649		Asphalt	Clear	Other (bagged and stored in on-site freezer)	**X**	N/A
-114.757664		Creosote Scrub Brush	Clear	Other (baged and stored in on-site freezer)	**X**	N/A
-114.749515		Creosote Scrub Brush	Clear	Other (baged and stored in on-site freezer)	**X**	N/A
-114.7497		Creosote Scrub Brush	Clear	Other (baged and stored in on-site freezer)	**X**	N/A
-114.743889		Creosote Scrub Brush	Clear	Other (baged and stored in on-site freezer)	**X**	N/A

USGS Band Number (if present)	Transmitter or other markers	Any Additional Information or Notes

FWSIMR2015MB58483B-016

FWSIMR2015MB58483B-017

FWSIMR2015MB58483B-018

FWSIMR2015MB58483B-019

FWSIMR2015MB58483B-020

FWSIMR2015MB58483B-021

FWSIMR2015MB58483B-022

UltraSystems
environmental management planning

Memo

To:	Magdalena Rodriguez	California Department of Fish and Game
From:	Mike Lindsay	Director of Operations
CC:	Daniel Steward	Bureau of Land Management
	Sharon Tyson	Bureau of Land Management
	Pete Sorenson	U.S. Fish and Wildlife Service
	Patricia Valenzuela	Imperial County Planning Department
Date:	12/09/2011	
Re:	Imperial Solar Energy Center (ISEC) South – Burrowing Owl (BUOW) Mortality Retraction	

On November 22, 2011 UltraSystems issued a memo that reported a burrowing owl mortality for the Imperial Solar Energy Center – South project.

This memo serves to retract that statement, since only burrowing owl feathers were found on site, and no carcass was discovered (GPS coordinates of feathers: +32.67201, –15.65852). There is no confirmation that a mortality occurred.

Should you have any questions, please contact me at (949) 788-4900.

MORT n/a

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 7/21/14 TIME: 0850 TRANSECT: n/a OBSERVER: Daniel LiVigni

PROXIMAL TO PROJECT COMPONENT: found ~10m E of block 3B, outside project infrastructure

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0621100 North: 3623932

BEARING (degrees) to PROJECT COMPONENT: 90°

DISTANCE (meters) to PROJECT COMPONENT: 10m

DISTANCE (meters) to TRANSECT: n/a

CARCASS DESCRIPTION

SPECIES: Burrowing Owl (Athene cunicularia)

SEX (*circle*): M F [✓ U] AGE (*circle*): A [✓ J] U Tag/Band Number: n/a

CONDITION (*circle*): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ <1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:
unknown

OBSERVABLE INJURIES:
Bone exposed in right wing, this BUOW's burrow is located alongside a paved road, with an eastern aspect facing the road, fluid observed on left wing and abdomen

SUBSTRATE/GROUND COVER (*at carcass location*): found in dirt next to paved road

DISPOSITION OF CARCASS¹ (*circle*): [✓ left in place] removed collected for trials collected for other:

SHIPPED TO:

[name of institution]

[physical address]

[phone/email]

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 94°F

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

MORT n/a

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: SE SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

nothing of note

PHOTOGRAPHS[2]:

Close Up: Photo 1 111-1165 Photo 2 111-1166

Landscape: Photo 3 111-1167 Photo 4 111-1168

PHOTO NOTES:

taken with DL's silver camera

NOTIFICATION[3]:

DATE: 7/21/14 TIME: 0614

NAME: Pat Golden AGENCY/ASSOCIATION: Heritage Environmental Consultants

NOTES:

Found ~2m from burrow S020

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

111-1165 (DL silver)

111-1166 (DL silver)

111-1167 (DL silver)

111-1168 (DL silver)

MORT N/A

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 07-21-14 TIME: 0900 TRANSECT: ______ OBSERVER: Scott Albrecht

PROXIMAL TO PROJECT COMPONENT: Next to road - outside blocks - East of Block 3B

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: ~~621191~~ 621111 North: ~~3623759~~ 3623956

BEARING (degrees) to PROJECT COMPONENT: 90°

DISTANCE (meters) to PROJECT COMPONENT: 15M from fence

DISTANCE (meters) to TRANSECT: N/A

CARCASS DESCRIPTION

SPECIES: Burrowing owl

SEX (*circle*): M F [✓ U] AGE (*circle*): [✓ A] J U Tag/Band Number: N/A

CONDITION (*circle*): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 [✓ 1 2 3] 4 5 6 7 7+

CAUSE OF DEATH:
Unknown - likely vehicle traffic

OBSERVABLE INJURIES:
Eyes absent, some flesh decay on legs

SUBSTRATE/GROUND COVER (*at carcass location*): Dirt/Bare Ground

DISPOSITION OF CARCASS¹ (*circle*): [✓ left in place] removed collected for trials collected for other: ______

SHIPPED TO:

[name of institution] ______

[physical address] ______

[phone/email] ______

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 94

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

MORT N/A

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: NW SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]: 105-

Close Up: Photo 1 0172 Photo 2 0173

Landscape: Photo 3 0174 Photo 4 0175

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 7-21-14 TIME: 1053

NAME: Pat Golden/Scott Yanco AGENCY/ASSOCIATION: Heritage Environmental

NOTES:

Found approximately 5M from Burrow S020 on E Side of road.

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

IMG 105-0172 – Close up

IMG 105-0173 – Close up

IMG 105-0174 - Landscape

IMG 105-0175 - Landscape

MORT N/A

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 07-21-14 TIME: 0900 TRANSECT:______ OBSERVER: Scott Albrecht

PROXIMAL TO PROJECT COMPONENT: Next to road - outside blocks - East of Block 3B

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 621191 North: 3623759

BEARING (degrees) to PROJECT COMPONENT: 90°

DISTANCE (meters) to PROJECT COMPONENT: 15M from fence

DISTANCE (meters) to TRANSECT: N/A

CARCASS DESCRIPTION

SPECIES: Burrowing owl

SEX (*circle*): M F [✓ U] AGE (*circle*): [✓ A] J U Tag/Band Number: N/A

CONDITION (*circle*): [✓ intact] scavenged dismembered feather spot injured

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): <1 [✓ 1 2 3] 4 5 6 7 7+

CAUSE OF DEATH:

Unknown - likely vehicle traffic

OBSERVABLE INJURIES:

Eyes absent, some flesh decay on legs

SUBSTRATE/GROUND COVER (*at carcass location*): Dirt/Bare Ground

DISPOSITION OF CARCASS[1] (*circle*): [✓ left in place] removed collected for trials collected for other:

SHIPPED TO:

[name of institution]

[physical address]

[phone/email]

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 94

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

MORT N/A

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: NW SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

PHOTOGRAPHS[2]: 105-

Close Up: Photo 1 0172 Photo 2 0173

Landscape: Photo 3 0174 Photo 4 0175

PHOTO NOTES:

NOTIFICATION[3]:

DATE: 7-21-14 TIME: 1053

NAME: Pat Golden/Scott Yarco AGENCY/ASSOCIATION: Heritage Environmental

NOTES:

Found approximately 5M from Burrow S020 on E Side of road.

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

IMG 105-0172 – Close up

IMG 105-0173 – Close up

IMG 105-0174 - Landscape

IMG 105-0175 - Landscape

Post-construction Avian Mortality Monitoring Report
Campo Verde Solar Project

Year 2 Annual Report (October 2014 – September 2015)

Prepared By:

Heritage Environmental Consultants, LLC

December 2015

Table of Contents

1 Introduction

The Campo Verde Solar Project is a solar photovoltaic (PV) energy generating facility (Solar Energy Facility) and an associated electrical transmission line (Gen-Tie Line) in southern Imperial County, California. The solar project is located on private lands and the gen-tie line is located on private and federal lands managed by the Bureau of Land Management (BLM). These are referred to collectively as the "project."

A Bird and Bat Conservation Strategy (BBCS) was prepared that addresses activities potentially occurring during construction and operation of the project (Heritage 2013). The BBCS was reviewed and approved by the U.S. Fish and Wildlife Service (FWS), California Department of Fish and Wildlife (CDFW), and BLM. The purpose of the Campo Verde BBCS was to develop and implement a program to identify and avoid risks to avian and bat species that could result from construction and operation of the project. The goal of this BBCS was to implement a series of best practices, in order to construct and operate the project to avoid or reduce risk to birds, bats and their habitats.

The post-construction avian mortality monitoring program was set up to comply with the methodology prescribed in the BBCS (Heritage 2013). The methodology is described in Section 6.1 of the BBCS and was approved by the FWS and CDFW. Quarterly reports documenting results of the monitoring program were required for the first year of the program, and annually thereafter. Monitoring began in October 2013 just after completion of construction. This report is the second annual report documenting the results of monitoring from October 2014 to September 2015.

1.1 Project Description

The general location of the project is approximately 7 miles southwest of the city of El Centro, Imperial County, California (**Figure 1**). The project is south of I-8, west of Drew Road, and northeast and south of the Westside Main Canal. The Project consists of two component parts: (i) the Solar Energy Facility, and (ii) an approximately 0.9-mile, 230-kilovolt (kV) aboveground, electrical gen-tie line and associated facilities that electrically connect the Solar Energy Facility on private land with the Imperial Valley Substation (IV Substation) located on federal land managed by the BLM.

The Solar Energy Facility is approximately 1,443 acres in size and uses First Solar PV modules that are generally non-reflective and convert sunlight into direct current (DC) electricity. The DC output of multiple rows of PV modules is collected through one or more combiner boxes and directed to an inverter that converts the DC electricity to alternating current (AC) electricity. From the inverter, the generated energy flows to a transformer where it is stepped up to distribution level voltage (approximately 34.5 kV). Multiple transformers are connected in parallel via 34.5 kV lines to the project substation, where the power is stepped up to 230 kV. This substation is located at the southern end of the Solar Energy Facility near Liebert Road. The Gen-Tie Line connects the project substation to the Imperial Valley Substation approximately 0.9 miles to the south.

The Gen-Tie Line uses double-circuit tubular steel monopole structures. Tower structure heights range from 100 to 135 feet. One side of the double-circuit structures currently supports three two- bundle conductors and one shield wire. Typical overall structure widths are approximately 20 feet.

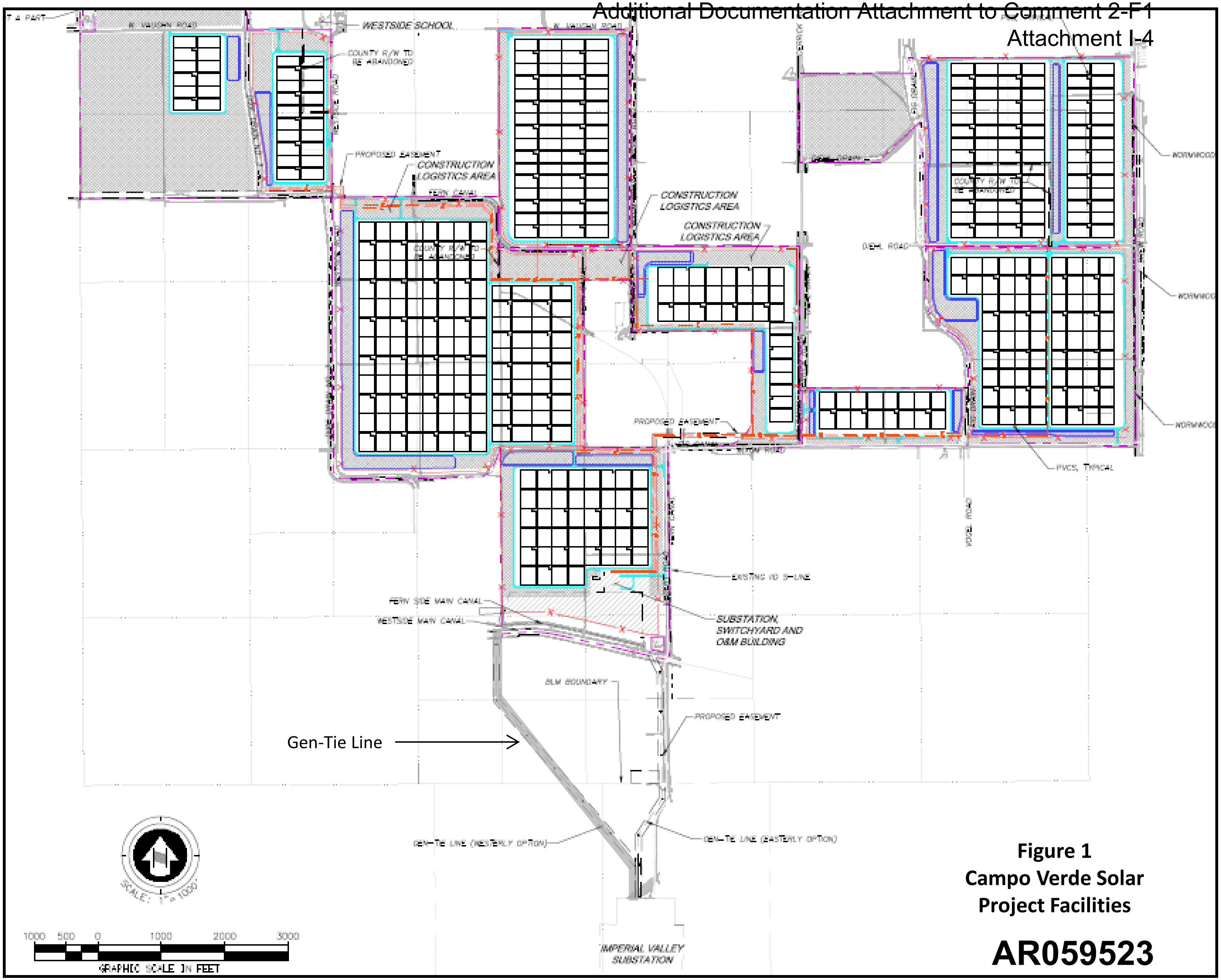


Figure 1
Campo Verde Solar
Project Facilities

2 Methods

Monitoring of the project was performed in order to document and report avian mortalities and identify areas of concern by tracking both the specific locations where mortalities occur as well as the extent of such mortalities. The monitoring program for the project is based on the FWS guidance entitled "Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach" (FWS 2012) with modifications, and was approved by FWS.

2.1 Transect Sampling

Sampling transects were established for both the gen-tie line and solar field. For each kilometer of Gen-Tie Line, 300-meter transects were randomly established along the Gen-Tie Line allowing for approximately 30-percent of the Gen-Tie Line to be sampled. Transects were positioned along the centerline of the Gen-Tie Line. For the Campo Verde Solar Energy Facility, transects were also positioned to result in approximately 30-percent coverage of the site with no less than eight transects placed within the solar field itself. Transect selection was systematic randomized. The entire perimeter of the panel arrays was also surveyed during each survey period in addition to the interior transects.

Transects were surveyed for 7 consecutive days each month and each transect was surveyed once daily. Because of the large number of transects, sampling periods were 14-days; the first half of transects were walked for 7-day period and the second half for another 7-day period. One qualified observer walked along the pre-determined transects searching for bird/bat carcasses. When a carcass was observed, a GPS location was recorded at the carcass, the species was identified, the perpendicular distance from the transect to the carcass was measured, and information regarding carcass condition, per FWS (2012), was recorded using paper datasheets. Once data were collected at a carcass, the observer returned to the pre-determined transect and continued with the survey.

The original protocol stated that each carcass would be marked uniquely and inconspicuously with tape and permanent marker to assess "recapture" rates. The federal special purpose utility permit (SPUT) was received in September of 2014 while the state scientific collection permit (SCP) enabling surveyors to handle carcasses was issued in November of 2014. The scavenger removal trials and searcher efficiency trials commenced during the Q1 2015 monitoring period.

2.2 Analysis

Program DISTANCE was used to determine the most effective transect width to search for carcasses. Distance models examined a variety of detection functions and used Aikake's Information Criterion (AIC)[1] for model selection. DISTANCE modeling was run using both a 5% upper truncation to remove outliers and without any truncation. Specific model components are discussed in **Section 3.2**.

Two annual project mortality estimates were calculated: one that incorporated statistical corrections for searcher bias and scavenger removal and one that did not. The mortality estimate that did not include detection probability corrections is presented to facilitate comparisons to past avian mortality reports for the Campo Verde Solar Project, which did not include detection probability estimates.

Uncorrected project mortality estimates rely on measuring a daily mortality rate that can be used as the basis for all mortality estimates. To calculate the corrected project mortality estimate, we did not count all mortalities observed during day 1 of the 7-day search period under the assumption that those mortalities represent "bleed through" from the period prior to 24 hours preceding the first search. To accurately generate a rate, all mortalities used for this analysis need to have occurred within the 24 hours preceding discovery. Mortalities observed during the subsequent 6 days were then up-corrected to adjust for time

---

[1] AIC measures the relative quality of a given model by assessing both the model's complexity as well as the model goodness-of-fit to the observed data. Lower AIC values indicate higher quality models. Typically AIC values are compared among several possible models to select the "best" model or models.

not searched (since the search period captured 6 out of 28, 30 or 31 days each month), producing a time-corrected mortality estimate for each month.

Scavenger removal trials were conducted in May and June of 2015. During each trial, 10 carcasses were placed along a set of transects in randomly selected locations. Carcasses were checked daily for seven days with the status of each carcass recorded during each check. Results from these trials were used to calculate daily persistence probability using an exponential model which assumes constant persistence probabilities over time (Klien and Moerschberber 2003; Korner-Nievergelt et al. 2011).

Searcher efficiency trials began in May of 2015 and were conducted on all observers each month. Carcasses were placed along a randomly selected transect without the knowledge of the observer being tested. Between five and ten carcasses were used during each trial. A searcher efficiency rate was calculated for each trial by determining the proportion of available carcasses that were successfully detected by the observer. Carcasses that were scavenged prior to the transect being walked were eliminated from analysis. The average searcher efficiency rate was calculated by calculating the mean of all trials and 95% upper and lower confidence intervals were also calculated.

Overall detection probability was calculated by combining the results of the searcher efficiency trials and the scavenger removal trials using the methods described by Korner-Nievergelt et al. (2011). This method allows for the calculation of a single detection probability for the project and assumes constancy for this value over time. This detection probability is then used to calculate a posterior distribution estimate of the number of fatalities. We used the median of this distribution as the corrected mortality estimate representing the estimated true number of carcasses available within the search area during days 2-7 of the surveys. This estimate was reported as well as the upper and lower 95% confidence interval for these estimates. We also used the time and area correction methods described above to generate a full-project annual mortality estimate that accounts for searcher efficiency and scavenger removal.

Because taxonomic analyses do not use a rate, but are instead only concerned with the overall breakdown in mortalities, these analyses used all recorded mortality data, including those mortalities observed during day 1 of the 7-day search period. The use of these data from day one assumes that there is not persistence bias for different taxa of birds.

3 Results

3.1 Overall Mortalities Observed

A total of 126 avian mortalities were recorded during the second year of surveys. Twenty-three (23) of these observed mortalities were recorded as "feather spots". **Table 1** provides a breakdown of mortalities by sampling period.

The inclusion of feather spots as observed mortalities is based on standard mortality monitoring protocols, which were largely developed for the wind energy industry. At wind energy facilities, the speed of the spinning blades can result in mortalities that leave very little detectible carcass behind, including only feather spots. Inclusion of feather spots as recorded mortalities at these facilities was intended to conservatively include mortalities caused by blade strikes that might otherwise go unrecorded. Potential bias resulting from the inclusion of feather spots in mortality data can arise from feather spots meeting the definition of a mortality but not actually resulting from an avian mortality. This bias can lead to overestimates of mortality rates and is problematic in situations where feathers are commonly deposited in non-mortality related events but get included as incidents of avian morality (e.g. in and around common roost or perch sites, near active nests, etc.). Feather spots may also be caused by predation or attempted-predation events within a survey area. Based on the large proportion of feather spots observed during early surveys at this site, observers used greater discretion when encountering feather spots to help mitigate this bias. Feather spots that strongly indicated a deposition of feathers that was unrelated to an avian mortality or injury were excluded from the database; in instances where observers were uncertain, the feathers spots were recorded as mortalities in order to be conservative. All of the following analyses present results that both include and exclude feather spots to present the full range of possible mortalities.

Table 1 – Observed Mortalities by Sampling Period

Mort. Type	**Q4 2014**			**Q1 2015**			**Q2 2015**			**Q3 2015**			***Total***
	Oct. 2014	**Nov. 2014**	**Dec. 2014**	**Jan. 2015**	**Feb. 2015**	**Mar. 2015**	**Apr. 2015**	**May 2015**	**Jun. 2015**	**Jul. 2015**	**Aug. 2015**	**Sep. 2015**	
Feather Spot Mort.	1	2	4	7	2	1	2	0	0	1	1	2	*23*
Non-Feather Spot Mort.	15	5	6	4	7	3	8	5	4	7	14	30	*108*
Total Mort.	16	7	10	11	9	4	10	5	4	8	15	32	*131*

A single Mexican free-tailed bat (*Tadarida brasiliensis*) carcass was found on July 10 underneath a solar panel. Due to differences in detection probabilities and collision risk between mammals and birds, this mortality is not included in mortality rate calculations or taxonomic compositions analyses. However, this mortality is included in the DISTANCE analysis, since effective transect width should account for observer detection of mammals despite the apparent infrequency with which they are found onsite (this mortality represents only the second bat detected during the 2 years of surveys).

3.2 Effective Transect Width

DISTANCE analyses were performed using the data pooled across the twelve-month sampling period. Analyses were run that both included and excluded feather spots as were analyses that both truncated the upper 5% of the data and left the data untruncated. **Tables 2-5** present the results of the DISTANCE analyses run. It is important to note that none of the models fit the data well. Multiple errors occurred due to parameters being constrained to obtain monotonicity and some parameters exhibiting high correlation. Overall sample sizes were very small relative to the area sampled during the first year of surveys, which is likely the primary factor limiting the reliability of the DISTANCE analysis.

Table 2 – Distance Analysis Results with no truncation– includes feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard – Cosine*	3	808.91	0.00	0.001	0.000-0.001	8.56
Half-Normal – Polynomial*	2	873.57	64.66	0.00	0.00-0.00	13.21
Half-Normal – Hermite*[,]**	2	878.14	69.23	0.00	0.00-0.00	13.96
Uniform – Polynomial*[,]**	2	953.65	144.74	0.00	0.00-0.00	22.97
Uniform – Cosine*[,]**	2	999.54	190.63	0.00	0.00-0.00	30.23

*Some parameters were constrained to obtain monotonicity.
**Some parameters are very highly correlated

Table 3 – Distance Analysis Results with 5% upper truncation – includes feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Uniform – Cosine*	3	694.59	0.00	0.001	0.000-0.001	8.77
Half-Normal – Polynomial*	3	695.27	0.68	0.001	0.000-0.001	9.14
Hazard – Cosine*	2	697.96	3.37	0.001	0.000-0.001	7.93
Half-Normal – Hermite**	3	532.73	8.00	0.001	0.001-0.001	10.40
Uniform – Polynomial***	--	--	--	--	--	--

*Some parameters were constrained to obtain monotonicity.
**Some parameters are very highly correlated
***Negative (invalid) variance estimate, model could not run.

Table 4 – Distance Analysis Results with no truncation – excludes feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Hazard-Cosine*	3	674.71	0.00	0.00	0.000-0.001	8.62
Half-Normal – Polynomial*	3	711.05	36.34	0.00	0.000-0.001	10.98
Uniform – Polynomial*	1	824.92	150.21	0.00	0.00-0.00	27.51
Uniform – Cosine*	1	960.41	285.70	0.00	0.00-0.00	76.63
Half-Normal – Hermit**,***	--	--	--	--	--	--

*Some parameters were constrained to obtain monotonicity.
**Model convergence failure.
***Negative (invalid) variance estimate, model could not run.

Table 5 – Distance Analysis Results with 5% upper truncation – excludes feather spots

Model Definition	# of Parameters	AIC	ΔAIC	Density (mortalities per hectare)	95% CI	Effective Transect Width (m)
Uniform – Cosine*	3	576.47	0.00	0.00	0.000-0.001	8.72
Half-Normal – Polynomial*	3	577.07	0.60	0.00	0.000-0.001	9.06
Hazard – Cosine*	2	578.34	1.87	0.001	0.000-0.001	7.92
Half-Normal – Hermite**	1	581.48	5.01	0.00	0.000-0.001	9.87
Uniform – Polynomial*,***	1	326.15	10.81	0.00	0.000-0.001	14.71

*Some parameters were constrained to obtain monotonicity.
**Some parameters are very highly correlated
***Could not evaluate area under the "cumulative distribution function".

The a priori estimate of effective transect width was approximately 7.5 meters (this represents the width of two panel rows measured from the bottom of the panel immediately north of the designated transects to the bottom of the second panel to the south of the transect). Generally, the most likely models were consistent with or exceeded that assumption. Sample sizes were relatively small for all models run this year and model results should be used with a high degree of caution (e.g. note that modeled density was rounded to 0.00 or 0.001 for all model definitions as a results of low sample sizes and unreliable model results).

3.3 Project Mortality Estimate

3.3.1 No Detection Probability Correction

Results from surveys conducted each month were used to generate discrete mortality estimates for each month surveyed that did not include any correction for detection probability. Monthly and overall project mortality estimates only used data from search days 2-7 (see **Section 2.2**). Monthly mortality estimates were used in order to detect seasonal variations in mortality rates. Also, data are presented to reflect estimates with and without feather spots, as discussed earlier. For the remainder of this section, mortality values are presented as "number of mortalities excluding feather spots"/"number of mortalities inclusive of feather spots".

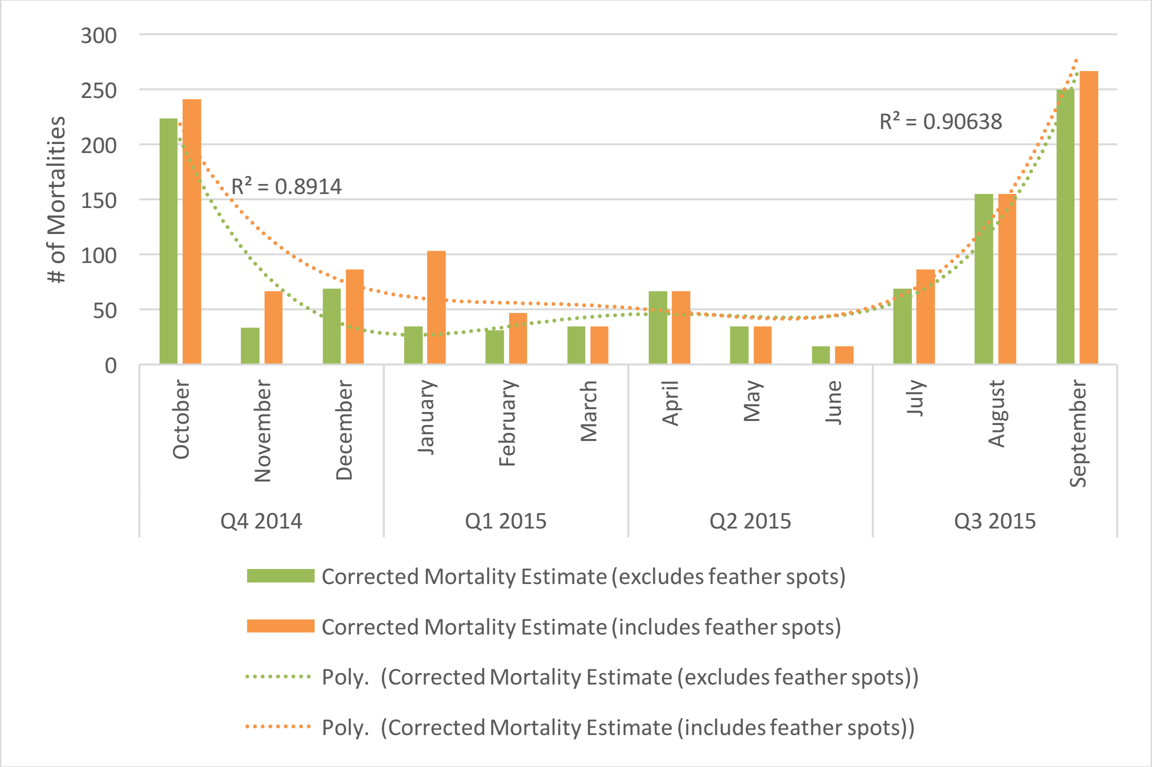
While results of the DISTANCE analyses were less than conclusive, they were at least consistent with the a priori assumption of a minimum 7.5-meter effective transect width. Transect layout, in consideration of this assumed effective transect width, was designed to sample 30% of the overall PV array area. The time-corrected mortality estimates for each month were again up-corrected to account for the area not surveyed. Mortality estimates were rounded to the nearest whole number. **Table 6** summarizes the corrected mortality estimates by month. **Figure 2** shows the trend of mortality estimates over the course of the year's surveys.

Table 6 – Uncorrected project mortality by month

	Q4 2014			Q1 2015			Q2 2015			Q3 2015			Annual Totals
	Oct. 2014	Nov. 2014	Dec. 2014	Jan. 2015	Feb. 2015	Mar. 2015	Apr. 2015	May 2015	Jun. 2015	Jul. 2015	Aug. 2015	Sep. 2015	
Raw Mortality Count (days 2-7)	13/14	2/4	4/5	2/6	2/3	2/2	4/4	2/2	1/1	4/5	9/9	15/16	60/70
Corrected Mortality Estimate	224/241	33/67	69/86	34/103	31/47	34/34	67/67	34/34	17/17	69/86	155/155	250/267	1,018/1,204

*Values reported as "excluding feather spots"/"including feather spots"

Figure 2 – Corrected mortality estimate trend.



*Trendlines are 4th order polynomial regressions.

3.3.2 With Detection Probability Correction

Overall searcher efficiency, beginning in May 2015, was calculated at over 93%. Average carcass persistence time in scavenger removal trials was 5.7 days. The overall detection probability for the project was calculated as approximately 0.73.

Table 7 presents the detection probability corrected results for each survey period along with upper and lower 95% confidence interval values. **Table 8** presents the time and area corrected monthly estimates. **Figure 3** shows the trend of corrected mortality estimates over the course of the year's surveys. The overall project mortality from October 2014 to September 2015 was 2,447/3,073 avian mortalities.

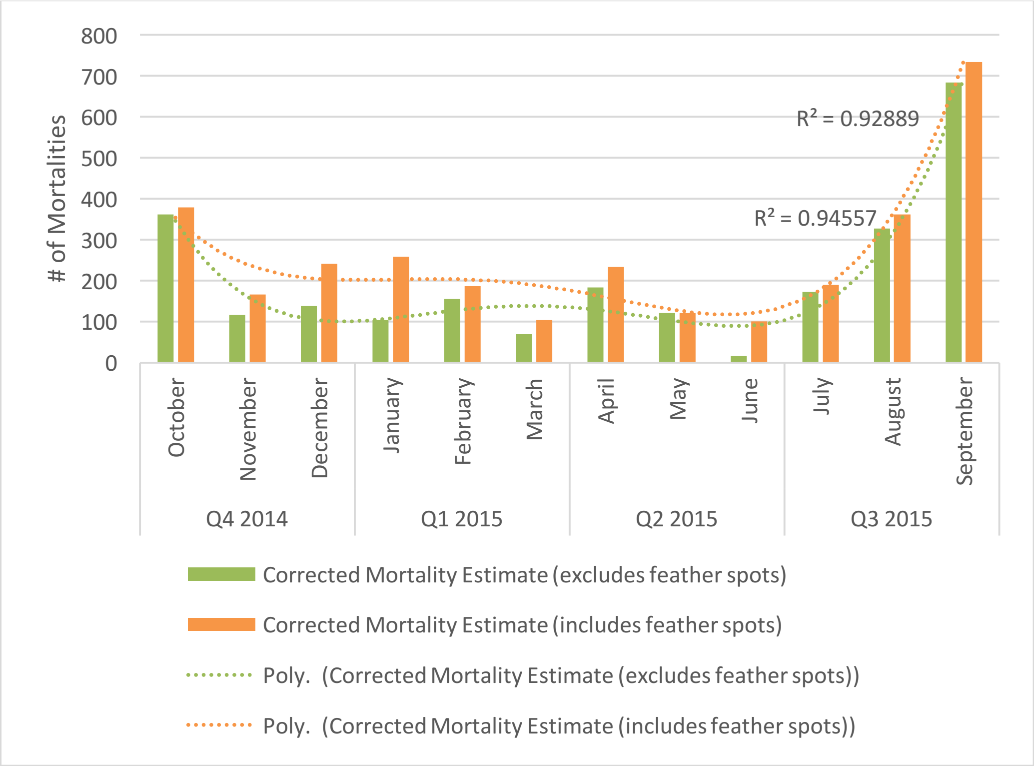
Table 7 – Detection probability corrected results for each survey period

	Excluding Feather Spots		Including Feather Spots	
	Mortality Estimate	**95% Confidence Interval**	**Mortality Estimate**	**95% Confidence Interval**
Oct. 2014	21	16-27	22	18-29
Nov. 2014	7	5-11	10	7-15
Dec. 2014	8	6-13	14	10-20
Jan. 2015	6	4-10	15	12-21
Feb. 2015	10	7-15	12	9-18
Mar. 2015	4	3-8	6	4-10
Apr. 2015	11	8-16	14	10-20
May 2015	7	5-11	7	5-10
Jun. 2015	6	4-10	6	4-10
Jul. 2015	10	7-15	11	8-16
Aug. 2015	19	15-26	21	16-27
Sep. 2015	41	35-50	44	37-53

Table 8 – Detection probability corrected project mortality by month

	Q4 2014			Q1 2015			Q2 2015			Q3 2015			Annual Totals
	Oct. 2014	**Nov. 2014**	**Dec. 2014**	**Jan. 2015**	**Feb. 2015**	**Mar. 2015**	**Apr. 2015**	**May 2015**	**Jun. 2015**	**Jul. 2015**	**Aug. 2015**	**Sep. 2015**	
Excluding Feather Spots	362	117	138	103	156	69	183	121	17	172	327	683	**2,447**
Including Feather Spots	379	167	241	258	187	103	233	121	100	189	362	733	**3,073**

Figure 3 – Corrected mortality estimate trend.



*Trendlines are 4th order polynomial regressions.

3.4 Taxonomic Composition of Observed Mortalities

The following analyses use all observed mortalities including those detected on search day 1 since the taxonomic composition is not a rate-dependent analysis (see **Section 2.2**).

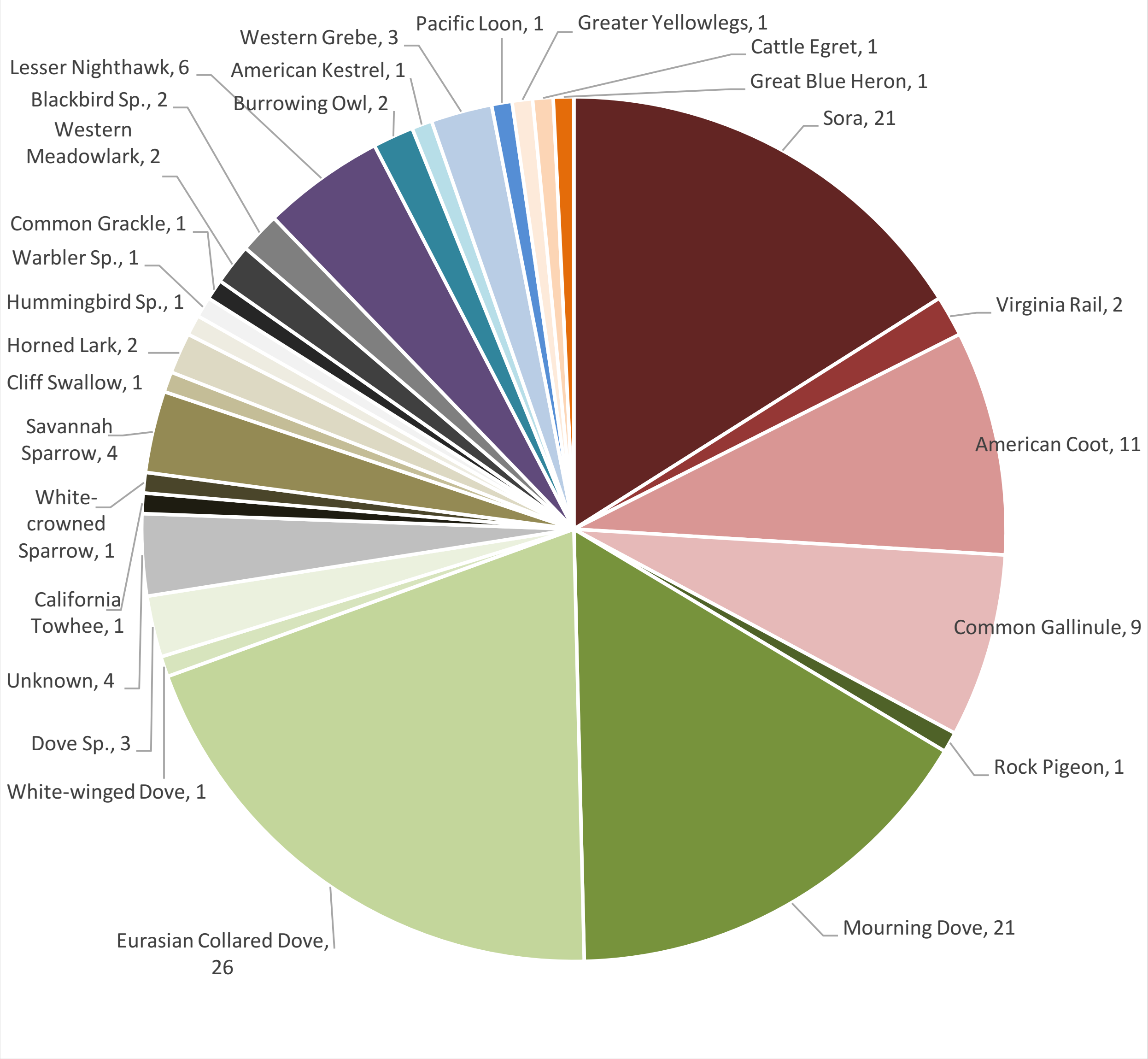
Table 9 – Raw Mortalities by Month (includes data from all search days)

	Q4 2014		Q1 2015		Q2 2015		Q3 2015		Annual Totals	
	Exc. Feather Spots	**Inc. Feather Spots**	**Exc. Feather Spots**	**Inc. Feather Spots**	**Exc. Feather Spots**	**Inc. Feather Spots**	**Exc. Feather Spots**	**Inc. Feather Spots**	**Exc. Feather Spots**	**Inc. Feather Spots**
Raw Mortality Count (days 1-7)	26	33	14	24	17	19	51	55	102	125

3.4.1 Mortalities Including Feather Spots

A total of 131 mortalities were observed during the first year of surveys when feather spots were included in the data set. Eleven (1) of these mortalities (8%) could not be identified to species. Of the 120 carcasses that could be identified to species, the most commonly observed species were Eurasian Collared Dove (*Streptopelia decaocto*; 26 mortalities; 22% of mortalities identified to species level), Mourning Dove (*Zenaida macroura*; 21 mortalities; 18% of mortalities identified to species level), and Sora; (*Porzana carolina*; 21 mortalities; 18% of mortalities identified to species level). **Figure 4** presents the breakdown of observed mortalities by species.

Figure 4 – Annual Mortalities by Species (includes feather spots)



One-hundred and twenty-seven (127; 97%) of the 131 observed mortalities could be identified to the family level. Of these 127 mortalities, the families Columbidae (52 mortalities; 41% of mortalities identified to family level) and Rallidae (43 mortalities; 34% of mortalities identified to family level) were the most commonly observed mortalities. **Figure 5** presents the breakdown of observed mortalities by family. **Figure 6** shows the proportion of mortalities that each family represents broken down by quarter.

Figure 5 – Annual Mortalities by Family (includes feather spots)

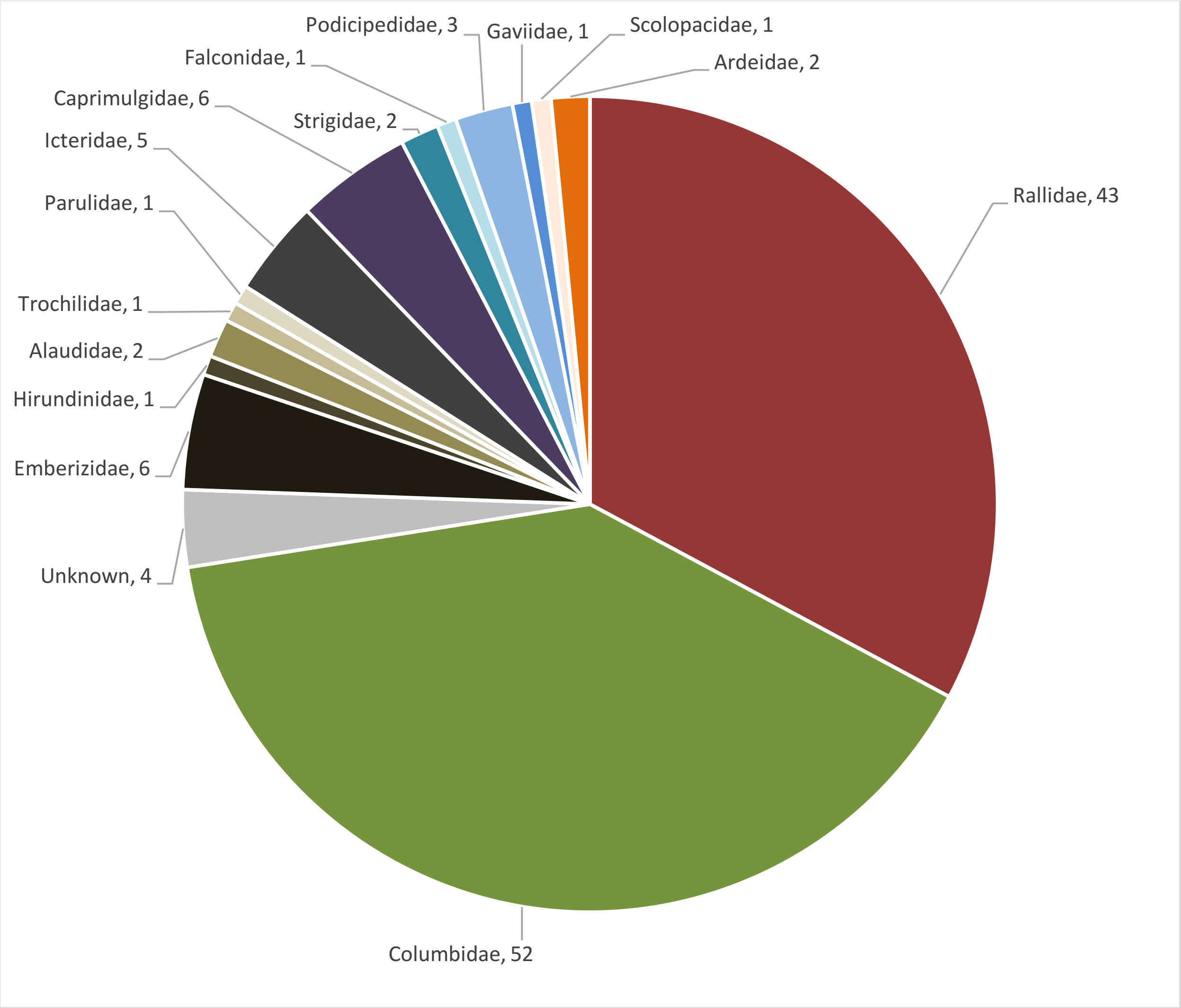
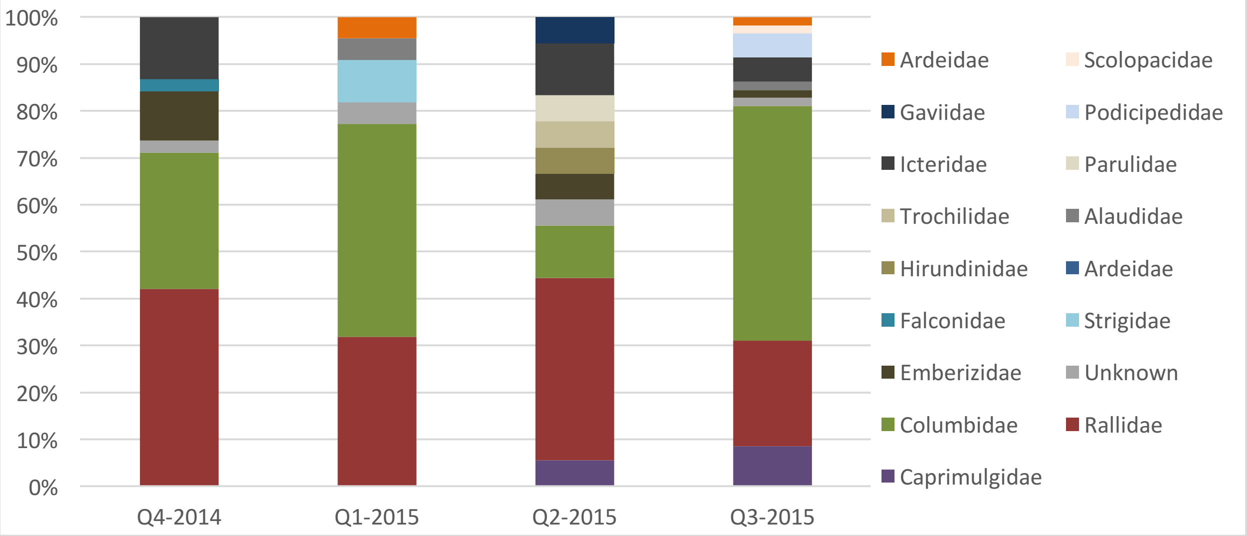


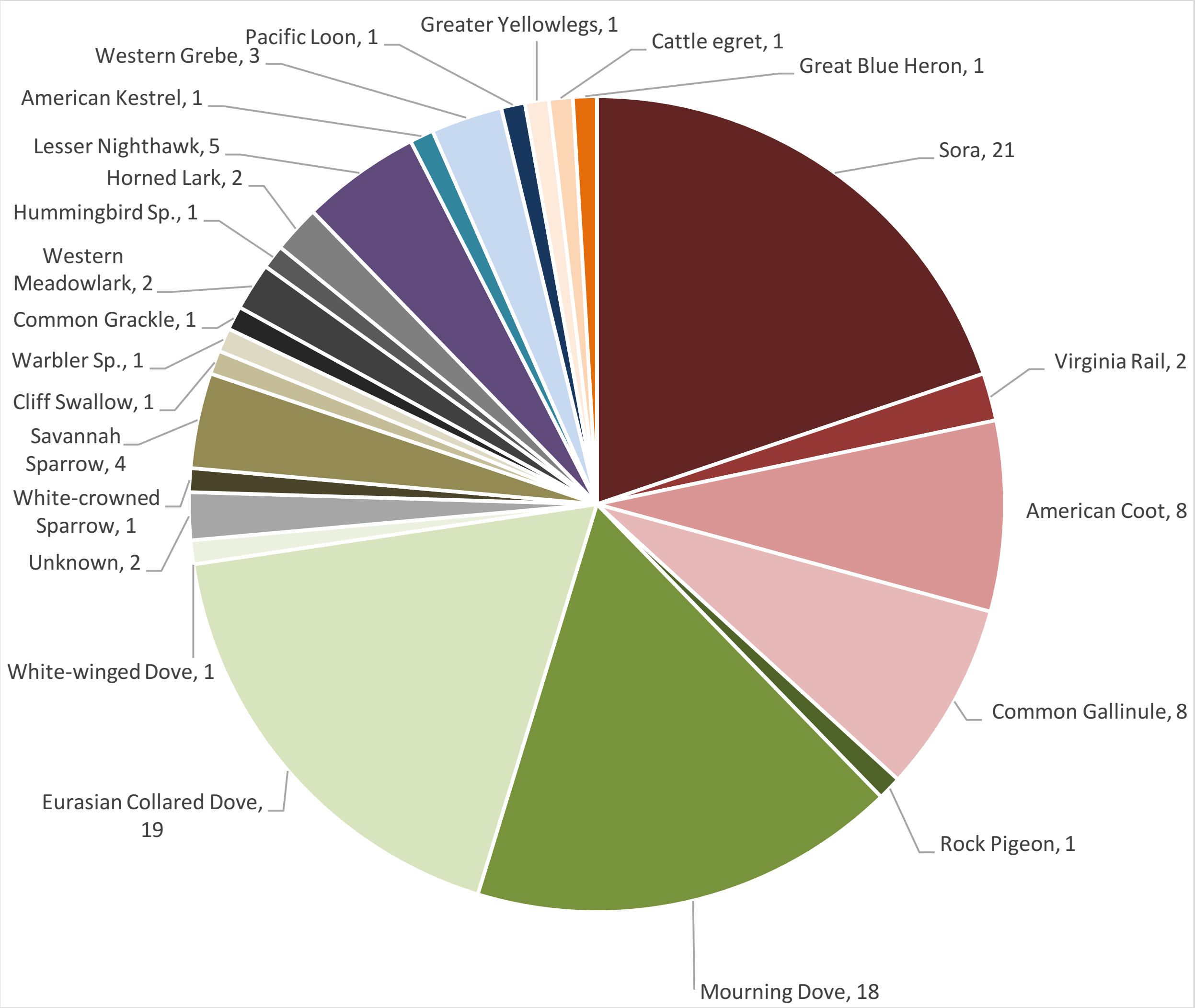
Figure 6 – Proportion of mortalities by family each quarter (includes feather spots)



3.4.2 Mortalities Excluding Feather Spots

A total of 108 mortalities were observed when feather spots were excluded from the data set. One-hundred and three (103) of these mortalities (95%) could be identified to species. Of these 103 carcasses, the most commonly observed species were Sora (21 mortalities; 20% of mortalities identified to species), Eurasion Collard Dove (19 mortalities; 18% of mortalities identified to species), and Mourning Dove (18 mortalities; 17% of mortalities identified to species). **Figure 7** presents the breakdown of observed mortalities by species.

Figure 7 – Annual Mortalities by Species (excludes feather spots)



One-hundred and six (106) of the 108 observed mortalities (98%) could be identified to the family level. Of these 106 mortalities, the families Columbidae (40 mortalities; 38% of mortalities identified to family level) and Rallidae (39 mortalities; 37% of mortalities identified to family level) were the most commonly observed. **Figure 8** presents the breakdown of observed mortalities by family. **Figure 9** shows the proportion of mortalities that each family represents broken down by quarter.

Figure 8 – Annual Mortalities by Family (excludes feather spots)

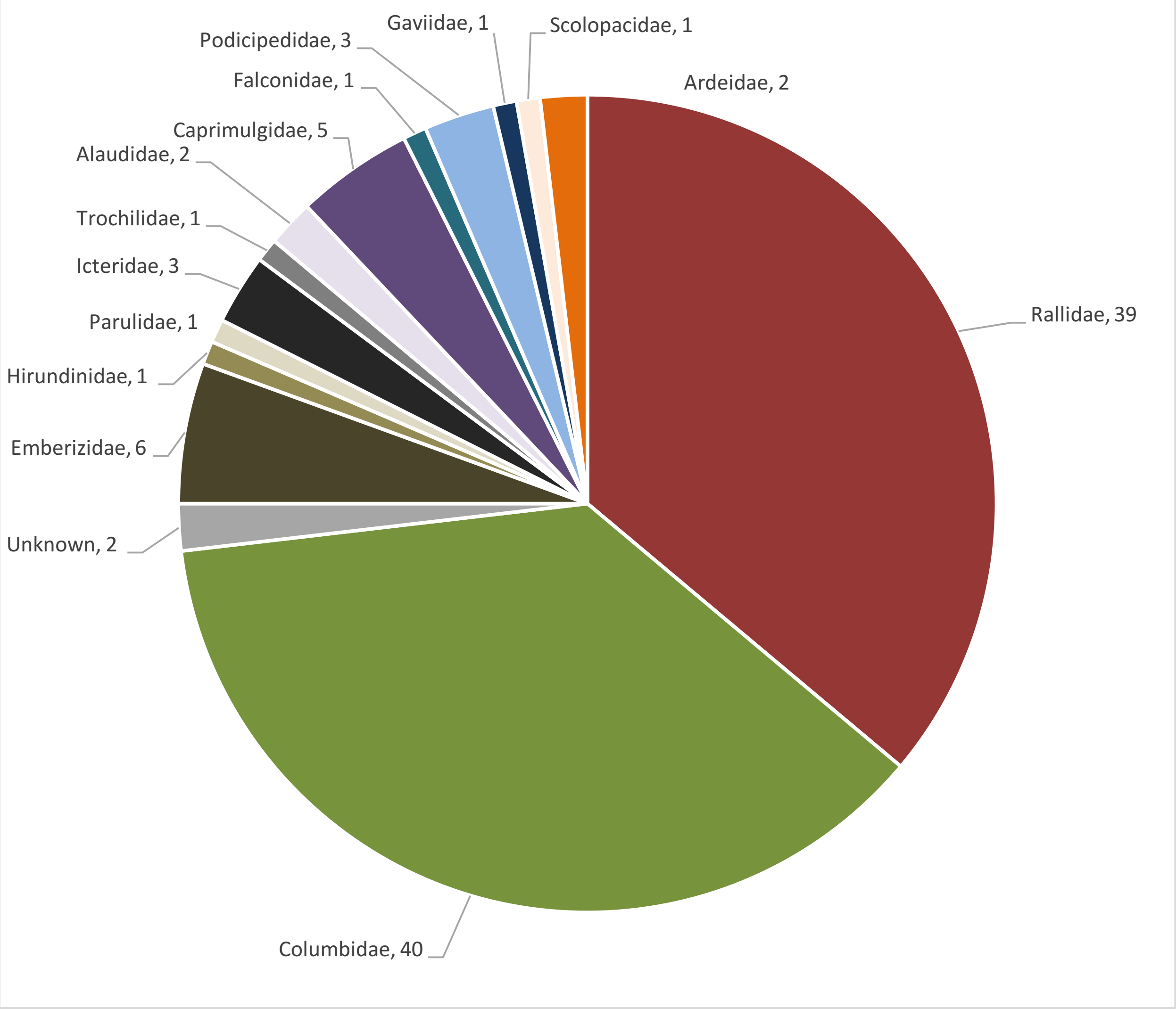
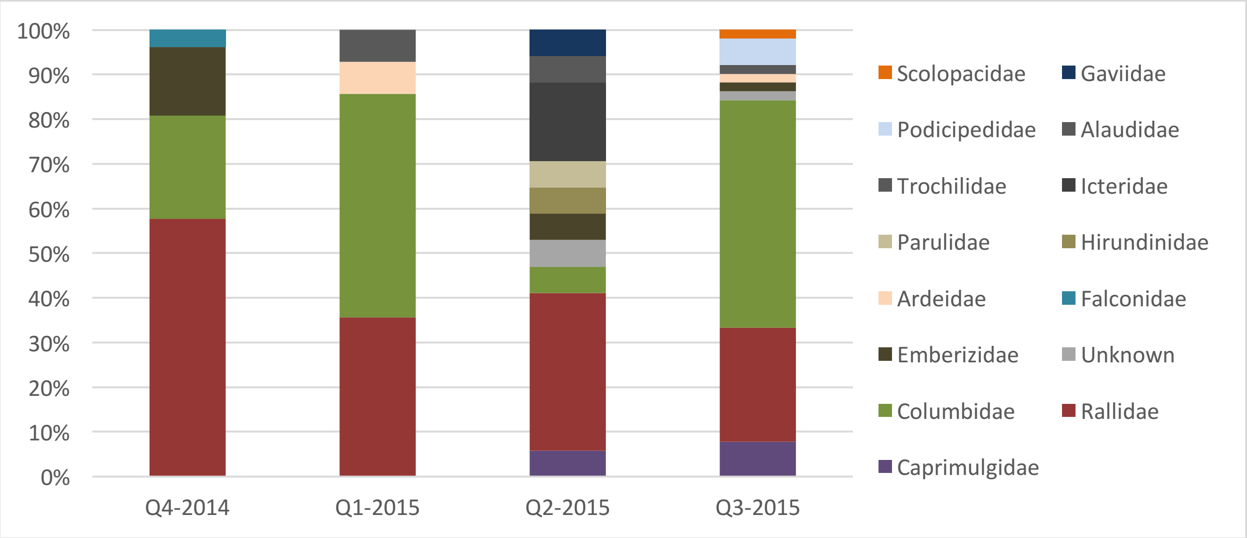


Figure 9 - Proportion of mortalities by family each quarter (excludes feather spots)



4 Discussion

4.1 Mortality Estimates

Because permit issuance allowing for detection probability estimation was delayed, this is the first report for the Campo Verde Solar Project that has incorporated the results of searcher efficiency trials and scavenger removal trials. These data were used to correct the overall estimated project mortality using the Korner-Nievergelt et al. (2011) method. This correction resulted in an overall project mortality estimate that was significantly higher than the uncorrected estimate (for estimates that both include and exclude feather spots), and they are likely a more accurate representation of actual mortality rates. Given the magnitude of this correction, previous results that were uncorrected should be used with caution.

Mortality estimates for this project are both inclusive and exclusive of feather spots. As is discussed above, estimates that include feather spots should be used with caution since most feather spot mortalities are unlikely to be attributable to the project. Similarly, the cause of death of the vast majority of mortalities was unknown. Thus, not all mortalities observed during surveys are definitively attributable to the project. For example, family Columbidae mortalities are much higher during the hunting season when dove hunting is regularly observed immediately adjacent to several portions of the project. The proportion of mortalities observed in this study that are directly or indirectly attributable to project infrastructure or activities is unknown.

The sample sizes associated with both searcher efficiency trials and scavenger removal trials were relatively small. Furthermore, the Korner-Nievergelt et al. (2011) method assumes constant detection probability over time. While this assumption is reasonable, it remains untested, as such these results should also be used with caution.

4.2 Seasonal Variations

Seasonal Patterns of seasonal variation were similar to those observed during the first year of surveys. There was strong variation month to month and a strong trend over the course of the entire second year. Both the datasets (including and excluding feather spots) showed a strong peak in corrected mortality rates during the fall months with September and October showing the greatest number of mortalities (September: 362/379 mortalities representing 15%/12% of all estimated mortalities; October: 683/733 mortalities representing 28%/24% of all estimated mortalities). Interestingly, no clear patterns in seasonal variations in taxonomic composition were apparent from the data (see **Figures 9 and 12**). The factors influencing this apparent seasonal peak are unclear but could include avian abundance fluctuations in the vicinity of the project, variations in avian behavior during the fall months (e.g. migration, foraging patterns), or an influx of juvenile birds in the project vicinity.

5 Literature Cited

APLIC (Avian Power Line Interaction Committee). 2006. Suggested practices for avian protection on power lines: The state of the art in 2006. Washington, D.C. and Sacramento, CA: Edison Electric Institute, Avian Power Line Interaction Committee, and California Energy Commission.

California Energy Commission (CEC). 2002. *A Roadmap for PIER Research on Avian Collisions with Power Lines in California*. California Energy Commission Staff Report. December, 2002.

Drewitt, A. L., and R. H. W. Langston. 2006. Assessing the impacts of wind farms on birds. *Ibis.* 148:29-42.

FWS. 2012. Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach. December, 2012. 23pp.

Heritage Environmental Consultants, LLC (Heritage). 2012. Campo Verde Solar Energy Project Avian Survey Report. May 2012. 11 pp.

Heritage. 2013. Campo Verde Solar Project Bird and Bat Conservation Strategy. February, 2013. 185pp.

Hovarth, G., M. Blahò, A. Egri, G. Kriska, I. Seres, and B. Robertson. 2010. Reducing the maladaptive attractiveness of solar panels to polarotactic insects. *Conservation Biol.* 24(6): 1644-1653.

Ironwood Consulting, Inc. 2014. 2013 Annual Report for Biological Resources Monitoring, First Solar Desert Sunlight Project, Riverside County, BLM Case File Number CACA-48629, Biological Opinion# FWS-ERIV-08B0789-11F0041, 1 January – 31 December 2013. 188pp.

Janss, G. F. E. 2000. Avian mortality from power lines: A morphologic approach of a species-specific mortality. *Biological Conservation* 95: 353-359.

Klien, J. P., and M. L. Moeschberber. 2003. Survival Analysis, Techniques for Censored and Truncated Data. Springer, New York.

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B Hellriegel. 2011. A new method to determine bird and bat fatality at wind energy turbines from carcass searches. Wildl. Biol. 17: 350-363.

Manville II, A. M. 2005. Bird strikes and electrocution at power lines, communication towers, and wind turbines: State of the art and state of the science – next steps toward mitigation. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Martin, G.R. and J.M. Shaw. 2010. Bird collisions with power lines: Failing to see the way ahead? *Biological Conservation* 143: 2695–2702.

McCrary, M. D., R. L. McKernan, R. W. Schreiber, W. D. Wagner, and T. C. Sciarrota. 1986. Avian mortality at a solar energy power plant. *J. Field Ornithol.* 57(2): 135-141.

Rusz, P. J., H. H. Prince, R. D. Rusz, and G. A. Dawson. 1986. Bird collisions with transmission lines near power plant cooling pond. *Wildlife Society Bulletin*. 14: 441-444.

Savereno, A. J., L .A. Savereno, R. Boettcher, and S. M. Haig. 1996. Avian behavior and mortality at power lines in coastal South Carolina. *Wildlife Society Bulletin*. 24: 636-648.

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 1/23/13 TIME: 1345 OBSERVER: S. Blanco

PROXIMAL TO PROJECT COMPONENT: Move-On Area

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 619863 North: 3624154

BEARING (degrees) to PROJECT COMPONENT: 90°

DISTANCE (meters) to PROJECT COMPONENT: 455

CARCASS DESCRIPTION

SPECIES: Red Tailed Hawk

SEX (*circle*): M F [✓ U] AGE (*circle*): A [✓ J] U Tag/Band Number: n/a

CONDITION (*circle*): intact scavenged dismembered feather spot [✓ injured]

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): >1 1 2 3 4 5 6 7 7+ [✓ unknown]

CAUSE OF ~~DEATH:~~ Injury.

Unknown - hawk was located near a public roadway + overhead powerlines.

OBSERVABLE INJURIES:

left wing appears broken, near distal end. Poor/limited flight. Low energy.

SUBSTRATE/GROUND COVER (*at carcass location*): n/a

DISPOSITION OF CARCASS[1] (*circle*): left in place removed collected for trials collected for other: brought to vetrinarian/rehab

SHIPPED TO:

[name of institution] Sky Hunters

[physical address] PO Box 1275 Lakeside, CA 92040

[phone/email] 619-445-6565

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 80°

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): clear mostly clear partly cloudy mostly cloudy [✓ cloudy]

WIND DIRECTION: N SPEED (mph, *circle*): [✓ 0-10] 10-20 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

none

PHOTOGRAPHS[2]:

Close Up: Photo 1 _______ Photo 2 ________

Landscape: Photo 3 _______ Photo 4 ________

PHOTO NOTES:

none → capture and transport were time sensitive due to the bird's injury - no time was taken for photographs.

NOTIFICATION[3]:

DATE: 1/23/13 TIME: 1400

NAME: Jim Thiede AGENCY/ASSOCIATION: USFWS

NOTES:

S. Yanco notified J. Thiede, USFWS of injured RTHA – Jim recommended Sky Hunters as appropriate rescue center and gave authorization for capture + transport of the individual. The hawk was brought to emergency vet facility associated with Sky Hunters per request of Nancy Conney, Sky Hunters.

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

CAMPO VERDE SOLAR ENERGY PROJECT

MORTALITY REPORTING FORM

DATE: 4/15/13 TIME: 1335 OBSERVER: CONOR BLANCHET

PROXIMAL TO PROJECT COMPONENT: 3A (Western edge)

CARCASS POSITION

GPS COORDINATES (UTM NAD83) 11S East: 0619661 North: 3624368

BEARING (degrees) to PROJECT COMPONENT: 90°

DISTANCE (meters) to PROJECT COMPONENT: 5 m

CARCASS DESCRIPTION

SPECIES: Common Nighthawk Chordeiles minor

SEX (*circle*): M F [✓ U] AGE (*circle*): A J [✓ U] Tag/Band Number: ___________

CONDITION (*circle*): intact scavenged dismembered feather spot [✓ injured]

ESTIMATED TIME SINCE DEATH/INJURY (no. of days): [✓ >1] 1 2 3 4 5 6 7 7+

CAUSE OF DEATH:

—

OBSERVABLE INJURIES:

BROKEN RIGHT WING

SUBSTRATE/GROUND COVER (*at carcass location*): Agricultural berm

DISPOSITION OF CARCASS[1] (*circle*): [✓ left in place] removed collected for trials collected for other: ___________

SHIPPED TO:

[name of institution] —

[physical address] —

[phone/email] —

WEATHER CONDITIONS

AIR TEMPERATURE (degrees Fahrenheit): 85°

PRECIPITATON (last 24 hours, *circle*): [✓ none] light rain rain heavy rain hail snow

CLOUD COVER (*circle*): [✓ clear] mostly clear partly cloudy mostly cloudy cloudy

WIND DIRECTION: EAST SPEED (mph, *circle*): 0-10 [✓ 10-20] 20-30 30+ gusty

NOTES (describe noteworthy weather conditions since last search, including high wind, fog, precipitation, and storm events):

Injured Common nighthawk found on western edge of 3A. HIGH WINDS.

PHOTOGRAPHS[2]:

Close Up: Photo 1 103-0151 Photo 2 103-0152

Landscape: Photo 3 103-0153 Photo 4 103-0154

PHOTO NOTES:

taken with black camera

NOTIFICATION[3]:

DATE: 4/15/13 TIME: 1350

NAME: Jim Theed AGENCY/ASSOCIATION: CDFG

NOTES:

PG left message with CDFG's Jim theed.

---

[1] Permit required to handle bird carcasses.

[2] At least four photographs should be taken. Two should be close-in shots of the carcass and should be taken from at least two different angles. Two should be shots taken farther away showing the landscape (project components, surrounding habitat, etc.) and should be taken from at least two different angles).

[3] Indicate who was notified of the event, date, time, etc.

 	103-0151 Black Camera
 	103-01512 Black Camera

	103-0153 Black Camera
	103-0154 Black Camera

Additional Documentation Attachment to Comment 2-F1
Attachment I-5

Genesis Red-tailed Hawk

German, Charles <Charles.German@aecom.com> Wed, Feb 27, 2013 at 10:49 AM
To: Magdalena Rodriguez <Magdalena.Rodriguez@wildlife.ca.gov>, David Elms <DElms@dfg.ca.gov>, "mmassar@blm.gov" <mmassar@blm.gov>, "Tera_Baird@fws.gov" <Tera_Baird@fws.gov>, "AGolden@energy.state.ca.us" <AGolden@energy.state.ca.us>, "DElms@wildlife.ca.gov" <DElms@wildlife.ca.gov>
Cc: "Guigliano, Jennifer" <Jennifer.Guigliano@aecom.com>, "Jennifer.Gavaldon@fpl.com" <Jennifer.Gavaldon@fpl.com>, "Ireland, Mike" <Mike.Ireland@aecom.com>, "Dayman, Shelly" <Shelly.Dayman@aecom.com>, "Chuck.griffin@us.bureauveritas.com" <Chuck.griffin@us.bureauveritas.com>, "German, Charles" <Charles.German@aecom.com>, "rhaverland@blattnerenergy.com" <rhaverland@blattnerenergy.com>, William Watson <william.watson3@fpl.com>

An injured Red-tailed Hawk was found about 6 miles east of the plant site ne of the Wiley's Well Rest Area during linear monitoring of a construction bore (11 N 0695179 3721231.) The bird was located beneath existing powerlines and may have been injured as a result of a powerline strike. The freeway is also close to where the bird was found.

CDFW was contacted and a reference was made to a Licensed Blythe Rehabilitation Location. Permission/Instruction was given to collect the hawk. The hawk was delivered for rehabilitation at approximately 1800. The contact person whom the bird was delivered to is Ms. Almquist, (760) 552-3239.

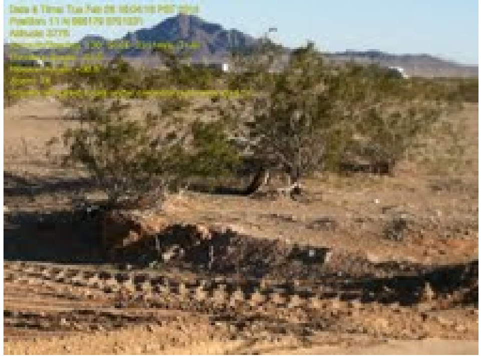
Thank you,

Eric German

Designated Biologist

Genesis Solar Energy Project

(805) 895-9842



20130226Redtail.JPG
1022K

Avian and Wildlife Reporting Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Observation Made During (circle one):
Evaporation Pond Monitoring / Scheduled Mortality Survey / [✓ Incidental]

Date: APRIL 30, 2013 Observer: ERIC GERMAN

Type of Incident (circle one): Injury / [✓ Fatality] / Nest

Condition (circle one): [✓ Intact Carcass] / Dismembered Carcass / Feathers Only

Age of Remains (days) (circle one):
[✓ 1-5] (fluid filled eyes) / 6-30 (maggots) / 30+ (bones)

Photo No. ATTACHED

Carcass Condition Details, Behavior of Injured Animal or Nest Details:
CARCASS ENTANGLED IN EVAPORATION POND NETTING - CARCASS APPEARS TO HAVE BEEN IN PLACE LONGER THAN ONE DAY LESS THAN A WEEK

LOCATION

DATUM: NAD 83

UTM N: 3727414 UTM E: 685660

Found Near (circle one):
Solar Trough / [✓ Evaporation Pond] / Road / Power Line / Other (explain below)

Location Details: GENESIS SOLAR PROJECT - NORTHERN EVAP POND NETTING - MIDDLE OF WESTERN HALF OF NORTHERN POND

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)

Species (if unknown, write 'unknown'): PIED-BILLED GREBE

Color/Markings:

Sex (circle one): Male / Female / [✓ Unknown]

Age (circle one): [✓ Adult] / Juvenile / Unknown

Is Animal Tagged? (circle one): Yes / [✓ No]

Identification Remarks:

ENVIRONMENTAL CONDITION

Weather (circle one): [✓ Clear] / Fog / Cloudy / Rain

Approx. Temperature (circle one) [✓ °F] / °C: 100

Wind (circle one): [✓ Calm] / Gusty / Storm / Violent Storm

~10 mph WINDS

Habitat (circle all that apply):
Bare Ground / Creosote Bush Scrub / Sand Dunes /
Sand Drifts over Playa / Ephemeral Wash / Desert Pavement PLANT SITE EVAP POND

NOTIFICATION

Who was Notified, and When? ____________________

Actions Taken (e.g., left in place, taken to rehab): LEFT IN PLACE

COMMENTS: THE MORTALITY WAS DISCOVERED DUE TO TWO GREAT-TAILED GRACKLES BEING OBSERVED WITHIN THE ENCLOSURE - THE GRACKLES WERE FLUSHED WITHOUT FURTHER INCIDENT

* Turn in completed form and incident photos to the on-site Environmental Manager.

* Report any incidental observations of dead birds or other wildlife at the evaporation ponds to the Designated Biologist within one day of the detection of the carcass.

* Report any nests immediately to the on-site Environmental Manager.

Date & Time: Wed May 1 06:59:42 PDT 2013
Position: 11 N 685660 3727414
Altitude: 405ft
Azimuth/Bearing: 014° N14E 0249mils (True)
Elevation Angle: +08.5°
Horizon Angle: -00.5°
Zoom: 1X
bird mortality in evap pond netting.

Avian and Wildlife Reporting Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Observation Made During (circle one):
Evaporation Pond Monitoring / Scheduled Mortality Survey / [✓ Incidental]
Date: 5-1-2013 Observer: Andrew Fisher
Type of Incident (circle one): Injury / Fatality / Nest / [✓ Live bird]
Condition (circle one): Intact Carcass / Dismembered Carcass / Feathers Only / [✓ Alive]
Age of Remains (days) (circle one):
1-5 (fluid filled eyes) / 6-30 (maggots) / 30+ (bones) / [✓ NA]
Photo No. NA
Carcass Condition Details, Behavior of Injured Animal or Nest Details:
Live bird found resting on ground.

LOCATION

DATUM: 11 S
UTM N: 3726261 UTM E: 0686787
Found Near (circle one):
[✓ Solar Trough] / Evaporation Pond / Road / Power Line / Other (explain below)
Location Details: Bird found Live between 2 Solar Trough rows (2 WF/E6 and 2WF/E5) in Unit 2.

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)
Species (if unknown, write 'unknown'): Eared Grebe
Color/Markings: Breeding Plumage
Sex (circle one): Male / Female / [✓ Unknown]
Age (circle one): [✓ Adult] / Juvenile / Unknown
Is Animal Tagged? (circle one): Yes / [✓ No]
Identification Remarks: NONE

ENVIRONMENTAL CONDITION

Weather (circle one): [✓ Clear] / Fog / Cloudy / Rain
Approx. Temperature (circle one) [✓ °F] / °C: 80°F
Wind (circle one): [✓ Calm] / Gusty / Storm / Violent Storm

Habitat (circle all that apply):
[✓ Bare Ground] / Creosote Bush Scrub / Sand Dunes /
Sand Drifts over Playa / Ephemeral Wash / Desert Pavement

NOTIFICATION

Who was Notified, and When? DB - Erin German was immediately notified

Actions Taken (e.g., left in place, taken to rehab): Live bird was taken to Lissa the rehab Lady.

COMMENTS: No apparent injuries to bird. No apparent broken bones and bird was active and responsive

* Turn in completed form and incident photos to the on-site Environmental Manager.

* Report any incidental observations of dead birds or other wildlife at the evaporation ponds to the Designated Biologist within one day of the detection of the carcass.

* Report any nests immediately to the on-site Environmental Manager.

INFORMATIONAL

Construction Wildlife Incident Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Date: 1/15/14 Observer: Eric German

Type of Incident (circle one): ~~Injury / Fatality / Nest~~ OBSERVED

Cause of Death: N/A

Condition (circle one): ~~Intact Carcass / Dismembered Carcass / Feathers Only~~

Photo No. PHOTO OF BURROW

~~Carcass Condition Details, Behavior of Injured Animal, or Nest Details:~~

WBO APPEARED HEALTHY AND RETURNED TO BURROW SITE

LOCATION

DATUM: NAD 83

UTM E: 686871 UTM N: 3727362

Location Details (microhabitat, etc.):

CREOSOTE SCRUB
140 METERS NORTH OF EAST WEST LINEAR OF TEMPORARY DESERT TORTOISE EXCLUSION FENCE

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)

Species (if unknown, write 'unknown'): WESTERN BURROWING OWL

Sex (circle one): Male / Female / [✓ Unknown]

Age (circle one): Adult / Juvenile / [✓ Unknown]

Is Animal Tagged? (circle one): Yes / No - NOT SEEN

Identification Remarks:

ENVIRONMENTAL CONDITIONS

Weather (circle one): [✓ Clear] / Fog / Cloudy / Rain

Approx. Temperature (circle one) [✓ °F] / °C: 65°

Wind (circle one): [✓ Calm] / Gusty / Storm / Violent Storm

Habitat (circle all that apply):

Bare Ground / [✓ Creosote Bush Scrub] / Sand Dune or Sand Sheet /

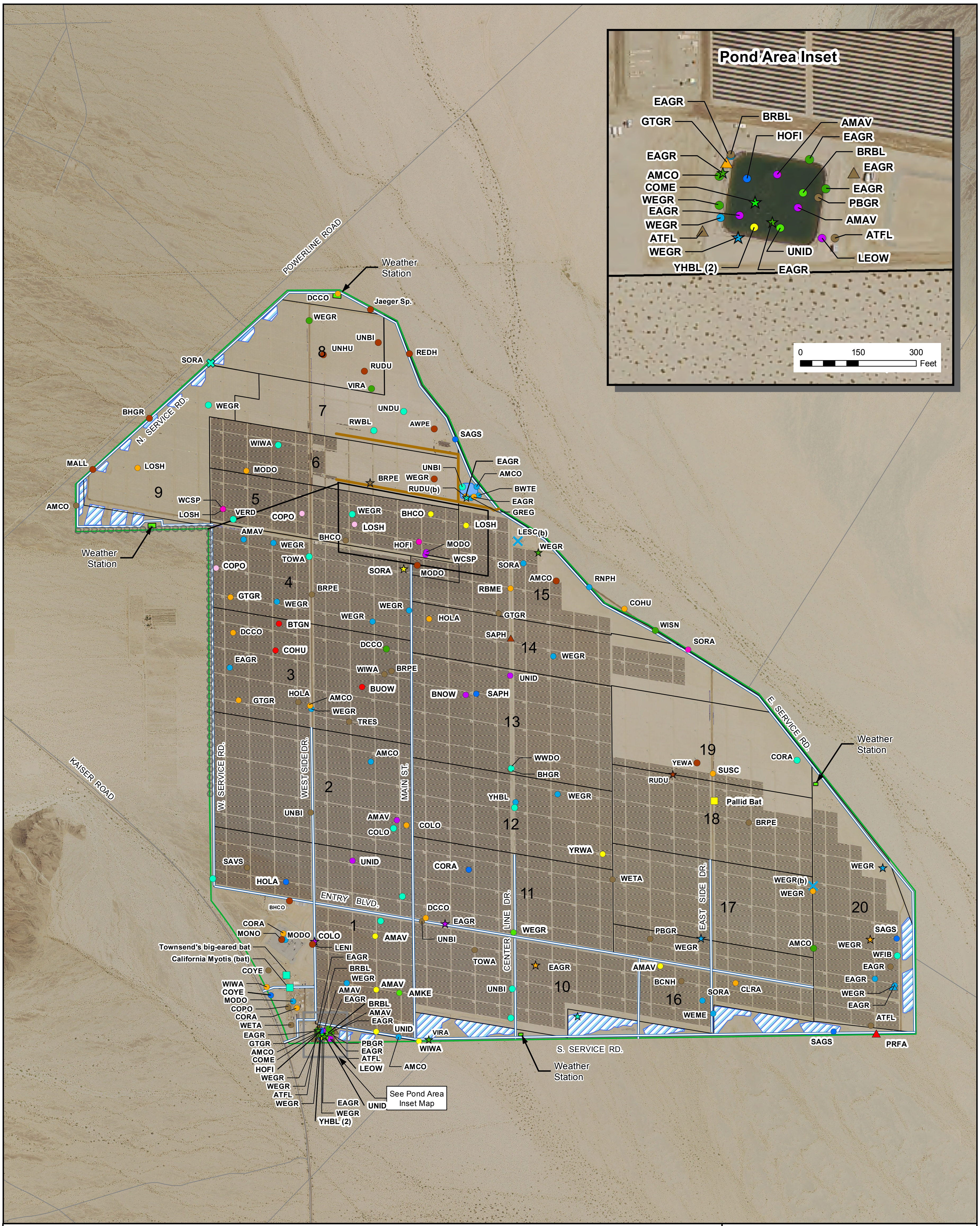
Playa / Ephemeral Wash / Desert Pavement

NOTIFICATION

Actions Taken (e.g., left in place, taken to rehab): LEFT IN PLACE

Date & Time: Wed Jan 15 16:00:20 PST 2014
Position: 11 N 686865 3727364
Altitude: 398ft
Azimuth/Bearing: 199° S19W 3538mils (True)
Elevation Angle: -36.5°
Horizon Angle: -41.3°
Zoom: 1X
WBO Burrow.

D:\GIS\Projects\DesertSunlight\GIS\Desert_Sunlight_GDB\MXD\Avian_Bat_Mortality_20141103.mxd | 11/3/2014



Avian and Bat Mortality and Injury

2011
● Avian Mortality (8)

Q1 2012
● Avian Mortality (3)
▲ Injured prairie falcon

Q2 2012
● Avian Mortality (4)
★ Common merganser, uninjured/relocated to Lake Tamarisk

Q3 2012
● Avian Mortality (10)
■ Bat Mortality
★ Sora, uninjured/relocated to Lake Tamarisk

Q4 2012
● Avian Mortality (10)
★ Common loon, uninjured/relocated to Lake Tamarisk
Eared grebe, uninjured/relocated to Lake Tamarisk

Q1 2013
● Avian Mortality (3)

Q2 2013
● Avian Mortality (20)
★ Eared grebe, uninjured/ relocated to Lake Tamarisk
Western grebe, uninjured/ relocated to Lake Tamarisk
▲ Injured Great tailed Grackle

Q3 2013
● Avian mortality (25)
▲ Injured Eared grebe, injured Ash-throated flycatcher
★ Brown Pelican uninjured relocated to Lake Tamarisk

Q4 2013
● Avian Mortality (26)
▲ Western grebe, injured/ taken to rehab facility (1)
★ Wester grebe, uninjured/ relocated to Lake Tamarisk (3)
✕ Western grebe$_{(a)}$, Lesser Scaup$_{(b)}$ uninjured/flew away (2)

Q1 2014
● Avian Mortality (4)

Q2 2014
● Avian Mortality (18)
■ Bat Mortality (2)
★ Eared grebe(a), Ruddy Duck(b) uninjured/relocated to lake Tamarisk
✖ Sora, uninjured/flew away

Q3 2014
● Avian Mortality (15)
★ Ruddy Duck(a) uninjured/relocated to lake Tamarisk
▲ Say's Phoebe(a) injured/flew away

Q4 2014
● Avian Mortality (9)
★ VIRA (a), WEGR (b), EAGR (c,d) Uninjured/relocated to lake Tamarisk
═ Main Solar Farm Road
— Temporary Tortoise Fence
○○○○ Vegetation Screen
—
☐ Construction Blocks
▨ Retention Basin
■ Retention Pond

DESERT SUNLIGHT
SOLAR PROJECT
DESERT SUNLIGHT HOLDINGS, LLC

Figure 1

Solar Farm Avian and Bat Mortality through 11/03/2014

N
0 1,000 2,000
Feet

Bird and Bat Conservation Strategy
Desert Sunlight Solar Farm Project -
Riverside County, California

Prepared for:

Desert Sunlight 250, LLC and
Desert Sunlight 300, LLC
700 Universe Blvd., Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.

415 West 17th Street, Suite 200
Cheyenne, Wyoming 82001

February 26, 2015 (Final)

LIST OF ACRONYMS

BBCM	Bird and Bat Conservation Measure
BBCS	Bird and Bat Conservation Strategy
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
CDFW	California Department of Fish and Wildlife
CVSR	California Valley Solar Ranch
EIS	Environmental Impact Statement
Gen-tie	Generation Tie-Line
MBTA	Migratory Bird Treaty Act
MW	Megawatt
NEPA	National Environmental Policy Act
O&M	Operations and Maintenance
PV	Photovoltaic
ROD	Record of Decision
USFWS	United States Fish and Wildlife Service
FEIS	Final Environmental Impact Statement
APLIC	Avian and Power Line Interaction Committee
Project	Desert Sunlight Solar Farm Project
Ha	Hectare
ESA	Endangered Species Act
HEA	Habitat Equivalency Analysis
M	Meter
Ft	Foot
Km	Kilometer
SE	standard error
kV	Kilovolt

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Appendix A: Incidental Bird and Bat mortalities and injuries previously reported during construction of Desert Sunlight Solar Farm Project as of October 31, 2014 (First Solar 2014).

Appendix B: Summary of Statistical Simulations for Experimental Design from CVSR

Appendix C: Desert Sunlight Wildlife Incident Reporting System (WIRS)

1.0 INTRODUCTION

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC (collectively, Desert Sunlight), has constructed and will operate the Desert Sunlight Solar Farm Project (Project), which consists of two main components: 1) a 550-megawatt (MW) photovoltaic (PV) generating facility; and 2) a 220-kilovolt (kV) generation interconnection (Gen-tie) line. The Project comprises approximately 1,700 hectares (ha; 4,200 acres) of land administered by the Bureau of Land Management (BLM) six miles north of Desert Center in Riverside County, California (Figure 1).

Information on pre-construction site conditions, avian and bat species present at the Project, risk assessment, and conservation measures implemented during pre-construction and construction phases are found in the Project's "Avian and Bat Protection Plan, Desert Sunlight Solar Farm Project, BLM Case File Number CACA-48649, Riverside County, California" (Ironwood Consulting 2011). The Avian and Bat Protection Plan (ABPP) was included as part of Appendix H in the Desert Sunlight Solar Farm Project, California Desert Conservation Area Plan Amendment and Final Environmental Impact Statement (USDI BLM 2011) and the Project received a Record of Decision from the Secretary of the Department of the Interior on August 09, 2011. Avian and Bat Protection Plans have since been renamed, and are presently known as Bird and Bat Conservation Strategies (BBCS). This BBCS replaces the ABPP and was developed in coordination with BLM to provide a written record of the Project's post-construction efforts to monitor potential project impacts to birds and bats and to document conservation measures that have been or will be taken to avoid, minimize, and/or mitigate for potential impacts. After introductory material on project description, the BBCS purpose, and regulatory framework, this BBCS addresses post-construction monitoring and adaptive management.

Figure 1. Location of the Desert Sunlight Solar Farm Project, Riverside County, California.

1.1 Purpose

The primary purpose of this BBCS is to describe post-construction monitoring protocols that will identify the extent of mortality and injury to bird and bat species and guide the adaptive management process intended to avoid, minimize, and/or mitigate impacts consistent with the Project's approval documentation. This BBCS includes the following objectives:

- Identify operational activities that may increase potential adverse effects to avian and bat species on and adjacent to Project components;
- Describe measures that were taken before and during construction to minimize and document mortality;
- Provide details for an avian fatality monitoring plan to be conducted post-construction, including applicable approved protocols that would be used for any surveys and/or monitoring;
- Specify the adaptive management process that will be used to address potential adverse effects on these species.

1.2 Regulatory Setting

Several federal and state laws and regulations, including National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Migratory Bird Treaty Act (MBTA), the Bald and Golden Eagle Protection Act (BGEPA), and California Endangered Species Act, provide the foundation for the development of this BBCS.

1.2.1 National Environmental Policy Act

Under NEPA (42 United States Code [USC] §§ 4321-4370h), federal agencies are required to prepare an environmental impact statement (EIS) for any major federal action significantly affecting the quality of the human environment. An EIS must include an examination of the environmental impacts of a proposed project, a reasonable range of alternatives for a project, and other related matters. The environmental impacts of the Project have been addressed in the Final EIS and ROD (BLM 2011a,b). This BBCS implements Mitigation Measure (MM) WIL-5 in the Project's ROD.

1.2.2 Endangered Species Act

Certain species at risk of extinction, including many birds and bats, are protected under the federal ESA. The ESA defines and lists species as "endangered" and "threatened" and provides regulatory protection for the listed species. The ESA provides a program for conservation and recovery of threatened and endangered species. Section 7(a)(2) of the ESA directs all federal agencies to insure that any action they authorize, fund, or carry-out does not jeopardize the continued existence of an endangered or threatened species or destroy or adversely modify designated or proposed critical habitat (collectively, referred to as protected resources).

1.2.3 Migratory Bird Treaty Act

The MBTA (16 USC §§ 703, *et seq.*), makes it unlawful to “pursue, hunt, take, capture or kill; attempt to take capture or kill; possess; offer to or sell, barter, purchase, or deliver; or cause to be shipped, exported, imported, transported, or received any native migratory bird, part, nest, egg, or product.” The MBTA, enforced by USFWS, protects all MBTA-listed migratory birds within the United States. In the continental U.S., native non-covered species generally belong to the Order Galliformes. Common non-native species not protected by the MBTA include rock pigeon (*Columba livia*), Eurasian collared-doves (*Streptopelia decaocto*), European starling (*Sturnus vulgaris*), and house sparrow (*Passer domesticus*; USFWS 2005). Although permits may be obtained to collect MBTA-listed birds for scientific purposes or to destroy depredating migratory birds, the MBTA does not provide any permit mechanism authorizing the incidental take of migratory birds in connection with otherwise lawful activities. Nevertheless, federal agencies such as the BLM have been directed to evaluate the effects of its actions on migratory birds, with an emphasis on species of concern (per Executive Order 13186).

1.2.4 Bald and Golden Eagle Protection Act

The BGEPA (16 USC §§ 668-668d) prohibits the take, defined as “pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb,” of any bald eagle (*Haliaeetus leucocephalus*) or golden eagle (*Aquila chrysaetos*). Through recent regulation (50 Code of Federal Regulations [CFR] § 22.26; USFWS 2009), the USFWS can authorize take of bald and golden eagles when the take is associated with, but not the purpose of, an otherwise lawful activity and cannot practicably be avoided. The USFWS has issued Eagle Conservation Plan Guidance (USFWS 2013a) for land-based wind energy projects to help project proponents avoid unanticipated take of bald and golden eagles and comply with the BGEPA. Although the guidelines were developed for land-based wind energy projects, certain components of eagle surveys and monitoring are applicable to other renewable energy projects, including PV solar plants, and have been incorporated into this BBCS as appropriate.

1.2.5 California Department of Fish and Game Codes

CDFG Code Sections 2050-2085 – These codes encompass the applicable declarations and definitions of the California Endangered Species Act (CESA).

CDFG Code Sections 3503 and 3503.5 – These codes state that it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird (including birds of prey) or take, possess, or destroy birds of prey, except as otherwise provided by this code or any regulation made pursuant thereto.

CDFG Code Sections 3511, 4700, 5050, and 5515 – These state laws classify and prohibit the take of “fully protected” bird, mammal, amphibian/reptile, and fish species in California.

CDFG Code Section 3513 – This code prohibits any take or possession of birds that are designated by the MBTA as migratory non-game birds except as allowed by federal rules and regulations promulgated pursuant to the MBTA.

CDFG Code Section 4150 – This code defines all mammals that naturally occur in California as non-game mammals with exceptions for those defined as game mammals, fully protected mammals, or fur-bearing mammals. Non-game mammals or parts thereof may not be taken or possessed except as otherwise provided by this code or any regulation made pursuant thereto.

1.3 Corporate Policy and Coordination

Desert Sunlight maintains a commitment to work cooperatively to minimize adverse impacts to protected bird and bat species. Through the planning and construction stages of the Project, Desert Sunlight and its contractors and consultants worked in coordination with federal and state agency personnel regarding necessary wildlife surveys, siting considerations, mitigation measures and adaptive management to ensure that potential issues that could affect bird and bat species were identified as early as possible in the planning process and addressed through appropriate design, mitigation and adaptive management measures. Desert Sunlight will continue to work with the agencies to implement conservation measures intended to avoid, minimize, and/or mitigate potential impacts to bird and bat species, including those measures identified in this BBCS.

2.0 PROJECT DESCRIPTION

The Project is a PV solar power plant being developed on approximately 1,700 ha (4,200 acres) of public land administered by the BLM in Riverside County, California, approximately 9.7 km (six miles) north of the rural community of Desert Center (Figure 1). Project construction is anticipated to be concluded on or about January 2015. The Project consists of two main components: 1) a 550 MW PV generating facility (Solar Farm) of solar equipment; and 2) a 220 kV Gen-tie Line. More specifically, the Solar Farm consists of 466 individual PV arrays, with each array occupying 2.4 to 2.8 ha (6 to 7 acres) and consisting of rows of PV panels supported on steel posts, a power conversion station, and a transformer. High-capacity 34-kV collection lines will transfer power output from the PV arrays to the onsite substation via overhead lines. The total acreage of the Project (including the Gen-tie Line) is 4,085 acres (1,653 ha). A chain-link fence topped with barbed wire encloses the entire Solar Farm, including support facilities (encompassing approximately 3,697 acres [1,496 ha]). The solar arrays cover 2,984 acres (1,208 ha).

In addition to the PV generating facility, other primary Project features include an operations and maintenance (O&M) building, visitor center, parking areas, access roads, fiber-optic lines, water wells, wastewater treatment facilities, an onsite electrical substation, and the 220 kV Gen-tie Line connecting the Project to the power grid.

Project features -- including solar panels, overhead electrical feeder and distribution lines, the Gen-tie Line, temporary retention basins, and the perimeter security fence -- pose potential mortality and injury risks to birds and bats. This BBCS focuses on permanent Project infrastructure elements including the solar panel arrays, perimeter fence and the Gen-tie Line. To minimize the threat of electrocution and collision, the Project's electrical distribution infrastructure is being built to avian-safe standards following Avian Power Line Interaction

Committee (APLIC) guidelines (APLIC 2005, 2006, 2012). Should birds or bats collide with the on-site distribution powerlines, injuries and fatalities will be documented during sampling of the solar arrays, as well as incidentally by Project staff during other activities.

3.0 SITE CHARACTERIZATION

The Project site is located in a relatively flat, previously undeveloped area of Chuckwalla Valley in eastern Riverside County. It is approximately 9.6 km (5.9 mi) north of Interstate 10 and the rural community of Desert Center, between the cities of Coachella to the west and Blythe to the east. Joshua Tree National Park wraps around the Project site to the west, north, and east; at its closest point, the Project is approximately 2.2 km (1.4 miles) southwest of the park boundary. Lake Tamarisk, a small golf-resort community, is approximately 6.4 km (four miles) to the south. The inactive Kaiser Eagle Mountain Mine is approximately 1.6 km (one mile) to the west.

The Project site is in the Colorado Desert Bioregion, which is the western extension of the Sonoran Desert of southern Arizona and northwestern Mexico. The Mojave Desert, which includes portions of Joshua Tree National Park, lies immediately north of the Project area. Chuckwalla Valley encompasses a series of alluvial fans that gently slope toward the southwest and southeast.

The 2011 FEIS prepared for the Project (BLM 2011a) describes the biological setting of the Project area. The FEIS included the results of biological surveys conducted in areas of potential impact associated with the Solar Farm, Gen-tie Line, Red Bluff Substation, and possible alternative sites (all collectively referred to as the Biological Study Area [BSA]). Before construction began on the Project, vegetation in the BSA consisted of Sonoran creosote (*Larrea tridentata*) bush scrub and desert dry wash woodland communities. To prepare for installation of the solar arrays, the Solar Farm site was disked and rolled, such that the Project landscape is now relatively flat and uniform, with vegetation re-establishing on the site. Stabilized sand sheets and pockets of sand dune deposits are located to the east of the Project area, but the Solar Farm site lacks wind-blown sand formations. Disturbed and developed areas that are either barren or dominated by ruderal vegetation occur primarily along roadsides. Agricultural areas, mostly fallow jojoba (*Simmondsia chinensis*) farms, are located southeast of the Project site.

Two temporary 0.4-ha (1-acre) ponds provided water during construction of the Project. One of the ponds was removed, and the second pond will be removed by the end of 2014. Several retention basins, which may hold water for some time after a storm event, are located within the Project’s perimeter security fence, along the western upstream boundary and on the southeastern downstream boundary. An open portion of the Colorado River Aqueduct runs around the north end of Chuckwalla Valley, from about six to 10 km (four to six miles) north of the Project site. An aquaculture facility, covering approximately 24 ha (60 acres), lies about three km (two miles) south of the Project site and contains perennially open water. The community of Lake Tamarisk includes homes, a golf course, and a small lake complex. The habitat structure and available water in this community routinely attract resident and migratory birds. All of these water features (when watered, in the case of the retention basins) can attract water-associated birds and shorebirds, either during migration stopover periods or in the course of local and intraregional movements.

4.0 CONSERVATION MEASURES IMPLEMENTED BEFORE AND DURING CONSTRUCTION

4.1 Pre-Siting Data Collection

In an effort to place the Project infrastructure in locations that would result in the least risk to populations of birds and bats, data on site characteristics and wildlife occurrence was collected and evaluated.

4.1.1 Coarse Site Assessment

In accordance with USFWS guidance, a siting evaluation of the solar farm site, Gen-tie line, and substation was completed. The Project conducted the equivalent of a Potential Impact Index (USFWS 2003) by evaluating suitability of the site proposed for development and estimating use of the site by selected wildlife species as an indicator of potential impact (USFWS 2010). Initial biological assessments conducted in 2007 recommended avoidance of Pinto Wash as potential habitat for special status species, and this assessment was supported during a site visit in 2010. Several modifications to Project design occurred that reduced the proposed Project footprint and moved it away from areas suspected to contain high-quality habitats for birds or bats. Alternative sites for the solar farm, Gen-tie line route, and substation were confirmed to occur outside any Important Bird Areas, Western Hemisphere Shorebird Reserve Network sites, and areas designated by the Convention on Wetlands of International Importance. The Gen-tie line and substation alternatives are located within the Chuckwalla Desert Wildlife Management Area and Critical Habitat Unit designated as management areas for desert tortoise.

4.1.2 Habitat Equivalency Analysis

A Habitat Equivalency Analysis (HEA) was conducted to quantify potential temporary disturbance versus permanent loss of habitat and to guide the habitat compensation process. The most significant step the Proponent took to promote wildlife conservation during this process was to coordinate with the BLM to determine suitability of habitat remaining within the solar application as area to be excluded from future development due to biological concerns.

4.1.3 Site-Specific Wildlife Surveys

As recommended by USFWS (2010), multiple survey techniques were used to collect baseline data on wildlife populations at the Project. Specific survey methods included:

- Diurnal point counts, conducted in April, May, and October 2010
- Raptor nest searches including golden eagle surveys (Pagel et al. 2010), conducted in April and May 2010

- Reconnaissance-level survey of Project components to determine which bat species could occur at the site
- Incidental data collection conducted during all biological surveys in 2010; additionally, incidental observations were collected over four years of activity at the Project

Thirty-eight passerines were recorded during baseline surveys. The only special-status species recorded were Brewer's sparrow (*Spizella breweri*), Costa's hummingbird (*Calypte costae*), and Le Conte's thrasher (*Toxostoma lecontei*). All three species are listed as USFWS Birds of Conservation Concern (BCC; USFWS 2008). Thirteen raptor species were documented, including California Species of Special Concern: burrowing owl (*Athene cunicularia*), loggerhead shrike (*Lanius ludovicianus*), and northern harrier (*Circus cyaneus*; CDFW 2008). Swainson's hawk (*Buteo swainsoni*) was also recorded, which is state-listed as threatened (CDFW 2014), along with federally-protected golden eagle (*Aquila chrysaetos;* BGEPA 1940). Surveys for bat habitat suggested that pallid bat (*Antrozous pallidus*), canyon bat (*Parastrellus hesperus*), hoary bat (*Lasiurus cinereus*), and California leaf-nosed bat (*Macrotus californicus*) could potentially occur at alternative sites given the habitat present. The list of most common species observed is found in Figure 2.

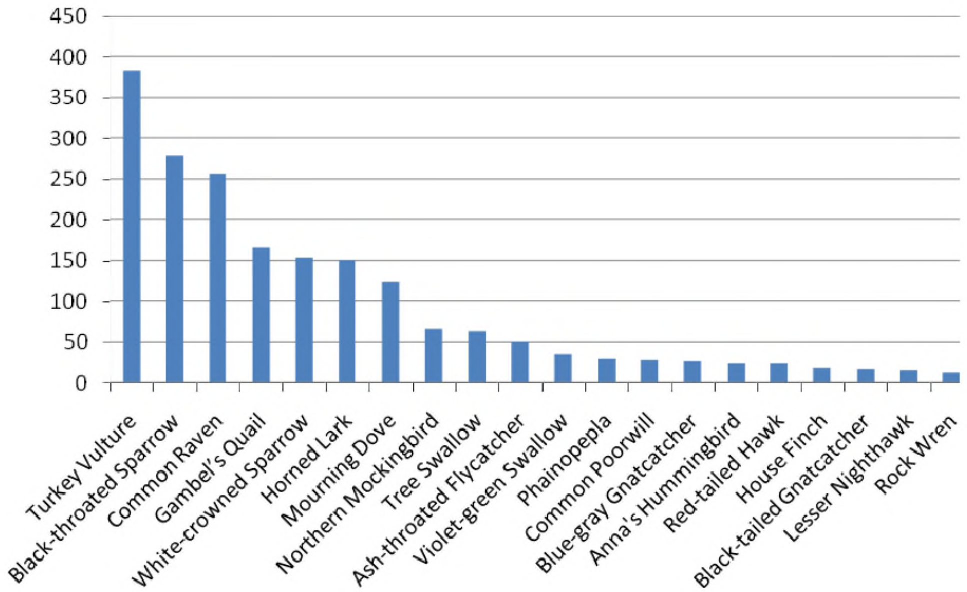


Figure 2. Avian species most frequently encountered during baseline surveys at Desert Sunlight Solar Farm Project, Riverside County, California.

5.0 CONSERVATION MEASURES

5.1 Project Siting

The process of siting the Project components included both macro- and micro-siting considerations. Macro-siting considerations occurred in 2007 during initial site surveys and were refined in 2008 after review of data. During this process, Pinto Wash and other larger areas of desert wash woodland were removed from Project consideration because they were deemed likely to support greater numbers of species or individuals than other habitats in the Right-of-Way area. Macro-siting considerations also included avoidance of:

- Locations with special status species and areas managed for the conservation of listed species
- Areas frequently used for daily bird and bat movements (e.g., areas between roosting and feeding sites)
- Breeding and wintering eagle use areas
- Known migration flyways for birds and bats
- Areas near known bat hibernacula, breeding, and maternity/nursery colonies
- Fragmentation of large, contiguous tracts of wildlife habitat

Micro-siting consideration for the Project components began in 2008 and continued as wildlife surveys were conducted and through informal meetings with the BLM, USFWS, and CDFW throughout the Project's planning process. Siting was also refined in response to concerns from the public and agencies involved in the process. Additional considerations of micro-siting included:

- Avoiding features that attract raptors (i.e., areas supporting tall perching structures including trees, utility poles, etc.)
- Avoiding features that attract migrant birds (e.g., water sources and vegetation)
- Minimizing the potential for enhancing habitats suitable for raptor prey such as rodents that would potentially attract raptors to the site.

5.2 Facility Design

Many conservation measures were incorporated into the design of Project facilities to reduce the potential effects of Project infrastructure on bird and bat populations, including:

- Avoidance of lattice-type structure or placing external ladders and platforms on towers to minimize perching and nesting
- Avoidance of meteorological towers with guy wires
- Minimal lighting and where lighting was necessary, facility lighting focused down ward to reduce sky illumination
- Power lines built in accordance with guidelines from the Avian Power Line Interaction Committee

- Minimal creation of new roads

5.3 Construction Phase Conservation Measures

Conservation measure implemented by the Project during construction included:

- Minimization of permanent disturbance area by minimizing creation of roads, avoidance of excessive clearing of vegetation, and grading whenever possible
- To the extent practicable, clearing of vegetation took place outside the bird breeding season. When not practicable, the Desert Sunlight communicated reasons to BLM, USFWS, and CDFG and provided a biological monitor to locate active nests, establish buffers, and stop construction when necessary when Project activity threatened a nest. Buffer distances of 100 m (330 ft), 152 m (500 ft), or one mile were used for active passerine, raptor, and golden eagle nests, respectively.
- Clearance surveys to locate and identify active nests or bat colonies
- Surveys for golden eagle nests conducted during each year there were construction activities within the nesting season
- Clearance surveys for burrowing owls completed in each construction unit and including a 150-m buffer area
- Mandatory site training for all construction personnel regarding avoidance of nests and bat colonies
- Following APLIC guidelines for overhead utilities
- Conducting construction activities in a manner consistent with reducing fire danger
- Trash promptly removed and disposed of to avoid creating attractions for birds or bats
- Established and implemented an Integrated Weed Management Plan (Ironwood Consulting 2010a)
- Used native species for seeding and planting during re-vegetation efforts

6.0 Incidental Avian Mortality Information during Construction and Early Operation

As of Oct 31, 2014, 198 avian and bat injuries or mortalities have been documented on-site during construction of the Project (Appendix A, First Solar 2014). Avian mortalities are being reported by construction workers and other staff incidental to their work activities. Consequently, the incidental nature of the data needs to be considered when evaluating the information reported to date. Data collected incidentally do not provide enough information to accurately quantify the scope of actual avian mortalities on a project site. However, these data can provide important information such as the composition of species which may be at risk in the future. In addition, the data provide insights into project features and types of injuries that may be associated with fatalities (U.S. Fish and Wildlife Service 2014). The majority of fatalities documented on the Project site are water-associated taxa (SPUT data). However, whether this pattern is representative of overall composition of fatalities at the Project remains to be determined through standardized monitoring.

7.0 POST-CONSTRUCTION MONITORING PLAN

This section outlines a standardized approach to document known and projected bird and bat fatalities and injuries, and to estimate seasonal and annual post-construction fatality rates associated with Project features. The Plan includes an approach to determine whether there are spatial patterns of fatality rates within the solar field (i.e., different fatality rates near panels on the edge of the solar arrays vs. the interior area of the arrays). The Plan is consistent with the Bird Monitoring and Avoidance Plan outlined in the Project's FEIS (BLM 2011a), and builds on standards and guidelines developed for the electric-utility and renewable-energy industries to quantify the risk of fatality and injury for birds and bats that may result from interactions with energy-related infrastructure (e.g., Anderson et al. 1999; APLIC 2005, 2006, 2012; California Energy Commission [CEC] and CDFG 2007; USFWS 2010, 2012). In particular, the Plan outlines a statistically sound spatial and temporal sampling plan, including protocols for independently estimating and correcting for quarterly searcher-efficiency and seasonal (i.e., at least quarterly) scavenger (avian and mammalian) removal rates. It describes specific data to be collected during scheduled carcass searches, protocols for handling any dead or injured birds and bats that are found, and procedures for reporting incidents to relevant government agencies. The study design is compatible with the BLM (2011b) Record of Decision requirement (MM-WIL-05) that, after the study is complete, Desert Sunlight will ultimately submit a description of the study design and monitoring results to peer-reviewed scientific journals.

7.1 Goals and Objectives

Primary goals of the post-construction fatality monitoring program are to:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the Gen-tie Line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
3. Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.

4. Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

These goals are structured in a way that provides information on seasonal differences in fatality rates, and information about which taxonomic groups are most vulnerable. Fatality estimates will be adjusted to address carcass persistence and searcher efficiency as they change through seasons. Additionally, carcass persistence trials will inform search intervals.

Consistent with the above goals, the specific objectives of this Plan are as follows:

2. Conduct fatality searches for a minimum of 2 years according to a spatial and temporal sampling plan that provides representative and statistically sound coverage of the solar arrays, consistent with monitoring required of other industries. The need for additional monitoring beyond the second year will depend on an evaluation of the survey results from the first 2 years to determine if the goals of the monitoring program have been met (see Section 10.0, Adaptive Management). The need to extend the monitoring period will be determined by the BLM in consultation with the USFWS. To the extent possible, standardized monitoring, as approved by the BLM in consultation with the USFWS, will commence within 30 days of 1) date a final BBCS has been approved, and 2) the commercial operation delivery (COD) date (anticipated January 2015). Implementation of any agency required pre-monitoring meetings, training and searcher efficiency/carcass removal trials may extend the start of monitoring beyond 30 days after the BBCS is deemed final.
3. Conduct statistically sound, seasonal assessments to quantify and evaluate carcass removal rates (i.e., carcass removal, destruction including dismemberment, or burial in sand due to scavengers, decay, or other abiotic [e.g., wind] or human [e.g., vehicle activity] factors) and support calculation of adjusted fatality rates that account for variation in carcass removal rates by season and carcass type/size classes. These assessments will also be used to guide search intervals.
4. Use current, scientifically validated and accepted methods for calculating fatality rates adjusted for searcher-efficiency, carcass removal rates, and spatial and temporal sampling intensity. At present, the best methods are distance sampling combined with searcher efficiency and carcass removal bias adjustments and a fatality estimator such as the Shoenfeld (2004) or Huso (2012) estimators, but it should be noted that fatality estimation is an area of active research and 'best methods' are changing rapidly. Therefore, as data are collected, adaptive management of the study design and monitoring protocol may be necessary and will follow the process in Section 10.0.
5. Summarize the species composition of fatalities according to taxonomic family, and ecological guild (e.g., raptors, water-associated birds, passerines, etc.) to aid in understanding species or groups at risk.
6. To the extent possible, summarize the composition of fatalities according to their likely propensity to collide with project components during the day vs. during the night based on known migratory patterns for the particular species.

7. Aid in identifying potential fatality causes and correlates by including additional information that is readily available beyond that which is under the SPUT such as the weight of fresh whole birds, or summaries of preceding weather conditions which would have made migration likely (e.g., low pressure systems moving cross continent to the north of the project area, followed by periods of high pressure systems).
8. Data summaries, and accompanying raw data, and any GIS shapefiles will be reported to the BLM with each seasonal report.

7.2 Monitoring Methods

A monitoring program will be implemented for at least 2 years post-construction as specified below. Survey results and analysis will inform adaptive management decisions regarding any additional appropriate and practicable BBCMs to avoid, minimize, and/or mitigate for observed impacts.

7.2.1 Post-Construction Monitoring of Solar Arrays

The fundamental characteristics of a sampling program designed to produce valid estimates of fatality rates for a solar farm (including the number of arrays to be searched, the search interval, the seasonal extent of coverage, and the number of years of sampling) are determined based on several factors. These factors include the questions of interest; the species of interest (e.g., resident, migratory, and/or wintering species) in the Project area, desired precision, best estimates of carcass-removal rates, searcher efficiency, the Project size and layout, and other relevant environmental (i.e., seasonal patterns), landscape, and habitat characteristics.

The following hierarchical terminology is useful for describing the spatial and temporal sampling design used to monitor solar arrays:

1) **Panel Cartridge:** An engineered assembly of solar panels installed as a single unit (approximately 2.5 x 2.9 meters [m; 8.2 x 9.5 feet (ft)]).
2) **Row:** A collection of panel cartridges arrayed side-by-side on a common, linear support structure (variable lengths ranging from approximately 71 to 142 m [232 to 464 ft]).
3) **Section or Subarray:** A collection of usually 20 commonly energized rows that represent one quarter of a typical array; dimensions (on the order of 71 x 84 m [232 x 274 ft]) are mostly uniform within blocks, but vary slightly among blocks; in most cases, structurally continuous rows span sections of two adjacent arrays.
4) **Array:** A collection of four sections connected to a common power converter station (PCS) and transformer, encompassing 2.4–2.8 ha (5.9-6.9 ac), depending on subsection dimensions and spacing between subsections (i.e., 466 total units in the Solar Farm).
5) **Block:** Collections of commonly energized arrays (20 blocks, each composed of 11–32 arrays).

7.2.2 Survey Strategy

Sampling strategies used in carcass searches have typically involved transect sampling, whereby searchers walk or drive along pre-defined transects and search for carcasses in a swath where width depends on visibility, target taxa, and other factors. The layout of PV facilities presents problems for a transect-sampling approach because rows of panels are close together (i.e., less than 5 m [16 ft] at the Project). Because the panels are mounted off-horizontal, a searcher walking or driving a transect between two rows can only effectively search one side of the transect (a 2.5-m [8.2-ft] swath), and the other side is obscured by the edge of a PV cartridge. However, traveling perpendicular to panel rows along the edges of the rows allows observers to see a greater distance of the ground beneath the panels. Surveyors will walk or drive the lines in air-conditioned vehicles. Should driving surveys be used, searcher efficiency trials will be conducted prior to implementation; results will be submitted and evaluated by the BLM and FWS within 2-weeks of completion of the trials to determine if conducting surveys using vehicles is acceptable. Other accommodations may be required to enable completion of surveys during high temperatures, such as shifting surveys to dawn and dusk.

The layout of PV facilities is well-suited to a distance-sampling approach. Distance sampling involves searching a transect line and assumes that searcher efficiency decreases (possibly dramatically) as a function of distance from the observer, and is ideally suited to situations in which animals (or carcasses) are sparsely distributed across a landscape (Buckland et al. 1993). The landscape at the Project is flat and relatively clear of vegetation, which should support a distance sampling design.

Distance sampling adjusts carcass counts for variable searcher efficiency by accounting for the *effective* area searched along a transect. Effective area is the total area searched multiplied by the average probability of detection in the searched area. As a highly simplified example, if a searcher walks a 10-m long transect line and detects 90% of all carcasses within 10-m of the line, and 60% of carcasses that are 10 to 20 m (33 to 66 ft) from the line, then the effective area between zero and 10 m would be $10\,m \times 10\,m \times 0.9 = 90\,m^2$ and the effective area searched between 10 and 20 m would be $10\,m \times 10\,m \times 0.6 = 60\,m^2$. For the total 10 by 20-m area searched, the adjustment factor would be $\frac{90\,m^2 + 60\,m^2}{100\,m^2 + 100\,m^2} = 0.75$. In practice, searcher efficiency is modeled as a continuous function of distance, and the detection function is estimated from the carcass data (as opposed to a bias trial). The searcher efficiency bias trials can be used to augment carcass data for the detection function. If the detection function calculated from the bias trials differs from the detection function calculated from the carcass data, this suggests non-random distribution of carcasses within the arrays, and simultaneously provides an adjustment factor to account for non-random distribution of carcasses. Preliminary data from the California Valley Solar Ranch (CVSR) suggests that non-random carcass distribution may not be a problem at PV solar facilities (H.T. Harvey and Associates 2014). One advantage to a data-driven detection function is that it is not necessary to specify a transect width: the detection function includes information about the distance at which searcher efficiency drops to zero. The detection function is used to determine the overall probability of detection as well as to inform the approximate effective view shed of non-zero detection probability for observers.

7.2.3 Spatial Sampling Design

The sampling design is intended to follow to the USFWS Land-Based Wind Energy Guidelines (2012), which states that “the carcass searching protocol should be adequate to answer applicable Tier 4 questions at an appropriate level of precision to make *general* conclusions about the project*, and is not intended to provide highly precise measurements of fatalities*” (p. 45; emphasis added). Under the proposed sampling plan, precision is expected to vary based on carcass detectability: less precision is expected for estimates of small-bird fatality compared to estimates of large-bird fatality. However, monitoring programs at two other PV solar facilities (CVSR and Topaz) suggest that the level of impact for small birds due to PV was not very extensive, and was similar in composition and rates than what was found on control plots for passerines.

The sampling design is based on a statistical precision analysis using data from CVSR, as well as a simulation-based analysis that was informed by searcher efficiency and carcass removal rates in the Mojave desert region (Appendix B). Sampling effort that includes 20% of the solar arrays is expected to produce a reasonable coefficient of variation (CV = 100% * standard deviation / mean) (~20%) if fatality rates are greater than 1.0 fatality / MW / year, and the search interval is at most 21 days. This level of precision is generally considered adequate for answering the primary questions of interest in fatality monitoring studies (Strickland et al 2011).
Based on the simulation analyses, data from CVSR, consultation with relevant permitting and wildlife agencies, and consideration of the characteristics of this particular Project, sampling will encompass approximately 30% of the completed solar arrays as summarized in Table 1.

Table 1. Solar array sampling area characteristics.

Total area	1,208 ha
Proportion sampled	30%
Sampling unit	~2.6-ha spatial equivalent of 1 array
Number of sampling units (whole facility)	466
Migration season search interval (March 1 thru May 31, September 1 thru October 31)	7 days unless adjusted by BLM in consultation with the Wildlife agencies based on results carcass persistence trials.
Non-migration season search interval (June 1 thru August 31, November 1 through Feb 28)	21 days unless adjusted by BLM in consultation with the Wildlife agencies based on results of carcass persistence trials.
Anticipated surveys per year	31
Duration of sampling	Minimum of 2 years

Because both the layout of the solar arrays and the landscape of the Solar Farm (i.e., mostly flat and free of vegetation) are largely uniform, a relatively simple random sampling design is likely to be adequate for sampling the arrays. However, in the absence of data, a spatially balanced sampling design will be used. Because spatially balanced designs ensure that sample effort is distributed over the whole study area, they help to ensure that spatially organized trends in mortality–should they exist-- can be extracted from the data. The drivers of spatial variation in avian activity may be important to the statistical sampling design if avian use patterns affect the distribution of mortalities on the project site. As an example, factors that may affect avian use patterns include: 1) habitat variation around the Project site; 2) the possibility that distinct movement corridors variably concentrate birds over certain areas of the Project site (e.g., migrating or commuting water-associated birds); or 3) use of distribution lines (and other transmission line infrastructure) as roosting sites. Distribution lines within the solar field may also pose a collision risk to birds. To achieve spatially balanced sampling, the site will be divided into 10 approximately equal-sized sampling areas and sampling will be stratified among those areas. Sampling will also be stratified proportionally among areas with distribution lines and those without.

The sampling units for the surveys consist of areas equivalent in size to a single array, but because of the concatenation of panel rows across arrays, they may include conjoined sections from multiple individual arrays (Figure 3). Within sampling areas, individual sampling units will be randomly selected to compose a 30% sample (± 1–2%).

Observers will survey sampling units from the outer edges of collections of continuous solar panel rows and scanning between each row for fatalities, with each side-specific survey covering half the width of the sampling unit (Figures 3 and 4). Surveys will occur along roadways that run approximately north–south (consistent with the “Bio Blitz” report; USFWS

2013) through the middle of most arrays and along the outer edges of some arrays. Most sampling units consist of combined array sections from four adjacent arrays. In most cases, the four sections run together both north to south and east to west, forming a continuous block composed of 40 continuous panel rows that are approximately 140 m- (460-ft) long. In these cases, two north-south routes will comprise the sampling-unit survey, with each route involving scanning across a maximum of 70 m (230 ft; Figure 3). Other sampling units have an additional roadway and powerline corridor running through the middle, such that the sampling unit consists of two subsections, each composed of 40 panel rows that are approximately 70 m long. In these cases, four north-south routes will comprise the sampling unit survey, with each route involving a maximum scanning distance of 35 m (115 ft) covering half the width of a subsection (Figure 3). For a few other sampling units with different layouts along the perimeter of the Solar Farm, the analysis will need to take into account the potentially different row lengths. Distance sampling and resulting data will be used to calculate detectability curves to calculate the average detection probabilities, and taking into account the potential for different detection curves depending on the direction of the survey viewshed.

Given the results of an initial detectability field trial (see below), the expectation is that effective sampling for larger birds (1000+ grams) will extend the full width of all sampling units, whether composed of 140-m or 70-m long panel rows. For smaller and possibly medium sized birds (0-100 grams and 101-999 grams) and bats, however, effective sampling is expected to be constrained to less than the maximum viewing distance. Density estimation using distance sampling techniques is easier, and can be accomplished with greater precision if the data are truncated at a distance beyond which the probability of detection is low (Buckland et al. 1993). Accordingly, data will be truncated and the density of carcasses in the effective search area will be used to calculate the density of carcasses in the whole solar facility.

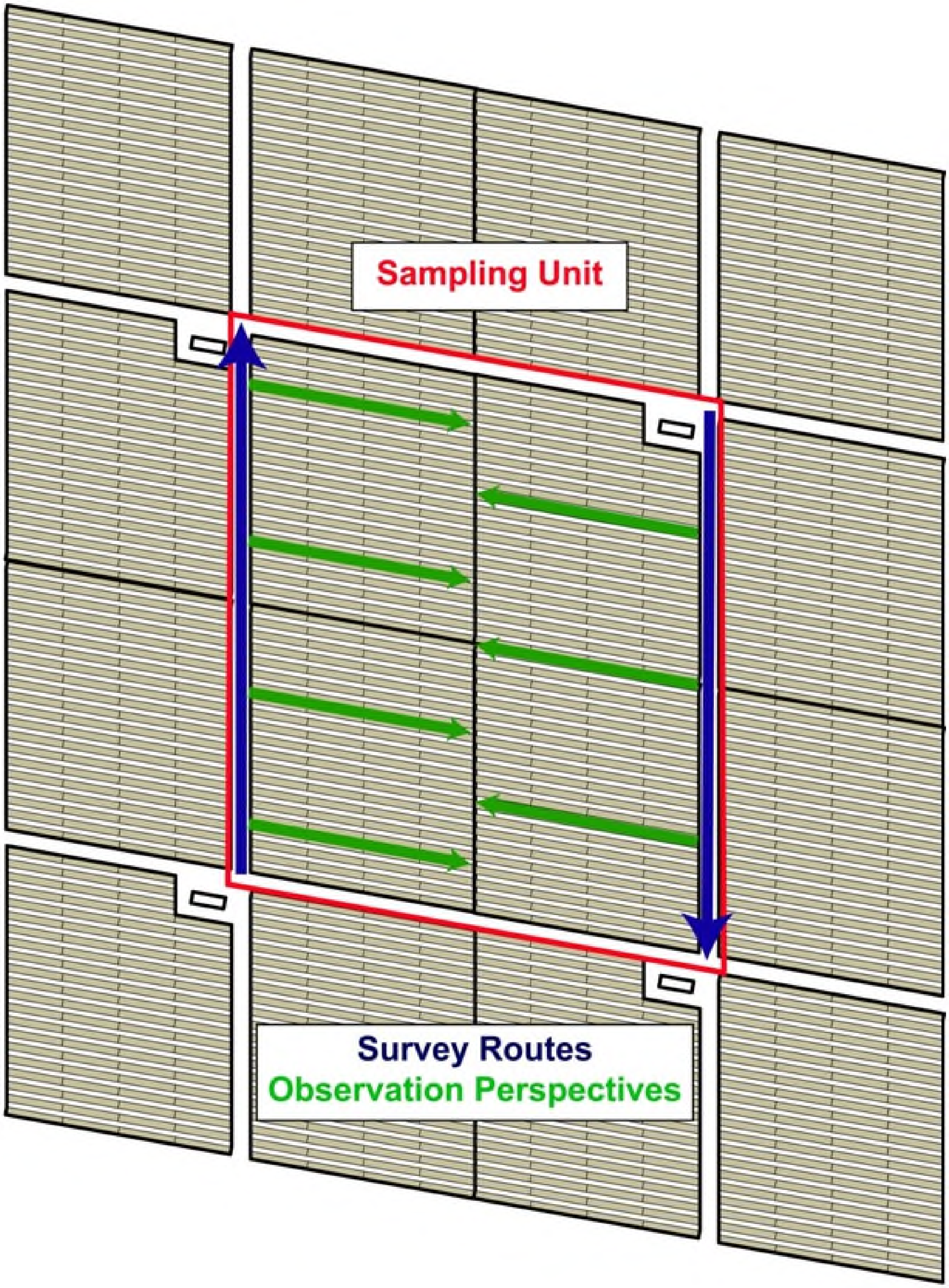


Figure 3. Illustration of a typical sampling unit and perimeter survey with travel routes and search areas (‘observation perspectives’).

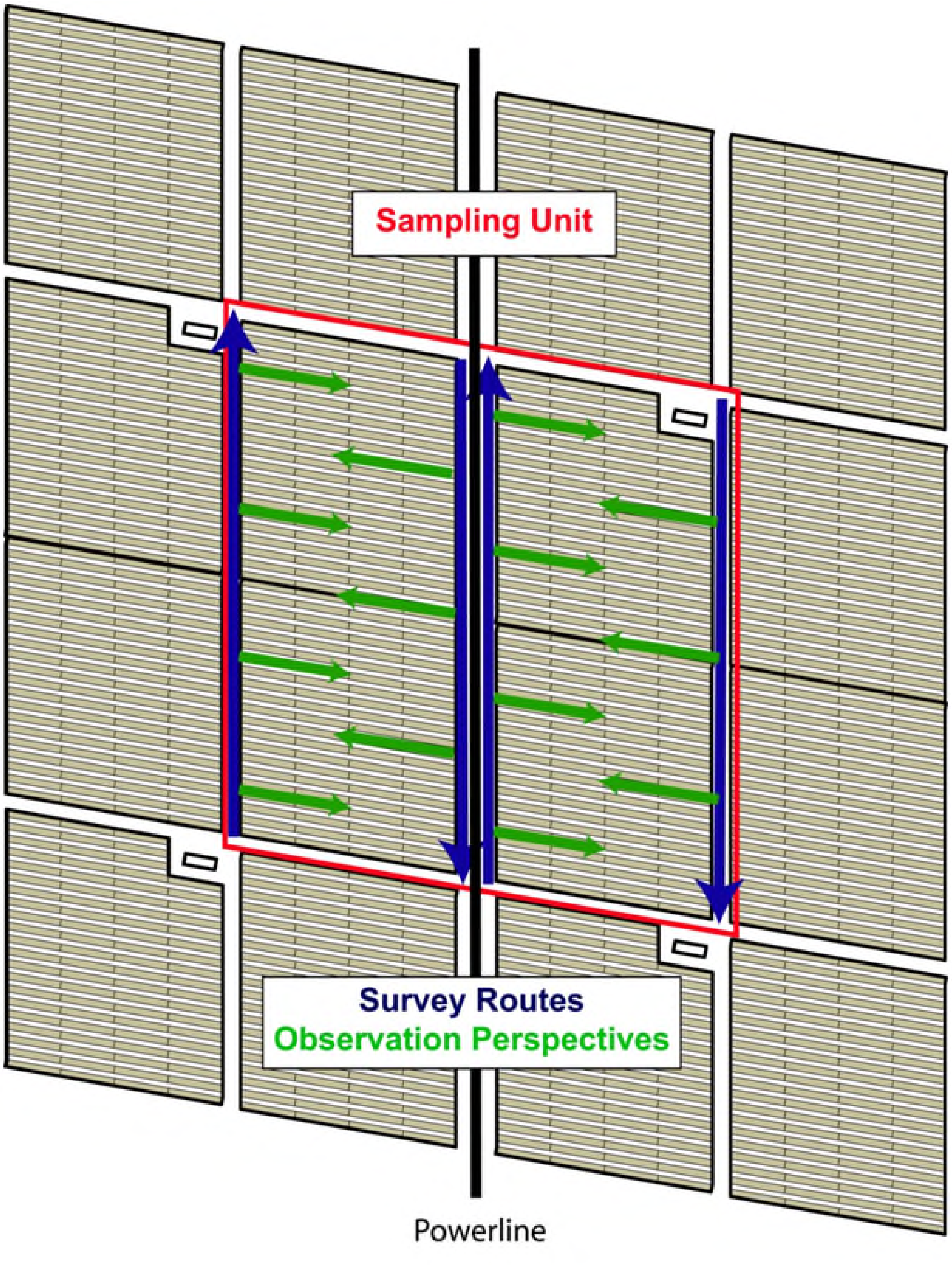


Figure 4. Illustration of a sampling unit survey including a distribution powerline with travel routes and search areas ('observation perspectives').

The perimeter-only survey design reflects two concerns: 1) minimizing movement between rows of solar panels. Because the area between electrified panel rows is an area of elevated risk, best practices dictate that personnel do not enter elevated risk zones unnecessarily; and 2) achieving an effective balance between logistic efficiency and sampling rigor given the constraints of transect spacing due to the width of panel rows. In support of the latter objective, a field trial was conducted to evaluate the ability of observers to detect carcasses of different types and sizes based on perimeter-only surveys that did not require walking between the rows of panels (H.T. Harvey and Associates 2013c). The field-trial surveys involved walking along the north-south edges of array sections perpendicular to the rows of panels and using naked-eye and binocular-aided scanning to search for placed carcasses of five non-native bird species, ranging in size from small house sparrows (*Passer domesticus*) to large ring-necked pheasants (*Phasianus colchicus*).

The field trial confirmed that, given the relatively flat, sandy, and uncluttered substrate that characterizes most of this solar facility, relatively large carcasses, such as rock pigeons (*Columba livia*) and pheasants, can be reliably detected (average detection probability over a 70–m wide transect > 0.75; Figure 5) using perimeter-only surveys, even when the continuous span of the solar-panel rows is 140 m, which applies across most of the facility. For smaller carcasses up to the size of small quail (*Coturnix japonica* in this case), however, detection probabilities will be much more strongly a function of distance (average detection probability over a 70–m wide transect > 0.35; Figure 5). Distance sampling is well-equipped to estimate population sizes, even when the detection function indicates a rapid decay in detectability with distance (Buckland et al. 1993).

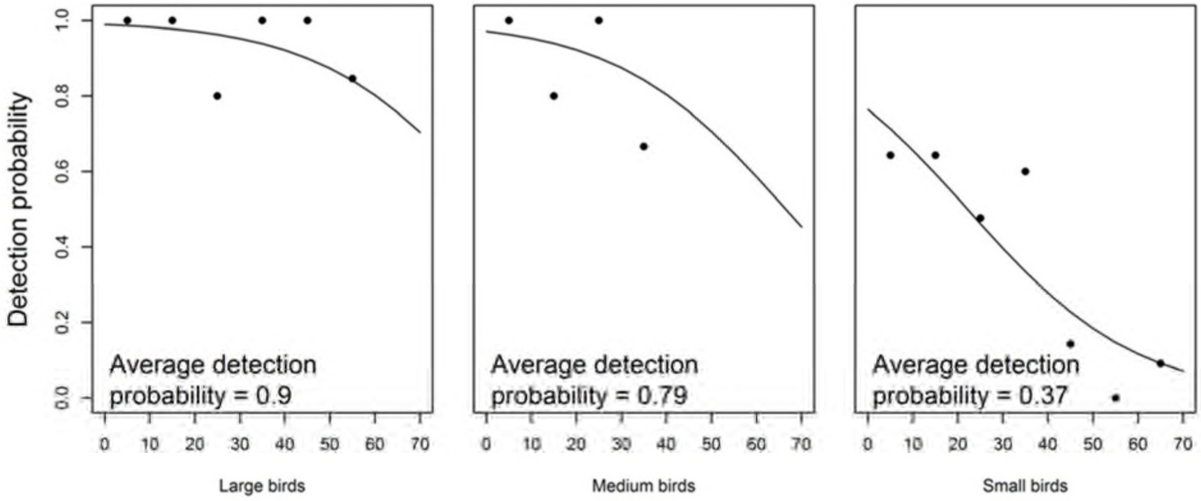


Figure 5. Logistic regression lines were fitted to detection data from the distance sampling trials at Desert Sunlight (HT Harvey 2013c). Data were binned into 10-m intervals prior to analysis. Fitted regression lines and observed proportions are shown. The fit for medium birds may be unreliable due to sparse data, but is probably intermediate between the fits for large and small birds.

Not being able to detect most small to many medium-sized carcasses over a substantial portion of the solar facility would comprise a problematic bias if the probability of carcass occurrence was non-random within arrays (i.e., within sample units). In other words, the bias would create a problem for achieving representative sampling if the probability of mortality due to panel collisions varied in some predictable fashion relative to the distance from array edges, or if there was a tendency for fatalities to be clustered in the interior of the panel areas. Whether or not such conditions may apply to this facility is currently unknown; however, initial post-construction monitoring at another large photovoltaic solar facility in central California has not demonstrated any particular spatial bias in the distribution of fatalities documented there (H.T. Harvey and Associates 2014).

On this basis, fatality sampling will proceed using distance-sampling survey techniques and analytical methods, which include estimating and accounting for distance-related variation in the probability of detection based on the carcass data and bias trial data. In addition, searcher-efficiency trials that are tailored to include evaluating the influence of distance on the probability of detection will be conducted to assess and adjust for the possibility of a spatial bias in the distribution of fatalities. This can be accomplished by comparing the detection function derived from independent searcher-efficiency trials with the detection function derived from the actual fatality data (as it is calculated based on standard distance-sampling techniques). If the two independently derived functions suggest divergent relationships between distance and the probability of detection, the pattern of divergence between them can be used to adjust results of the distance-sampling-based fatality estimate

7.2.4 Temporal Sampling Design

The appropriate frequency of fatality surveys depends on the species of interest and average carcass persistence times (Smallwood 2007, Strickland et al. 2011, USFWS 2012). Large raptors tend to persist and remain detectable for extended periods (weeks to months) due to low scavenging rates and relatively slow decay rates. If only large species were of interest, extended search intervals of 30–45 days might be appropriate; however, smaller birds and bats typically disappear at much faster rates, so shorter search intervals are required to ensure effective documentation of fatality rates among these species.

Publically accessible data from three wind-energy studies in the nearby Mojave Desert region of California and western Arizona provide additional, relevant insight (Chatfield et al. 2009, 2010; Thompson and Bay 2012). These studies recorded average persistence times of 17.5–46.8 days for large birds (average 29.0 days, median 22.6 days) and from 5.6–17.4 days (average 9.9 days, median 6.5 days) for small birds. If the median carcass-persistence time for small and medium birds and bats on the Project site is low a 7-day search interval may be required to effectively document fatality rates for small birds and bats. If, however, median small-bird and bat carcass-persistence rates are greater than 7 days, then a longer search interval may be more appropriate. The initial indications of rapid scavenging by ravens at the Project site suggested that a shorter search interval may be needed to provide precise fatality estimates for small bird and bat carcasses. Later data from Corvus (2014) suggests that there is a period of rapid initial removal, particularly for small and medium carcasses with 50% of carcasses in these size classes removed in 8 and 5 days, respectively. Overall, mean carcass persistence in May and June was greater than 10 days for any size of carcass, and greater than 24 days for large carcasses.

Based on these considerations and preliminary data, and based on the simulation analyses discussed previously, the search interval for fatality monitoring will be variable depending on season (Table 2). Searches will be conducted every 7 days during standard spring and fall migration periods (March 1 – May 31, and September 1 – October 31), and every 21 days during summer and winter (June 1 to August 31, and November 1 to February 28/29). After the first 6 months of fatality monitoring and concurrent carcass-removal trials (see below) have been conducted, the search interval may be adjusted based on estimates of carcass persistence. Some migration for some species may occur outside these periods and this will be considered when evaluating the data regarding timing of mortality for species.

Adjusting fatality counts for carcass removal works best when the search interval remains constant through time (Huso 2010); however, within survey periods, season-specific estimates of carcass persistence can be calculated and incorporated in the overall estimation process when variable search intervals are used in different seasons (Shoenfeld 2004; Huso 2010, 2012; and other estimators all have facility to accommodate season-specific estimates). In addition, survey schedules will ensure that fatality surveys are evenly spaced in time to maximize detection of potential, unusual fatality events (Strickland et al. 2011). For these reasons, a standard schedule for completing the surveys will be developed and followed, such that some surveys will occur during most weeks of the year and all sampling units are surveyed on a regular schedule, as dictated by the season.

7.2.5 Survey and Data Collection Protocols

Fatality surveys will be conducted with the observers striving for a consistent pace/speed and approach, and a uniform search effort throughout the search. Searchers will use binoculars at their discretion to survey for carcasses between each row of panels. The Project has rigorous safety protocols in place that address heat and other safety issues. When a potential carcass is detected, the observer will immediately proceed down the row to confirm the detection and, if valid, fully document and bag it according to standard protocols (see below). Depending on the size and nature of the carcass, the observer will either immediately collect the carcass (smaller, easily collected and transported packages) or flag it for pick-up once the sampling-unit survey is completed (larger, messier, or otherwise complicated collections) or to identify it to species. All carcasses will be stored in freezers on-site until the BLM and FWS determine the ultimate disposition.

All bird and bat injuries and fatalities discovered during, or incidental to, the standard carcass surveys will be documented according to the requirements and standards reflected in the USFWS Avian Injury and Mortality Reporting Form. The form is a reporting requirement of the USFWS Special Utility (SPUT) Permit issued to the Project to authorize the handling of dead or injured birds. In addition, finds will be classified as a fatality according to standards commonly applied in California (Altamont Pass Monitoring Team 2007, CEC and CDFG 2007), which dictate that when only feathers are found, to be classified as a fatality, each find must include a feather spot of at least five tail feathers or two primaries within 5 m (16.4 ft) or less of each other, or a total of 10 feathers. Searchers will make their best attempt to classify feather spots by size according to the sizes or identifying features of the feathers. A separate fatality estimate will be made for feather spots for which size classification is impossible. Digital photographs will be taken to document all incidents, and when possible, plausible cause of death will be indicated on data sheets based on evidence (such as blood or fecal smears on solar panels, burns that may indicate electrocution or blunt trauma that may indicate collisions). All carcasses will be examined and where possible cause of death will be recorded (e.g. burns may indicate electrocution, and blunt trauma may indicate collisions). An avian biologist will make decisions on likely cause of death and this will be reviewed by the Biologist overseeing the program.

All fatalities will be assigned to a size class, a taxonomic family, and an ecological guild and weight categories (e.g., 0-100 grams; 101-999 grams; and 1000+ grams). Species will also be classified as resident, overwintering, or whether they are diurnal or nocturnal migrants (or both). It is necessary to know size classes to appropriately correct for searcher efficiency and scavenging, and information about taxonomic family, ecological guild, and time of day when active are relevant to the specific USFWS and project goals of the monitoring plan.

To ensure accurate documentation of the fatality locations, the observer will record the array number, Global Positioning System (GPS) coordinates in latitude/longitude of the carcass location using a handheld device accurate to ± 3 to 4 m (9.8 to 13.1 ft), and a measurement of the distance from the fatality location to the end of the panel row from which the carcass was detected. When an observer proceeds down panel rows to confirm and document detected fatalities, they may detect other fatalities that they did not observe based on the perimeter-only survey. Including such detections in the fatality estimate will confound estimation of fatality density based on application of standard distance-sampling analytical methodology. Therefore, all such supplementary detections will be classified as “incidental” finds (discussed further below). Carcasses that are found within standardized search areas but incidental to the distance sampling searches can be used as an additional validation of the detection functions: the detection function specifies the distribution of found carcasses, but it also specifies the distribution of missed carcasses, and incidentals should follow the latter distribution.

Data records for each survey will also include: 1) full first and last names of all relevant surveyors in case of future questions; 2) start and stop times for each individual sampling-unit survey; 3) a description of the weather conditions during each search; 4) a standardized description of the current habitat and visibility classes represented within each sampling unit; and 5) a description of any search-area access issues, if relevant. Data collected will also include all appropriate fields contained in the SPUT permit.

All personnel involved in implementing this Plan will be included as sub-permittees under the Project’s USFWS SPUT Permit, issued either to the Project or a consultant authorized by the Project. If the CDFW does not consider coverage under the USFWS SPUT permit sufficient, all personnel implementing this plan will also be covered under any applicable CDFW Scientific

Collecting Permit if provided and issued either to the Project or its consultant. Ideally, the relevant state and federal permits will allow fatalities discovered during the study to be removed from the field, stored on-site in a freezer, and used in searcher-efficiency and carcass-removal bias trials. Necessary exceptions will apply to all special-status species (see below). Otherwise, surveyors will place all discovered carcasses or body parts that are not of a special-status species and are not part of an ongoing bias trial in zip-locked plastic bags, clearly label each bag with the incident number, and deliver the bags for storage in the designated freezer at the Project facility.

4.2.6 Fence Line Monitoring

The perimeter fence is subject to inspections approximately once every 7 days during spring and fall migration, and approximately once every 21 days during winter and summer periods with intervals adjusted as necessary based on the carcass persistence trials. A searcher will drive the areas accessible by vehicle close to the inner perimeter of the fence, scanning for fatalities within an approximate 6-m strip transect centered on the fence. Some sections along the fence cannot be driven close to the fence line. The fence line along the western edge of the Project is drivable but the road is approximately 15 m away from the fence and the road and fence are separated by a drainage ditch. The fence along this section is currently covered with a tan tarp to block and trees and shrubs have been planted to reduce visibility of the project from the west. Additions of vegetation and the tarp likely reduce potential for bird collision with the fence. This section of the fence will be driven to document carcasses, but will not be included in adjusted fatality estimates because detection rates are expected to be low. A separate section of the fence in the southeastern corner of the Project cannot be driven because the eastern edge of the berm that bounded construction ponds is too narrow for a vehicle. In this case, the observer will stop at both north and south ends of the berm and use binoculars to search for carcasses. Finally, the road along a portion of the southwest fence line near the entrance gate is approximately 30 to 50 m from the road and is separated from the fence by an area that has recently undergone vegetation restoration. This area will be eliminated from sampling. Fatality rates estimated for sections of the fence that are sampled will be extrapolated to sections of the fence where the standard monitoring protocol cannot be used. Travel speed will be no greater than 5 miles per hour (8 kilometers per hour) while searching to ensure quality detection, and safety. Personnel conducting fence checks will document bird and bat injuries and fatalities discovered along the inner fence line. Injuries and fatalities along the fence line will be documented in the same manner as used for those discovered during the array carcass surveys, and will be reported to the USFWS and CDFW as part of the same overall reporting process. Searcher efficiency trials will be conducted along the inside of the fence in a similar fashion to the trials at the solar arrays. Carcass removal trials conducted at solar arrays will include areas near the inside of the fence as well.

4.2.7 Power Line Monitoring

Power lines are built to APLIC (2005, 2006, 2012) guidelines; however, there is still a collision risk for many bird species. Consequently, a 50% sample of the Gen-tie Line will be monitored every 7 days during spring and fall migration and approximately every 21 days during summer and winter with intervals adjusted as necessary based on the carcass persistence trials.

Searchers will drive or walk 50% of the Gen-tie Line during each visit, scanning for birds within 15 m from the line. Injuries and fatalities along the Gen-tie Line will be documented in the same manner as used for those discovered during the array carcass surveys, and will be reported to the USFWS and CDFW as part of the same overall reporting process.

Some overhead electrical feeder and distribution power lines are co-located within the solar arrays and these co-located power lines may be searched as part of the regular monitoring schedule at arrays. Fatalities that are determined to have been caused by the power lines (as determined by the nature of injuries) will be reported as such to the USFWS and CDFW as part of the same overall reporting process and included in overall fatality estimates. In addition, portions of the Gen-tie Line are co-located with third-party structures and facilities, including other transmission infrastructure and roadways and, therefore, the source of a particular fatality may not be attributable to the Project's facilities.

4.2.8 Clearance Surveys

Depending on when fatality surveys commence, a one-time clearance survey will be conducted beginning approximately 21 days before the first round of official surveys begins in all areas planned for survey (fence line, gen-tie sample areas and solar arrays). The purpose of this survey will be to clear the survey area of any accumulated carcasses that may be present. The sequence of clearance surveys will mirror the schedule for the first official survey to ensure that the interval between the clearance survey and the first standard survey is the same for all sampling units. This is necessary to ensure that carcasses detected during the first round of surveys represent only fatalities that occurred during a preceding interval equivalent to the search interval that will apply afterward. Carcasses that are missed during the clearance survey will cause an upward (conservative) bias in the fatality estimate. Additionally, some estimators (such as the Huso estimator described above) become biased if carcasses that are not detected during a trial are still available during subsequent trials. This 'bleed through' effect can be ameliorated by including only fresh carcasses in the fatality estimate, where 'fresh' means a carcass that has arrived since the previous search. Carcasses that cannot reliably be aged (probably most carcasses) will be assumed to be fresh; this will cause an upward (conservative) bias in the fatality estimate.

7.3 Bird Rescue

Surveyors will record any injured or rescued birds or bats located during surveys. Birds will be assessed by a qualified biologist to determine if it is appropriate to transport the individual to the nearest permitted rehabilitation facility for proper care, or to release them. Injured raptors will be handled only by experienced personnel and will be taken only to rehabilitation facilities that are permitted to handle raptors; this provision is particularly important for eagles. From the Project site, the closest rehabilitation facilities capable of handling all avian species are:

- Coachella Valley Wild Bird Center, 46500 Van Buren, Indio, California, 92201; Phone: 760-347-2647; Contact: Linda York, Executive Director; Hours of Operation: 9:00am-12:00pm, 7 days a week. http://coachellavalleywildbirdcenter.org/

- The Living Desert Zoo & Gardens, 47900 Portola Avenue, Palm Desert, California, 92260; Phone: 760-346-5694 x8 x1; Contact: Sheila Lindquist, North American Manager; Hours of operation: 8:00am-1:30pm (June-September), 9:00am-5:00pm (October-May), 7 days a week (closed Christmas Day). http://www.livingdesert.org/animals/wildlife-rehabilitation/
- Hope Wildlife Rescue, 18950 Consul Avenue, Corona, CA 92881; Phone: 951-279-3232; Contact: Bill Anderson or Cyndi Floreno; **must call first (this is a CA-licensed rehabilitator working out of a personal residence)**.
- All God's Creatures Wildlife Rescue & Rehabilitation, Chino Hills, CA; Phone: 909-393-1590; Contact: Lori Bayour; http://www.allgodscreatures.net/index.html; no address available, contact by phone.
- International Bird Rescue, Los Angeles Center, San Pedro, CA, 90731; Phone: 310-514-2573; Hours: 8:00am - 5:00pm.
- A list of wildlife rehabilitators maintained by California Department of Fish and Wildlife: http://www.dfg.ca.gov/wildlife/WIL/rehab/facilities.html
- The California Council for Wildlife Rehabilitators: http://www.ccwr.org/resources/rehabilitation-facilities-region-6.html

If stranded, but apparently uninjured, water-associated birds are discovered at any time during surveys, the surveyor will take immediate steps to notify an on-call biologist, and assist with efforts to secure the bird and have it transferred as expediently as possible to Lake Tamarisk for release into the water. Injured water-associated birds may be taken to International Bird Rescue, which specializes in the care and rehabilitation of water-associated birds. If a mass event involving many such birds is observed, the surveyor will immediately notify on-call biologist or other biological personnel working on the site about the details and request their assistance identifying injured versus non-injured birds and transporting injured birds to the nearest rehabilitation facility. International Bird Rescue can also assist with mass stranding events. Rehabilitation facilities should be compensated for the costs associated with each bird put under their care.

If a surveyor discovers a dead individual of a species that is fully protected by the state or federally or state-listed as threatened or endangered, and for which handling is not specifically authorized under the applicable salvage permits, he/she will collect data and photos as for any other fatality, but then flag the carcass to mark its location and leave it in place. If it has been confirmed as a federally listed species under the Endangered Species Act, the surveyor will immediately call a USFWS Office of Law Enforcement special agent to determine the appropriate follow-up action.

7.4 Searcher Efficiency Trials

Estimating searcher-efficiency (distance-related detection functions) is a standard component of the distance-sampling approach. Moreover, because estimating detection functions is applied to all survey data and can be organized to variably adjust in relation to covariates of interest (e.g., season, habitat, and carcass size classes), application of this approach will account for typical factors of interest for fatality studies (CEC and CDFG 2007, Huso 2010, Korner-Nievergelt et al. 2011, USFWS 2012, Smallwood 2013). In this case, independent searcher-efficiency trials per season will be conducted to help assess and adjust for potential spatial bias in the distribution of fatalities among arrays. Separate trials will be conducted to assess detection probability associated with fence and gen-tie line searches.

The desert landscape in which this Project is located generally changes little with the seasons, save for brief periods following winter and spring rains when floods may occur and blooming plants may flourish. A recent meta-analysis involving data from more than 70 wind-energy projects suggested that including habitat visibility class as a predictive variable generally eliminated any otherwise apparent seasonal effects on searcher efficiency (Smallwood 2013). Nevertheless, the supplementary searcher efficiency trials for this Project will be repeated seasonally (winter, spring, summer, and fall) and trials will be organized so that all search personnel participate in bias trials. Placement of trial specimens will be timed to limit the number of trial carcasses placed on the landscape at any one time (minimizing the chance of artificially attracting scavengers or, conversely, scavenger swamping; Smallwood 2007). This approach will also ensure that any new surveyors that join the crew participate in searcher efficiency trials. The trials will also be managed to ensure effective quantification of searcher efficiency in relation to predefined habitat visibility classes (low, medium, and high, if relevant), size classes of birds (small and large), and detection distance.

The bias-trial sample sizes required to produce precise, adjusted fatality estimates are not well established, in part because needs may vary substantially depending on actual project-specific searcher efficiency, carcass removal, and fatality rates. However, using searcher-efficiency trials to help evaluate the efficacy of perimeter-only surveys and the distance-sampling approach used in this investigation will require larger sample sizes to produce a sampling design that effectively accounts for distance as a key covariate of interest. In addition, if growth of new ruderal vegetation, or substrate heterogeneity caused by flood events, is sufficient to create a new visibility class under the arrays, the specimen numbers would need to increase to effectively account for this factor. It will also be necessary to ensure that the estimates of searcher efficiency encompass variation among multiple surveyors. The influence of individual surveyors will not be accounted for in a formal, statistical sense by including “surveyor” as a covariate in the estimation model; however, all surveyors will be tested similarly. Each surveyor will be exposed to multiple test specimens of each size class, and at similar repeated levels if testing in different habitat visibility classes is required. A minimum of 15 carcass samples per small size class, 10 for medium, and 5 for large is anticipated within the fence line, solar array, and gen-tie sampling areas per season. Searcher efficiency will be summarized for each individual searcher but to avoid needlessly inflating the variance of the estimate, individual searcher effects will not be included in the fatality estimation model.

Besides representing birds of different sizes, another important factor to consider in searcher-efficiency and carcass-removal trials is the bird species to use as trial specimens. Ideally, all carcasses used for both searcher-efficiency and carcass-removal trials should reflect the range of species likely to be encountered as fatalities in the Project area (CEC and CDFG 2007). Because obtaining sufficient samples of "natural" carcasses often is difficult, researchers frequently resort to using readily available, non-native surrogate species in bias trails; however, this practice may result in biased results when compared to studies that use only "natural" specimens (Smallwood 2007). For all bias trials, this program will maximize use of representative native or naturalized species authorized by permits, either found during the study or gathered elsewhere, as needed, and from diverse sources where possible, but all trial carcasses will be obtained and deployed in a manner that are consistent with applicable regulatory requirements.

Another factor that influences carcass detectability is how fresh and intact the carcass is (Smallwood 2007, 2013). If multiple pieces of a depredated or scavenged carcass are scattered over a modest area, in some cases the fatality may be more easily detected; however, detectability generally decreases when only remnants of a carcass are present, or when the carcass is aged and degraded. Nevertheless, in contrast to wind-energy projects, there is little expectation that this Project will cause injuries and fatalities that result in dismembered carcasses, so this factor is not expected to influence searcher-efficiency or carcass-removal rates (Smallwood 2013). Therefore, bias trials conducted in this study will involve primarily intact carcasses. The searcher-efficiency trial specimens may range from freshly thawed to partially decayed (i.e., selected, subject to availability, to mimic the range of carcass decay that typically accrues over 7-day periods).

A field supervisor or other technician not involved in the standard surveys will place the trial specimens and will recover any specimens missed by the surveyors. All trial specimens will be placed according to a sampling plan that randomly allocates carcasses of different sizes among survey plots and survey days within the assessment areas, but is stratified to ensure equitable representation of different surveyors, fence line vs. solar arrays vs. gen-tie and seasons. To minimize the possibility of unnecessarily attracting scavengers or, conversely, contributing to scavenger swamping, which could affect ongoing carcass-removal trials (Smallwood 2007, Smallwood et al. 2010), placement of searcher-efficiency trial specimens will be distributed throughout the year (appropriately organized to provide season-specific estimates with adequate samples to provide a robust estimate of searcher efficiency), with few specimens placed at any one time. Carcasses will be placed carefully to minimize disturbance of substrates that may bias carcass detection. Sample size and frequency of trials in the second year may be reduced if the TAG deems appropriate (see section 10.0).

All trial specimens will be inconspicuously marked with a piece of black electrical tape wrapped around one leg, in a manner that allows the surveyor to readily distinguish trial specimens from new fatalities, but without rendering the specimen unnaturally conspicuous (Smallwood 2007, USFWS 2012). To ensure a degree of "natural" placement, carcasses need to be represented by placing between rows of panels, under panels, near i-beams supporting the panels, or in the open. Therefore, carcasses will be tossed towards the designated, randomly chosen placement spot from a distance of three to six m. Documentation of each location will include GPS coordinates, notes about the substrate and carcass placement, and a digital photo of the placement location.

Surveyors will have only one opportunity to discover placed specimens. Any missed specimens will be recovered as quickly as possible after surveys have been completed in a given area, and after the surveyor(s) have become aware of the trial through discovery of one or more specimens. Some researchers have argued for leaving missed specimens in place to enable possible discovery in a subsequent survey and thereby mimic the natural situation in which “bleed-through” is possible (e.g., Smallwood 2013, Warren-Hicks et al. 2013; discussed further below). Although this approach may have merit in some situations, its potential value for this Project is offset by the need to avoid attracting ravens, which represent a threat to desert tortoises living in the area (Ironwood Consulting 2010b).

7.5 Carcass Persistence Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal variation in landscape/climatic conditions and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. Seasonally variable climatic conditions also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Therefore, to ensure accurate treatment of this bias factor, carcass-persistence rates will be assessed on a quarterly or at least semi-annual basis during the first year that fatality surveys are conducted (CEC and CDFG 2007, USFWS 2012, Smallwood 2013), and during the second year as needed. It is also imperative that carcass-persistence trials effectively account for the influence of carcass type/size, given that persistence times may vary widely depending on the species and size class involved (Smallwood 2013).

To quantify carcass persistence, 15 small, 10 medium, and 5 large carcasses will be randomly placed and monitored within the solar arrays (including the fence line), and along 50% of the Gen-tie Line each season. A minimum of ½ of the carcasses in the solar arrays will be monitored, using motion-triggered, digital trail cameras (e.g., see Smallwood et al. 2010) while the remaining will be visited on foot, for 30 days or until the carcass has deteriorated to a point where it would no longer qualify as a documentable fatality. Some of the carcasses along the gen-tie line will be monitored with cameras if theft and vandalism concerns can be resolved. For carcasses not set up with cameras, the carcass will be visited once a day for the first 4 days, and then every 3 to 5 days until 30 days is reached. Fake cameras or cameras without bias trial carcasses will also be placed to avoid training ravens to recognize cameras as “feeding stations”. Periodic ground-based checking of carcasses also will occur to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera’s field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens will be distributed across the entire Solar Farm, not just in areas subject to standard surveys, and new specimens will be placed every two to three weeks in small numbers. Sample size and frequency of trials in the second year may be reduced if the TAG deems appropriate.

Trial specimens will include only intact, fresh (i.e., estimated to be no more than one or two days old and not noticeably desiccated) bird carcasses that are either discovered during the study or are acquired from other sources after having been frozen immediately following death. If permits allow, preference will be to use carcasses of species that occur in the area. Surrogates, such as game birds and waterfowl, that are similar in size and appearance to species that occur in the area, will be obtained from commercial sources and used if necessary to meet the required sample sizes. However, domestic waterfowl or gamebirds that are white or brightly colored (e.g. male pheasants) will not be used. Scavenging rates for surrogates may be artificially high, at least when compared to raptors (Smallwood 2007, 2013) and may lead to conservative fatality estimates (i.e., an overestimate) for some taxa/groups.

To reduce possible biases related to leaving scent traces or visual cues that may unnecessarily alert potential scavengers, all carcasses used in carcass-persistence trials will be handled with latex gloves, and handling time will be minimized. All trial specimens will be inconspicuously marked with a small piece of green electrical tape wrapped around a leg to distinguish them from both unmarked fatalities and searcher-efficiency trial specimens.

Upon conclusion of the relevant monitoring period, each trial specimen will be classified into one of the following categories:

Intact: Whole and un-scavenged other than by insects

Scavenged/depredated: Carcass present but incomplete, dismembered, or flesh removed

Feather spot: Carcass scavenged and removed, but sufficient feathers remain to qualify as a fatality, as defined above

Removed: Not enough remains to be considered a fatality during standard surveys, as defined above

7.6 Estimating Adjusted Fatality Rates

The sampling design will enable calculation of fatality estimates adjusted for searcher-efficiency, carcass-removal rates, and proportion of area sampled. The adjustment for searcher efficiency will occur by virtue of applying standard methods for analyzing detection data collected using distance-sampling methods, with the data partitioned by season and standardized carcass size classes.

The fatality estimates will be adjusted for variation in carcass persistence, by applying seasonal and carcass-size-specific correction factors to the fatality estimates that have been adjusted for distance-related variation in the probability of detection.

The analytical approach used to calculate adjusted fatality estimates will be similar to that applied in cases where the fatality estimates are derived from strip transects.

For illustrative purposes, we summarize here the basic formulation of the Huso estimator, the first part of which pertains to fatality estimation for different strata, or groups. Essentially, the smallest group for which fatalities are estimated can be considered a stratum, with stratum *k* representing, for example, a set of similarly sized birds within a defined habitat visibility class. Note that strata should be defined to ensure minimum variance in detection probabilities within individual strata, whereas probabilities may vary considerably among strata (e.g., for small versus large birds, or in habitats of low versus high visibility). Depending on the circumstances, there can be strata based on species groups, size classes, seasons, habitats, and/or infrastructure types (also could conceivably model distance categories as another covariate).

For a particular stratum *k* for a given survey plot and search interval, fatality can be estimated as:

$$\hat{F}_k = \frac{c_k}{g_k},$$

where c_k is the number of observed carcasses and g_k is the probability of detecting a carcass. The detection probability g typically is the product of three variables: the probability of a carcass persisting (r), the probability of a carcass being observed given that it persists (p), and the effective proportion of the interval sampled (v):

$$\hat{g} = \hat{p} * \hat{r} * \hat{v}.$$

The probability of a carcass being observed given that it persists (i.e., searcher efficiency) is estimated as:

$$\hat{p} = \frac{number\_observed}{number\_available},$$

with data for calculating this metric derived from searcher-efficiency trials where known numbers of carcasses are distributed over the search area and carcass detection rates are quantified.

The probability of a carcass persisting is estimated as:

$$\hat{r} = \frac{\bar{t}(1 - e^{-I/\bar{t}})}{I},$$

where $\bar{t}$ is the estimated mean carcass persistence time and I is estimated as:

$$I = \min(I_a, \tilde{I}),$$

where I_a is the minimum actual time between searches and $\tilde{I}$ is the effective search interval, defined as:

$$\tilde{I} = -\log(0.01) \cdot \bar{t}.$$

The effective proportion of the interval sampled is estimated as:

$$\hat{v} = \min(1, \tilde{I} / I_a).$$

For this investigation, the formulation for calculating $\hat{F}_j$ would differ from that outlined above, in that "c_k" would represent the estimated number of fatalities already adjusted for searcher efficiency, based on application of distance-sampling methodology, and then g_k would represent the product of only the estimated carcass persistence (r) and the effective proportion of the interval sampled (v). With this modification, the rest of the formulation would be similar.

For a given plot in search interval j, the adjusted total number of fatalities is calculated as:

$$\hat{F}_j = \sum_{k=1}^{K} \hat{F}_{jk},$$

where $\hat{F}_{jk}$ is the estimated number of fatalities within stratum k of search interval j.

Finally, the estimate of Project-wide total fatalities during a given search interval is estimated as:

$$\hat{F} = \frac{1}{a} \times \left(\sum_{i=1}^{n} \frac{1}{\pi_i} \sum_{j=1}^{J} \hat{F}_{ij} \right),$$

where $\hat{F}_{ij}$ is the number of fatalities on plot i in search interval j, a is the proportion of area that was searched and π_i represents a modified weight associated with an unequal probability sample (Huso 2010), and is the product of the probability of selecting plot i and the proportion of fatalities contained in plot i. The total number of search intervals is J, assuming that there is the same number of search intervals for each plot. In practice, one need not assume that J is constant, but presenting it this way simplifies the notation.

Adjusted fatality estimates for the Solar Farm will be expressed per unit area (e.g., acres and arrays) per year.

7.7 Incidental Mortality Documentation

Once post-construction fatality monitoring begins, all subsequent bird and bat injuries and fatalities detected incidental to the standardized, post-construction monitoring program will be classified as “incidental finds,” documented using similar procedures as are used for specimens discovered during the standardized surveys, and integrated with records from the standardized surveys for summary reporting and evaluation purposes. Incidental finds that occur outside of standard search areas will not be included in calculations of adjusted post-construction fatality estimates, but will be summarized within seasonal and annual reports (discussed below).

From a statistical standpoint, a bias will occur if carcasses that are found in standard search areas but not during standardized surveys are recorded and removed prior to the next search of that array. Per USFWS direction, and to be consistent with the raven management plan, these carcasses will be reported directly to an authorized Biologist. These incidental finds will be documented using the same procedures as those discovered during standardized surveys. Data from incidental finds within standardized search areas will be included in analyses to estimate mortality within the solar arrays to be conservative. Appropriate caveats can be included within the seasonal and annual reports to document the potential magnitude of any biases created by recovering these carcasses.

8.0 MINIMUM CREDENTIALS OF MONITORING PERSONNEL AND TRAINING

The fatality monitoring program will be overseen by an Avian Biologist approved by BLM in consultation with Wildlife agencies that has demonstrated the ability to accurately identify the species of birds and bats potentially impacted by the project. Additional Biologists will be approved by the BLM in consultation with the Wildlife agencies for the purpose of accurately identifying species of birds and bats potentially impacted by the project. The approved biologists will assist with fatality monitoring and will be available to respond to incidents at the Project that require expert assistance (e.g. uncertain species identification, possible listed species, or injuries) within 24 hours. In addition, a biologist (minimum of B.S. in wildlife sciences) will be on-site during days of standardized monitoring.

Monitoring personnel may include solar facility staff. Monitors will be trained in distance-sampling search methodology, correct identification and documentation of carcasses, implementation of carcass removal trials and notification of a rehabilitation center in the event of injured birds or bats. Only staff/technicians that are listed under the SPUT and CDFW Scientific Collecting Permits will be allowed to handle carcasses. Accurate identification of rare, special status species will be emphasized during training. All surveyors will have photo cards to classify specimens and will take photographs of all finds. All data collection will be standardized and the Approved Avian Biologist will decide which to report as survey observations; however, all observations that were not conclusive will be reported.

The trainer, curriculum and training materials for training of non-biologist personnel in monitoring methods will be approved by BLM in consultation with the Wildlife agencies and will be conducted by The Approved Avian Biologist prior to initiation of the study. Training materials may be augmented by wildlife agency input. Components of the training program will include:

- A classroom-based portion with lecture and handout materials, and photographic or specimen-based (if available) species identification;
- A field-based portion that allows trainees the opportunity to practice and receive feedback on conducting carcass searches and trials, identification of species, completing data forms, and following protocols for assessing and assisting injured birds and bats;
- Assessment of learning outcomes for each participant;
- A training log to be updated with each trainee's name and contact information upon successful completion of the course.

The Avian Biologist that will conduct the training will, minimally, have a master's degree in biological sciences, zoology, botany, ecology, or a related field, and at least one year of field experience with avian or bat research or monitoring in the region. All reference material should be maintained and provided to the agencies in the event that there are questions about species identification.

9.0 REPORTING

9.1 USFWS Bird Fatality/Injury Reporting Program

The Project will report all documented bird injuries and fatalities to the USFWS using the required Avian Injury and Mortality Reporting Form that is a reporting requirement of the USFWS SPUT Permit issued to the Project to authorize the handling of dead or injured birds. SPUT reporting will be submitted monthly or in accordance with the terms of the permit. Similar reporting to the CDFW will be accomplished as a condition of any relevant Scientific Collecting Permit that the CDFW may issue to authorize the handling of dead or injured birds under state law.

9.2 Incidental Bird Injury/Fatality Reporting

All injury and fatality incidents discovered outside of the standardized carcass surveys will be documented in the same manner as used for those discovered during the carcass surveys, and will be reported to the USFWS and CDFW as part of the SPUT process. Special status or listed species will also be handled in a way that is consistent with project-specific SPUT permit conditions. Additional details on reporting are found in the Desert Sunlight Wildlife Incident Reporting System (Appendix C).

9.3 Summary Reports

Seasonal electronic summaries of all biological monitoring activities will be submitted to BLM, USFWS, and CDFW throughout the monitoring period. After the fourth quarter of each year of monitoring, a biologist representing the Project will assist the Project in preparing and submitting to the CDFW, BLM, and USFWS an annual report that summarizes dates, durations, and results of all fatality monitoring conducted to date.

To address the specific objectives of the monitoring plan, summary reports will include overall fatality estimates with confidence intervals, and fatality estimates by season. In addition, to the extent possible, fatality rates will be estimated and reported for likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines). Summary reports will also include spatial analyses of the data that address whether fatalities are randomly distributed throughout the facility. All raw field notes, field data, photographs, and GIS data will be submitted to the agencies.

10.0 TECHNICAL ADVISORY GROUP AND ADAPTIVE MANAGEMENT

A Technical Advisory Group (TAG) will monitor Project activities, including fatality data, to provide recommendations to the BLM on the need for any adaptive management, including the adoption of avoidance and minimization measures and methods for assessing their effectiveness. The TAG will consist of resource specialists and project biologists from the BLM, USFWS, and CDFW. Persons with scientific expertise may be invited by TAG. In addition, representatives from the Project and the consultants involved in the conduct of the studies will attend and participate in meetings. The TAG will provide advice and recommendations, consistent with the principles below, to the BLM Authorized Officer on developing and implementing effective measures to monitor, avoid, minimize, and mitigate impacts to wildlife species and their habitats related to operations. The BLM Authorized Officer will evaluate any recommendations of the TAG, including discussions with Desert Sunlight concerning new measures or measures that are not completely detailed in this BBCS and make a decision on what measure(s) and monitoring to require for implementation.

A TAG Lead from the Project will be designated for the group whose duties will include disseminating Project data, including data on fatality events, setting up and moderating meetings, reviewing of fatality data, and documenting adaptive management recommendations for the Project. Because the Project occurs on BLM land and BLM is the federal decision-maker, BLM will provide a designated TAG Lead for the Project. It is the TAG Lead’s responsibility to coordinate meetings and involve all team members.

The guiding principles, duties, and responsibilities of the TAG include the following:

- The TAG is only an advisory group.

- Recommendations will be made based on best available science and existing approvals and permits to address specific issues resulting from the Project.
- Recommendations will generally be made by consensus. Where consensus cannot be reached, multiple recommendations will be put forth to the BLM for a final decision.
- Provide sufficient flexibility to adapt as more is learned about the Project as well as strategies to reduce avian impacts if warranted.
- Review results of fatality monitoring.
- In accordance with Mitigation Measure (MM) WIL-5 of the Project's Record of Decision (ROD), if BLM, in consultation with the Wildlife agencies, determine, based on post-construction monitoring, that bird mortality caused by solar facilities is substantial and is having potentially adverse impacts on special-status bird populations, the TAG may recommend adaptive management strategies such as installing additional bird flight diverters, alterations to project components that have been identified as key mortality features, or implementing other appropriate actions to address the relevant findings based on the data.
- Review annual report on status of compliance with mitigation measures and permit conditions and provide recommendations to the BLM Authorized Officer, as necessary.
- Evaluate effectiveness of implemented adaptive management strategies and provide the BLM Authorized Officer with recommendations based on findings.
- The TAG will terminate when the BLM Authorized Officer determines that it is no longer a necessary pathway in reducing avian and bat impacts.

The TAG shall hold the first meeting prior to commencement of post-construction monitoring to review any final details of the monitoring plan. Subsequent meetings will be held following each monitoring season and after the end of each annual monitoring cycle.

After the initial 3-month period, the TAG will review the findings for each monitoring season to determine if adjustments to the monitoring frequency are warranted based on carcass persistence trial results. Desert Sunlight and the agencies will also meet at the end of the second year of monitoring to determine if continued/focused monitoring is warranted. Continued/focused monitoring may be warranted if data indicate that bird mortality caused by solar facilities is substantial and is having potential adverse impacts on special-status bird populations or there are other special circumstances. Such monitoring will be designed to address specific concerns that are identified after review of the data.

11.0 REFERENCES

Anderson, et al. 1999. Studying wind energy/bird interactions: a guidance document. Metrics and methods for determining or monitoring potential impacts on birds at existing and proposed wind energy sites. Avian Subcommittee, National Wind Coordinating Committee, 93 pp.

Avian Power Line Interaction Committee (APLIC). 2005. Avian Protection Plan (APP) Guidelines. A Joint Document prepared by the Edison Electric Institute's Avian Power Line Interaction Committee (APLIC) and the US Fish and Wildlife Service (USFWS).

Avian Power Line Interaction Committee (APLIC). 2006. Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006. Public Interest Energy Research Program (PIER) Final Project Report CEC-500-2006-022. Edison Electric Institute, APLIC, and the California Energy Commission. Washington D.C. and Sacramento, California.

Avian Power Line Interaction Committee (APLIC). 2012. Reducing Avian Collisions with Power Lines: The State of the Art in 2012. Edison Electric Institute and APLIC, Washington D.C.

Buckland, S, D.R. Anderson, K. P. Burnham, and J.L. Laake. 1993. Distance Sampling: estimating abundance of biological populations. Chapman & Hall, London. 446 pp.

Bald and Golden Eagle Protection Act (BGEPA). 1940. 16 United States Code (USC) § 668-668d. Bald Eagle Protection Act of 1940, June 8, 1940, Chapter 278, § 2, 54 Statute (Stat.) 251; Expanded to include the related species of the golden eagle October 24, 1962, Public Law (PL) 87-884, 76 Stat. 1246. As amended: October 23, 1972, PL 92-535, § 2, 86 Stat. 1065; Nov. 8, 1978, PL 95-616, § 9, 92 Stat. 3114.Bureau of Land Management (BLM) and US Department of the Interior (DOI). 2011a. Desert Sunlight Solar Farm Project, California Desert Conservation Area Plan Amendment and Final Environmental Impact Statement. http://www.blm.gov/ca/st/en/fo/palmsprings/Solar_Projects/Desert_Sunlight.html

Bureau of Land Management (BLM) and US Department of the Interior (DOI). 2011b. Record of Decision, Desert Sunlight Solar Farm Project and Amendment to the California Desert Conservation Area Land Use Management Plan, Riverside County, California.

California Department of Fish and Wildlife (CDFW). 2008. California Bird Species of Special Concern. http://www.dfg.ca.gov/wildlife/nongame/ssc/birds.html.

California Department of Fish and Wildlife, Natural Diversity Database. September 2014. Special Animals List. Periodic publication. 52 pp.

California Energy Commission and California Department of Fish and Game. 2007. California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development. Commission Final Report. California Energy Commission, Renewables Committee, and Energy Facilities Siting Division, and California Department of Fish and Game, Resources Management and Policy Division. CEC-700-2007-008-CMF.

ESRI. 2014. Geographic Information System (GIS) Online Topographic Base Map. ESRI, producers of ArcGIS software. Redlands, California.

Ironwood Consulting Inc. 2010a. Revised Biological Resources Technical Report, Desert Sunlight Holdings, LLC Desert Sunlight Solar Farm Project.

Ironwood Consulting Inc. 2010b. Common Raven Management Plan, Desert Sunlight Solar Farm Project. BLM Case File Number CACA-48649, Riverside County, California.

Ironwood Consulting Inc. 2011. Avian and Bat Protection Plan, Desert Sunlight Solar Farm Project, BLM Case File Number CACA-48649, Riverside County, California.

Migratory Bird Treaty Act (MBTA). 1918. 16 United States Code (USC) § 703-712. July 13, 1918.

National Environmental Policy Act (NEPA). 1970. 42 United States Code (USC) 4321-4370h. Pub. L. 91–190, § 2, Jan. 1, 1970, 83 Stat. 852

Pagel, J. E., D. M. Whittington, and G. T. Allen. 2010. Interim Golden Eagle Technical Guidance: Inventory and Monitoring Protocols; and Other Recommendations in Support of Golden Eagle Management and Permit Issuance. US Fish and Wildlife Service (USFWS). February 2010. Available online at: http://steinadlerschutz.lbv.de/fileadmin/www.steinadlerschutz.de/terimGoldenEagleTechnicalGuidanceProtocols25March2010_1_.pdf

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonata. 2010. Novel scavenger removal trials increase wind turbine-caused avian fatality estimates. Journal of Wildlife Management 74: 1089-1096.

Smallwood, K.S. 2013. Comparing bird and bat fatality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37: 19-33.

US Fish and Wildlife Service (USFWS). 2003. Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines. http://www.fws.gov/habitatconservation/wind.html.

US Fish and Wildlife Service (USFWS). 2008. Birds of Conservation Concern 2008. December 2008. Division of Migratory Bird Management. Arlington, Virginia. http://www.fws.gov/migratorybirds/NewReportsPublications/SpecialTopics/BCC2008/BCC2008.pdf

US Fish and Wildlife Service (USFWS). 2010. Interim Guidance for Solar Energy Facilities.

US Fish and Wildlife Service (USFWS). 2012. U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines.

Appendix A. Incidental bird and bat mortalities and injuries previously reported during construction of Desert Sunlight Solar Farm Project as of October 31, 2014 (First Solar 2014).

Bird Species Common Name (AOU English Name)	Count
Western Grebe	25
Eared Grebe	16
American Coot	10
American Avocet	7
Unidentified Bird	7
Loggerhead Shrike	6
Mourning Dove	6
Common Loon	5
Sora	5
Wilson's Warbler	5
Brown Pelican	4
Common Raven	4
Double-crested Cormorant	4
Great-tailed Grackle	4
Ruddy Duck	4
Ash-throated Flycatcher	3
Brown-headed Cowbird	3
Common Poorwill	3
Horned Lark	3
Sagebrush Sparrow	3
Townsend's Warbler	3
Western Tanager	3
White-crowned Sparrow	3
Yellow-headed Blackbird	3
Black-headed Grosbeak	2
Brewer's Blackbird	2
Common Yellowthroat	2
Costa's Hummingbird	2
House Finch	2
Lesser Nighthawk	2
Pied-billed Grebe	2
Say's Phoebe	2
Unidentified Sparrow	2
Virginia Rail	2
Yellow-rumped Warbler	2
American Kestrel	1

Bird Species Common Name (AOU English Name)	**Count**
American White Pelican	1
Barn Owl	1
Black-crowned Night-Heron	1
Black-tailed Gnatcatcher	1
Blue-winged Teal	1
Burrowing Owl	1
Clapper Rail	1
Common Merganser	1
Great Egret	1
Lesser Scaup	1
Long-eared Owl	1
Mallard	1
Northern Mockingbird	1
Prairie Falcon	1
Red-breasted Merganser	1
Redhead	1
Red-necked Phalarope	1
Red-winged Blackbird	1
Savannah Sparrow	1
Surf Scoter	1
Tree Swallow	1
Unidentified Blackbird	1
Unidentified Duck	1
Unidentified Empidonax Flycatcher	1
Unidentified Hummingbird	1
Unidentified Jaeger	1
Verdin	1
Western Meadowlark	1
White-faced Ibis	1
White-winged Dove	1
Wilson's Snipe	1
Yellow Warbler	1
Bird Total	194
Bat Species	
California Myotis	1
Pallid Bat	1
Townsend's Big -eared Bat	1
Western Mastiff Bat	1

Bird Species Common Name (AOU English Name)	**Count**
Bat Total	4
Grand Total	198

Appendix B
Summary of Statistical Simulations for Experimental Design from CVSR

Recent statistical power and precision analyses conducted for another solar project being built roughly 193 km (120 miles) north of the Project site provides some guidance for developing a spatial sampling regime (TerraStat Consulting Group 2013). These simulations were based on projected sampling across an entire 392-MW solar thermal facility, so the results may not accurately reflect the expectation at facilities of different sizes or where sampling is constrained to smaller portions of a large facility; nevertheless, the general guidance they provide is useful. The simulation analyses were parameterized based on several wind-energy studies conducted in the Mojave Desert, and incorporated one of several well-studied mathematical approaches for estimating fatality rates adjusted for proportion of area sampled, search interval, searcher efficiency, and carcass persistence (Shoenfeld 2004). The power analyses assessed the effect of varying the proportion of area sampled from 1% to 30%, using search intervals of 7, 21, and 25 days, and simulating four hypothetical mortality rates (0.5, 1.0, 5.0, and 10 fatalities/MW/year), assuming exponentially distributed carcass removal rates with means of 7.4 or 21.8 days and searcher efficiencies of 0.55 and 0.69 for small and large birds, respectively. The simulation results indicated that the 90% confidence interval for the facility-wide fatality estimate narrowed as the survey area increased, as the search interval decreased, and as the simulated mortality rate increased. The coefficient of variation (CV: $100\% \times$) provides a way to evaluate the relative amount of imprecision in an estimate. The CV is useful because it doesn't depend on the size of the estimate and so can be compared between large and small estimates. Larger values of CV are associated with estimates that are less precise: a CV of 100% indicates an estimate with a standard deviation that is equal to the mean. At all of the simulated mortality rates, and based on a 21-day search interval, the CV for the fatality estimates approached an asymptote once the proportion of area searched reached about 20%. In addition, at the 20% sample level, the CV for the fatality estimates was less than 25% for mortality rates that exceeded 1.0 fatality/MW/year. This level of precision generally is considered adequate for answering the primary questions of interest in such fatality studies (Strickland et al. 2011), and is consistent with guidance from the USFWS Land-Based Wind Energy Guidelines (2012), which states that "the carcass searching protocol should be adequate to answer applicable Tier 4 questions at an appropriate level of precision to make *general* conclusions about the project*, and is not intended to provide highly precise measurements of fatalities*" (p. 45; emphasis added). At the lowest simulated mortality rate, with a 21-day search interval, the coefficient of variation was above 50% at 20% of area sampled, which would be considered a marginal precision level for answering the questions of interest. From a practical standpoint, the importance of precision is diminished if impacts are low. For example, if the take estimate is 0.1 bird per year with 200% CV, this suggests a 90% confidence interval of about (0, 0.4), or a range of less than half a bird per year. On the other hand, if the take estimate is 100 birds per year and the CV is 20%, the 90% confidence interval is (61, 139), or a range of 78 birds per year.

At the lower simulated mortality rates, increasing the proportion of area sampled from 20% to 30% had less impact on the precision compared to decreasing the search interval from 21 days to 7 days. For the two highest simulated mortality rates, however, varying the search interval had less effect on the precision of the adjusted fatality estimates, whether based on 20% or 30% of area sampled, with the CVs remaining between about 8% - 19%. At the 1.0

fatality/MW/year mortality rate with 20% of the area sampled, the CV increased from about 25% with a 7-day search interval to about 40% with a 21-day search interval. At the 0.5 fatalities/MW/year mortality rate with 20% of the area sampled, the relevant change in the CV was from 37% to 57%.

Analysis of data from the CVSR in San Luis Obispo County, California (H.T. Harvey and Associates 2014) corroborates the simulation results. The CVSR is a recently completed 250-MW facility comprising nine discrete photovoltaic solar arrays, which collectively cover approximately 642 ha (1,586 acres) of primarily degraded annual grassland. Beginning in fall 2012, 100% of two arrays were surveyed weekly for bird and bat fatalities using 50-foot transects for large birds and 20-foot transects for bats and small birds. A total of 175 avian fatalities were found during standardized surveys in the two arrays over 10 months. The Huso (2010) estimator was used to estimate the number of fatalities based on documented fatalities adjusted for searcher efficiency and carcass persistence.

Two methods were used to evaluate the potential effects of reduced search area on fatality estimates at CVSR. Spatial clustering of fatalities was evaluated using Global Moran’s I index, which indicates whether objects are clumped, uniform, or random in their spatial distribution (ESRI ArcInfo 10.0, geographic statistical toolbox). Spatial clumping of fatalities within the individual arrays would introduce additional uncertainty into the fatality estimates if sampling covered considerably less than 100% of the survey area. The second method involved resampling the observed fatality data to generate distributions of fatality estimates that would have resulted from searching less than 100% of the study area. Sample sizes varied from one sample unit up to the total number of sample units in the study area (180). (At CVSR, a sample unit was one “tracker unit,” a group of 18 rows of solar panels covering approximately 0.34 ha (0.85 acres); sample units at CVSR were about a quarter the size of the proposed sample units at Desert Sunlight.) For each sample size, 2,000 simulated datasets were generated from the original data. Then, for each simulated dataset, the total number of fatalities for the study area was calculated by scaling the sample count according to the proportion of area represented in the sample. This procedure resulted in a distribution of possible fatality estimates for each level of area sampled. Based on these distributions, means, 90% confidence intervals (CI), and CVs were calculated for each sample size to evaluate the effect of sampling variation on the magnitude and precision of the fatality estimates.

The geospatial analysis indicated that the distribution of fatalities in the two, 100% searched arrays did not differ significantly from a random distribution (H.T. Harvey and Associates 2014). Results of the resampling analysis indicated that the mean fatality estimates and the 90% CIs for those estimates stabilized at about 20% of area sampled (Figure 1). Examined in a different way, the results indicated that the CVs of the sample distributions declined with increasing sample size and that, again beyond about 20% of area sampled, further increases in area sampled resulted in only small increases in precision (Figure 2). Moreover, at the 20% sample level, the CV for the fatality estimates was well below 20%, which is a level of precision that is considered adequate for answering the primary questions of interest in such fatality studies (Strickland et al. 2011, USFWS 2012). With regard to applying these results to other sites, it is important to note that the results may be sensitive to: 1) the relative proportions of large and small birds represented in the fatality sample, which were combined for this analysis; 2) the number and distribution of fatalities across the site; and 3) the influence of variation in searcher efficiency and carcass persistence.

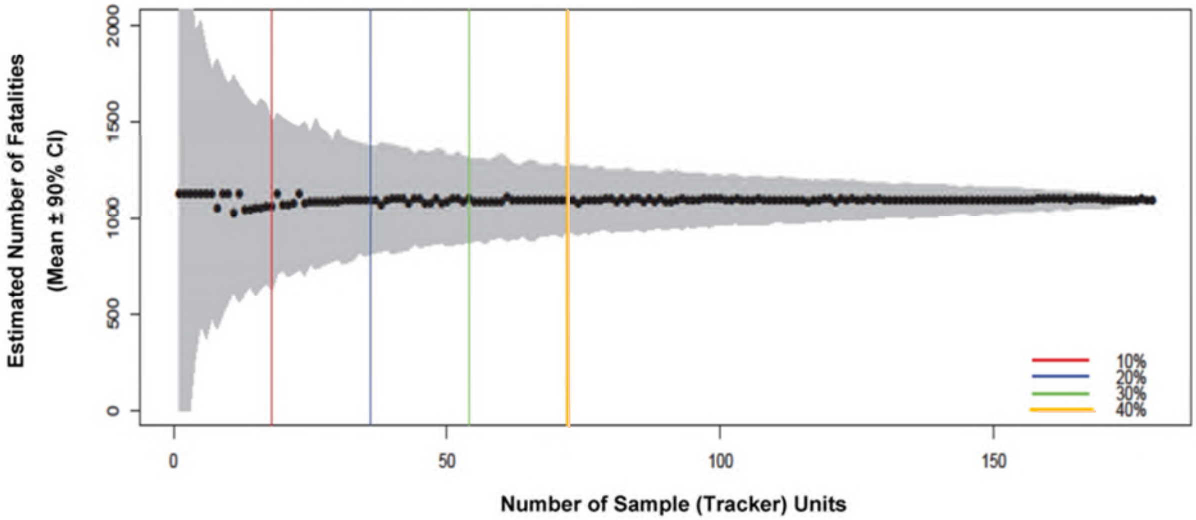


Figure 1. Resampling results from the California Valley Solar Ranch illustrating how the accuracy and precision of fatality estimates and varies with proportion of area sampled.

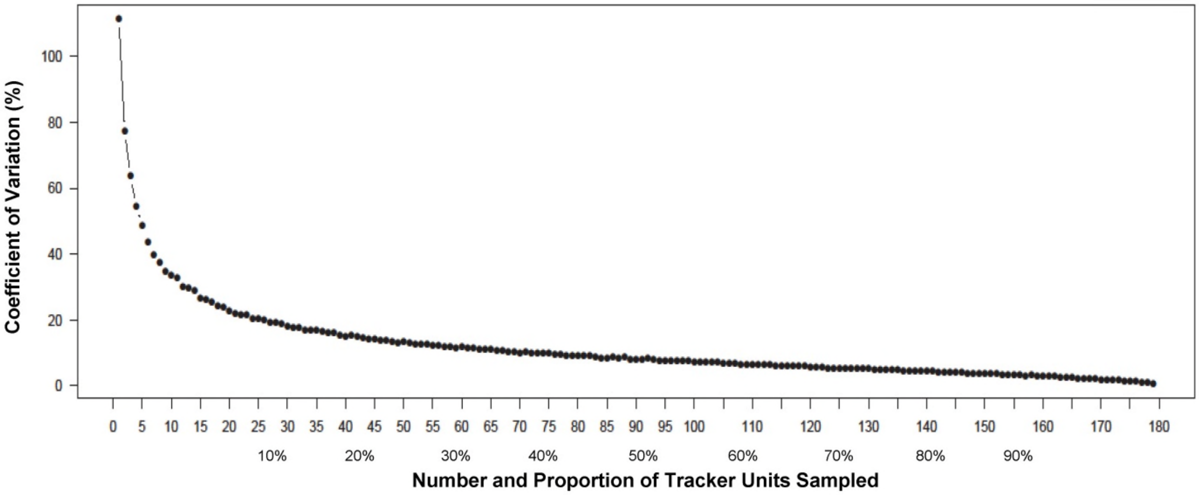


Figure 2. Resampling results from the California Valley Solar Ranch illustrating how the coefficient of variation for fatality estimates varies with proportion of area sampled.

Appendix C
Desert Sunlight Wildlife Incident Reporting System (WIRS)

DESERT SUNLIGHT
WILDLIFE INCIDENT REPORTING SYSTEM (WIRS)

BACKGROUND AND INTRODUCTION

Desert Sunlight will voluntarily implement a wildlife incident response and reporting system. Desert Sunlight will record and report all dead and injured wildlife including but not limited to birds found incidentally in the project areas over the entire life of the project as part of the project operations and monitoring efforts. The purpose of this Wildlife Incident Reporting System (WIRS) is to standardize the actions taken by site personnel in response to wildlife incidents found within project boundaries. The WIRS provides direction for site personnel who may encounter a wildlife incident in an effort to fulfill obligations in reporting wildlife incidents. Wildlife fatalities or injuries found by project personnel or others will be reported and processed following the protocols described in this document.

DESERT SUNLIGHT WIRS POLICY

This WIRS will be active for the life of the solar projects. All employees, contractors and subcontractors of Desert Sunlight have a responsibility to comply with all environmental laws and regulations. Most birds are protected by the federal MBTA, and eagles are further protected by the BGEPA. In addition, the state of California has an Endangered Species Act (CESA). Under the federal statutes, it is illegal to harm, harass, kill, or collect birds that may be found in the solar facility. A summary of these statutes is presented below. It is recognized that other wildlife including bats are generally not protected by federal or state law unless listed as a threatened or endangered species. However, it is the policy of FS to treat all wildlife incidents the same as avian incidents and include them in the WIRS.

It is illegal to collect an injured or dead bird without appropriate federal and state permits. **THE TOUCHING, POSSESSION, TRANSFER, OR TAMPERING WITH ANY WILDLIFE SPECIES (ALIVE OR DEAD) BY DESERT SUNLIGHT EMPLOYEES OR SUBCONTRACTORS IS STRICTLY PROHIBITED UNLESS CONSISTENT WITH PERMITS.** The WIRS is designed to provide a means of recording and collecting data about wildlife species found in the solar facilities to increase the understanding of solar and wildlife interactions. Desert Sunlight maintains an ongoing commitment to investigate wildlife incidents involving company facilities and to work cooperatively with federal and state agencies in an effort to minimize the potential for future bird and wildlife fatalities. The objective of this policy is to insure that the best available information about wildlife incidents found in Desert Sunlight facilities is recorded and the proper authorities are notified. It is the responsibility of Desert Sunlight employees, contractors and subcontractors to report all wildlife incidents as outlined in this WIRS.

APPLICABLE LAWS AND REGULATIONS

Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918 (MBTA) (16 USC 703-712) is the cornerstone of migratory bird conservation and protection in the United States. The MBTA implements four treaties that provide for international protection of migratory birds. It is a strict liability statute wherein proof of intent is not an element of a "taking" violation. Wording is clear that most actions resulting in a taking or possession (permanent or temporary) of a protected species can be a violation, regardless of intent.

Specifically, the MBTA states: “Unless and except as permitted by regulations...it shall be unlawful at any time, by any means or in any manner, to pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess…any migratory bird, any part, nest, or egg of any such bird…(The Act) prohibits the taking, killing possession, transportation, and importation of migratory birds, their eggs, parts, and nests, expect when specifically authorized by the Department of the Interior." The word "take" is defined as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap capture, or collect."

The MBTA protects 836 species of migratory birds (listed in 50 CFR 10.13), including waterfowl, shorebirds, seabirds, wading birds, raptors, and passerines. Generally, the MBTA protects all birds in the U.S. except upland gamebirds (e.g., pheasant, quail, etc), rock doves (pigeons), European starlings, and English house sparrows. Nearly all birds found at Desert Sunlight are protected under the MBTA.

Bald and Golden Eagle Protection Act

In June 1940, Congress signed into law the Bald and Golden Eagle Protection Act (BGEPA) (16 USC 668-688d) which affords additional protection to the bald and golden eagle. Specifically, the BGEPA states: “Whoever, with the United States or any place subject to the jurisdiction thereof, without being permitted to do so as provided…shall knowingly or with wanton disregard for the consequences of his act take, possess, transport…at any time or in any manner, any bald or golden eagle, alive or dead, or any part, nest or egg thereof shall be fined…that the commission of each taking or other act prohibited by this section, with respect to a bald or golden eagle, shall constitute a separate violation of this section." Penalties for violations of the BGEPA are up to $250,000 and/or 2 years imprisonment for a felony (violations are defined as a felony), with fines doubled for organizations. FS

Endangered Species Act

In 1973, the Endangered Species Act (ESA) (16 USC 1513-1543) was passed to protect endangered and threatened species and to provide a means to conserve their ecosystems. Under the ESA, Federal agencies are directed to utilize their authorities to conserve listed species, as well as "Candidate" species that may be listed in the near future, and make sure that federal agencies' actions do not jeopardize the continued existence of these species. As with the MBTA and the BGEPA, the ESA as amended prohibits the taking of species listed under the act as threatened or endangered.

BLM Sensitive Species

BLM Sensitive Species are species designated by the State Director and includes only those species that are not already federal listed proposed, or candidate species, or State listed because of potential endangerment. BLM's policy is to "ensure that actions authorized, funded, or carried out do not contribute to the need to list any of these species as threatened or endangered."

California Fish and Game Code

Sections 3511, 4700, 5050, and 5515 of the California Fish and Game Code outline protection for fully protected species of mammals, birds, reptiles, amphibians, and fish. Species that are fully protected by these sections may not be taken or possessed at any time. CDFW cannot issue permits or licenses that authorize the "take" of any fully protected species, except under certain circumstances such as scientific research and live capture and relocation of such species pursuant to a permit for the protection of livestock. Furthermore, is the responsibility of the CDFW to maintain viable populations of all native species. To that end, the CDFW has designated certain vertebrate species as Species of Special Concern because declining population levels, limited ranges, and/or continuing threats have made them vulnerable to extinction**.**

DESERT SUNLIGHT WILDLIFE INCIDENT REPORTING

The following procedures are to be followed when Desert Sunlight personnel or subcontractors discover a wildlife fatality or injury while on site. These procedures are intended to be in place for the life of the project and are independent of the post-construction monitoring studies. Prior to the initiation of operations, on-site training will be provided to Desert Sunlight personnel and subcontractors regarding the implementation of this WIRS.

When To Use The WIRS - What Constitutes A Reportable Incident?

For the purposes of this reporting system, *incident* is a general term that refers to any wildlife species, or evidence thereof, that is found dead or injured within the wind project. Note that an incident may include an injured animal and does not necessarily refer only to a carcass or fatality.

An intact carcass, carcass parts, bones, scattered feathers, or an injured wildlife species all represent reportable incidents. Desert Sunlight personnel and subcontractors shall report all such discoveries even if you are uncertain if the carcass or parts are associated with the facility.

> A ***fatality*** is any find where death occurred, such as a carcass, carcass parts, bones, or feather spot (10 or more feathers).
>
> An ***injury*** or injured animal is any wildlife species with an apparent injury, or that exhibits signs of distress to the point where it cannot move under normal means or does not display normal escape or defense behavior.

Prior to assuming a wildlife species is injured, it should be observed to determine if it cannot or does not display normal behaviors. For example, raptors will occasionally walk on the ground, especially if they have captured a prey item. Raptors also "mantle" or hold their wings out and down to cover a prey item. These types of behaviors may make the wings appear broken or the animal injured. Identification of specific behaviors typical to the life cycles and distress behaviors of wildlife will be part of the Desert Sunlight wildlife training program. Always exercise caution before approaching an injured wildlife species. **Under no circumstances are site personnel that are not included in the SPUT permit allowed to handle carcasses or injured animals.**

Note: *Any incident involving a federally or state listed threatened or endangered species, bald eagle, or golden eagle must be reported to USFWS and/or California Department of Fish and Wildlife (CDFW) within 24 hours of identification. See project personnel listing for contact information.*

MATERIALS NEEDED TO REPORT AN INCIDENT

1. A copy of this WIRS

2. A Wildlife Incident Report Form (see Attachment 1)
3. Project Personnel Listing and Contact Information
4. Pencil, Pen
5. Camera
6. Flagging

DESERT SUNLIGHT WILDLIFE INCIDENT REPORTING PROCEDURES

The following procedures apply if the incident involves a **Wildlife Fatality** or **Injured Wildlife Species**:

- **Leave the subject animal in place**. A flag may be used to mark its location for easy finding while the data sheet is being completed. It is recommended that any flagging be marked with the date, time, and initials of the recorder. **DO NOT HANDLE THE CARCASS.**
- **Report** the find to the Site Operations Manager immediately.
- The Site Operations Manager shall complete the following steps:
    - **Photograph** the incident as it was found in the field. Take at least two pictures: a close up shot of the animal as it lays in the field and a broader view of the animal (marked by a flag) with the road, turbines, or other local features in the view. For the close up picture, place an object (e.g., radio, pencil, coin, etc.) next to the carcass for a scale of size.
    - **Prepare a Wildlife Incident Report Form.** The form and associated instructions are presented below.
    - **Report** the find to Desert Sunlight's Environmental Department.

The following procedures apply if the incident involves an **Injured Wildlife Species**:

- **Move** to a distance far enough away that it is not visibly disturbed or uneasy due to your presence. **DO NOT ATTEMPT TO CAPTURE OR HANDLE AN INJURED ANIMAL.**
- **Report** the find immediately to the Operations Site Manager
- The Site Operations Manager shall complete the following steps:
    - **Report** the find to the Environmental Affairs Lead immediately.
    - **Contact** a local rehabilitation center (*see contact list below*) for further instructions on handling and transport/pickup of the injured animal.
    - **Prepare a Wildlife Incident Report Form.** The form and instructions for filling out the form are provided below.

*** Any incident involving a federally or state listed threatened or endangered species or a bald or golden eagle must be reported to the USFWS and/or CDFW within 24 hours of identification. These**

incidents will be reported to the agency verbally by the Operations Manager or Desert Sunlight's Environmental Department.

DESERT SUNLIGHT
WILDLIFE INCIDENT REPORTING FORM

INCIDENT DETAILS

Project Location/Name:

Name of Observer/s:_________________________ Date: ______________ Time: _________

Type of Incident: ☐ Injury ☐ Fatality

Carcass Condition: ☐ Intact Carcass ☐ Partial Carcass ☐ Feathers Only

Age of Remains (days): ☐ 1-2 (fluid filled eyes) ☐ 2-4 (maggots) ☐ 5+ (dried bones/feathers)

Photos Taken: ☐ Yes ☐ No (Take photos of - Birds: beak, legs, feathers, body. Wildlife: face and ears, tail and feet, body)

Who was notified of incident? (see contact list below)____

Comments on Carcass Condition or Behavior of Injured Animal:_______________________________________
____

LOCATION

Where Found: ☐ On Access Road ☐ Solar Array ☐ Under Power Line ☐ Substation

GPS Coordinates: UTM N:_________________ UTM E:_________________ DATUM:__________

Comments on Location:____

IDENTIFICATION

☐ Bird ☐ Bat ☐ Mammal ☐ Other:__________________________

Species (to best of ability):____

Description of Color/Markings:____

Does Animal Resemble a Species of Concern discussed at Training? ☐ Yes ☐ No

Identification Remarks:____
_

(Describe details of - Birds: beak size, color, and shape; leg size, color, and shape; feather color; body size. Bats: color of fur and wings; muzzle long or short, tail attached or extending; ear color and shape); Other Wildlife: color of fur, any markings, and body size.

ENVIRONMENTAL CONDITIONS

Weather (Check all that apply): ☐ Clear ☐ Cloudy ☐ Rain ☐ Dust Storm

Approximate Temperature (F°):_________

Wind: ☐ Calm ☐ Breezy/Gusty ☐ Strong Winds

Habitat where found: ☐ Gravel (access road/turbine pad) ☐ Bare Ground ☐ Wash ☐ Desert scrub

OTHER NOTES/COMMENTS:____

CONTACT LIST (Immediately notify one of these individuals of incident)

1. Operations Manager:
2. Environmental Affairs Lead:

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Ecological Services
Palm Springs Fish and Wildlife Office
777 East Tahquitz Canyon Way, Suite 208
Palm Springs, California 92262

In Reply Refer To:
FWS-ERIV-08B0789-15TA0228

MAR 10 2015

Memorandum

To: Deputy State Director, California State Office, Bureau of Land Management
Sacramento, California
Attention: Amy Fesnock

From: Assistant Field Supervisor, Palm Springs Fish and Wildlife Office
Palm Springs, California

Subject: Bird and Bat Conservation Strategy for the Desert Sunlight Solar Project in Riverside County, California

The U.S. Fish and Wildlife Service (Service) appreciates the continued coordination among the Renewable Energy Action Team (REAT) agencies on project-specific planning, environmental review, and development of compliance plans, including Bird and Bat Conservation Strategies (BBCS). The Bureau of Land Management (BLM) recently approved the BBCS for the Desert Sunlight Solar Project. We have provided substantive comments on several iterations of the draft BBCS that were not incorporated into the accepted version, and would like to highlight the importance of the monitoring program within the adaptive management[1] framework as a means of addressing and evaluating our stated concerns. As we learn more about the relationship between solar facilities and avian impacts, we anticipate the need for further refinement of this and other project-level BBCSs, as monitoring results and changing agency policy may warrant.

Because utility-scale solar development is a relatively nascent industry, systematic monitoring designed to assess the impacts associated with construction and operation of these types of facilities has not been conducted. Consequently, our current scientific understanding of the effects of all aspects of facility operations (e.g., noise, lighting, panels, utility lines, etc.) on bird and bat impacts, such as differential effects on behaviors and mortality rates of resident and migratory species, and changes in population status of those groups, is limited.

---

[1] Adaptive management is an iterative, science-based process that involves: (a) formulating alternative actions to meet measurable objectives; (b) predicting the outcomes of alternatives based on current knowledge; (c) monitoring to test the assumptions underlying those predictions; (d) implementing alternatives; (e), monitoring the results; and (f) using the monitoring results to improve knowledge and adjust actions and objectives accordingly.

The Service will participate in the Technical Advisory Group (TAG) that has been established for this project. Therefore, in preparation for the TAG process, we offer the following key components of the BBCS that will best help the REAT agencies better understand the risks to avian communities and how best to avoid and minimize impacts to migratory birds on this and other solar energy projects. Among other issues, we will ask that the TAG address the topics below as part of their responsibilities.

- The Desert Sunlight Solar Project will be one of the first utility-scale solar projects where systematic mortality monitoring will be conducted. Accordingly, the adaptive management section of the BBCS focuses on the mortality monitoring component of the plan; however, discussions regarding effectiveness monitoring of existing conservation measures and the identification of metrics or thresholds necessary to trigger implementation of additional conservation measures should be articulated in the plan. These types of metrics will be useful in addressing impacts that may not have been accounted for during the permitting process. We believe it will be important for the TAG to consider effectiveness monitoring in the adaptive management process to minimize adverse effects to the extent feasible.

- To our knowledge, distance sampling has never been used for this application (mortality monitoring on wind and solar projects). Due to site-specific conditions (obstructed visibility inherent to the project panel configuration), 100 percent of the proposed search area may not be adequately observed. Therefore, additional survey area may be needed to meet the stated objective to survey 30 percent of the solar field. The TAG should evaluate the results after each monitoring season and make recommendations to BLM to modify the methodology, if warranted.

- The BBCS establishes mixed monitoring intervals (7 and 21 days) for different seasons. Longer monitoring intervals are not supported by the Corvus carcass persistence trials performed on the Desert Sunlight site to date, HT Harvey's detectability study, and much of the available literature from the Mojave region. Longer survey intervals could introduce a bias toward larger bodied species, with medium and smaller sized species being under-represented. This bias could be further complicated by sampling only a subset of the fall and spring migration periods. Consequently, these intervals coupled with the distance sampling method as proposed, could result in statistically significant under-sampling, which cannot be corrected for using estimators. We suggest the TAG evaluate the methods and results in accordance with an agreed upon schedule as discussed below.

- There are over 400 species of resident and migratory birds known to occur in this region (Rosenberg et al. 1991, Patten et al. 2003). The migration periods specified in the BBCS are inadequate to cover the suite of species that have been documented in the area. We will work within the framework of the TAG to review a subset of avian species migratory patterns and make recommendations to adjust the migration monitoring periods, as appropriate, to avoid bias where possible, in the mortality monitoring results.

- Mortalities of rare species have been documented at this and other solar facilities in the California desert. Currently, the BBCS includes systematic monitoring of 30 percent of the solar field; however, this level of survey effort may not be sufficient to detect rare mortality events of uncommon and/or listed species, such as Yuma Ridgway's rail. New modeling tools, such as the Evidence of Absence tool (Huso *et al.* in press), have recently become available and can be used to inform what level of monitoring will be needed to increase the level of confidence that a rare mortality event has not occurred during the monitoring period. We recommend that the TAG assess whether the use of this tool should be used to inform future monitoring efforts.

- The BBCS allows the use of monitoring personnel who do not have academic ornithological and field ecology/biology background or personnel with limited experience in the desert Southwest. While training will be conducted, locating carcasses can be quite difficult, especially for surveyors unfamiliar with scientific principles, and measurements for distance sampling will need to be precise to support a robust analysis. An assessment of searcher efficiency rates and a complete description of methods [i.e., the number, size (weight), and species of trial carcasses used, exact time and location of carcass placement, surveyor detectability thresholds, etc.] should be reviewed periodically by the TAG to determine if modifications are warranted.

  Accurate identification of species is critical to understanding which species/taxa may be at risk from the project. We appreciate that an Authorized Avian Biologist will be available to ensure proper identification of carcasses and implementation of collection protocols and that a biologist will be on-site during monitoring periods to provide oversight. However, for carcasses and feathers that the Authorized Avian Biologist cannot identify, we would like to establish a process to have these items identified by a federally permitted natural history museum, ornithological research institution, or public wildlife forensic laboratory approved by the Service.

- As part of our efforts to gain a better understanding of cumulative impacts associated with solar projects throughout the desert region, biological samples from bird carcasses need to be collected. Identification of affected sub-populations of priority species is needed to help determine the significance of demographic impacts. Determination of the sub-species and regional populations affected require the collection of morphometric, genetic, and isotope data from collected carcasses (including those currently in storage on the project site).

One of the primary functions of an effective mortality monitoring program is to obtain the data necessary for the TAG to make informed decisions on the implementation and/or modification of conservation actions needed to reduce the impacts of mortality. Data are also needed to assist the TAG in determining the effectiveness of those conservation actions once they are adopted. We recommend that the TAG review the site-specific avoidance and minimization measures implemented to date by the project proponent, and assess whether effectiveness monitoring data could be collected to determine the utility of these and any future conservation actions.

The BBCS for Desert Sunlight states that the TAG meets subsequent to each monitoring season to review results of the carcass persistence, searcher efficiency, and mortality monitoring surveys. Seasonal meetings will allow the TAG to evaluate the concerns listed above and recommend any necessary adjustments to the monitoring methods prior to the next seasonal survey, if warranted and the meeting schedules allow.

We also recommend that an annual comprehensive report that includes mortality estimates for all birds and key taxa identified by the TAG, an analysis of meteorological data, taxa-specific migration information that may affect avian presence on and around the project site during the monitoring period, be submitted to the TAG after each full year of monitoring. The report should analyze the assumptions associated with the protocol, monitoring methods employed, and results that inform any conclusions. Based on a review of the report, the TAG may recommend continuation of the current protocol or recommend modifications to the methods to better achieve the monitoring goals and objectives.

We look forward to participating in the TAG and working together to develop and implement a meaningful adaptive management strategy that will facilitate conservation of our shared trust resources. If you have any questions regarding these comments or our recommendations, please contact Thomas Dietsch in our Division of Migratory Birds at thomas_dietsch@fws.gov; (760) 431-9440, extension 214 or Jody Fraser in the Palm Springs Fish and Wildlife Office at jody_fraser@fws.gov; (760) 322-2070, extension 207.

cc:
Magdalena Rodriguez, California Department of Fish and Wildlife, Ontario, California

LITERATURE CITED

Huso, M.M.P., D. Dalthorp, D. Dail, L. Madsen. In press. Estimating wind-turbine caused bird and bat fatality when zero carcasses are observed. Ecological Applications.

Patten, M.A., G. McCaskie, and P. Unitt. 2003. Birds of the Salton Sea. University of California Press. Berkeley, CA, 363 p.

Rosenberg, K.V., R.D. Ohmart, W.C. Hunter, and B.W. Anderson. 1991. Birds of the Lower Colorado River Valley. University of Arizona Press. Tuscon, AZ, 416 p.

ALTHOUSE AND MEADE, INC.
BIOLOGICAL AND ENVIRONMENTAL SERVICES

1602 Spring Street, Paso Robles, CA 93446
(805) 237-9626 • Fax (805) 237-9181 • www.althouseandmeade.com

Memo

To: Dave Hacker (CDFW), and John McKenzie (County of San Luis Obispo)

Cc: Wendy Greene (BHE Renewables)

From: Jason Dart

Date: June 8, 2015

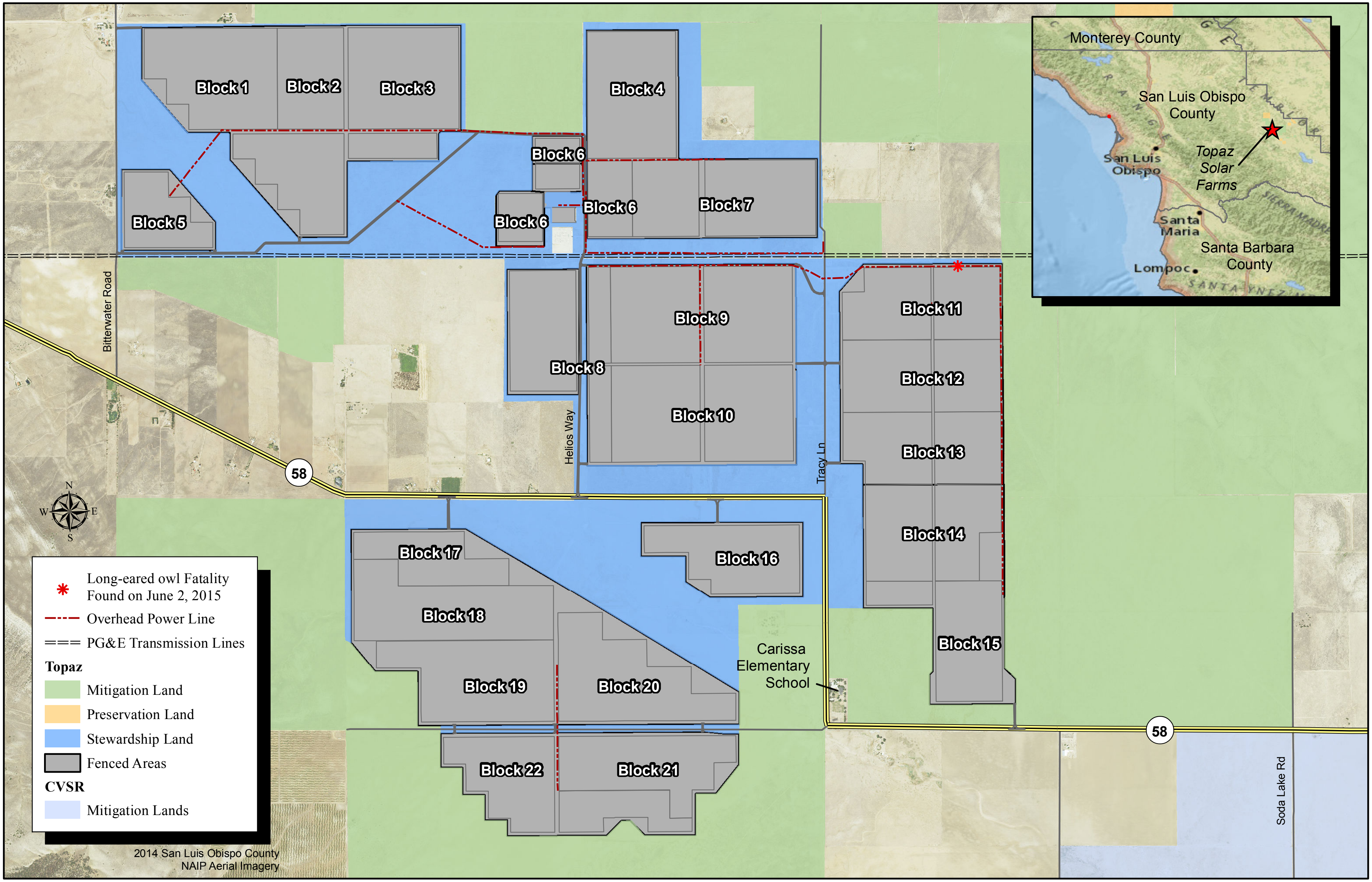
Re: Notification of Long-eared Owl Fatality

In accordance with the Conditional Use Permit (CUP) and Tract Map DRC2008-00009 & SUB2010-00060/Topaz Conditions of Approval (COA) 43l, this memorandum serves as formal written notification of the finding of a dead special status wildlife species at the Topaz Solar Farms project.

On June 2, 2015 during Avian Fatality Surveys an Althouse and Meade, Inc. biologist detected a group of feathers from an owl along a medium voltage collection line transect in Block 11 (Figure 1 attached). On June 8 the feathers were confirmed to be from a long-eared owl (*Asio otus*), a California Species of Special Concern. The feathers included primaries, secondaries, and coverts from a right wing. The primaries were in a clump, attached at the base by flesh. Condition and location of the wing, and damage to the base of the shafts, is consistent with raptor predation, but actual cause of death is unknown.

A long eared owl nest located in trees at the Carissa Elementary School is the only known nest location in the vicinity of Topaz Solar Farms. At least three fledglings were observed in 2015 at this nest.

Figure 1. Location of Long-Eared Owl Fatality at Topaz Solar Farms



BHE RENEWABLES

ALTHOUSE AND MEADE, INC.
BIOLOGICAL AND ENVIRONMENTAL SERVICES

Post-Construction Monitoring at the Desert Sunlight Solar Project Riverside County, California

---

2015 Spring Report

Prepared for:

Desert Sunlight 250, LLC and
Desert Sunlight 300, LLC
700 Universe Blvd.,
Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.
415 West 17th Street, Suite 2000
Cheyenne, Wyoming

July 17, 2015

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from February 10 to May 31, 2015 (the reporting period) at Desert Sunlight Solar Farm Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the first seasonal report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS.

The spring season at the Project is defined as March 01 to May 31. Included in this report are data from the spring season and data collected from February 10-28. Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 29.5% sample of solar photovoltaic (PV) panels, 2) along inner portions of the fenceline, resulting in 74.4% of the length of the perimeter fence, and 3) along 47.9% of the total length of generation-tie (gen-tie) line from the Project fence to the Red Bluff Substation located south of Interstate 10 (I-10). The two searches conducted during February had an interval of approximately 16 days, and searches conducted within the spring season had intervals of approximately seven days.

Comentado [FWS1]: Pre-spring survey data are not meaningful and should probably be excluded. Please describe how these data were or were not incorporated into estimates.

All bird and bat fatalities and injuries that were discovered by observers, referred to as "detections" in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, 25 avian detections (including 1 injured bird) were made, while there were no detections of bats.

According to specifications of the BBCS, avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were applied to a fatality estimator model (Huso 2010) to provide a preliminary estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias. The estimate is considered preliminary because the annual report may pool information from bias trials and other data across seasons which could affect seasonal estimates.

Comentado [FWS2]: Please record and report the time of the surveys. This will help determine if the surveys can be used to predict nocturnal vs. diurnal mig behavior.

During the reporting period, carcass persistence was influenced by carcass size and Project component. Small carcasses (0-100 g) in the arrays and along the fence (combined) had a 0.54 probability (90% confidence interval [CI]: 0.47 – 0.61) of persisting through the 7-day search interval, medium carcasses (101 – 999 g) had a 0.82 (90% CI: 0.69 – 0.92) probability, and large carcasses (1000+ g) had a 0.94 (90% CI: 0.88 – 0.98) probability. Mean removal time within the arrays for small, medium, and large carcasses was 5.7, 29.8, and 126.8 days, respectively. Along overhead lines, probability of persistence for small, medium, and large carcasses were 0.29, 0.71, and 0.72, respectively; mean removal time for small, medium, and large carcasses was 2.0, 13.7, and 14.7 days, respectively. Within the solar arrays, searcher efficiency was influenced by carcass size: 60.0% for small birds, 87.2% for medium birds, and

Comentado [FWS3]: Please include median times and/or a curve showing # remaining over time.

97.3% for large birds. Along the fence, searcher efficiency ranged from 79.3% to 100% depending on carcass size class. Along overhead lines, searcher efficiency ranged from 53.9% to 87.8%.

Using the Huso (2010) fatality estimator model, during the spring period 2015, there were an estimated total 111 fatalities (90% CI: 58 - 193) at the Project. Of these, 49 fatalities (44.1%; 90% CI: 19 – 86) were estimated for the solar arrays, 2 fatalities (1.8%; 90% CI: 2 – 4) were estimated for the fence, and 60 fatalities (54.1%; 90% CI: 16 – 132) were estimated for the overhead lines (gen-tie and medium voltage overhead lines combined). During spring 2015, there were an estimated 0.02 carcasses per acre (49 estimated carcasses/2,585 acres) and an estimated 0.09 carcasses per nameplate MW (49 estimated carcasses/ 550 MW) within the solar field.

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Tracey Johnson	Research Biologist
Paul Rabie	Statistician
Andrea Polachek	Technical Editor
Tracey Johnson	Field Supervisor
Pamela Bullard	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2015. Post-construction monitoring at the Desert Sunlight Solar Farm Project, Riverside County, California. 2015 Spring Report. 43 pp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Project Background

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC (collectively, Desert Sunlight) constructed and operates the Desert Sunlight Solar Farm Project (referred to in this report as "Project"), which consists of two main components: 1) a 550-megawatt (MW) photovoltaic (PV) generating facility; and 2) a 220-kilovolt (kV) generation interconnection (gen-tie) line. The Project comprises approximately 1,700 hectares (ha; 4,200 acres) of land administered by the Bureau of Land Management (BLM) six miles north of Desert Center in Riverside County, California (Figure 1).

1.2 Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (2014; “BBCS”) was prepared by the Project proponent in collaboration with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), (BLM) to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency approval of the BBCS occurred in December 2014.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Desert Sunlight in collaboration with the USFWS, CDFW, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the gen-tie line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
3. Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

Figure 1. Desert Sunlight Solar Farm Project vicinity map, Riverside County, California.

1.3 Purpose of This Report

This report represents the first seasonal report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS. This report covers the period February 10 to February 28, 2015, as well as the 2015 spring season, which includes the period from March 01 to May 31, 2015. All bird and bat fatalities and injuries that were discovered by observers are referred to as “detections” in this report. As stated in the approved BBCS, this seasonal report includes the observed detections for likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and suspected causes of death. Species composition of detections and the results of the bias trials are also reported. This report presents information related to the spatial distribution of detections, but no formal statistical analysis of the spatial distribution of carcasses will be conducted until the end of the monitoring year, given the limited data presently available.

2.0 METHODS

The BBCS describes the methods by which monitoring and certain analyses, including compilation of the overall fatality estimate, will occur. Below is an abridged description (see BBCS for detailed methods).

2.1 Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. Dead or injured birds and bats are called detections in this report to provide consistency in naming. This section also describes the methods for conducting carcass removal and searcher efficiency trials; how data were reported and analyzed; and the methods for producing fatality estimates for the Project.

2.1.1 *Areas Surveyed*

Standardized carcass searches were conducted at sampling units, which include the solar arrays; the "fenceline" defined as the perimeter fence for the Project (Table 1, Figure 2); and the gen-tie line (from the Project fence to the Red Bluff Substation on the south side of I-10; Table 1, Figure 3). Some overhead lines co-occur with solar arrays (medium voltage overhead lines [MVOH]). The MVOH were part of standardized carcass searches to the extent that they co-occured with solar arrays included in the sample. Table 1 provides the total area of each component as well as the percent of each component that was searched.

Table 1. Areas included in standardized carcass searches at the Desert Sunlight Solar Farm Project during spring 2015 (including February).

Project Component	Total Size	Units	% of Component Searched
Solar arrays	1045.9	Hectares	28.2[1]
Solar arrays	1045.9	Hectares	1.3[2]
Solar arrays	1045.9	Hectares	1.3[3]
Fence	16.7	Kilometers	99%[4]
Gen-tie line	19.2	Kilometers	47.9[5]

[1] Percent area that was searched continuously since monitoring commenced in February 2015. Slightly less than 30% total (including areas affected by the tornado) because of unequal size arrays.

[2] Percent that was searched before the April 21, 2015 tornado but not after.

[3] Percent that was searched after the tornado but not before.

[4] 74.4% of the fence is fully accessible and surveyed following the standard protocol, while approximately 25% of the fence is surveyed from a distance. A very short segment near the gate is not sampled due to restoration activities

[5] 52.1% of gen-tie will be sampled in 2016.

Comentado [FWS4]: Please describe how detectability is being handled for the 25% being surveyed from a distance.

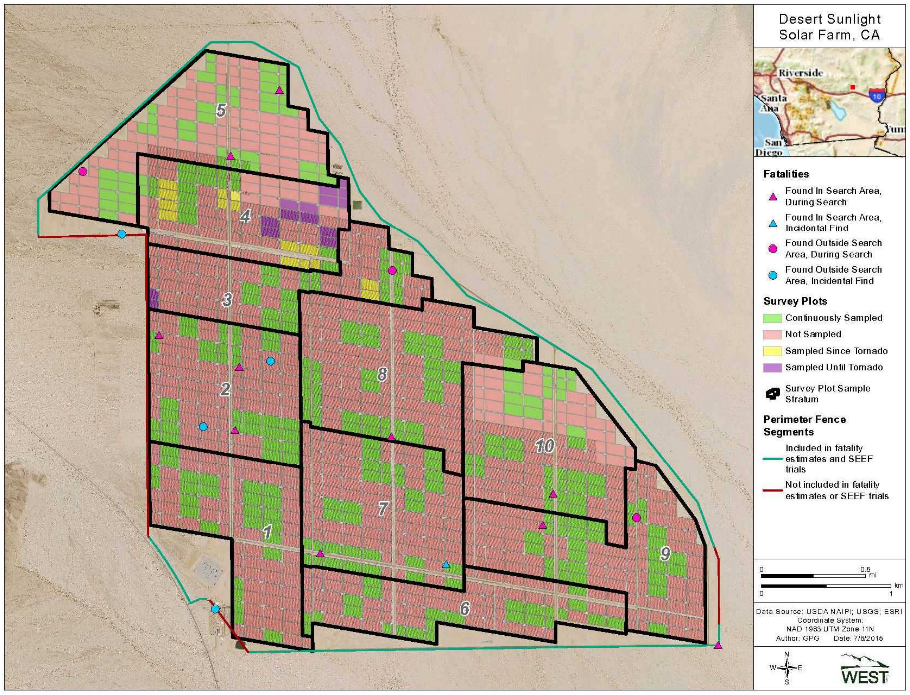


Figure 2. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at the solar field, fence, and overhead lines within the fence at Desert Sunlight Solar Farm Project during spring 2015 (including February). Because of the presence of medium voltage overhead lines within the solar arrays, some detections within the arrays were assigned to overhead lines.

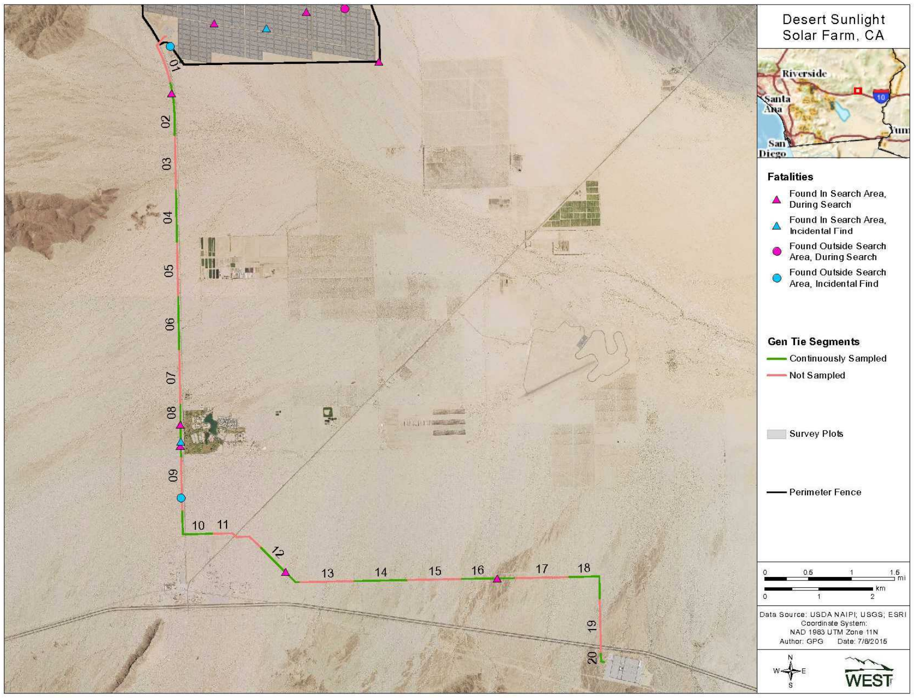


Figure 3. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance activities) along the generation tie line at the Desert Sunlight Solar Farm Project during spring 2015 (including February). Detailed maps of detections along the line are presented in Appendix A.

To ensure a balanced distribution of sample units in the solar field (defined as the collection of all photovoltaic [PV] solar panels), the entire field was divided into ten strata, and individual sampling units were randomly selected within each stratum to compose an approximately 30% sample. The solar field consists of arrays of solar panels (referred to as a solar array). This sampling design ensures that units included in the sample were not spatially clumped within the solar field.

2.1.1 *Search Frequency and Timing*

Standardized searches began February 10, 2015 (during the winter season outlined in the BBCS). The spring survey season includes the period from March 01 through May 31, 2015. All project components included in standardized searches were surveyed 14 times from February 10 to May 31, 2015 (twice in February and 12 times during spring).

The average search interval for all Project components included in standardized carcass searches during February was 16.1 days (median 15 days), and during spring was 7.1 days (median 7 days). Slight variation in search interval was anticipated due to weather and logistical delays. On April 21, 2015, the Project was struck by a tornado. The tornado damaged some of the sampling units, and resulted in limited access that ultimately lasted longer than initially expected. Thus, 142 sample units (128 arrays, fence, and gen-tie combined) were visited 14 times continuously and without interruption during the reporting period (two times in February and 12 times in spring). Six arrays were visited seven times before the tornado occurred; 3 weeks elapsed before the six damaged arrays were replaced with undamaged arrays. Five of the replacement arrays were visited twice and one was visited once.

Comentado [FWS5]: Based on persistence trials?

I suggest putting the carcass and searcher efficiency trials first since they dictate the timing of the standardized carcass searches.

Comentado [FWS6]: This is not clear. Please clarify how sampling was affected by the damage from the tornado.

Further, articulate what was done to replace the arrays that were damaged in the sampling scheme.

2.1.2 *Search Methods*

Standardized carcass searches were performed by BLM-approved biologists, in accordance with methods outlined in the BBCS.

Within the solar field, arrays of solar panels were surveyed by observers traveling on foot. A distance sampling approach was used, whereby biologists slowly walked a transect line along the ends of rows of solar panels in a direction perpendicular to the rows, searching ahead and to the side within the array for bird and bat detections. Biologists scanned out to a maximum perpendicular distance of approximately 70 m from the transect. Biologists carried binoculars to allow them to verify the presence of a detection versus rocks or vegetation. Once a detection was confirmed, the distance of the detection to the transect line was estimated using laser range finders. Each array included in the sample was searched by observers walking two transects – one on the west side and one on the east side of the array with observers looking toward the center of the array.

Comentado [FWS7]: Was the carcass then processed and removed? Please clarify the carcass processing procedure.

Most (74.4%) of the length of fenceline (approximately 10 miles) was searched from a vehicle using the standard protocol (Figure 2). Biologists searched a 6-m wide strip transect centered on the fence from the inner perimeter. Travel speed was below five miles per hour (mph) while searching. Some sections along the fence cannot be driven close to the fence line. The fence line along the western edge of the Project is drivable but the road is approximately 15 m away from the fence and the road and fence are separated by a drainage ditch. The fence along this section is covered with a tan tarp to block and trees and shrubs have been planted to reduce visibility of the project from the west. Additions of vegetation and the tarp likely reduce potential for bird collision with the fence. This section of the fence was driven to document carcasses, but detections along this portion of the fence are not included in adjusted fatality estimates because detection rates are likely very low. A separate section of the fence in the southeastern corner of the Project cannot be driven because the eastern edge of the berm that bounded construction ponds is too narrow for a vehicle. Along this portion of the fence, the observer stopped at both north and south ends of the berm and used binoculars to search for carcasses. Finally, the road along a portion of the southwest fence line near the entrance gate is approximately 30 to 50 m from the road and is separated from the fence by an area that has recently undergone vegetation restoration. This area was eliminated from sampling. Fatality rates estimated for

Comentado [FWS8]: Please describe how this is this accounted for in the overall estimates.

Comentado [FWS9]: Again, please describe how this was accounted for in the estimates.

sections of the fence that were sampled were extrapolated to sections of the fence where the standard monitoring protocol was not used.

Comentado [FWS10]: This doesn't seem valid, given the site differences in these segments of the fences.

The gen-tie line was searched using a 30-m wide strip transect (i.e., 15 m of ground on either side of the overhead line). Sample units along the gen-tie line were chosen by dividing the total length of line from the Project fence south to the Red Bluff Substation just south of I-10 into 1-km segments. Thus, a 47.9% sample of the total length of the line was searched (Figure 3). Biologists slowly walked every other 1-km segment of the line, meandering the width of the strip transect, scanning for dead or injured birds or bats within 15 m (49.2 ft) of the overhead line.

For each detection, a suspected cause of death or injury was assigned based on available evidence and proximity of a detection to Project infrastructure. Detections that had evidence of scavenging were assigned as “unknown” because it cannot be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed.

Comentado [FWS11]: The Servicde disagrees with this assumption. If it's under the line, the better assumption is that it was caused by the line and a scavenger subsequently discovered the carcass.

2.2 Carcass Persistence Trials

Carcass persistence trials were conducted for the truncated winter season and throughout the spring period. Carcasses from three size classes (small [0-100 g], medium [101-999], and large [1000+ g]) were used for trials. The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), and the large size class comprised hen mallard (*Anas platyrhynchos*) and hen ring-necked pheasant (*Phasianus colchicus*).

2.2.1 *Carcass Persistence Data Collection*

To quantify carcass persistence rates, 15 small, 10 medium, and 5 large carcasses were randomly placed and monitored along the gen-tie line during spring 2015. Within the solar arrays and along the perimeter fence, the same numbers of small and medium carcasses were placed, along with 10 large carcasses, for a total of 65 carcass persistence trials at Desert Sunlight during the spring season. Thirty-five carcasses within the Project fence (within solar arrays and along the fence) were monitored using motion-triggered digital trail cameras, while the remaining carcasses were visited on foot, for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality. No carcasses along the gen-tie line were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as “feeding stations”, trail cameras were installed five days before specimens were placed, and two fake cameras without bias trial carcasses were also placed within the Project fence and periodically moved to new locations within the fence. Periodic ground-based checking of carcasses with trail cameras also occured to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera’s

Comentado [FWS12]: This number of carcasses is extremely low. Did you do a power analysis?

field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire Project, not just in areas subject to standard searches, and trials were initiated in small numbers on six different dates throughout the spring season.

Comentado [FWS13]: With such a low number of carcasses this is unlikely to be a problem.

In February, 15 (*n* = 7 small, 5 medium, and 3 large) carcass persistence trials were placed in the solar arrays and along the Project fence, and 15 trials (*n* = 8 small, 5 medium, and 2 large) were placed along the gen-tie line. Eight carcasses within the arrays and fence were monitored with trial cameras, and four fake cameras were placed within the arrays and along the fence. Carcass persistence trials were initiated on two different dates in February.

Comentado [FWS14]: Does this mean n=15 was put out twice for the Feb trials? Please clarify. Also, are the gen-tie carcasses outside the project fence? If so, there seem to be two difference scavenger communities being tested.

2.2.2 *Estimating Carcass Persistence Times*

Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g. days a carcass is present before being removed) may not be known exactly, but is known to be within a finite range. For example, suppose a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass was available to be found for between 7 and 10 days. This carcass would be considered "interval censored". Similarly, if a carcass lasts the entire 30-day trial period, that carcass is "right censored"— it is known that the carcass lasted at least 30 days, but it may have persisted longer.

Comentado [FWS15]: Please describe the interval that carcasses were checked. Is there a reason that they are not checked daily, particularly during the first week?

Comentado [FWS16]: This does not seem true. If the carcass is not there on day 10, they it has been removed before that and would not be available during some portion of the interval. Please clarify how this uncertainty affects the analysis. There should probably be a convention for determining the removal data (i.e., the mid-point). In general, the interval should be kept as short as possible.

Comentado [FWS17]: How does "censored" status affect the analysis?

There were four distributions implemented in survival models used to estimate the probability a carcass is unscavenged and available to be found at the end of the search interval (*r*): exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike's Information Criterion adjusted for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model with combinations of the covariates carcass size, location, and visibility, to observed carcass persistence data.

2.3 Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the spring period (including February). Carcasses from three size classes (small, medium, and large) were used for trials. The small size class comprised house sparrows and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons, and the large size class comprised hen mallards and hen ring-necked pheasants.

2.3.1 *Searcher Efficiency Data Collection*

Training of biologists on the Project-specific protocol and early assessments of habitat conditions at the Project site suggested that the amount of cobble present in the soil may be an important factor influencing searcher efficiency. To satisfy requirements regarding consideration of visibility class per the BBCS and address the influence of cobble cover on searcher efficiency, sample units in the solar arrays and along the gen-tie were stratified by cobble cover and assigned to one of two classes (<15% and >15% cobble cover). Classes were determined by making ocular estimates of cobble cover at each sample unit and then evaluating the frequency histogram of sample units across the range of estimated cobble cover (Figure 4). A natural break point was identified at 15% cobble cover, so the same value was chosen as the break point that defined the two strata. In the solar arrays, one set of searcher efficiency trials (*n* = 15 small birds, 10 medium birds, and 5 large birds) was conducted in each strata. Similarly, searcher efficiency trials along the gen-tie occurred in two visibility strata (easy: ≥90% bare ground, vegetation <6” tall; and more difficult: <90% bare ground, vegetation ≥6” tall). Thirty searcher efficiency trials (*n* = 15 small birds, 10 medium birds, and 5 large birds) occurred along the fence in the only stratum present on the fence (easy visibility). Thus, in February, a total of 150 searcher efficiency trials occurred at the Project, and the same methods and number occurred during the spring season. Locations for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches.

Comentado [FWS18]: Has this been evaluated as adequate to determine searcher efficiency for a single strata? Please provide justification for small sample size.

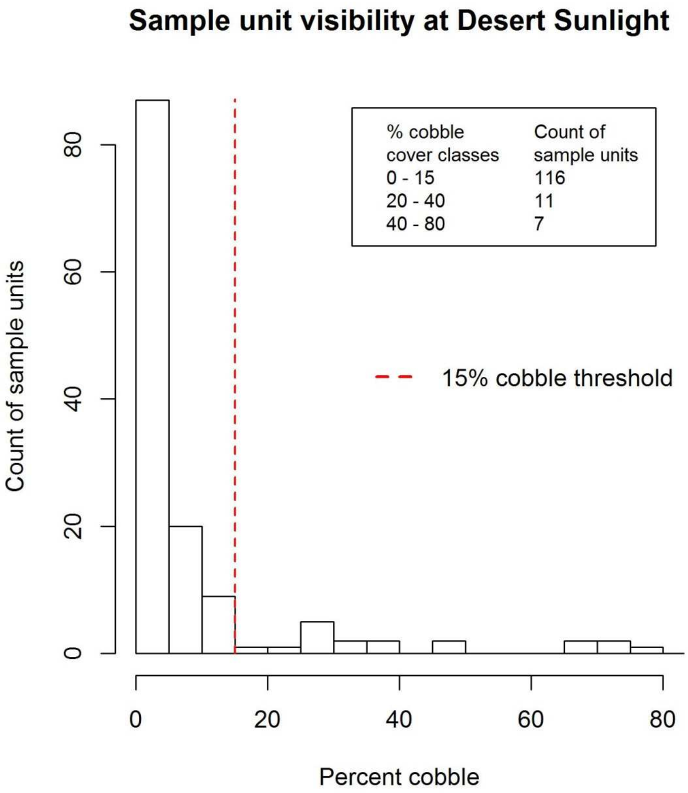


Figure 4. Frequency histogram of sample units (in the arrays only) at Desert Sunlight Solar Farm Project by estimates of cobble cover. Based on this distribution, each sample unit was assigned to one of two classes of cobble cover (<15%; >15%).

2.3.2 *Estimating Searcher Efficiency*

Comentado [FWS19]: Is searcher efficiency tested for each observer? Please provide these results along with an indication of variation in searcher efficiency across observers.

Searcher efficiency at Desert Sunlight was estimated separately for linear features (the project fence and the generation tie line), and the solar arrays, reflecting the different search methods used on arrays and linear features. For linear features, logistic regression models were fit to searcher efficiency data and AICc was used to compare models. Models including effects of carcass size (three classes) and visibility (two classes; gen-tie only), were compared to each other and the null model. Model selection indicated that best models accounted for component, carcass size, and on the gen-tie line, visibility. Once the best model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, *p*, was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from February and the spring 2015 season.

For the solar arrays, searcher efficiency was evaluated using a distance sampling approach (Buckland et al. 1993). Distance sampling assumes perfect detection on the transect line (at distance = 0), an assumption that is likely valid in the solar arrays given the relatively flat & vegetation-free nature of the soil surface. A curve is fitted to the observed carcass data that predicts probability of detection as a function of distance from the transect line. The mean value of this function over a specified distance, *w,* is equal to the average searcher efficiency for a transect of width *w*. One departure in the methods used here, relative to the methods presented in Buckland et al. (1993), was that for this study the detection function was estimated using trial carcasses, which meant that there were both presence (detected) and absence (not detected) data available to fit the detection function (Figure 5). The availability of both presence and absence data means that the detection function can be estimated using only trial carcasses whose distribution is known. Therefore the detection function, the average searcher efficiency among the arrays and the final fatality estimate within the arrays are all insensitive to the spatial distribution of carcasses within individual arrays, and the overall searcher efficiency estimate is valid even if the distribution of carcasses among the arrays is not uniform.

Distances of trial carcasses (trials both found and missed) from the transect line were used to fit a half-normal detection function for searches among the arrays (Figure 5). The half-normal detection function is a commonly used function for distance sampling surveys (Buckland et al. 1993). The detection function was fit with and without covariates (carcass size, visibility index, or no covariates) and AICc indicated that the best among these models included only carcass size as a covariate.

Comentado [FWS20]: Is sample size adequate to detect a difference between visibility categories?

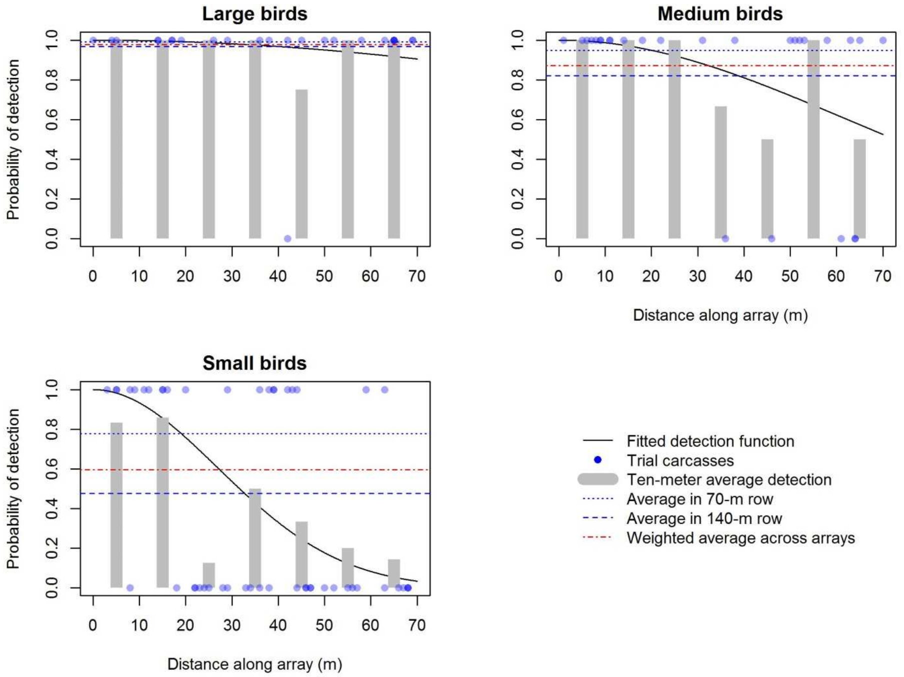


Figure 5. Estimated detection probabilities for bird carcasses by size class during spring 2015 (including February) at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m and 140-m panel rows in solar arrays are presented.

Because the solar arrays were surveyed by searchers who walked down both sides of the rows of panels, the width of the search transect was specified as half the width of the rows of panels. For larger birds, there is almost certainly a non-zero detection probability beyond this distance but the bias that occurs by ignoring this non-zero detection probability is conservative (i.e. the searcher efficiency is underestimated). Some solar arrays have row widths of 70 m (search transect width of 35 m) and some have row widths of 140 m (search transect width of 70 m). Searcher efficiency was higher for the arrays with a width of 70 m, and overall searcher efficiency was estimated as a weighted average based on the proportions of 70-m arrays and 140-m arrays in the sample units.

Comentado [FWS21]: Shouldn't the curves then be for 35m and 70m?

Comentado [FWS22]: How does this relate to the curves above. Detectability for small birds drops off before 70 m and presumably is near zero for greater than 70 m.

2.4 Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots are also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie line versus cleared areas beneath solar panels). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where F is the total number of fatalities, C is the number fatalities detected and included in fatality estimation, r is the probability a carcass is unscavenged and available to be found at the end of the search interval, and p is the probability of detecting a carcass (Huso 2010).

All fatality estimates were calculated using the Huso estimator, as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates were used. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

2.5 Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by WEST avian biologists and operational personnel and were considered “incidental” detections. When found by operational personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the Desert Sunlight SPUT Avian Injury and Mortality Report Forms February – May 2015. All detections made in search areas were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

3.0 MONITORING RESULTS

3.1 Summary of Avian Detections

During spring 2015 (including February), a total of 25 avian detections (including one injured bird and incidentals) of 13 identified species were recorded (Table 2). The most numerous detection of an identified species was common loon (*Gavia immer*)~~,~~ ~~but~~ with ~~only~~ four detections. Most detections (n = 12, or 48.0% of total detections) occurred in the solar arrays (Figures 2 and 3; Tables 2, 3, and 4). Eighteen (72%) detections were made during standardized carcass searches and seven (28.0%) were documented as incidentals. For fresh carcasses, body weights and weather conditions the preceding nights are described in Appendix B.

Table 2. Number of individual bird detections, by species, during spring 2015 (including February) at the Desert Sunlight Solar Farm Project, Riverside County, California. Overhead lines include the gen-tie line and medium voltage overhead lines that co-occur with the solar arrays.

Common Name	Scientific Name	Migration Behavior*	Guild	Count	Project Component
common loon	*Gavia immer*	diurnal	waterbirds/waterfowl	4	solar arrays
common raven	*Corvus corax*	resident	corvids	1	solar arrays
greater roadrunner	*Geococcyx californianus*	resident	cuckoos	1	overhead lines
mallard	*Anas platyrhynchos*	variable	waterbirds/waterfowl	1 1	fence overhead lines
Nashville warbler	*Oreothlypis ruficapilla*	nocturnal	warblers	1	overhead lines
pied-billed grebe	*Podilymbus podiceps*	nocturnal	waterbirds/waterfowl	1	solar arrays
Savannah sparrow	*Passerculus sandwichensis*	nocturnal	grassland/sparrows	1	solar arrays
sora	*Porzana carolina*	nocturnal	rails/coots	1	solar arrays
Townsend's warbler	*Setophaga townsendi*	unresolved	warblers	1	overhead lines
unidentified bird (small)	–	–	unidentified birds	1	solar arrays
unidentified bird (unknown size)	–	–	unidentified birds	1 2	solar arrays overhead lines
unidentified grebe	–	nocturnal	waterbirds/waterfowl	1	solar arrays
unidentified hummingbird	–	–	swifts/hummingbirds	1	solar arrays
western tanager	*Piranga ludoviciana*	nocturnal	tanagers	1	overhead lines
western wood-pewee	*Contopus sordidulus*	nocturnal	flycatchers	1	O&M building

Table 2. Number of individual bird detections, by species, during spring 2015 (including February) at the Desert Sunlight Solar Farm Project, Riverside County, California. Overhead lines include the gen-tie line and medium voltage overhead lines that co-occur with the solar arrays.

Common Name	Scientific Name	Migration Behavior*	Guild	Count	Project Component
white-winged dove	*Zenaida asiatica*	variable	doves/pigeons	1	fence
				2	overhead lines
Wilson's warbler	*Cardellina pusilla*	nocturnal	warblers	1	overhead lines
Total				**25**	

* See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in Birds of North America (BNA) Online (http://bna.birds.cornell.edu/bna/); where information on migration behavior was lacking in BNA accounts, Newton (2008) or Murray (2004) were used.

Table 3. Total avian detections by Project component and detection category during spring 2015 (including February) at the Desert Sunlight Solar Farm Project, Riverside County, California. Overhead lines includes the gen-tie and medium voltage overhead lines that co-occur with the solar arrays. Only carcasses found within search areas were included in fatality estimates.

	Inside carcass search area		Outside carcass search area	
Project Component	**Carcass search**	**Incidental**	**Carcass search**	**Incidental**
Fence	1	0	0	1
O&M Building	0	0	0	1
Overhead lines	7	1	0	1
Solar arrays	6	1	3	2

Table 4. Total avian detections (including incidentals) by Project component and suspected cause of death during spring 2015 (including February) at the Desert Sunlight Solar Farm Project, Riverside County, California. Overhead lines includes the gen-tie and medium voltage overhead lines that co-occur with the solar arrays.

	Suspected Cause of Death*				
Project Component	**Collision**	**Predation**	**Other**	**Unknown**	**Percent of Total**
Fence	1	0	0	1	8.0
O&M building	0	0	1	0	4.0
Overhead lines	7	1	1	1	40.0
Solar arrays	1	0	4	7	48.0
Percent of Total	**36.0**	**4.0**	**24.0**	**36.0**	**100.0**

* Suspected cause of death was assigned based on available evidence and proximity of detection to Project infrastructure. Detections that had evidence of scavenging were assigned as "unknown" because it can't be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, in the absence of a completed necropsy, ~~it should be noted that~~ there is ~~substantial~~ some uncertainy associated with cause of death assignments because no events were directly observed.

Comentado [FWS23]: Was proximity to project features evaluated? Please describe how this information was utilized. Proximity distances may provide insights into which features may pose the greatest risks.

Comentado [FWS24]: Since scavenger rates are so high, this definition too easily categorizes carcasses as unknown. Low levels of scavenging should not exclude birds from a more thoughtful evaluation of the cause of the mortality. Other criteria should be considered, including patterns of disturbed dust on solar panels, proximity to a feature with collision risk. Such a blanket categorization, probably masks useful information.

3.2 Temporal Patterns of Avian Detections

The number of detections recorded daily during the reporting period ranged from zero to two (Figure 6). The period from March 30 to May 27 was characterized by slightly higher numbers of detections with more days with two detections than the previous period. The number of detections per day represents those discovered during standardized carcass searches and incidentally.

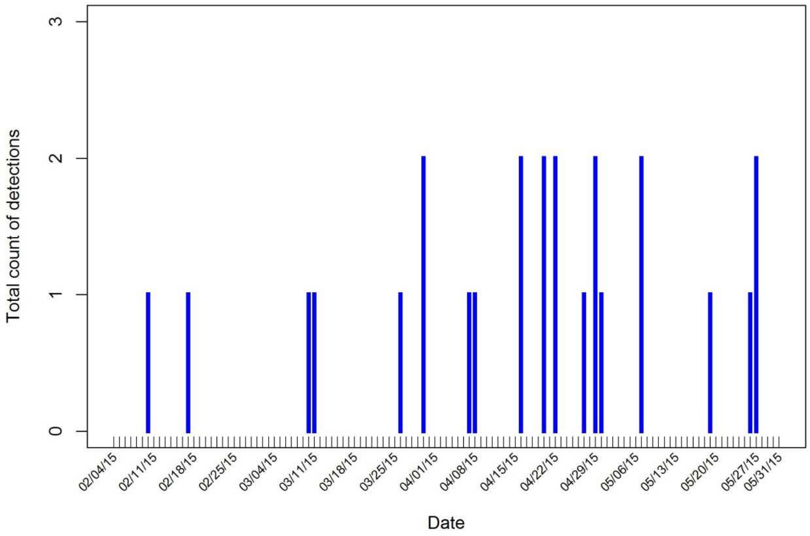


Figure 6. Total number of detections by date during spring 2015 (including February) at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.3 Spatial Distribution of Avian Detections

Comentado [FWS25]: Spatial distribution of different taxonomic groups should be discussed, particularly as more data come in.

3.3.1 *Detections by Project Component*

During the reporting period, detections were documented from the solar arrays, perimeter fence, gen-tie line, MVOH lines within the solar field, and the O&M building (Tables 2, 3, and 4). Of the 12 detections within the solar arrays, most (7, or 58.3%) were assigned to the "unknown" category for suspected cause of death.

3.3.2 *Feather Spot Detections*

Eight (32.0%) of the 25 detections consisted only of feather spots. Along the fence, one detection (4.0%) was a feather spot. Three detections (12.0%) along the overhead lines were feather spots. Four detections (16.0%) in the solar arrays were feather spots.

3.4 Detections of Injured Birds

One bird was located during the reporting period that was injured. A mourning dove (*Zenaida macroura*) was discovered on April 22 along the northern section of the perimeter fence. The bird had an obvious injury to its breast. Because the bird was found the day after the tornado struck the Project, the injury may have been a result of the storm. The bird was taken to Coachella Valley Wild Bird Center and left with Linda York for rehabilitation. Numerous attempts to determine the final outcome for the dove were unsuccessful. The single injured bird detection was included in the fatality estimates.

Comentado [FWS26]: This is a good (and more conservative) practice, even if the dove were successfully released, because the viability of the released bird is unknown..

3.5 Summary of Bat Detections

No bats were located during the spring 2015 season (including February).

3.6 Carcass Persistence Trials

Based on carcass persistence data from the spring 2015 season, 20 survival models were compared for relative quality using the corrected AICc score, as suggested in Huso (2010). The AICc score provides a relative measure of model fit and parsimony among a selection of candidate models. Carcass size is a potentially important variable, as larger carcasses tend to persist longer and may be more likely to leave feather spots which persist for long durations, whereas smaller carcasses may be more likely to be completely removed.

The model with lowest AICc score is typically chosen as the "best" model relative to other models tested; however, any model within two AICc points of the best model is considered competitive with the best model (Burnham and Anderson 2004). The top model had a ∆AICc value of 2.84 and included carcass size (small, medium or large), and location (solar arrays/fence or generation-tie line) with a Weibull-distributed removal time. Estimates of carcass removal time and persistence probabilities are provided in Table 5.

Table 5. Mean carcass removal time and probability of a carcass persisting through the 7-day search interval during the reporting period at the Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass size	Project component	Mean removal time (days)	Probability of persistence
Small	Arrays/fence	5.7	0.54
Small	Overhead lines	2.0	0.29
Medium	Arrays/fence	29.8	0.82
Medium	Overhead lines	13.7	0.71
Large	Arrays/fence	126.8	0.94
Large	Overhead lines	14.6	0.72

Comentado [FWS27]: This looks like there may be an effect on persistence time from being outside the fence. This may be due to differences in the scavenger community. Was this tested?

3.7 Searcher Efficiency Trials

During the reporting period, a total of 300 searcher efficiency trials were placed at the Project. Most trials were available to be found, but some disappeared before or during the trial. Overall, 120 trials were placed in the solar arrays and 102 were available to be found; 60 trials were placed along the perimeter fence (inner perimeter only) and 59 were available to be found; and 120 trials were placed along the gen-tie line and 105 were available to be found.

Comentado [FWS28]: How was this broken down by visibility categories and size classes? See Appendix C?

In the solar arrays, the model that included an effect of carcass size was chosen as the best model to estimate searcher efficiency. Within the solar arrays, searcher efficiency was influenced by carcass size: 60.0% for small birds, 87.2% for medium birds, and 97.3% for large birds. Along the fence, searcher efficiency ranged from 79.3% to 100% depending on carcass size class. Along overhead lines, searcher efficiency ranged from 53.9% to 87.8%. Detailed estimates of searcher efficiency estimates specific to each component and carcass size are reported in Appendix C.

3.8 Fatality Estimates

Fatality estimates were calculated separately for each component (solar arrays, fence, and overhead lines). Ultimately, nine detections were excluded from the fatality analysis: five were found outside standardized search areas; one was estimated to be older than the 7-day search interval (Huso 2010); and three were both outside standard search areas and estimated to be older than the 7-day search interval.

During spring 2015, there were an estimated total 111 fatalities (90% CI: 58 - 193) at the Project. Of these, 49 fatalities (44.1%; 90% CI: 19 – 86) were estimated for the solar arrays, 2 fatalities (1.8%; 90% CI: 2 – 4) were estimated for the fence, and 60 fatalities (54.1%; 90% CI: 16 – 132) were estimated for the overhead lines (gen-tie and medium voltage overhead lines combined). There were an estimated 0.02 fatalities per acre (within the solar field only) and an estimated 0.20 fatalities per nameplate MW at the Project. A complete list of estimates for each Project component and carcass size class with confidence intervals is presented in Appendix C.

4.0 DISCUSSION

The 2015 spring season represented the first full season of standardized monitoring at Desert Sunlight per the BBCS. Searcher efficiency trials and carcass removal trials were conducted concurrently at the solar arrays, fencelines, and along the gen-tie line. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. Although these estimates were produced from a statistically robust sample, only limited inference may be drawn from a single season of data. These results should be considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. As more data are collected throughout the monitoring year (and additional quality assurance/quality control measures occur, for example characterizing feather spots to species or size class), data from all seasons may be pooled. At that time, data will be tested for seasonal differences retrospectively, but because seasonal estimates will be produced from the much larger annual data set, they may differ from what is reported here because they are based on a larger, more informative sample.

4.1 Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Thus, rates of carcass persistence reported here should be interpreted cautiously as they may change over the coming months.

Searcher efficiency was influenced by Project component, carcass size, and visibility class (along the gen-tie only). In the solar arrays, searcher efficiency was high (> 0.5) for all carcass size classes and this is likely influenced by the limited vegetation cover beneath solar panels. Beneath the gen-tie line vegetation cover is higher in some portions of the strip transects, and results reported here support the hypothesis that visibility class is a factor in searcher efficiency along the lines.

For the current analysis, searcher efficiency in the solar arrays was assumed to be best predicted by a half-normal distribution. For future analyses, AICc will be used to compare and choose the best among multiple detection functions.

Searcher efficiency trials for this Project will be repeated seasonally. The desert landscape in which this Project is located generally changes little with the seasons, save for brief periods following winter and spring rains when floods may occur and blooming plants may flourish. A recent meta-analysis involving data from more than 70 wind-energy projects suggested that including habitat visibility class as a predictive variable generally eliminated any otherwise apparent seasonal effects on searcher efficiency (Smallwood 2013). Further, the possibility exists that searcher efficiency varies seasonally in some cover types but not others. Data from searcher efficiency trials conducted over the coming seasons will therefore continue to be tested for effects of habitat visibility class rather than effects of season.

Comentado [FWS29]: Shouldn't both season and habitat visibility class be evaluated?

4.2 Distribution of Fatalities and Fatality Estimates

The number of detections was more or less evenly distributed across the spring season, and there were no clear associations between number of detections and date. Given the small number of detections overall, it is premature to draw any conclusions about the spatial distribution of carcasses.

Detections attributed to an unknown cause accounted for 36.0% of all detections during the reporting period, and the distribution of the unknown cause detections varied by project component with 48.0% occurring in association with the solar arrays. Of the 12 detections made in the solar arrays, 16.0% were feather spots. Determining a cause of mortality from a feather spot is challenging because there is rarely visible evidence available on which to determine a cause of death. Thus, feather spots with an unknown cause of mortality could be encountered anywhere birds occur, and an unknown cause of a sizeable proportion of the carcasses is not unique to the Project. Further, the relatively large proportion of feather spots (32%) among the detections for the Project as a whole may inflate the fatality estimate when unknown cause detections are included based on the potential for multiple feather spots resulting from one fatality, feather spots resulting from predation not associated with the facility, or other causes.

Comentado [FWS30]: Again, a more thoughtful evaluation of cause of mortality should be done to reduce the number of unknowns. In particular, mortalities associated with project features that may present a collision risk are probably better categorized as collisions (i.e., solar panels and overhead electrical lines).

Comentado [FWS31]: This is the same as for Genesis.

5.0 LITERATURE CITED

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in 2nd International Symposium on Information Theory (B. N. Petran and F. Csaki, Eds.). Akademiai Kiado, Budapest, Hungary.

Ammon, Elisabeth M. and William M. Gilbert. 1999. Wilson's warbler (*Cardellina pusilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/478

Boarman, William I. and Bernd Heinrich. 1999. Common raven (*Corvus corax*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/476 doi:10.2173/bna.476

Buckland, S, D.R. Anderson, K. P. Burnham, and J.L. Laake. 1993. Distance sampling: estimating abundance of biological populations. Chapman & Hall, London. 446 pp.

Burnham, K.P., and D.R. Anderson. 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociological Methods & Research 33: 261-304.

Evers, David C., James D. Paruk, Judith W. Mcintyre and Jack F. Barr. 2010. Common loon (*Gavia immer*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/313 doi:10.2173/bna.313

Hudon, Jocelyn. 1999. Western tanager (*Piranga ludoviciana*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/432 doi:10.2173/bna.432

Hughes, Janice M. 2011. Greater roadrunner (*Geococcyx californianus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/244 doi:10.2173/bna.244

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. doi: 10.1002/env.1052

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A new method to determine bird and bat fatality at wind energy turbines from carcass searches. Wildlife Biology 17: 350-363.

Lowther, Peter E. and Janet McI. Williams. 2011. Nashville warbler (*Oreothlypis ruficapilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/205 doi:10.2173/bna.205

Manly, B.F.J.1997. Randomization, bootstrap and Monte Carlo methods in biology. Second Edition. CRC Press, LLC, Boca Raton, Florida, 455 pp.

Melvin, Scott M. and James P. Gibbs. 2012. Sora (*Porzana carolina*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/250 doi:10.2173/bna.250

Muller, Martin J. and Robert W. Storer. 1999. Pied-billed grebe (*Podilymbus podiceps*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/410 doi:10.2173/bna.410

Murray, J. 2004. Nocturnal flight call analysis as a method for monitoring density and species composition of migratory songbirds (Order Passeriformes) across southern Vancouver Island, British Columbia in 2004. Rocky Point Bird Observatory, 16 pp.

Newton, I. 2008. The migration ecology of birds. Academic Press, London.

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine-cause avian fatality estimates. Journal of Wildlife Management 74(5): 1089-1096.

Smallwood, K. S. 2013. Comparing bird and bat ratality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37(1): 19-33.

Western Ecosystems Technology (WEST), Inc. 2014. Bird and bat conservation strategy, Desert Sunlight Solar Farm Project, Riverside County, California. 57 pp.

Wheelwright, N. T. and J. D. Rising. 2008. Savannah sparrow (*Passerculus sandwichensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/045 doi:10.2173/bna.45

Appendix A. Detailed Areas of Standardized Searches and Carcass Locations along the Generation Tie Line of the Desert Sunlight Solar Farm Project during Spring 2015 (Including February)

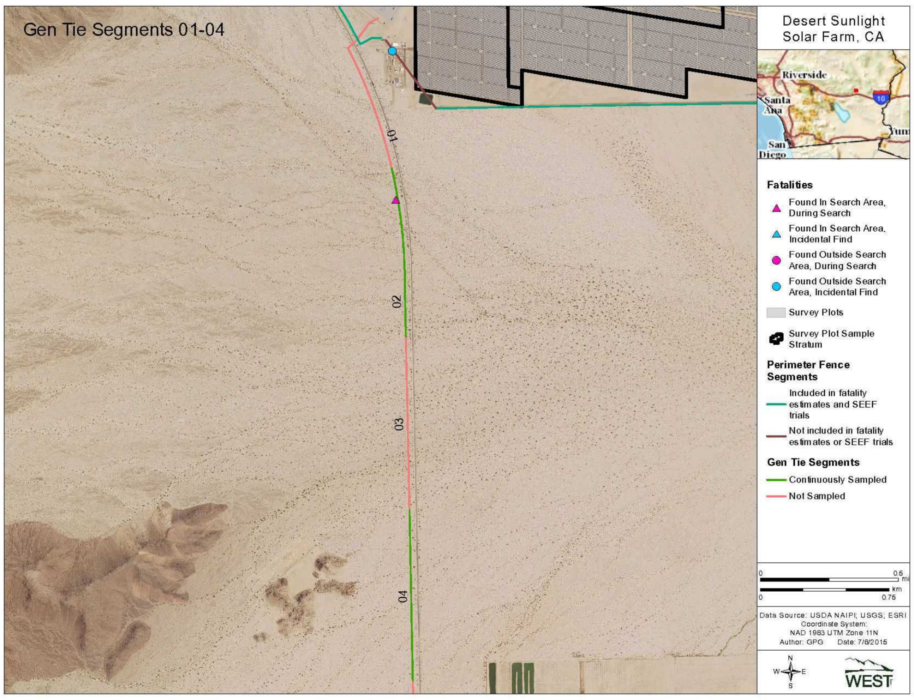


Figure A-1. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015 (including February).

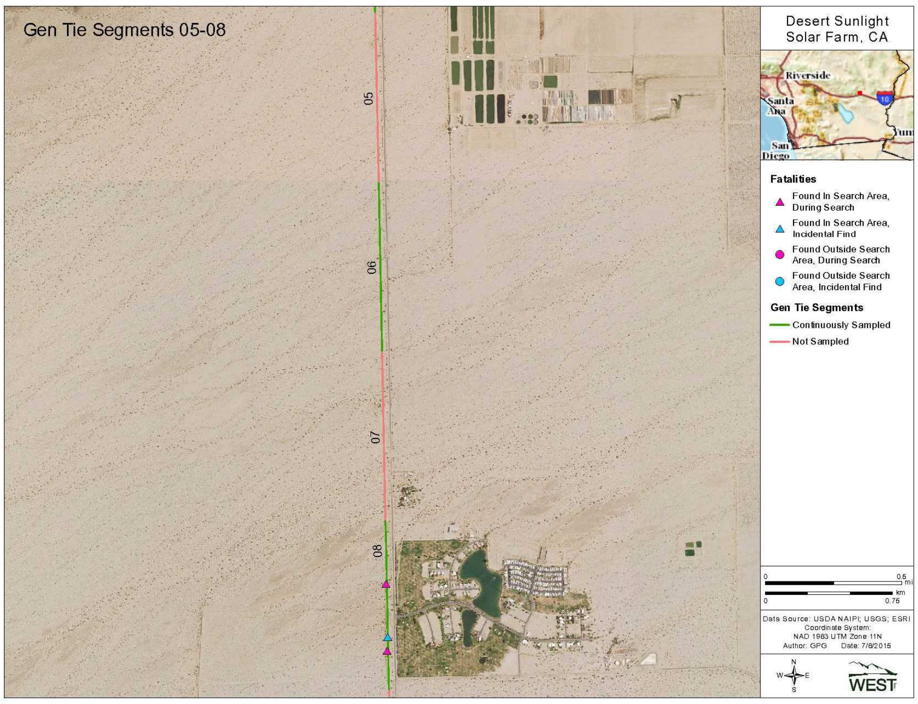


Figure A-2. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015 (including February).

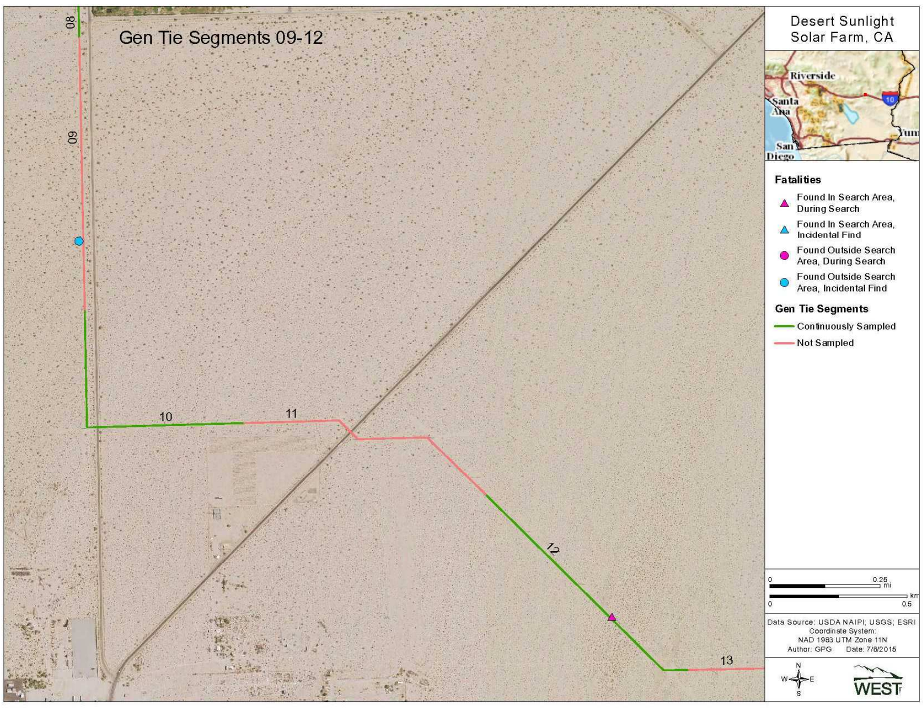


Figure A-3. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015 (including February).

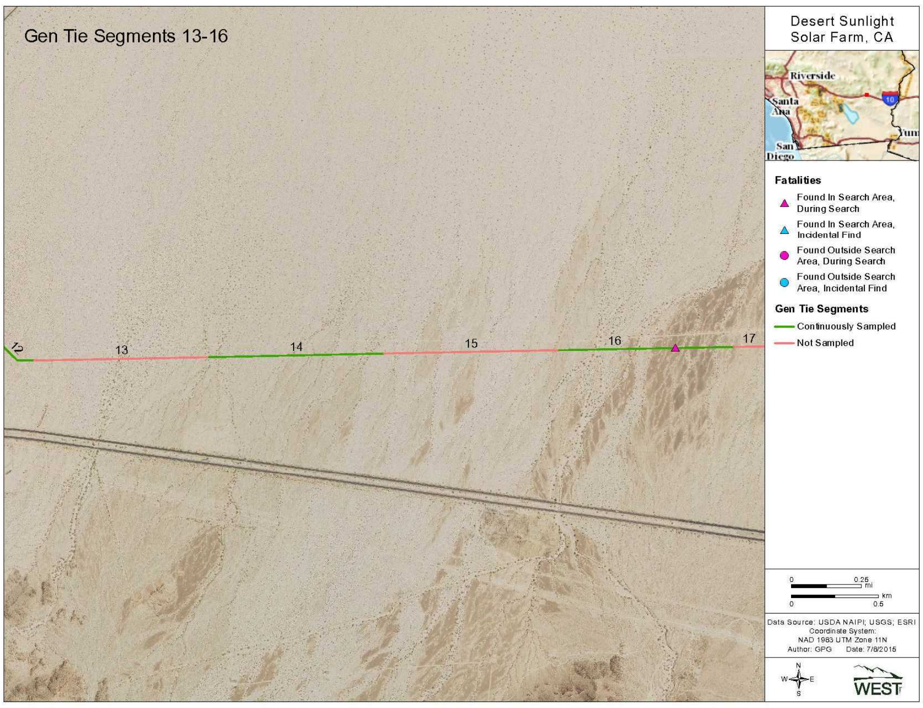


Figure A-4. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015 (including February).

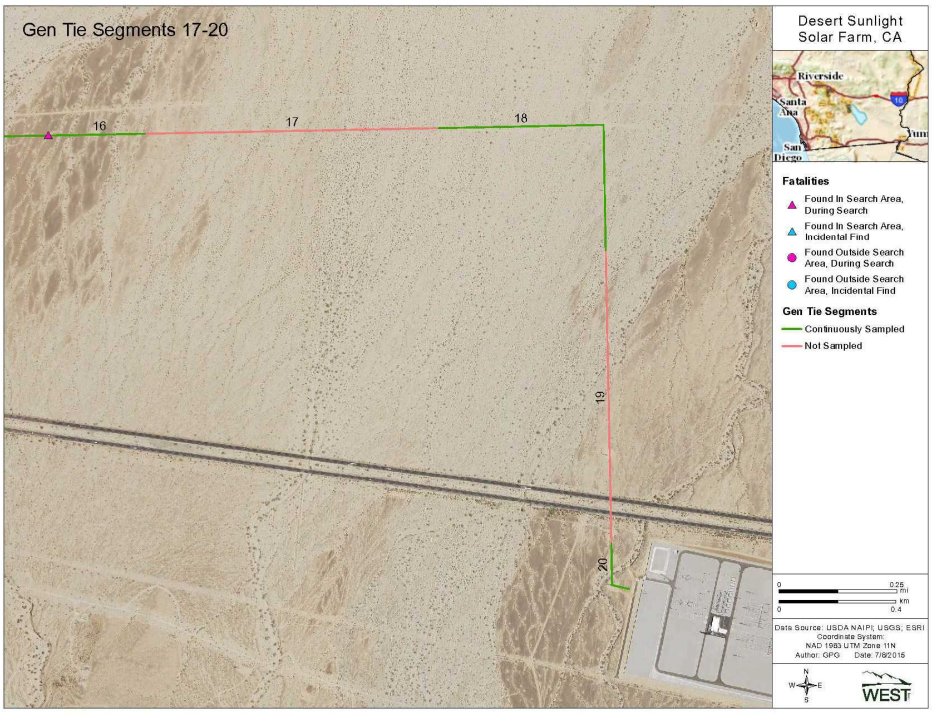


Figure A-5. Areas of standardized searches and carcass locations along the generation tie line at Desert Sunlight Solar Farm Project during spring 2015 (including February).

Appendix B. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during Spring 2015

Table B-1. Weather conditions and body weights associated with avian detections estimated to be less than 24 hours old during spring 2015 at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hrs)	Species	Weight (g)	Weather Summary for Preceding 24 hrs
040715-TOWA-13-27A-MVOH-1	4/7/2015	8-24hrs	Townsend's warbler		
043015-WIWA-GENTIE-08-1	4/30/2015	8-24hrs	Wilson's warbler		TEMP HIGH 97 DEGREES, 2-5 PM OVERNIGHT LOW WAS 67 DEGREES, WINDS < 10 MPH
042215-WWDO-FENCE-NORTH-15-1	4/22/2015	8-24hrs	white-winged dove		TORNADO
042215-WWDO-18-19A-MVOH-1-1	4/22/2015	8-24hrs	white-winged dove		
050715-WETA-GENTIE-12-1	5/7/2015	8-24hrs	western tanager		
051915-WEWP-O&MBUILDING-1	5/19/2015	0-8hrs	western wood-pewee	7	CLEAR OVERNIGHT, RELATIVELY CALM WINDS, MAX 8MPH

Appendix C. Correction Factors and Bird Fatality Rates at the Desert Sunlight Solar Farm Project during Spring of 2015 (Including February).

Table B-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Farm Project during spring 2015. *Distribution of easy and difficult visibility on the generation-tie line was about 70% and 30%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero. ***Adjusted fatality estimates for spring are weighted to account for variable area adjustments during spring.

Comentado [FWS32]: This table/appendix requires more explanation.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Search Area Adjustment								
Overhead lines	0.479	-	0.479	-	0.479	-	0.479	-
Fence	0.744	-	0.744	-	0.744	-	0.744	-
Solar arrays: Winter	0.295	-	0.295	-	0.295	-	0.295	-
Solar arrays: Spring weeks 1 - 7	0.295	-	0.295	-	0.295	-	0.295	-
Solar arrays: Spring weeks 8 - 10	0.282	-	0.282	-	0.282	-	0.282	-
Solar arrays: Spring weeks 11 - 12	0.295	-	0.295	-	0.295	-	0.295	-
Observer Detection Rate								
Overhead lines: Easy vis.*	0.583	0.417 - 0.750	0.952	0.857 - 1.000	0.8	0.600 - 1.000	0.583	0.417 - 0.750
Overhead lines: Difficult vis.*	0.435	0.261 - 0.609	0.706	0.529 - 0.882	0.6	0.300 - 0.800	0.435	0.261 - 0.609
Overhead lines: Weighted avg.*	0.539	0.419 - 0.665	0.878	0.794 - 0.947	0.74	0.570 - 0.880	0.539	0.419 - 0.665
Fence	0.793	0.690 - 0.897	1	1.000 - 1.000	0.9	0.700 - 1.000	0.793	0.690 - 0.897
Solar arrays	0.596	0.505 - 0.671	0.872	0.786 - 0.953	0.977	0.931 - 1.000	0.596	0.505 - 0.671
Average probability of carcass persistence to the next search								
Overhead lines: Winter	0.15	0.130 - 0.207	0.549	0.325 - 0.731	0.563	0.339 - 0.727	0.15	0.130 - 0.207
Overhead lines: Spring	0.29	0.192 - 0.387	0.714	0.520 - 0.852	0.724	0.529 - 0.849	0.29	0.192 - 0.387
Solar arrays & fence: Winter	0.343	0.284 - 0.403	0.705	0.511 - 0.848	0.885	0.794 - 0.956	0.343	0.284 - 0.403
Solar arrays & fence: Spring	0.536	0.470 - 0.610	0.824	0.678 - 0.917	0.935	0.881 - 0.978	0.536	0.470 - 0.610
Observed Fatality Rates (Fatalities /Season)								
Overhead lines: Winter	0	-	0	-	0	-	0	-
Overhead lines: Spring	3	1 - 5	2	0 - 4	0	-	1	0 - 3
Fence: Winter	0	-	0	-	0	-	0	-
Fence: Spring	0	-	1	0 - 2	0	-	0	-
Solar arrays: Winter	1	0 - 3	0	-	1	0 - 3	0	-
Solar arrays: Spring	2	0 - 4	2	0 - 5	2	0 - 5	1	0 - 3
Average Probability of Carcass Availability and Detected								
Overhead lines: Winter	0.081	0.062 - 0.122	0.482	0.280 - 0.652	0.416	0.240 - 0.578	0.081	0.062 - 0.122
Overhead lines: Spring	0.156	0.094 - 0.222	0.627	0.455 - 0.761	0.536	0.357 - 0.690	0.156	0.094 - 0.222
Fence: Winter	0.272	0.214 - 0.336	0.705	0.511 - 0.848	0.796	0.627 - 0.941	0.272	0.214 - 0.336
Fence: Spring	0.425	0.350 - 0.515	0.824	0.678 - 0.917	0.842	0.664 - 0.967	0.425	0.350 - 0.515
Solar arrays: Winter	0.204	0.159 - 0.247	0.615	0.442 - 0.765	0.865	0.767 - 0.948	0.204	0.159 - 0.247
Solar arrays Spring	0.319	0.259 - 0.378	0.719	0.585 - 0.835	0.914	0.847 - 0.970	0.319	0.259 - 0.378

Table B-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Farm Project during spring 2015. *Distribution of easy and difficult visibility on the generation-tie line was about 70% and 30%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero. ***Adjusted fatality estimates for spring are weighted to account for variable area adjustments during spring.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Adjusted Fatality Estimates (Fatalities /Season)**								
Overhead lines: Winter	0	-	0	-	0	-	0	-
Overhead lines: Spring	40.1	4.3 - 107.2	6.7	0.5 - 8.6	0	-	13.4	(1) - 22.1
Overhead lines: Total	40.1	4.3 - 107.2	6.7	0.5 - 8.6	0	-	13.4	(1) - 22.1
Fence: Winter	0	-	0	-	0	-	0	-
Fence: Spring	0	-	1.6	1.6 - 3.5	0	-	0	-
Fence: Total	0	-	1.6	1.6 - 3.5	0	-	0	-
Solar arrays: Winter	16.6	(1) - 26.3	0	-	3.9	(1) - 4.2	0	-
Solar arrays: Spring***	21.2	9.3 - 23.5	9.4	4.9 - 16.2	7.6	(2) - 26.7	10.6	(1) - 20.1
Solar arrays: Total	37.8	19.0 - 36.8	9.4	4.9 - 16.2	11.5	(3) - 30.7	10.6	(1) - 20.1
Facility: Winter	16.6	(1) - 26.3	0	-	3.9	(1) - 4.2	0	-
Facility: Spring	61.3	20.1 - 121.6	17.7	12.4 - 22.8	7.6	(2) - 26.7	24	(2) - 38.1
Facility: Total	77.9	25.5 - 135.7	17.7	12.4 - 22.8	11.5	(3) - 30.7	24	(2) - 38.1

Comentado [FWS32]: This table/appendix requires more explanation.

Topaz Solar Farms

COA 62 Year 4 First Quarter Report

January 1 – March 31, 2015

for

Avian and Bat Protection Plan

and

Bird Monitoring and Avoidance Plan

Prepared for

Topaz Solar Farms LLC
10400 Helios Way
Santa Margarita, CA 93453

by

ALTHOUSE AND MEADE, INC.
BIOLOGICAL AND ENVIRONMENTAL SERVICES
1602 Spring Street
Paso Robles, CA 93446
(805) 237-9626

August 2015

654.76

Table of Contents

Tables

Figures

Exhibits

1.0 Introduction

This Year 4 First Quarter Report for January 1 through March 31, 2015 provides bird and bat information as specified in the Topaz Solar Farms Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan (ABPP and BMAP; Althouse and Meade, Inc. June 2011). Section 5.5 of the ABPP and BMAP describes information to be included in reports and requires quarterly reports to be submitted to the County of San Luis Obispo (County), U.S. Fish and Wildlife Service (USFW) and the California Department of Fish and Wildlife (CDFW). The Avian and Bat Protection Plan (ABPP; Section 2.0 of this report) and Bird Monitoring and Avoidance Plan (BMAP; Section 3.0 of this report) are requirements of County of San Luis Obispo Conditions of Approval (COA) 61 and 62, and were prepared in consultation with USFWS and CDFW.

1.1 Construction Status

Construction of the Topaz Solar Farms project was completed in December 2014. All 22 solar array blocks were transferred to Operations & Maintenance (O&M) by October 2014 (Table 1). Exhibit 1 in Section 5.0 illustrates construction status through December 2014.

TABLE 1. CONSTRUCTION STATUS BY BLOCK. Date of transfer to O&M is provided for Blocks 1-22.

Block(s)	Month and Year Transferred to O&M	Block(s)	Month and Year Transferred to O&M
1	March 2013	12	March 2014
2	March 2013	13	April 2014
3	March 2013	14	January 2014
4	April 2013	15	February 2014
5	April 2013	16	May 2014
6	March 2013	17	June 2014
7	May 2013	18	July 2014
8	June 2013	19	August 2014
9	July 2013	20	September 2014
10	December 2013	21	September 2014
11	March 2014	22	October 2014

2.0 Avian and Bat Protection Plan

The ABPP monitoring program compiles general information on bird and bat presence, interactions with facility components, injuries, and mortality at the Topaz Solar Farms (TSF) project. This task is completed by the project biologists as part of routine daily biological monitoring. In blocks under Operations and Maintenance (O&M) control, data is collected from a variety of sources, including pre-activity surveys, O&M technician reports, and during field work conducted for BMAP studies. Information regarding the detailed bird use and mortality risk assessment study is reported in Section 3.0.

For the ABPP, this quarterly report provides information collected during the period from January 1 through March 31, 2015.

2.1 General Bird Surveys

2.1.1 Methods

General bird surveys are conducted on and around the TSF project site on a daily basis five days a week throughout the year by project biologists. Lists of bird species observed by each biological monitor are recorded daily.

2.1.2 Results

Monitors recorded a total of 61 species of birds in January, February, and March 2015. Of the 61 species, 8 were waterbirds and 11 were raptors. Some of the 8 waterbird species were observed in lands surrounding Topaz including a private pond less than a thousand feet from TSF, and others were observed flying over TSF without using project features as habitat. Table 1 lists all bird species observed in this quarter with information on observation frequency.

Table 2. January – March 2015 General Bird Survey Results. All bird species recorded this quarter are listed. Top twenty species most frequently observed, waterbirds, and raptors are indicated.

Species	**Most Frequent**	**Waterbird**	**Raptor**
American Coot		✓	
American Crow			
American Goldfinch			
American Kestrel	✓		✓
American Pipit			
American Robin			
Anna's Hummingbird			
Bald Eagle			✓
Brewer’s Blackbird	✓		
Bullock's Oriole			
Burrowing Owl			✓
California Towhee			
Canada Goose		✓	
Common Raven	✓		
Dark-eyed Junco			
Eurasian Collared-Dove	✓		
European Starling	✓		
Ferruginous Hawk	✓		✓
Golden Eagle	✓		✓
Golden-crowned Sparrow			
Great Blue Heron		✓	
Greater Roadrunner			
Greater Yellowlegs		✓	
Horned Lark	✓		
House Finch	✓		
House Sparrow	✓		
Killdeer		✓	
Lark Sparrow			
Lawrence's Goldfinch			
Least Sandpiper		✓	
Lesser Goldfinch			
Loggerhead Shrike			
Long-billed Curlew	✓	✓	
Merlin			✓
Mountain Bluebird	✓		
Mountain Plover			
Mourning Dove	✓		
Northern Flicker			
Northern Harrier			✓
Northern Mockingbird			
Prairie Falcon			✓
Red-tailed Hawk	✓		✓
Red-winged Blackbird			
Rock Pigeon	✓		
Rock Wren			
Sage Thrasher			
Savannah Sparrow	✓		
Say's Phoebe	✓		
Sharp-shinned Hawk			✓
Snowy Egret		✓	
Spotted Towhee			
Tree Swallow			
Tricolored Blackbird			
Turkey Vulture	✓		
Vesper Sparrow			
Western Bluebird			
Western Kingbird			
Western Meadowlark	✓		
White-crowned Sparrow	✓		
White-tailed Kite			✓
Yellow-rumped Warbler			

2.2 Nesting Activity

Nest searches were not conducted during this reporting period. No nests were incidentally observed or reported by O&M technicians.

2.3 Avian and Other Wildlife Mortality

General biological monitoring of the Topaz work area documented bird, bat, and other wildlife mortality, as required by COA 62. All mortality identified on site during this reporting period is provided in Table 3. Cause of death is reported when known. Several of the avian fatalities identified were feather spots, so cause of death could not be confirmed. "Probable" is used for a confidence of >50 percent in the cause of death determination, while "Possible" indicates 1-50 percent confidence. "Valid" indicates 100 percent confidence in the cause of death determination. This table includes all fatalities found in areas managed by Operations and Maintenance.

TABLE 3. JANUARY – MARCH 2015 AVIAN AND OTHER WILDLIFE MORTALITY. Bird and other wildlife mortality detected at the Topaz Solar Farms from January 1 to March 31, 2015. Asterisk indicates it was found during formal fatality surveys.

Month	Species	Location	Cause of Death
Jan.	Mourning Dove	Block 13	Possible Predation
	Mourning Dove	Block 13	Possible Predation
	Western Meadowlark*	Block 9 Array 14	Unknown
	Mourning Dove	Block 13 Array 8	Possible Predation
	Mourning Dove	Block 14 Array 1	Probable Predation
	Unknown Blackbird	Block 15 Array 16	Unknown
	Red-Tailed Hawk	Fence in Block 1 Array 19	Probable Collision
	Domestic Chicken	Block 17 Array 1	Possible Predation
Feb.	Domestic Chicken*	Block 20 Array 1	Possible Predation
Mar.	Domestic House Cat	Block 6	Unknown
	Western Meadowlark*	Block 7 Array 4	Unknown
	Common Raven	Block 11 Medium Voltage Collector Lines	Collision
	Common Raven (2)	Block 13 Photovoltaic Combining Switchgear	Electrocution
	Common Raven	Block 12 Photovoltaic Combining Switchgear	Electrocution

2.4 Adaptive Management

No adaptive management practices were implemented during the period from January through March 2015.

2.5 Bat Surveys

2.5.1 Methods

Acoustic monitoring surveys for bats on the project site were conducted one night per month using a Pettersson D240x (Pettersson Elektronik, Sweden) bat detector and Sonobat® (v.3.1 US west; DNDesign, Arcata, CA) acoustic analysis software. Sound frequencies in the range utilized by bats (10 to 120 kHz) were detected and synthesized into time-expanded sound files and analyzed by Sonobat® software. Surveys were initiated near dusk, when bats commonly begin foraging. Monitoring periods for each survey were limited to the battery life of the Pettersson detector and typically ranged from three to six hours depending on the number of sound files detected. On January 28, the detector was deployed on the perimeter fence at the northeastern corner of Block 7. On February 10 and March 30, the bat detector was placed on a T-post near the parking lot west of the Operations and Maintenance building. All sound files recorded were analyzed for bat calls. Any identification to species was determined with a discrimination probability of 0.95 or higher using Sonobat® software.

2.5.2 Results

From January through March 2015, bats were not detected at Topaz Solar Farms. The decrease in bat activity observed during the 2015 winter months was expected. Seasonal fluctuations in distribution and activity has been documented in many species of bats throughout North America (e.g. O’Shea and Vaughan 1977, Cryan 2003), including changes in wintering range and activity. Similar decreases in bat abundance and species richness were also observed at Topaz Solar Farms during winter 2013-2014 and are likely to occur each winter.

3.0 Bird Monitoring and Avoidance Plan

The BMAP study analyzes avian use surveys and avian fatality surveys to produce a risk index for various project components deemed to be potentially dangerous to birds, including array areas, overhead power lines and the substation. Off-site grassland reference sites are used to gauge background mortality levels. Results are reported in this first quarter report for Avian Use Surveys (Section 3.1), Avian Fatality Surveys (Section 3.2), and for bias trials (Section 3.3). Risk index calculations will be provided in the annual report.

3.1 Avian Use Surveys

3.1.1 Methods

Avian Use Surveys have been conducted monthly from November 2011 through March 2015, and will continue through 2017 to satisfy the three-year post construction monitoring requirement. Each month, 63 randomly selected survey points are completed, including 31 inside existing array areas, 18 along existing overhead power lines, 10 in grassland reference sites and 4 at energized equipment (substation). At each point, a 10 minute bird use count is conducted within a 50 meter radius of the surveyor. Avian Use Survey points are randomly selected each month across all six phases of the project and in off-site grassland reference areas (Exhibit 3).

3.1.2 Results

The four Survey Area Categories used as treatment types in this study comprise different habitat elements that influence species composition, abundance and richness.

The Array Area category includes surveys conducted within solar array areas during active construction and in completed form. The habitat consists of rows of passive (non-moving) photovoltaic solar panels mounted to steel racking ranging from approximately 2 to 5 feet off the ground. The ground is seeded with a native seed mix to revegetate array areas to naturalized grassland habitat; vegetation density varied from 0 to 60 percent cover. Array Area survey point areas may also include perimeter fences, photovoltaic combining switchgear houses, as well as array roads.

The Energized Equipment category includes point counts conducted around the perimeter of the substation. The survey area includes the substation perimeter fence, transformers, power lines, and other electrical components. Within the substation fence the ground is gravel with no vegetation. Outside the perimeter fence, the ground is bare dirt with some patches of grass and forbs.

Overhead Powerline surveys represent areas underneath medium-voltage collector lines within the project. Vegetation varies depending on location. Most powerlines are along array or perimeter access roads, however some locations are outside the fenced project areas in annual grassland habitat.

Reference Sites are composed of annual grassland habitat. They included point counts conducted on annual grassland in mitigation lands owned and managed by California Department of Fish and Wildlife or Stewardship Land not developed by TSF.

In January, February, and March 2015, 189 avian point counts were conducted in the 4 Survey Area Categories totaling 366.8 acres of survey area. During these surveys, species composition consisted of 27 different bird species. Bird abundance is examined as total number of detections per species as well as average number of detections per Observation Point (Table 4). The most abundantly detected species, listed in decreasing order of total detections, were: horned lark (1,275 detections), Brewer’s blackbird (370), house finch (263), savannah sparrow (108), common raven (79), western meadowlark (70), mourning dove (32), American pipit (30), European starling (24), and Eurasian collared-dove (18).

The most frequently encountered species, the horned lark, was detected more than three times as often as that of that of the second most frequently encountered species, Brewer’s blackbird. It was detected three times more frequently in Grassland/Reference than in Overhead Powerline areas. The Array Area category had the lowest average detections per Observation Point.

TABLE 4. SPECIES COMPOSITION AND ABUNDANCE. All bird species detected during Avian Use Surveys in January, February, and March 2015 are listed, with the average number of bird use detections per observation point calculated for each of the four survey area categories. Total detections for each species and each survey area type are provided in far right column and bottom row. Species are listed in decreasing order of abundance according to the total detections column.

Species	**Array Area** Ave. Detections per Obs. Pt.	**Energized Equipment** Ave. Detections per Obs. Pt.	**Overhead Powerline** Ave. Detections per Obs. Pt.	**Grassland/ Reference** Ave. Detections per Obs. Pt.	**Total Detections**
Horned Lark	1.39	3.92	5.67	17.20	6.75
Brewer's Blackbird	2.78	0.00	3.60	0.06	1.96
House Finch	0.22	2.42	0.47	3.70	1.39
Savannah Sparrow	0.46	1.17	0.90	0.44	0.57
Common Raven	0.40	0.42	1.07	0.09	0.42
Western Meadowlark	0.37	0.00	0.77	0.24	0.37
Mourning Dove	0.13	0.58	0.17	0.15	0.17
American Pipit	0.01	2.00	0.17	0.00	0.16
European Starling	0.05	0.17	0.37	0.11	0.13
Eurasian Collared-Dove	0.09	0.83	0.00	0.00	0.10
House Sparrow	0.00	0.92	0.10	0.00	0.07
Rock Pigeon	0.02	0.00	0.13	0.00	0.03
Long-billed Curlew	0.02	0.00	0.07	0.00	0.02
Lesser Goldfinch	0.03	0.08	0.00	0.00	0.02
American Goldfinch	0.02	0.00	0.03	0.00	0.02
Ferruginous Hawk	0.01	0.00	0.07	0.00	0.02
Say's Phoebe	0.02	0.00	0.03	0.00	0.02
Burrowing Owl	0.00	0.00	0.00	0.04	0.01
Mountain Bluebird	0.00	0.00	0.07	0.00	0.01
Tricolored Blackbird	0.02	0.00	0.00	0.00	0.01
American Kestrel	0.00	0.00	0.03	0.00	0.01
Anna's Hummingbird	0.00	0.00	0.03	0.00	0.01
Golden Eagle	0.00	0.00	0.00	0.02	0.01

Species	**Array Area** Ave. Detections per Obs. Pt.	**Energized Equipment** Ave. Detections per Obs. Pt.	**Overhead Powerline** Ave. Detections per Obs. Pt.	**Grassland/ Reference** Ave. Detections per Obs. Pt.	**Total Detections**
Northern Harrier	0.00	0.00	0.00	0.02	0.01
Prairie Falcon	0.00	0.00	0.00	0.02	0.01
White-crowned Sparrow	0.00	0.08	0.00	0.00	0.01
Killdeer	0.00	0.08	0.00	0.00	0.01
Total Avian Detections	**562**	**152**	**412**	**1,193**	**2,319**

Species Richness was calculated as the average number of species detected at each Observation Point. Among the treatment types, Energized Equipment had the highest species richness with an overall average of 3.58 species detected per Observation Point. Reference Site had the next highest with an average of 1.98 species. Array Area and Overhead Powerline had the next lowest with 1.23 and 1.35 species per observation point, respectively (Table 5 and Figure 1).

Bird Utilization Rate (BUR) is calculated as the average number of birds observed per Observation Point. Bird Utilization Rate is calculated for the four Survey Area Categories for January through March 2015 (Table 5 and Figure 1). Reference Site had the highest BUR at 39.77 birds per Observation Point. Energized Equipment had the second highest BUR at 12.67 birds per observation point and Overhead Powerline and Array Area had the lowest with 7.63 and 6.04, respectively.

TABLE 5. AVIAN USE SURVEY POINT COUNTS AND DETECTIONS. Avian use survey point count data is provided for number of observation point counts, total area surveyed, total number of species detected, species richness and bird utilization rate. All results are from data collected in January, February, and March 2015.

Type	**Number of Obs. Pt. Counts**	**Total Area Surveyed (Acres)**	**Total No. Species**	**Ave. No. Species per Obs. Pt (Species Richness)**	**Ave. No. Birds per Obs. Pt (BUR)**
Array Area	93	180.49	9	1.35	6.04
Energized Equipment	12	23.29	7	3.58	12.67
Overhead Powerline	30	104.80	7	1.23	7.63
Reference Site	54	366.81	8	1.98	39.77
Total Combined	**189**	**366.81**	**11**	**1.66**	**12.27**

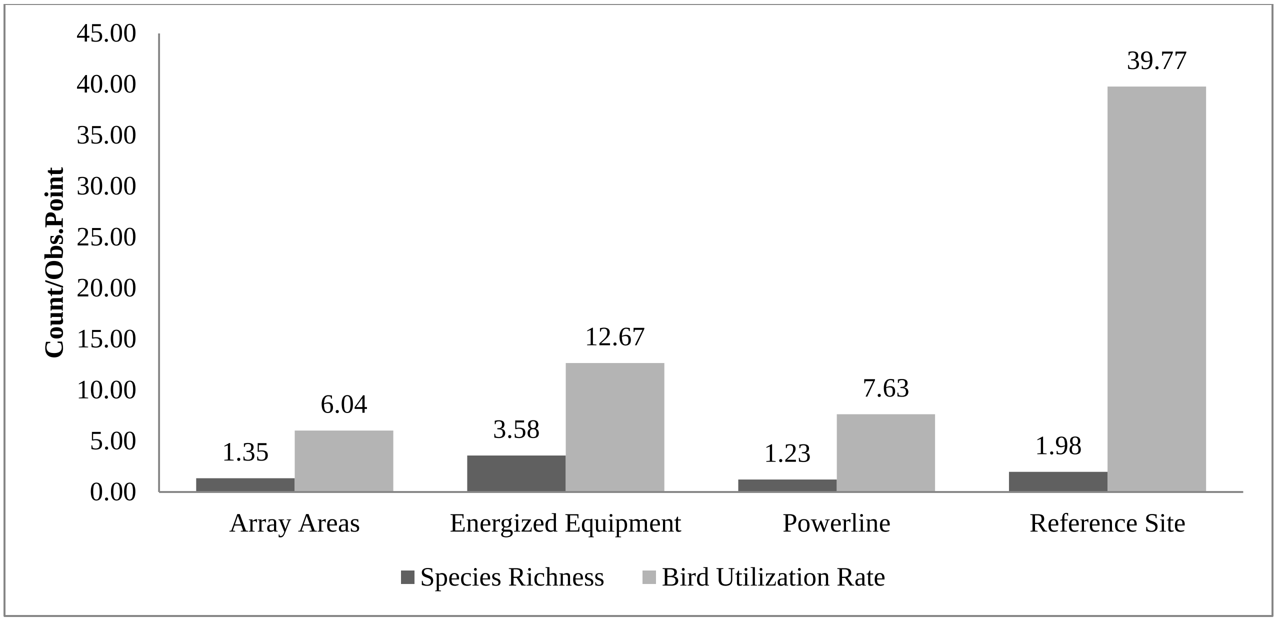


FIGURE 1. SPECIES RICHNESS AND BIRD UTILIZATION RATE. Species richness and bird utilization rate are provided for each of the 4 survey area categories for the first quarter of 2015.

3.2 Avian Fatality Surveys

3.2.1 Methods

Avian Fatality Surveys commenced upon completion of the first project components. Avian Fatality Surveys are conducted at randomly selected locations within four different survey area categories: Array Area, Overhead Powerline, Energized Equipment (Substation) and Reference Site. Search plots for Array Area, Reference Site and Overhead Powerline were defined as a transect 14 feet wide and 480 feet long, which equals the area of a typical aisle in a PV array. The area searched in the Array Area and Reference Site each month is equivalent to approximately three PV arrays. The search plot for Energized Equipment is the entire area of the substation, which is 4.48 acres. All survey areas except Energized Equipment are randomly selected using an ArcGIS random point generator having defined areas as the constraining polygon. Avian Fatality Surveys are conducted within the same search plots each day for seven consecutive days every month. Repetitive surveys increase the chance of finding fatalities in a given area before predators remove the carcass, and also facilitate per day calculations.

3.2.2 Results

Each month, January through March 2015, we completed walking Avian Fatality Surveys for all transects within each of the Survey Area Categories for seven consecutive days each. Reference Site search plots were completed for seven consecutive days each, totaling 10.4 linear miles (17.6 acres) each day of surveys. Array Area search plots were completed for seven consecutive days each, totaling 10.4 linear miles (17.6 acres) each day. Overhead Powerline search plots were completed for seven consecutive days each, totaling 4.4 linear miles (7.4 acres) each day. On days with low visibility due to poor weather, surveys were completed when conditions improved with an additional day of surveys. Energized Equipment was also surveyed for seven consecutive days, totaling 4.5 acres each day.

Three months of surveys yielded a total distance of 552 linear miles and coverage of 1,035.29 acres. These surveys resulted in discovery of five fatalities, two each in Reference Site and Array Area, and one in Overhead Powerline. Fatality rates were calculated per search plot and miles walked (Table 6). Overhead Powerline had the highest fatality rate of 0.00094 fatalities/search plot and Reference Site and Array Area each had the same fatality rate, at 0.00080 fatalities/search plot. No fatalities were found in Energized Equipment plots.

TABLE 6. BIRD FATALITY RATE. The survey results and efforts are indicated for each of the four survey area categories for the first quarter of 2015.

Survey Area Category	**Linear Miles**	**Acres**	**Search Plots**	**Total Fatalities**	**Fatality/ Search Plot**	**Fatality/ Mile**
Array Area	228	386.91	2508	2	0.00080	0.00877
Overhead Powerline	96	162.91	1056	1	0.00094	0.01041
Reference Site	228	386.91	2508	2	0.00080	0.00877
Energized Equipment	-	98.56	22	0	-	-
Total Combined	**552**	**1,035.29**	**-**	**5**	**-**	**-**

Cause of death was recorded for all fatalities, when known. The five fatalities documented during Avian Fatality Surveys in January, February, and March 2015 were classified as predation or unknown. Since it is difficult to determine cause of death with certainty, recent guidance from the U.S. Fish and Wildlife Service suggests attributing cause of death to a specific factor and including a confidence percent to indicate how confident the determination was (Table 7; Beck and Dietsch 2013). Predation as a cause of death may be higher than reported, as feather piles often could not be confidently linked to a predation event as opposed to a scavenging event, even though predation was likely the cause.

TABLE 7. CAUSE OF DEATH FOR AVIAN FATALITY SURVEY RESULTS. Cause of death tallied for avian fatalities detected within each of the four survey area categories, January – March 2015, during formal avian fatality surveys. Percentages indicate confidence level.

Survey Area Category	**Unknown**	**Predation Possible (1-50%)**	**Predation Probable (>50%)**	**Total**
Array Area	1	1	0	**2**
Overhead Powerline	1	0	0	**1**
Reference Site	0	1	1	**2**
Energized Equipment	0	0	0	**0**
Total Combined	**2**	**2**	**1**	**5**

3.3 Scavenger/Carcass Removal Trials and Searcher Efficiency Trials

3.3.1 Scavenger/Carcass Removal Trial

Scavenger removal trials were not conducted during this reporting period.

3.3.2 Searcher Efficiency Trial

Searcher efficiency trials were not conducted during this reporting period.

3.4 Discussion

This first quarter report for 2015 is the first reporting period to include data collected after the solar farm became completely operational. The last block was energized and fully operational in October 2014, and final construction activities and demobilization were completed by mid-December.

A variety of wildlife, including birds, are utilizing habitat within the completed project site. This 1st quarter winter reporting period saw the same number of fatalities in Array Areas and Reference Sites (2 each), compared with a single fatality recorded in the Overhead Powerline category. The off-site grassland Reference Site category had a bird utilization rate (BUR) 6.6 times higher than that of the Array Area category, but the bird fatality rates (BFR) were equivalent.

The 2015 Annual Report will provide more discussion of the data throughout the year and will provide comparisons of 2015 results with previous years.

4.0 References

Althouse and Meade, Inc. 2011. Topaz Solar Farms Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. June 2011.

Althouse and Meade, Inc. 2013. Topaz Construction Phase Programmatic Nesting Bird Management Plan. Revised August 19, 2013.

Althouse and Meade, Inc. 2014. Topaz Solar Farms 2013 Fourth Quarter/Second Annual Report for Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. March 2014.

Althouse and Meade, Inc. 2014. Topaz Solar Farms COA 62 Year 3 First Quarter Report, January 1 – March 31, 2014 for Avian and Bat Protection Plan and Bird Monitoring and Avoidance Plan. April 2014.

American Ornithologists Union. 1983. Check-list of North American Birds, 6th ed. Allen Press, Lawrence, KS. 877 pp.

Aspen Environmental Consultants. 2011. Final Environmental Impact Report for the Topaz Solar Farm. March.

Avian Power Line Interaction Committee (APLIC). 2006. *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006*. Edison Electric Institute, APLIC, and the California Energy Commission. Washington D.C. and Sacramento, CA.

Avian Power Line Interaction Committee (APLIC). 2012. *Reducing Avian Collisions with Power Lines: The State of the Art in 2012*. Edison Electric Institute and APLIC. Washington, D.C.

Beck, A. (First Solar) and T. Dietsch (USFWS) 2013. Personal communication regarding U.S. Fish and Wildlife Special Purpose Utility permit for avian fatality reporting.

Cryan, P.M. 2003. Seasonal distribution of migratory tree bats (*Lasiurus* and *Lasionycteris*) in North America. Journal of Mammalogy 84: 579-593.

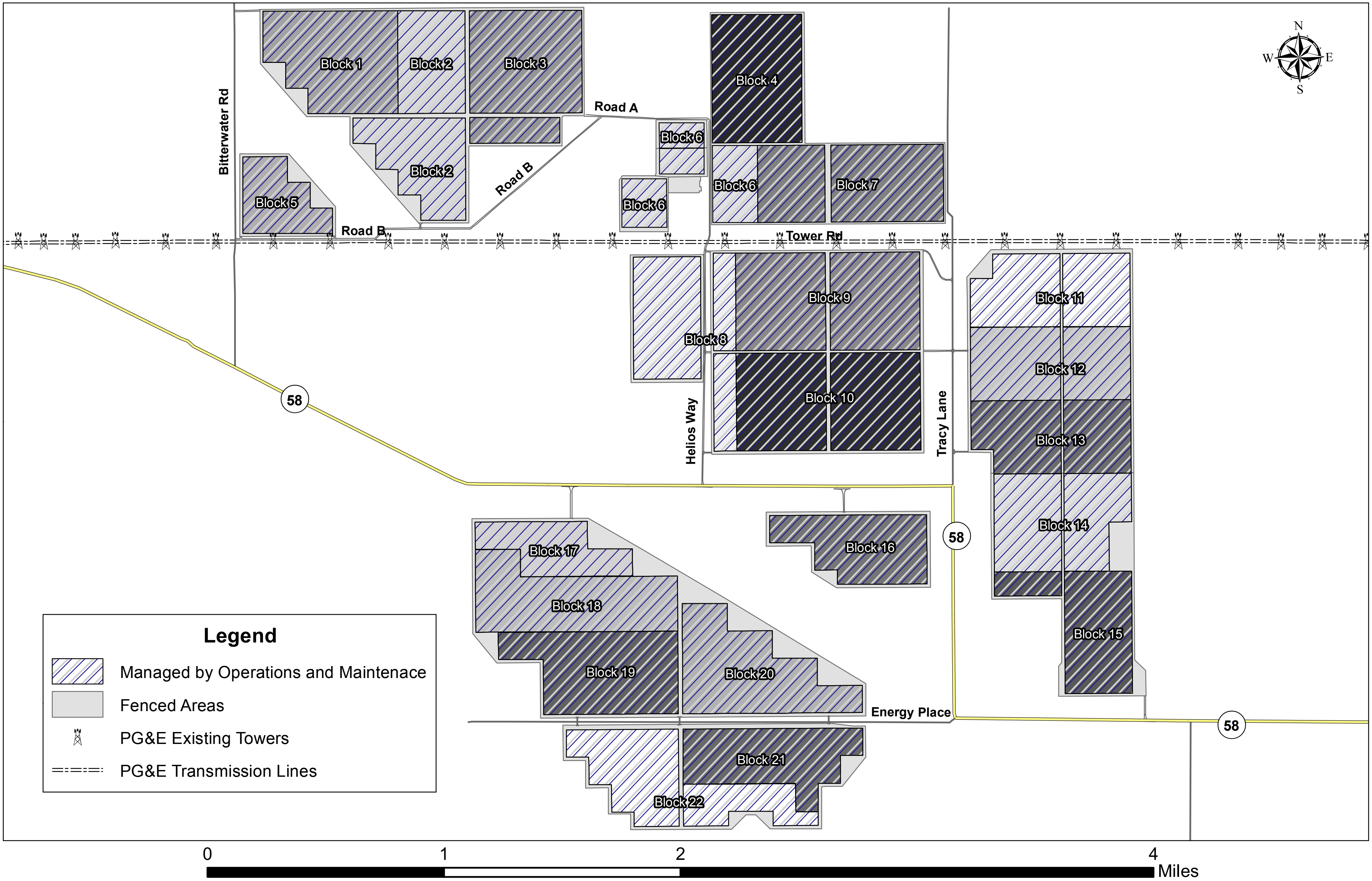
O’Shea, T.J. and T.A. Vaughan. 1977. Nocturnal and season activities of the pallid bat, *Antrozous pallidus*. Journal of Mammalogy 58: 269-284.

5.0 Exhibits

- Exhibit 1. Construction Status as of December 31, 2014.
- Exhibit 2. Avian Use Survey Points January – March 2015.
- Exhibit 3. Avian Fatality Survey Areas January – March 2015.

Exhibit 1. Construction Status

As of December 31, 2014



BHE RENEWABLES

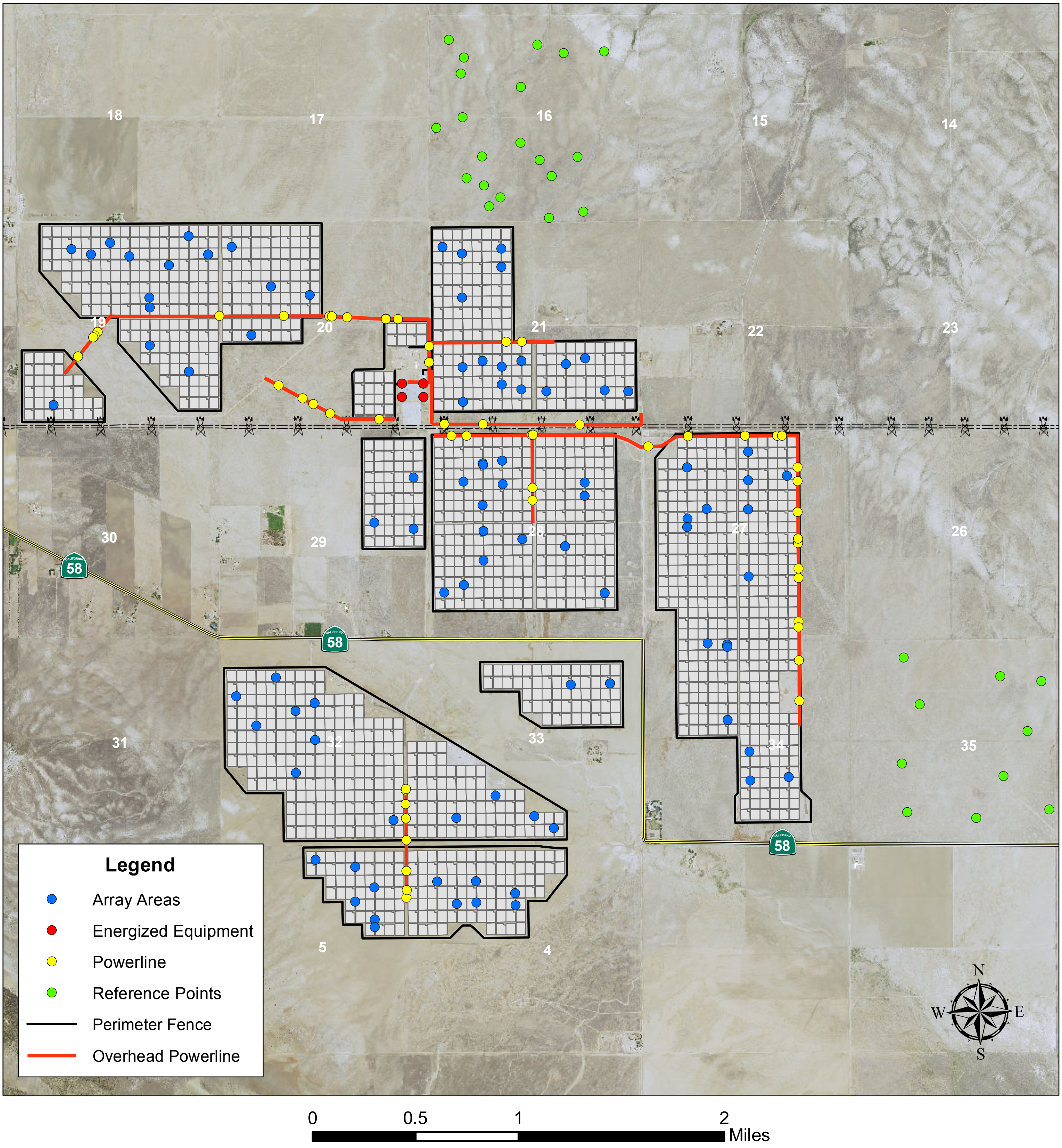
Map Updated: September 08, 2015 01:13 PM

ALTHOUSE AND MEADE, INC.
BIOLOGICAL AND ENVIRONMENTAL SERVICES

Additional Documentation Attachment to Comment 2-F1
Attachment I-5

Exhibit 2. Avian Use Survey Points

January 2015 to March 2015



BHE RENEWABLES

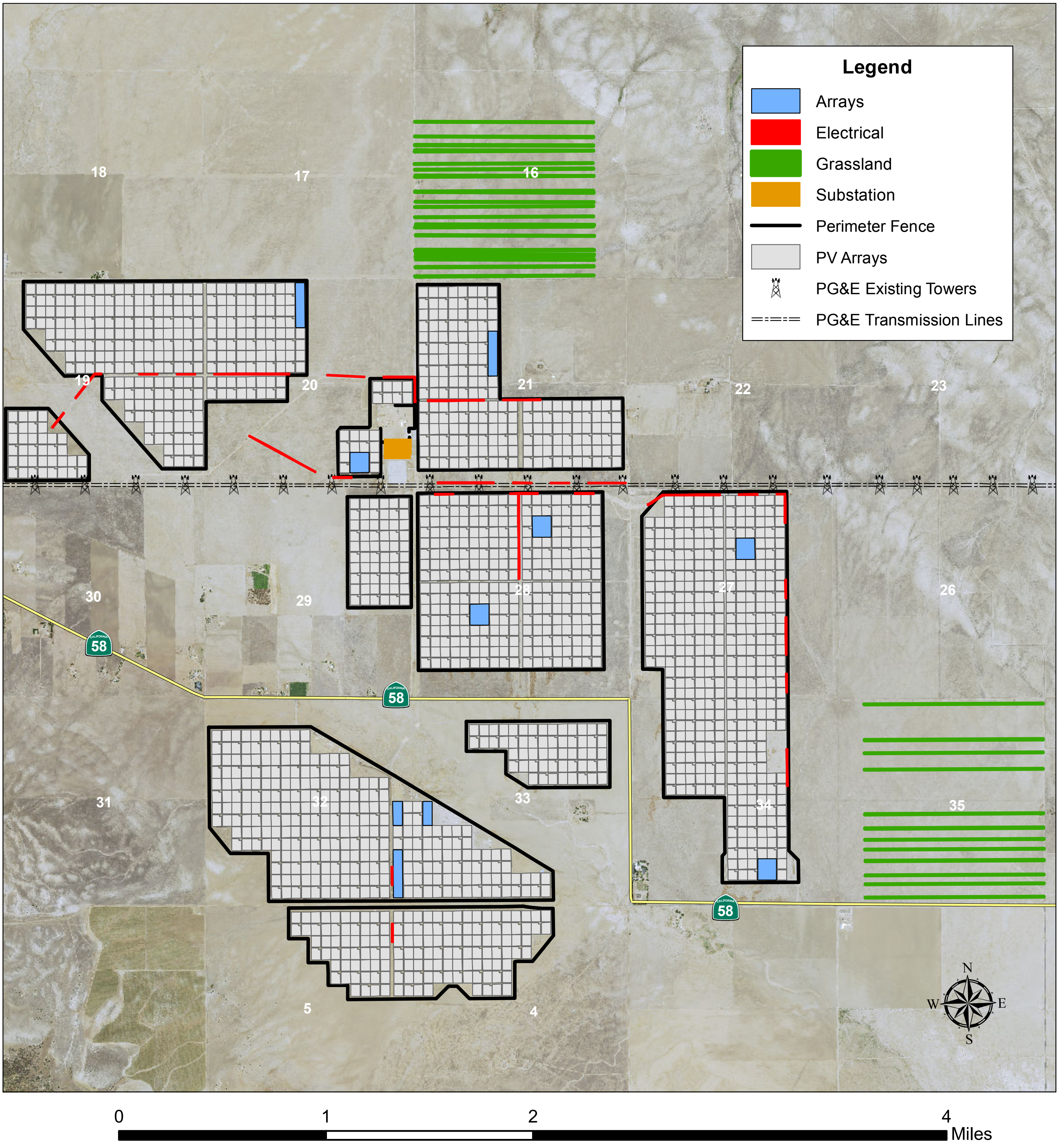
2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: September 08, 2015, 01:57 PM

ALTHOUSE AND MEADE, INC.
BIOLOGICAL AND ENVIRONMENTAL SERVICES

Additional Documentation Attachment to Comment 2-F1
Attachment I-5

Exhibit 3. Avian Fatality Survey Areas

January 2015 to March 2015



BHE
RENEWABLES

2012 San Luis Obispo County
NAIP Aerial Photography
Map Updated: September 08, 2015, 01:47 PM

ALTHOUSE AND MEADE, INC.
BIOLOGICAL AND ENVIRONMENTAL SERVICES

Post-Construction Monitoring at the Desert Sunlight Solar Project Riverside County, California

2015 Summer Report

Prepared for:

Desert Sunlight 250, LLC and
Desert Sunlight 300, LLC
700 Universe Blvd.,
Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.

415 West 17th Street, Suite 2000
Cheyenne, Wyoming

October 15, 2015

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from June 01 to August 30, 2015 (the reporting period) at Desert Sunlight Solar Farm Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). For logistical reasons, fall monitoring began on Monday, August 31, 2015. Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the second seasonal report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS.

Included in this report are data from standardized carcass searches conducted during the summer season at the Project, defined as June 01 to August 30, 2015. Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 29.5% sample of solar photovoltaic (PV) panels, 2) along inner portions of the fenceline, resulting in 74.4% of the length of the perimeter fence, and 3) along 47.9% of the total length of generation-tie (gen-tie) line from the Project fence to the Red Bluff Substation located south of Interstate 10 (I-10). Searches conducted within the summer season had intervals of approximately 21 days.

All bird and bat fatalities and injuries that were discovered by observers, referred to as "detections" in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, 15 avian detections were made, and there were no detections of bats.

According to specifications of the BBCS, avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were applied to a fatality estimator model (Huso 2010) to provide a preliminary estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias. The estimate is considered preliminary because the annual report may pool information from bias trials and other data across seasons which could affect seasonal estimates.

During the reporting period, carcass persistence was influenced by carcass size and Project component. Small carcasses (0-100 g) in the arrays and along the fence (combined) had a 63% chance (90% confidence interval [CI]: 48 – 76%) of persisting through the effective search interval, medium carcasses (101 – 999 g) had a 73% (55 – 86%) chance, and large carcasses (1000+ g) had a 100% chance because no removal was observed. Mean removal time within the arrays for small and medium carcasses was 15.5, and 19.2 days, respectively; mean removal time was not estimated for large carcasses because no removal was observed. Along the generation tie-line, chances of persistence for small, medium, and large carcasses were 22% (14 – 26%), 60% (37 – 74%), and 22% (14 – 26%), respectively; mean removal time for small, medium, and large carcasses was, 1.4, 14.8, and 0.9 days, respectively. Within the solar arrays, searcher efficiency was influenced by carcass size: 60.0% for small birds, 86.6% for

medium birds, and 98.1% for large birds. Along the fence, searcher efficiency ranged from 87.5% to 100% depending on carcass size class. Along the generation tie-line, searcher efficiency ranged from 43.5% to 100%.

Composition of detections during summer 2015 included eight avian guilds. Corvids comprised the majority of detections (n = 3): there were two detections each within the doves/pigeons, rails/coots, and waterbirds/waterfowl guilds. No bats have been detected since monitoring began at the Project.

Using the Huso (2010) fatality estimator model, during summer 2015, there were an estimated total 148 carcasses (90% CI: 10 – 365) at the Project. Of these, 44 carcasses (27.5%; 90% CI: 8 – 64) were estimated for the solar arrays and 104 carcasses (66.9%; 90% CI: 2 – 339) were estimated for the gen-tie line. While we are required to report the gen-tie estimates per the approved BBCS, these estimates are not reliable due to the high rates of scavenging that were observed during the limited trials at the gen-tie and the low number of carcasses detected (n = 2 in the fatality analysis). No carcasses were estimated for the perimeter fenceline because there were no detections made along the fence. All of these estimates should be interpreted with caution because variance estimates are in general unreliable when carcass counts are low (< 5 per category). Other projects (e.g. Ivanpah) are not reporting estimates when carcass counts are less than or equal to five. However, the TAG has asked for both the estimates and confidence intervals for this project with the appropriate caveat added. There were an estimated 0.017 fatalities per acre (within the solar field only; 44 estimated carcasses/2,585 acres) and an estimated 0.08 fatalities per nameplate MW (44 estimated carcasses/550 MW) within the solar field.

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Tracey Johnson	Research Biologist
Paul Rabie	Statistician
Pamela Bullard	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2015. Post-construction monitoring at the Desert Sunlight Solar Farm Project, Riverside County, California. 2015 Summer Report. 25 pp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Project Background

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC (collectively, Desert Sunlight) constructed and operates the Desert Sunlight Solar Farm Project (referred to in this report as "Project"), which consists of two main components: 1) a 550-megawatt (MW) photovoltaic (PV) generating facility; and 2) a 220-kilovolt (kV) generation interconnection (gen-tie) line. The Project comprises approximately 1,700 hectares (ha; 4,200 acres) of land administered by the Bureau of Land Management (BLM) six miles north of Desert Center in Riverside County, California (Figure 1).

1.2 Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (2014; “BBCS”) was prepared by the Project proponent in collaboration with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and BLM to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency approval of the BBCS occurred in December 2014. Amendments to the sampling protocol along some portions of the Project fenceline were made by Desert Sunlight and approved by the BLM on February 11, 2015.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Desert Sunlight in collaboration with the USFWS, CDFW, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the gen-tie line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
3. Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

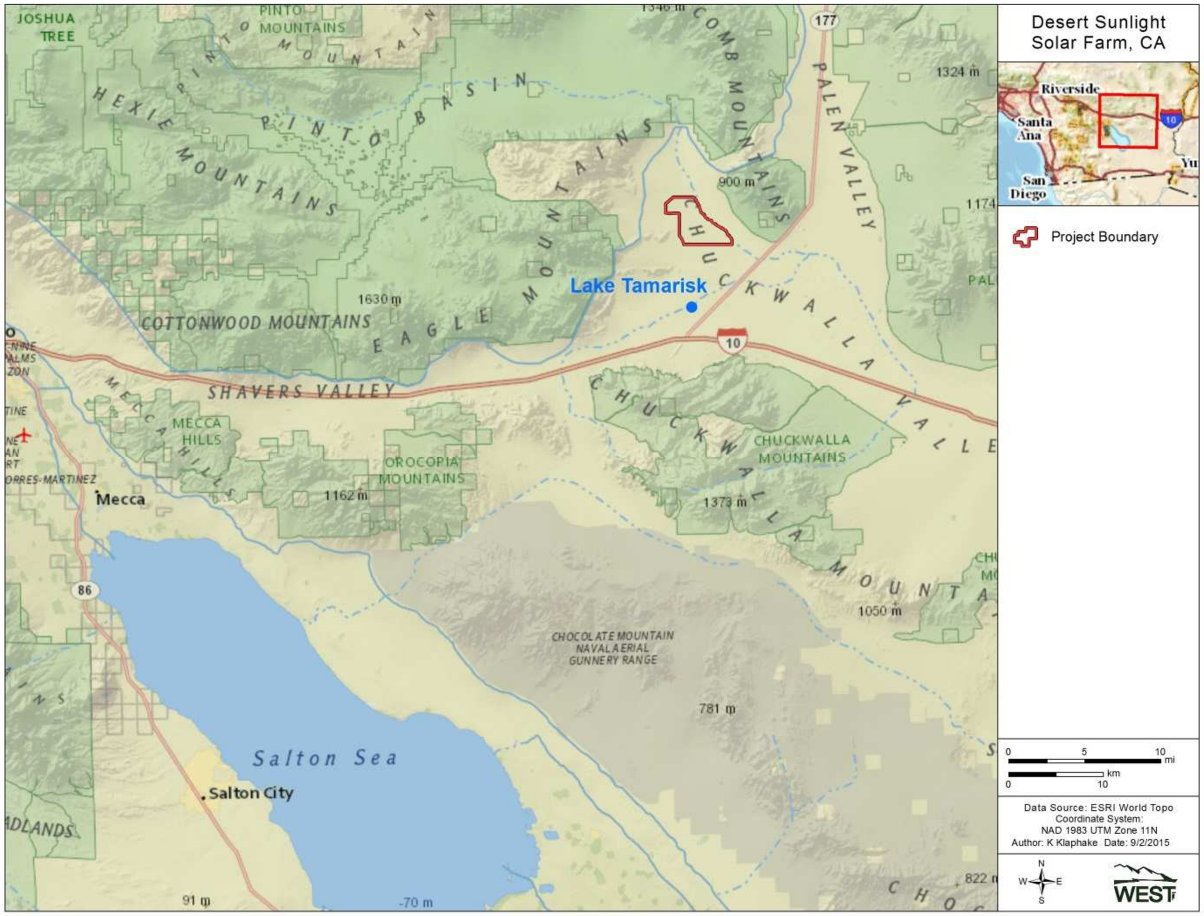


Figure 1. Desert Sunlight Solar Farm Project vicinity map, Riverside County, California.

1.3 Purpose of This Report

This report represents the second seasonal report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS. This report covers the period June 01 to August 30, 2015, or the 2015 summer season. For logistical reasons, fall monitoring began on Monday, August 31, 2015. All carcasses and injuries that were discovered by observers are referred to as “detections” in this report. As stated in the approved BBCS, this seasonal report includes the observed detections for likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and suspected causes of death. Species composition of detections and the results of the bias trials are also reported. This report presents information related to the spatial distribution of detections, but no formal statistical analysis of the spatial distribution of carcasses will be conducted until the end of the monitoring year, given the limited data presently available.

2.0 METHODS

The BBCS describes the methods by which monitoring and certain analyses, including compilation of the overall fatality estimate, will occur. Below is an abridged description (see BBCS for detailed methods).

2.1 Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. Dead or injured birds and bats are called detections in this report to provide consistency in naming. This section also describes the methods for conducting carcass removal and searcher efficiency trials; how data were reported and analyzed; and the methods for producing fatality estimates for the Project.

2.1.1 *Areas Surveyed*

Standardized carcass searches were conducted at sampling units, which include the solar arrays (Table 1, 2; Figure 2); the “fenceline” defined as the perimeter fence for the Project (Table 1, Figure 2); and the gen-tie line (from the Project fence to the Red Bluff Substation on the south side of I-10; Table 1, Figure 3). Some overhead lines co-occur with solar arrays (medium voltage overhead lines [MVOH]). The MVOH were part of standardized carcass searches to the extent that they co-occured with solar arrays included in the sample (Table 2; Figure 2).

Table 1. Areas included in standardized carcass searches at the Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

Project Component	Total Size	Units	% of Component Searched
Solar arrays	1045.9	Hectares	29.5[1]
Fence	16.7	Kilometers	99.0[2]
Gen-tie line	19.2	Kilometers	47.9[3]

[1] Percent area that was searched in summer 2015. Slightly less than 30% total because of unequally-sized arrays.

[2] 74.4% of the fence is fully accessible and surveyed following the standard protocol, while approximately 25% of the fence is surveyed from a distance. Fatality rates estimated for sections of the fence that are sampled were extrapolated to sections of the fence where the standard monitoring protocol cannot be used, as described in section 4.2.6 of the approved Desert Sunlight BBCS. A very short segment near the gate is not sampled due to restoration activities.

[3] 52.1% of the gen-tie will be sampled in 2016.

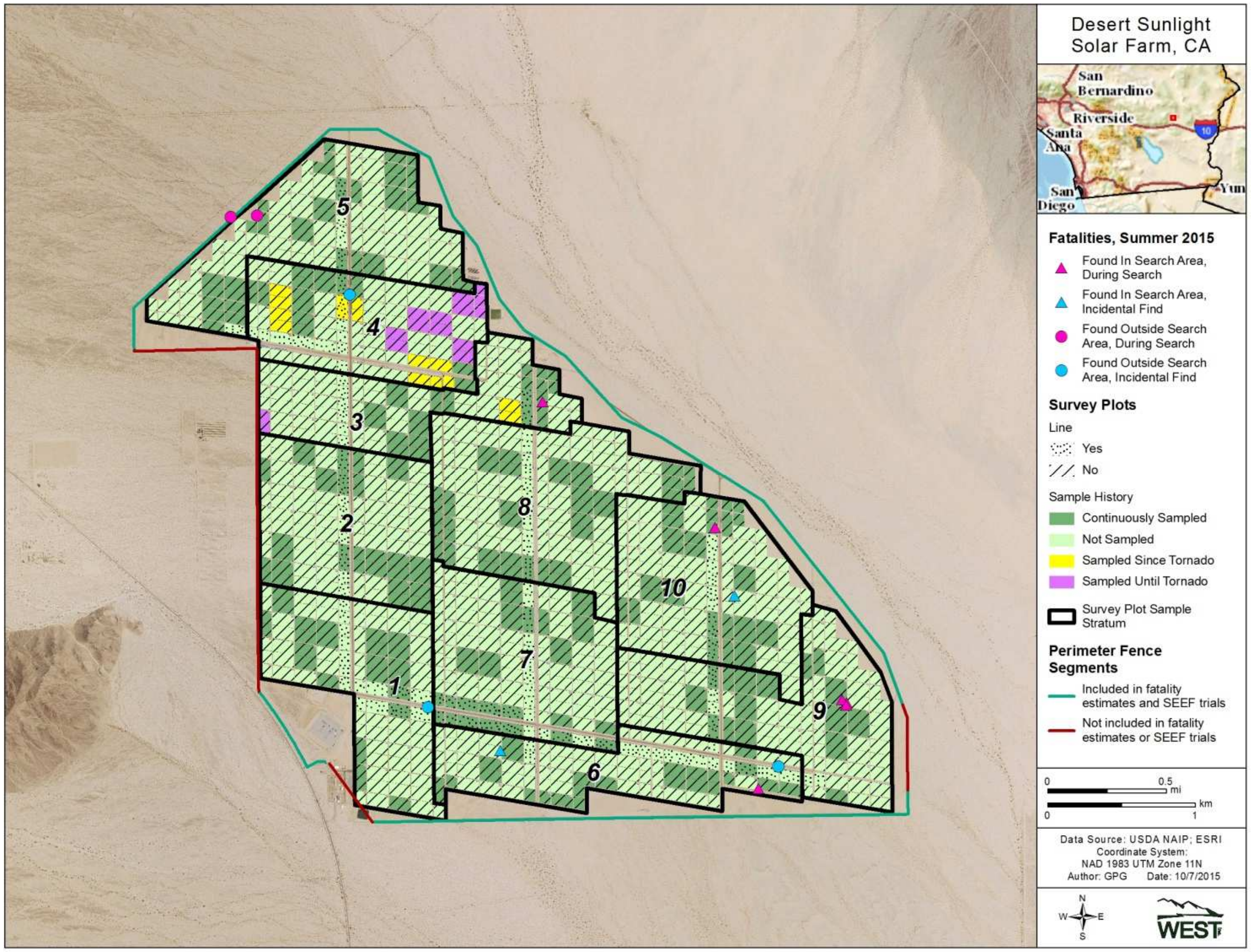


Figure 2. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at the solar field, fence, and overhead lines within the fence at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

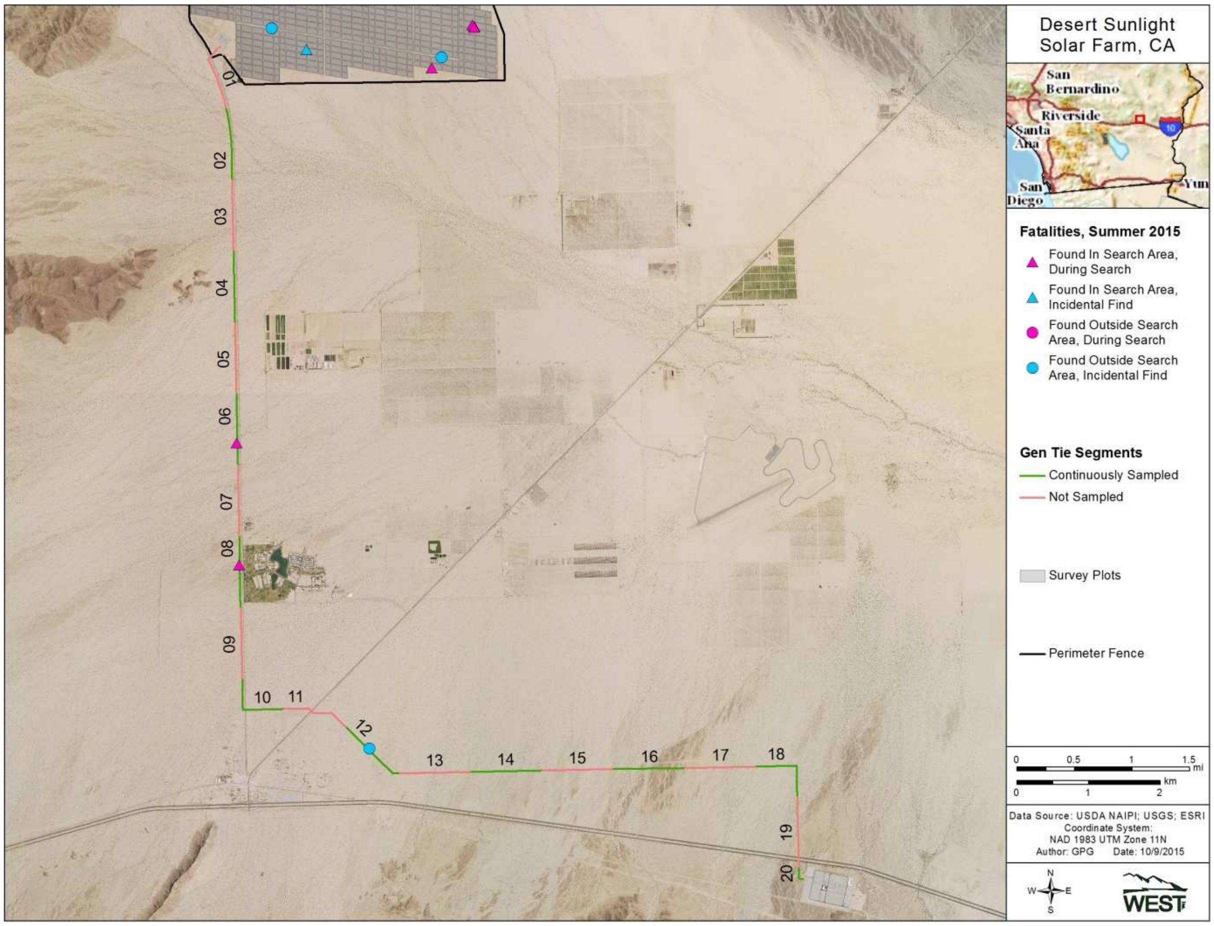


Figure 3. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance activities) along the generation tie line at the Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015. Detailed maps of detections along the line are presented in Appendix A.

To ensure a balanced distribution of sample units in the solar field (defined as the collection of all photovoltaic [PV] solar panels), the entire field was divided into ten strata, and individual sampling units were randomly selected within each stratum to compose an approximately 30% sample. This sampling design ensures that units included in the sample were not spatially clumped within the solar field. The solar field consists of arrays of solar panels (referred to as a solar array) that are either 70-m or 140-m wide. The sample includes 133 of each type of array. There are 2,580 70-m rows, and 3,900 140-m rows in the sample.

2.1.1 *Search Frequency and Timing*

Standardized searches occurred during the summer survey season, which includes the period from June 01 through August 30, 2015. All project components included in standardized searches were surveyed four times during summer. All searches took place during daylight hours from 06:30 to 17:00.

As specified in the approved Desert Sunlight BBCS, the average search interval for all Project components included in standardized carcass searches during summer was 21.0 days (median 21.0 days). Slight variation in search interval was anticipated due to weather and logistical delays.

Table 2. Area and proportion of solar arrays that are and are not associated with overhead lines at the Desert Sunlight Solar Farm Project, Riverside County, CA.

	Line-associated[1]	Not line-associated	Proportion line-associated
Entire facility	89.4 ha	956.5 ha	0.09
Standardized searches	32.2 ha	291.0 ha	0.10

[1] Line-associated area was estimated as the area of any array that fell within the 30-m strip transect below the MVOH.

2.1.2 *Search Methods*

Standardized carcass searches were performed by BLM-approved biologists, in accordance with methods outlined in the BBCS.

Within the solar field, arrays of solar panels were surveyed by observers traveling on foot. A distance sampling approach was used, whereby biologists slowly walked a transect line along the ends of rows of solar panels in a direction perpendicular to the rows, searching ahead and to the side within the array for bird and bat detections. Biologists scanned out to a maximum perpendicular distance of approximately 70 m from the transect. Biologists carried binoculars to allow them to verify the presence of a detection versus rocks or vegetation. Once a detection was confirmed, the distance of the detection to the transect line was estimated using laser range finders. Each array included in the sample was searched by observers walking two transects – one on the west side and one on the east side of the array with observers looking toward the center of the array.

Once a carcass was detected, it was photographed, and data were recorded according to specifications outlined in section 7.2.5 of the approved Desert Sunlight BBCS. Carcasses were then retrieved from their location on the ground, labeled, and placed in a freezer on site.

Most (74.4%) of the length of fenceline (approximately 10 miles) was searched from a vehicle using the standard protocol (Figure 2). Biologists searched a 6-m wide strip transect centered on the fence from the inner perimeter. Travel speed was below five miles per hour (mph) while searching. Some sections along the fence cannot be driven close to the fence line. The fence line along the western edge of the Project is drivable but the road is approximately 15 m away from the fence and the road and fence are separated by a drainage ditch. The fence along this section is covered with a tan tarp and trees and shrubs have been planted to reduce visibility of the project from the west. Additions of vegetation and the tarp likely reduce potential for bird collision with the fence. This section of the fence was driven to document carcasses, but detections along this portion of the fence are not included in adjusted fatality estimates because detection rates are likely very low. As specified in section 4.2.6 in the approved Desert Sunlight BBCS, we assume that fatality rates are similar between the portion of fence that was searched and the portion that was not. A separate section of the fence in the southeastern corner of the Project cannot be driven because the eastern edge of the berm that bounded construction ponds is too narrow for a vehicle. Along this portion of the fence, the observer stopped at both north and south ends of the berm and used binoculars to search for carcasses. Finally, the road along a portion of the southwest fence line near the entrance gate is approximately 30 to 50 m from the road and is separated from the fence by an area that has recently undergone vegetation restoration. This area was eliminated from sampling. Fatality rates estimated for sections of the fence that were sampled were adjusted to account for the proportion of fence not sampled with the standard monitoring protocol, as specified in section 4.2.6 of the approved Desert Sunlight BBCS.

The gen-tie line was searched using a 30-m wide strip transect (i.e., 15 m of ground on either side of the overhead line). Sample units along the gen-tie line were chosen by dividing the total length of line from the Project fence south to the Red Bluff Substation just south of I-10 into 1-km segments. Thus, a 47.9% sample of the total length of the line was searched (Figure 3). Biologists slowly walked every other 1-km segment of the line, meandering the width of the strip transect, scanning for dead or injured birds or bats within 15 m (49.2 ft) of the overhead line.

For each detection, a suspected cause of death or injury was assigned based on evidence available from the detection, evidence available on Project infrastructure, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it cannot be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed. Detections assigned to the “unknown” category were included in fatality estimates if they were located within standardized carcass search areas, and all detections made during the summer season are reported here.

2.2 Carcass Persistence Trials

Carcass persistence trials were conducted throughout the summer period. Carcasses from three size classes (small [0-100 g], medium [101-999], and large [1000+ g]) were used for trials. The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), chukar (*Alectoris chukar*), and older coturnix quail, and the large size class comprised hen mallard (*Anas platyrhynchos*) and hen ring-necked pheasant (*Phasianus colchicus*).

2.2.1 *Carcass Persistence Data Collection*

To quantify carcass persistence rates, 15 small, 10 medium, and 5 large carcasses were randomly placed and monitored along the gen-tie line during summer 2015. Within the solar arrays and along the perimeter fence, the same numbers of each size category were placed, for a total of 60 carcass persistence trials at Desert Sunlight during the summer season, as specified in the approved Desert Sunlight BBCS. By placing carcasses inside (within arrays and along inner perimeter of the fence) and outside (along the gen-tie) the project fence, the possibility that there are different carcass persistence rates inside and outside the project fence is accounted for. Fifteen carcasses within the Project fence (within solar arrays and along the fence) were monitored using motion-triggered digital trail cameras, while the remaining carcasses were visited on foot, for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality. No carcasses along the gen-tie line were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as “feeding stations”, trail cameras were installed five days before specimens were placed, and two fake cameras without bias trial carcasses were also placed within the Project fence and periodically moved to new locations within the fence. Periodic ground-based checking of carcasses with trail cameras also occurred to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera’s field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire Project, not just in areas subject to standard searches, and trials were initiated in smaller numbers on three different dates throughout the summer season.

2.2.2 *Estimating Carcass Persistence Times*

Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g. days a carcass is present before being removed) may not be known exactly, but is known to be within a finite range. For example, suppose a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass became unavailable at some point between 7 and 10 days. This carcass would be considered “interval censored”. Similarly, if a carcass lasts the entire 30-day trial period, that carcass is “right censored”— it is known that the carcass lasted at least 30 days, but it may have persisted longer. Because carcass persistence data were censored, persistence was analyzed using methods that can accommodate censored data and still produce unbiased estimates of the probability of persistence (Therneau 2015, Therneau and Grambsch 2000).

USGS-developed fatality estimator software (Huso et al 2012) was used to fit survival models to the censored carcass persistence data. The USGS software used to estimate carcass persistence calculates the period over which there is less than a 1% chance for a carcass to persist. The 'effective search interval' is defined as the shorter of the period during which there is less than a 1% probability that a carcass persists, and the actual search interval (Huso 2010). The probability of persistence is given for the effective search interval, and the probability that a carcass persists through the actual search interval is equal to p(persist through effective search interval) * effective search interval / actual search interval.

There were four distributions implemented in survival models used to estimate the probability a carcass is unscavenged and available to be found at the end of the search interval (*r)*: exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike's Information Criterion adjusted for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model with combinations of the covariates carcass size, Project component, season, and visibility, to observed carcass persistence data.

2.3 Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the summer period. Carcasses from three size classes (small, medium, and large) were used for trials. The small size class comprised house sparrows and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons, chukar, and older coturnix quail, and the large size class comprised hen mallards and hen ring-necked pheasants.

2.3.1 *Searcher Efficiency Data Collection*

Training of biologists on the Project-specific protocol and early assessments of habitat conditions within the solar arrays suggested that the amount of cobble present in the soil may be an important factor influencing searcher efficiency. To satisfy requirements regarding consideration of visibility class per the BBCS and address the influence of cobble cover on searcher efficiency, sample units in the solar arrays and along the gen-tie were stratified by cobble cover and assigned to one of two classes (<15% and >15% cobble cover). Classes were determined by making ocular estimates of cobble cover at each sample unit and then evaluating the frequency histogram of sample units across the range of estimated cobble cover (Figure 4). A natural break point was identified at 15% cobble cover, so the same value was chosen as the break point that defined the two cobble cover classes. Thus, in the solar arrays, two sets of searcher efficiency trials were conducted (one set in each cobble cover class; *n* for each trial = 15 small birds, 10 medium birds, and 5 large birds as agreed upon in section 7.4 of the approved Desert Sunlight BBCS). Along the gen-tie, visibility was expected to be related to vegetation and rock cover. Thus, searcher efficiency trials along the gen-tie occurred in two visibility classes (*n* for each class = 15 small birds, 10 medium birds, and 5 large birds (easy: ≥90% bare ground, vegetation <6" tall; and more difficult: <90% bare ground, vegetation ≥6" tall). Inadvertently, one large carcass was not placed and one extra small carcass was placed during summer, so total sample size for large carcasses along the gen-tie was nine, and for small carcasses was 31. Thirty searcher efficiency trials (*n* = 15 small birds, 10 medium birds, and 5 large birds) occurred along the fence in the only visibility class present on the fence (easy visibility). Thus, during summer, a total of 150 searcher efficiency trials occurred at the Project. Locations for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches.

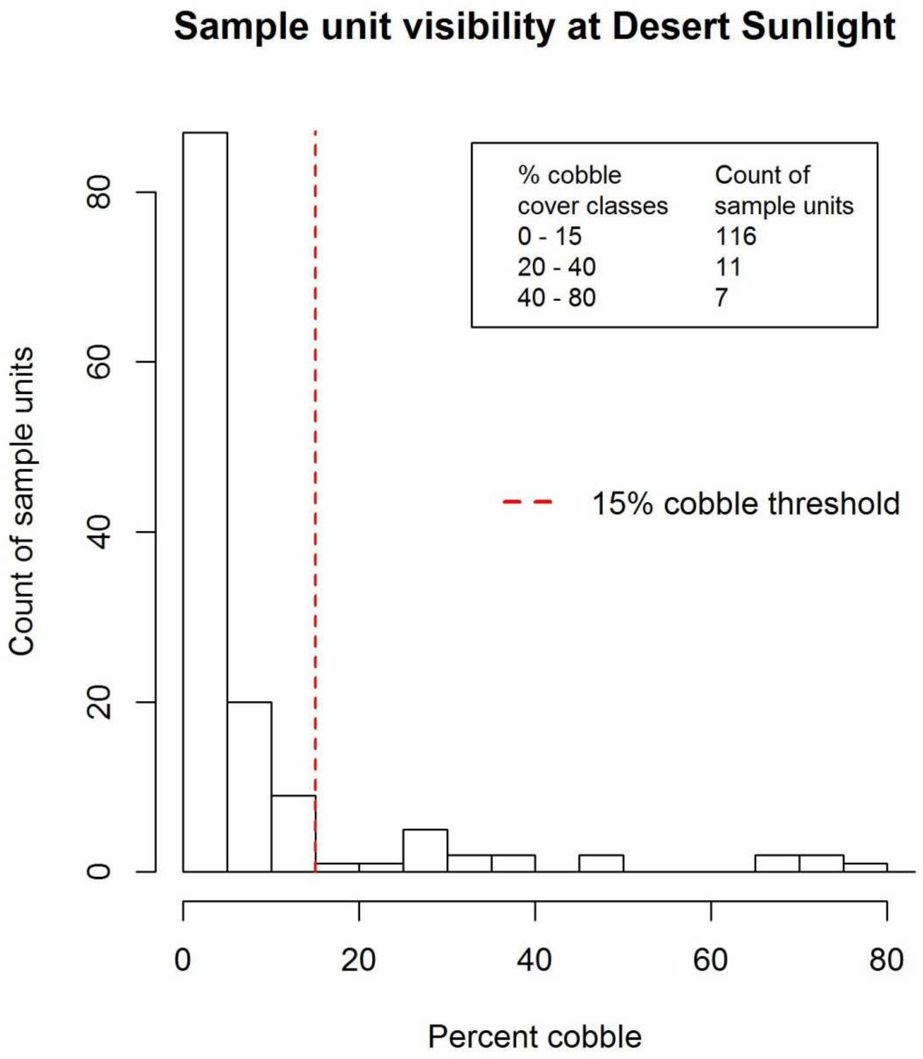


Figure 4. Frequency histogram of sample units (in the arrays only) at Desert Sunlight Solar Farm Project by estimates of cobble cover. Based on this distribution, each sample unit was assigned to one of two classes of cobble cover (<15%; >15%).

2.3.2 *Estimating Searcher Efficiency*

Searcher efficiency at Desert Sunlight was estimated separately for linear features (the project fence and the generation tie line), and the solar arrays, reflecting the different search methods used on arrays and linear features. For linear features, logistic regression models were fit to searcher efficiency data and AICc was used to compare models. Models including effects of carcass size (three classes), visibility (two classes; gen-tie only), and season were compared to each other and the null model. Model selection indicated that the best model included main effects of Project component, carcass size, and season. Once the best model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, *p*, was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from the summer 2015 season.

For the solar arrays, searcher efficiency was evaluated using a distance sampling approach (Buckland et al. 1993). Distance sampling assumes perfect detection on the transect line (at distance = 0), an assumption that is likely valid in the solar arrays given the relatively flat & vegetation-free nature of the soil surface. A curve is fitted to the observed carcass data that predicts probability of detection as a function of distance from the transect line. The mean value of this function over a specified distance, *w,* is equal to the average searcher efficiency for a transect of width *w*. The mean value of the detection curve is the integral of the detection function calculated between 0-m and the maximum survey distance (*w;* half the width of the solar array row), divided by the maximum survey distance:

$$p = \frac{\int_0^w f(x)dx}{w},$$

where f(x) is the detection function evaluated at distance, *x*.

One departure in the methods used here, relative to the methods presented in Buckland et al. (1993), was that for this study the detection function was estimated using trial carcasses, which meant that there were both presence (detected) and absence (not detected) data available to fit the detection function (Figure 5). The availability of both presence and absence data means that the detection function can be estimated using only trial carcasses whose distribution is known. Therefore the detection function, the average searcher efficiency among the arrays and the final fatality estimate within the arrays are all insensitive to the spatial distribution of carcasses within individual arrays, and the overall searcher efficiency estimate is valid even if the distribution of carcasses among the arrays is not uniform.

Distances of trial carcasses (trials both found and missed) from the transect line were used to fit a half-normal detection function for searches among the arrays (Figure 5). The half-normal detection function is a commonly used function for distance sampling surveys (Buckland et al. 1993). The detection function was fit with and without covariates (carcass size, visibility index, or no covariates) and AICc indicated that the best among these models included only carcass size as a covariate.

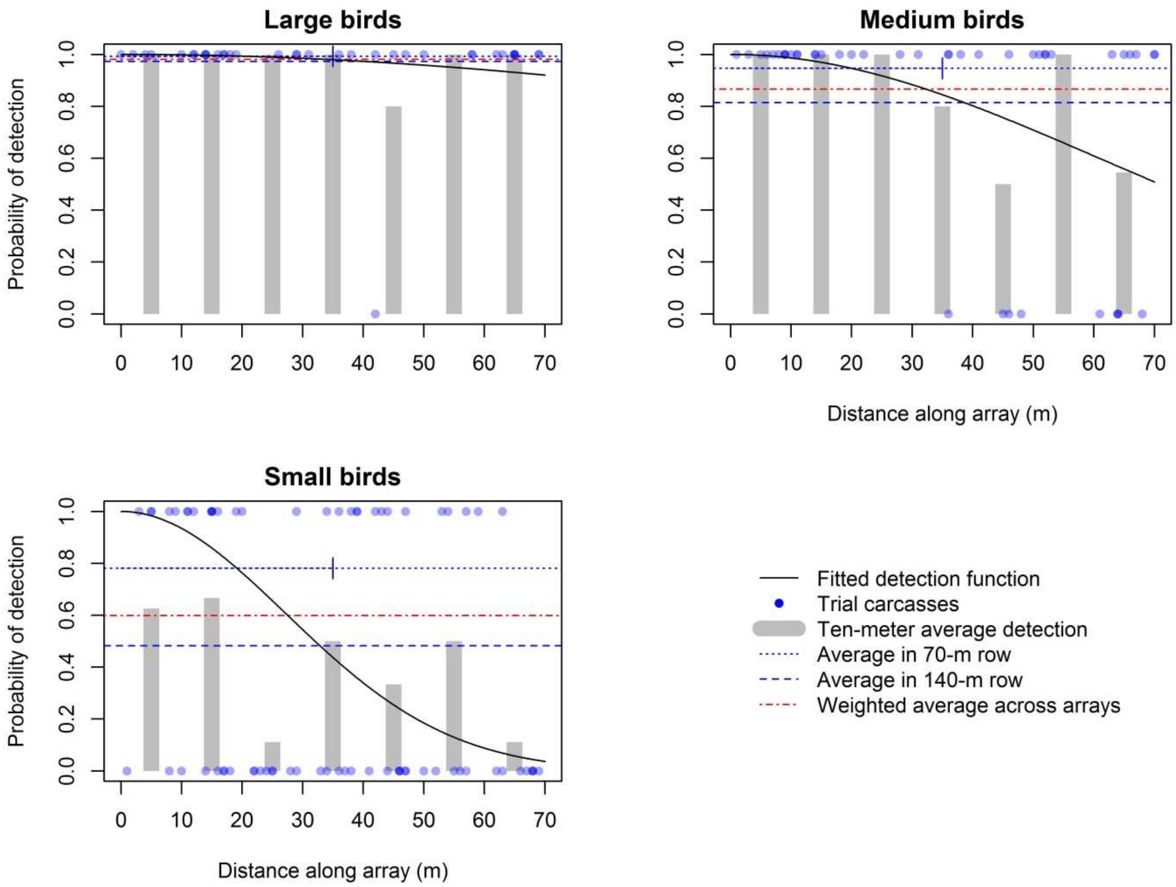


Figure 5. Estimated detection probabilities for bird carcasses by size class during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented.

Because the solar arrays were surveyed by searchers who walked down both sides of the rows of panels, the width of the search transect was specified as half the width of the rows of panels. For larger birds, there is almost certainly a non-zero detection probability beyond this distance but the bias that occurs by ignoring this non-zero detection probability is conservative (i.e. the searcher efficiency is underestimated). Some solar arrays have row widths of 70 m (search transect width of 35 m) and some have row widths of 140 m (search transect width of 70 m). The weighted average searcher efficiency is calculated based on the number of panel rows of each length in the survey sample:

$$p_{weighted\ average} = \frac{n_{70}}{n} \times \int_0^{35} f(x)dx + \frac{n_{140}}{n} \times \int_0^{70} f(x)dx,$$

where n_{70} is the number of 70-m rows in the sample, n_{140} is the number of 140-m rows in the sample, and n is the total number of rows in the sample. Searcher efficiency was higher for the arrays with a width of 70 m, and overall searcher efficiency was estimated as a weighted average based on the proportions of 70-m arrays and 140-m arrays in the sample units.

2.4 Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots are also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie line versus cleared areas beneath solar panels). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where F is the total number of fatalities, C is the number fatalities detected and included in fatality estimation, r is the probability a carcass is unscavenged and available to be found at the end of the search interval, and p is the probability of detecting a carcass (Huso 2010).

All fatality estimates were calculated using the Huso estimator, as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates were used. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

2.5 Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by WEST avian biologists and operational personnel and were considered “incidental” detections. When found by operational personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the Desert Sunlight SPUT Avian Injury and Mortality Report Forms June – August 2015. All detections made in search areas during the reporting period were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

3.0 MONITORING RESULTS

3.1 Summary of Avian Detections

During summer 2015, a total of 15 avian detections (including incidentals) of 11 identified species were recorded (Table 3). The most common identified species was common raven (*Corvus corax*) with three detections. Most detections (n = 11, or 73.3% of total detections) occurred in the solar arrays (Figures 2 and 3; Tables 4, 5, and 6). Ten (66.7%) detections were made during standardized carcass searches and five (33.3%) were documented as incidentals. No bats were detected during the summer season. For fresh carcasses, body weights and weather conditions the preceding nights are described in Appendix B.

Table 3. Number of individual bird detections, by species, during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Common Name	Scientific Name	Migration Behavior*	Guild	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Total
common raven	*Corvus corax*	resident	Corvids	-	2	1	-	3
white-winged dove	*Zenaida asiatica*	variable	Doves/Pigeons	-	-	-	1	1
black-throated sparrow	*Amphispiza bilineata*	diurnal	Grassland/ Sparrows	-	-	-	1	1
sora	*Porzana carolina*	nocturnal	Rails/Coots	-	-	-	1	1
Virginia rail	*Rallus limicola*	nocturnal	Rails/Coots	1	-	-	-	1
house wren	*Troglodytes aedon*	nocturnal	Wrens	1	-	-	-	1
mourning dove	*Zenaida macroura*	variable	Doves/Pigeons	-	1	-	-	1
Say's phoebe	*Sayornis saya*	diurnal	Flycatchers	-	1	-	-	1
northern rough-winged swallow	*Stelgidopteryx serripennis*	diurnal	Swallows	-	1	-	-	1
unidentified bird (small)	-	-	Unidentified Birds	-	1	-	-	1
unidentified bird (unknown size)	-	-	Unidentified Birds	-	1	-	-	1
unidentified grebe	-	-	Waterbirds/ Waterfowl	-	1	-	-	1
western grebe	*Aechmophorus occidentalis*	nocturnal	Waterbirds/ Waterfowl	-	1	-	-	1
Total				**2**	**9**	**1**	**3**	**15**

* See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in Birds of North America (BNA) Online (http://bna.birds.cornell.edu/bna/); where information on migration behavior was lacking in BNA accounts, Newton (2008) or Murray (2004) were used.

Table 4. Total avian detections by Project component and detection category during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. Only carcasses found within search areas were included in fatality estimates.

	Inside carcass search area		Outside carcass search area	
Project Component	**Carcass search**	**Incidental**	**Carcass search**	**Incidental**
Fence	0	0	1	0
O&M Building	0	0	0	0
Gen-tie line	2	0	0	1
Solar arrays				
Line-associated	0	0	0	2
Non-line associated	7	1	0	1

Table 5. Total avian detections (including incidentals) by Project component and suspected cause of death during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

	Suspected Cause of Death*				
Project Component	**Collision**	**Predation**	**Other**	**Unknown**	**Percent of Total**
Fence	0	0	1	0	6.7
O&M building	0	0	0	0	0
Gen-tie line	2	0	1	0	20
Solar arrays					
Line-associated	1	0	1	0	13.3
Non-line associated	1	0	5	3	60
Percent of Total	**26.7**	**0**	**53.3**	**20.0**	**100.0**

* Suspected cause of death was assigned based on evidence available on the detection, evidence available on Project infrastructure, and proximity of detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as "unknown" because it can't be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, there is substantial uncertainy associated with cause of death assignments because no events were directly observed.

3.2 Temporal Patterns of Avian Detections

The number of detections recorded daily during the reporting period ranged from zero to three (Figure 6). One detection was found per day with the exception of June 24 when three detections occurred. The number of detections per day represents those discovered during standardized carcass searches and incidentally.

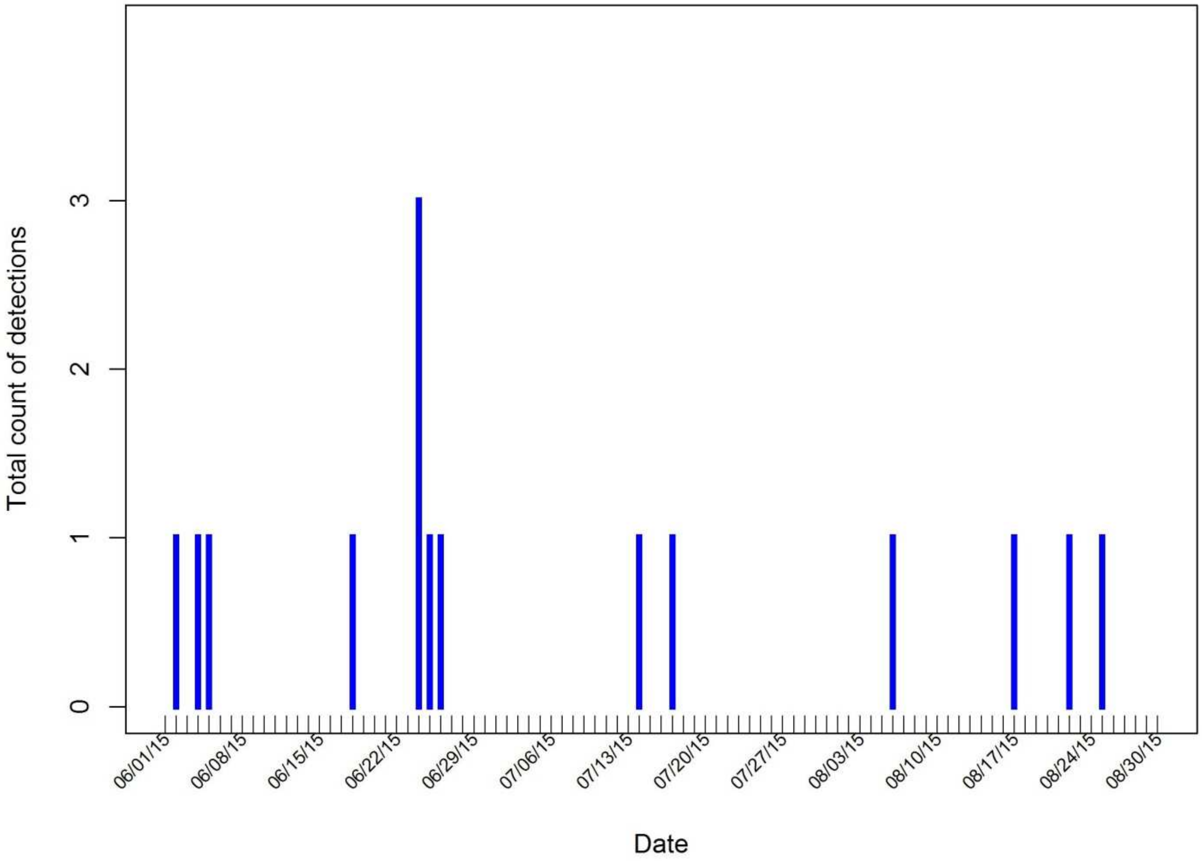


Figure 6. Total number of detections by date during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.3 Spatial Distribution of Avian Detections

3.3.1 *Detections by Project Component*

During the reporting period, detections were documented from the solar arrays, the northern section of the perimeter fence, and the gen-tie line; no detections occurred at the O&M building (Tables 3, 4, and 5). Of the 11 detections within the solar arrays, 18.2% (2) were associated either with overhead lines or arrays that co-occurred with overhead lines.

3.3.2 *Feather Spot Detections*

Five (33.3%) of the 15 detections consisted only of feather spots. Along the gen-tie, one of three detections (33.3%) was a feather spot. No detections along the fence were a feather spot. Four of 11 detections (36.4%) in the solar arrays were feather spots.

3.4 Detections of Injured Birds

No injured birds were detected during the summer 2015 season.

3.5 Summary of Bat Detections

No bats were detected during the summer 2015 season.

3.6 Carcass Persistence Trials

Data from carcass persistence trials were available from late winter, spring, and summer at the solar field and gen-tie line (n = 154 total). Based on carcass persistence data from late winter, spring, and summer 2015, survival models were compared for relative quality using the corrected AICc score, as suggested in Huso (2010). The AICc score provides a relative measure of model fit and parsimony among a selection of candidate models, and provides a framework for testing hypotheses regarding which factors contribute to carcass persistence rates. Carcass size was tested as a potentially important variable, as larger carcasses tend to persist longer and may be more likely to leave feather spots which persist for long durations, whereas smaller carcasses may be more likely to be completely removed. Project component (solar arrays/fence, generation-tie line) was also included as a potentially important variable, as was season.

The model with lowest AICc score is typically chosen as the “best” model relative to other models tested; however, any model within two AICc points of the best model is considered competitive with the best model (Burnham and Anderson 2004). The best model included main effects of season, carcass size, Project component, and interactions of Project component × season and Project component × size with a Weibull-distributed removal time. Given the main effect of season, further modeling efforts were restricted to data collected in summer only. The best model using only the summer data suggested an interaction between carcass size and Project component. Estimates of carcass removal time and persistence probabilities are reported in Table 6 from the best model, and estimates of proportion of carcasses remaining as a function of days since carcass placement are provided in Figure 7.

Table 6. Mean carcass removal time and probability of a carcass persisting through the effective search interval during the summer season (June 01 – August 30) at the Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass size	Project component	Mean removal time (days)	Probability of persistence
Small	Arrays/fence	15.53	0.63
Small	Overhead lines	1.37	0.22
Medium	Arrays/fence	19.2	0.73
Medium	Overhead lines	14.75	0.60
Large	Arrays/fence	-*	1.00
Large	Overhead lines	0.9	0.22

* Mean removal time was not estimated because no removal was observed for large carcasses within the solar field.

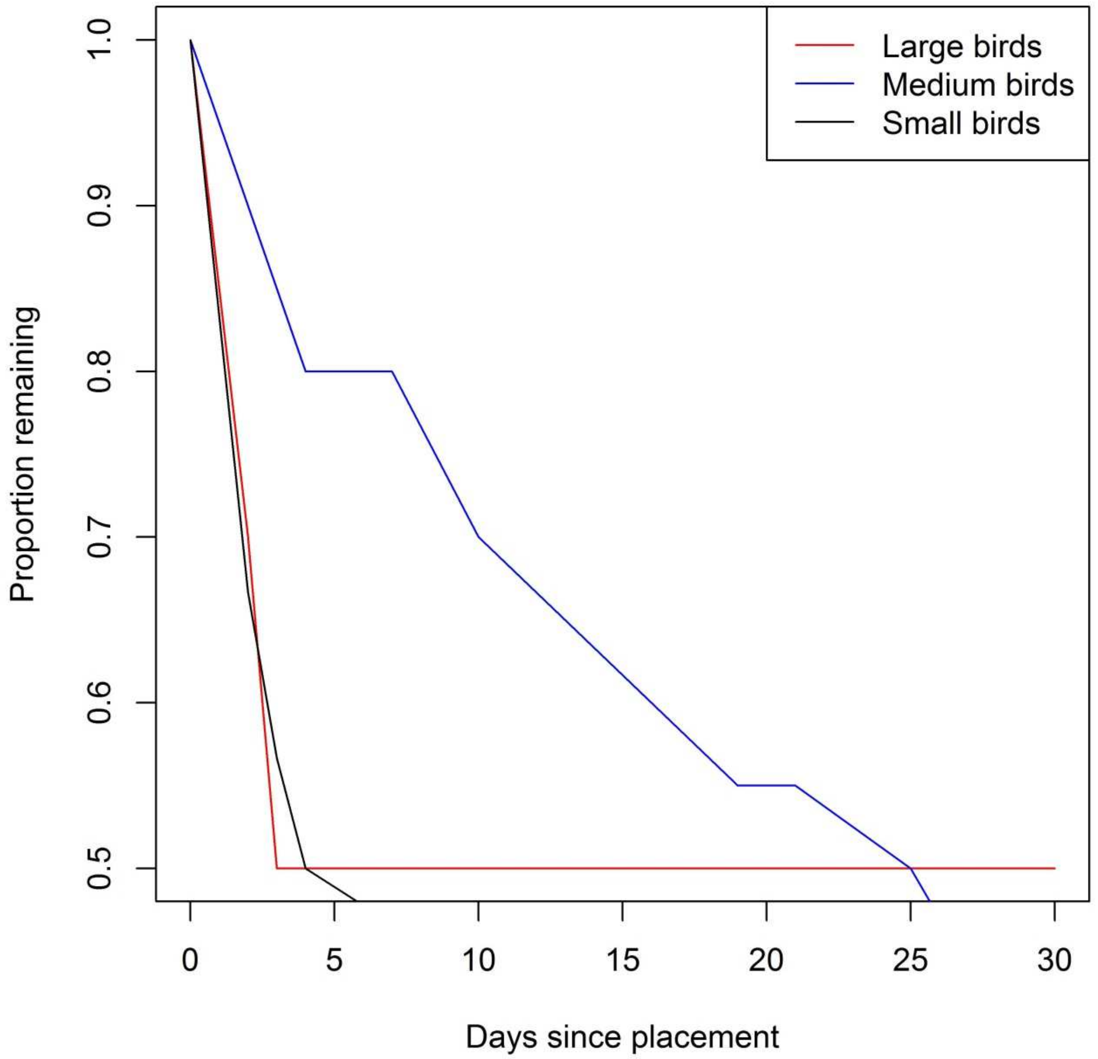


Figure 7. Proportion of trial carcasses remaining as a function of days since placement and carcass size class (n = 30, 20, and 10 for small, medium, and large size classes, respectively) during the summer (June 01 – August 30) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.7 Searcher Efficiency Trials

During the reporting period, a total of 150 searcher efficiency trials were placed at the Project. Most trials were available to be found, but some disappeared before or during the trial. Overall, 60 trials were placed in the solar arrays and 44 were available to be found; 30 trials were placed along the perimeter fence (inner perimeter only) and 30 were available to be found; and 60 trials were placed along the gen-tie line and 55 were available to be found.

In the solar arrays, the model that included an effect of carcass size was chosen as the best model to estimate searcher efficiency. Within the solar arrays, searcher efficiency was: 60.0% for small birds, 86.6% for medium birds, and 98.1% for large birds (Figure 5).

For linear Project components, the model that included an effect of carcass size, Project component, and season was chosen as the best model to estimate searcher efficiency. Along the fence, searcher efficiency ranged from 87.5% to 100% depending on carcass size class. Along overhead lines, searcher efficiency ranged from 43.5% to 100%. Detailed estimates of searcher efficiency estimates specific to each component and carcass size are reported in Appendix C.

3.8 Fatality Estimates

Fatality estimates were calculated separately for each component (solar arrays, fence, and overhead lines). Ultimately, five detections were excluded from the fatality analysis because they were found outside standardized search areas. All 15 detections made during summer are reported in Table 3.

During summer 2015, there were an estimated total 148 carcasses (90% CI: 10 – 365) at the Project. Of these, 44 carcasses (27.5%; 90% CI: 8 – 64) were estimated for the solar arrays and 104 carcasses (66.9%; 90% CI: 2 – 339) were estimated for the gen-tie line. While we are required to report the gen-tie estimates per the approved BBCS, these estimates are not reliable due to the high rates of scavenging that were observed during the limited trials at the gen-tie and the low number of carcasses detected (n = 2 in the fatality analysis). No carcasses were estimated for the perimeter fenceline because there were no detections made along the fence. All of these estimates should be interpreted with caution because variance estimates are in general unreliable when carcass counts are low (< 5 per category). Other projects (e.g. Ivanpah) are not reporting estimates when carcass counts are less than or equal to five. However, the TAG has asked for both the estimates and confidence intervals for this project with the appropriate caveat added. There were an estimated 0.017 fatalities per acre (within the solar field only; 44 estimated carcasses/2,585 acres) and an estimated 0.08 fatalities per nameplate MW (44 estimated carcasses/550 MW) within the solar field. A complete list of estimates for each Project component and carcass size class with confidence intervals is presented in Appendix C.

4.0 DISCUSSION

The 2015 summer season represented the second full season of standardized monitoring at Desert Sunlight per the BBCS. Searcher efficiency trials and carcass removal trials were conducted concurrently at the solar arrays, fencelines, and along the gen-tie line. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. Although these estimates were produced from a statistically robust sample, only limited inference may be drawn from two seasons of data. These results should be considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. As more data are collected throughout the monitoring year (and additional quality assurance/quality control measures occur, for example characterizing feather spots to species or size class), data from all seasons may be pooled. At that time, data will be tested for seasonal differences retrospectively, but because seasonal estimates will be produced from the much larger annual data set, they may differ from what is reported here because they are based on a larger, more informative sample.

4.1 Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Thus, rates of carcass persistence reported here should be interpreted cautiously as they may change over the coming months.

Searcher efficiency was influenced by Project component, carcass size, and season. In the solar arrays, searcher efficiency was high (> 0.5) for all carcass size classes and this is likely influenced by the limited vegetation cover beneath solar panels. Beneath the gen-tie line, vegetation cover is higher in some portions of the strip transects, but results reported here support the hypothesis that visibility class is not a factor in searcher efficiency along the lines during summer.

For the current analysis, searcher efficiency in the solar arrays was assumed to be best predicted by a half-normal distribution. For future analyses, AICc will be used to compare and choose the best among multiple detection functions.

4.2 Distribution of Fatalities and Fatality Estimates

The number of detections was more or less evenly distributed across the summer season, and there were no clear associations between number of detections and date. Given the small number of detections overall, it is premature to draw any conclusions about the spatial distribution of carcasses.

Composition of detections during summer 2015 included eight avian guilds. Corvids comprised the majority of detections (n = 3): there were two detections each within the doves/pigeons, rails/coots, and waterbirds/waterfowl guilds. No bats have been detected since monitoring began at the Project.

Detections attributed to an unknown cause accounted for 20.0% of all detections during the reporting period, and all those attributed to an unknown cause were found in the solar arrays. Of the 11 detections made in the solar arrays, 36.4% were feather spots. Determining a cause of mortality from a feather spot is challenging because there is rarely visible evidence available on which to determine a cause of death. Thus, feather spots with an unknown cause of mortality could be encountered anywhere birds occur, and an unknown cause of a sizeable proportion of the carcasses is not unique to the Project. Further, the relatively large proportion of feather spots (33.3%) among the detections for the Project as a whole may inflate the fatality estimate when unknown cause detections are included based on the potential for multiple feather spots resulting from one fatality, feather spots resulting from predation not associated with the facility, or other causes.

5.0 LITERATURE CITED

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in 2nd International Symposium on Information Theory (B. N. Petran and F. Csaki, Eds.). Akademiai Kiado, Budapest, Hungary.

Ammon, Elisabeth M. and William M. Gilbert. 1999. Wilson's warbler (*Cardellina pusilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/478

Boarman, William I. and Bernd Heinrich. 1999. Common raven (*Corvus corax*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/476 doi:10.2173/bna.476

Buckland, S, D.R. Anderson, K. P. Burnham, and J.L. Laake. 1993. Distance sampling: estimating abundance of biological populations. Chapman & Hall, London. 446 pp.

Burnham, K.P., and D.R. Anderson. 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociological Methods & Research 33: 261-304.

Evers, David C., James D. Paruk, Judith W. Mcintyre and Jack F. Barr. 2010. Common loon (*Gavia immer*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/313 doi:10.2173/bna.313

Hudon, Jocelyn. 1999. Western tanager (*Piranga ludoviciana*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/432 doi:10.2173/bna.432

Hughes, Janice M. 2011. Greater roadrunner (*Geococcyx californianus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/244 doi:10.2173/bna.244

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. doi: 10.1002/env.1052

Huso, Manuela, Som, Nicholas, and Ladd, Lew, 2012, Fatality estimator user's guide: U.S. Geological Survey Data Series 729, 22 p.

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A new method to determine bird and bat fatality at wind energy turbines from carcass searches. Wildlife Biology 17: 350-363.

Lowther, Peter E. and Janet McI. Williams. 2011. Nashville warbler (*Oreothlypis ruficapilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/205 doi:10.2173/bna.205

Manly, B.F.J.1997. Randomization, bootstrap and Monte Carlo methods in biology. Second Edition. CRC Press, LLC, Boca Raton, Florida, 455 pp.

Melvin, Scott M. and James P. Gibbs. 2012. Sora (*Porzana carolina*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/250 doi:10.2173/bna.250

Muller, Martin J. and Robert W. Storer. 1999. Pied-billed grebe (*Podilymbus podiceps*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/410 doi:10.2173/bna.410

Murray, J. 2004. Nocturnal flight call analysis as a method for monitoring density and species composition of migratory songbirds (Order Passeriformes) across southern Vancouver Island, British Columbia in 2004. Rocky Point Bird Observatory, 16 pp.

Newton, I. 2008. The migration ecology of birds. Academic Press, London.

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine-cause avian fatality estimates. Journal of Wildlife Management 74(5): 1089-1096.

Smallwood, K. S. 2013. Comparing bird and bat ratality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37(1): 19-33.

Therneau, T. 2015. _A Package for Survival Analysis in S. version 2.38, <URL: http://CRAN.R-project.org/package=survival>.

Therneau, T.M. and P. M. Grambsch 2000. Modeling Survival Data: Extending the Cox Model. Springer, New York. ISBN 0-387-98784-3.

Western Ecosystems Technology (WEST), Inc. 2014. Bird and bat conservation strategy, Desert Sunlight Solar Farm Project, Riverside County, California. 57 pp.

Wheelwright, N. T. and J. D. Rising. 2008. Savannah sparrow (*Passerculus sandwichensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/045 doi:10.2173/bna.45

Appendix A. Detailed Areas of Carcass Locations along the Generation Tie Line of the Desert Sunlight Solar Farm Project during Summer (June 01 – August 30) 2015

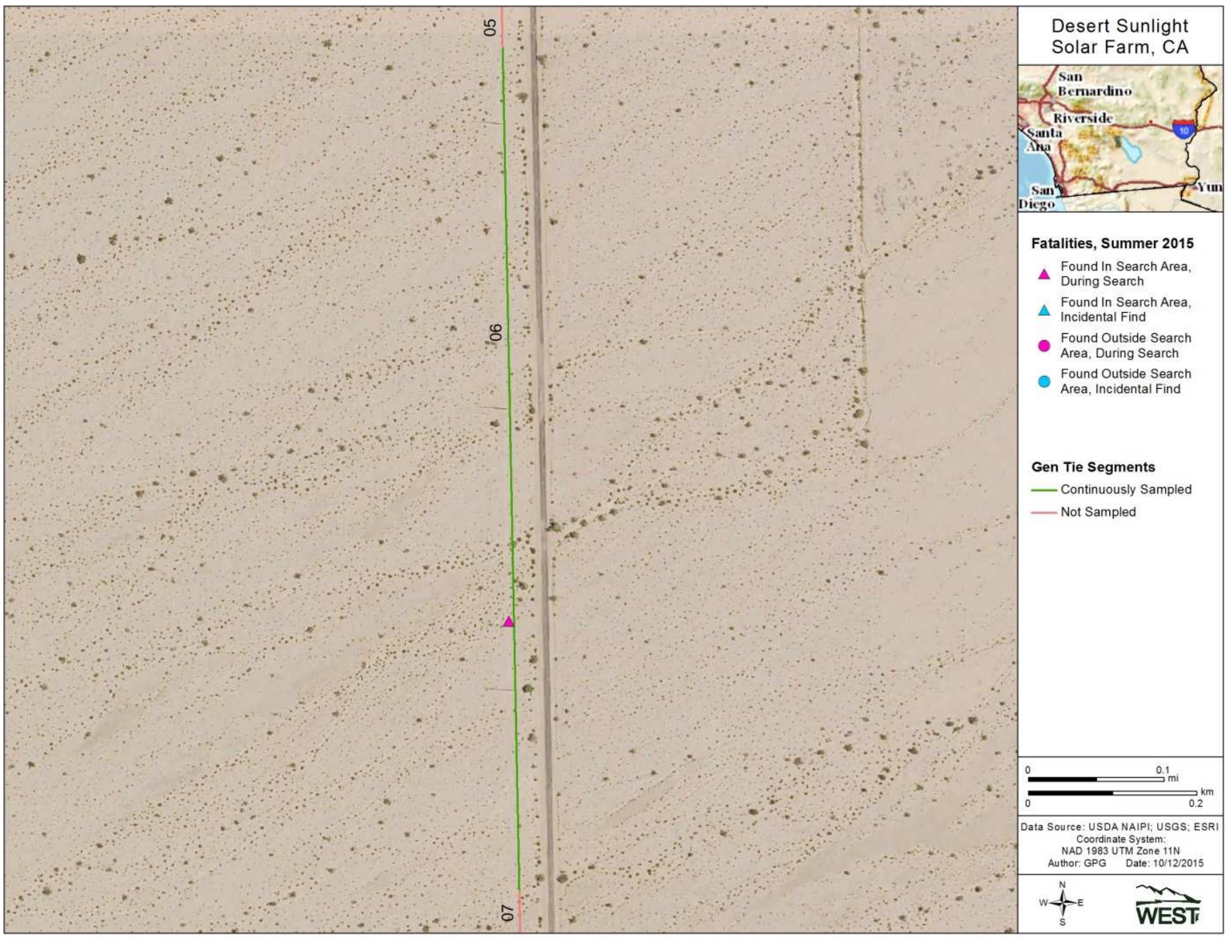


Figure A-1. Detailed map of a carcass location along the generation tie line at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

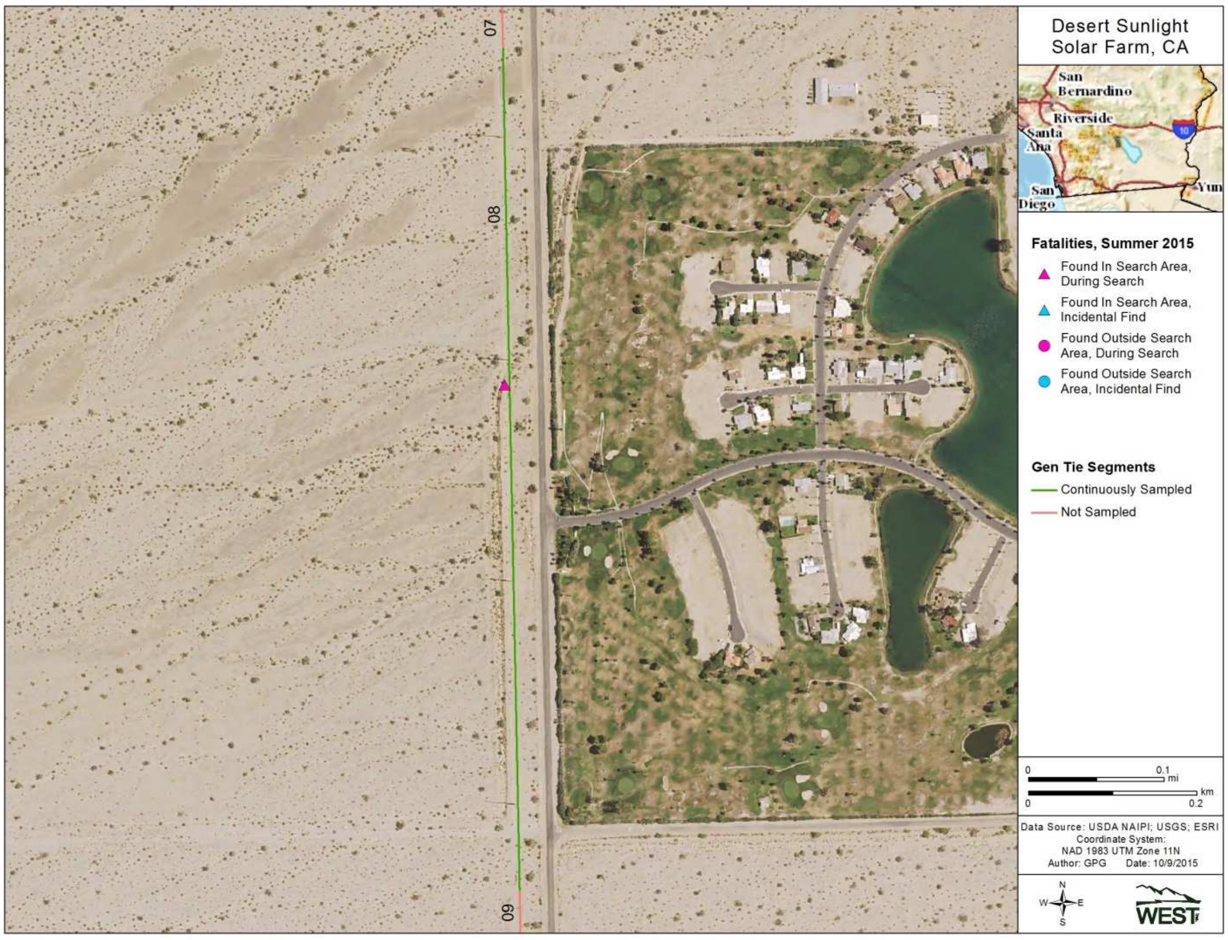


Figure A-2. Detailed map of a carcass location along the generation tie line at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

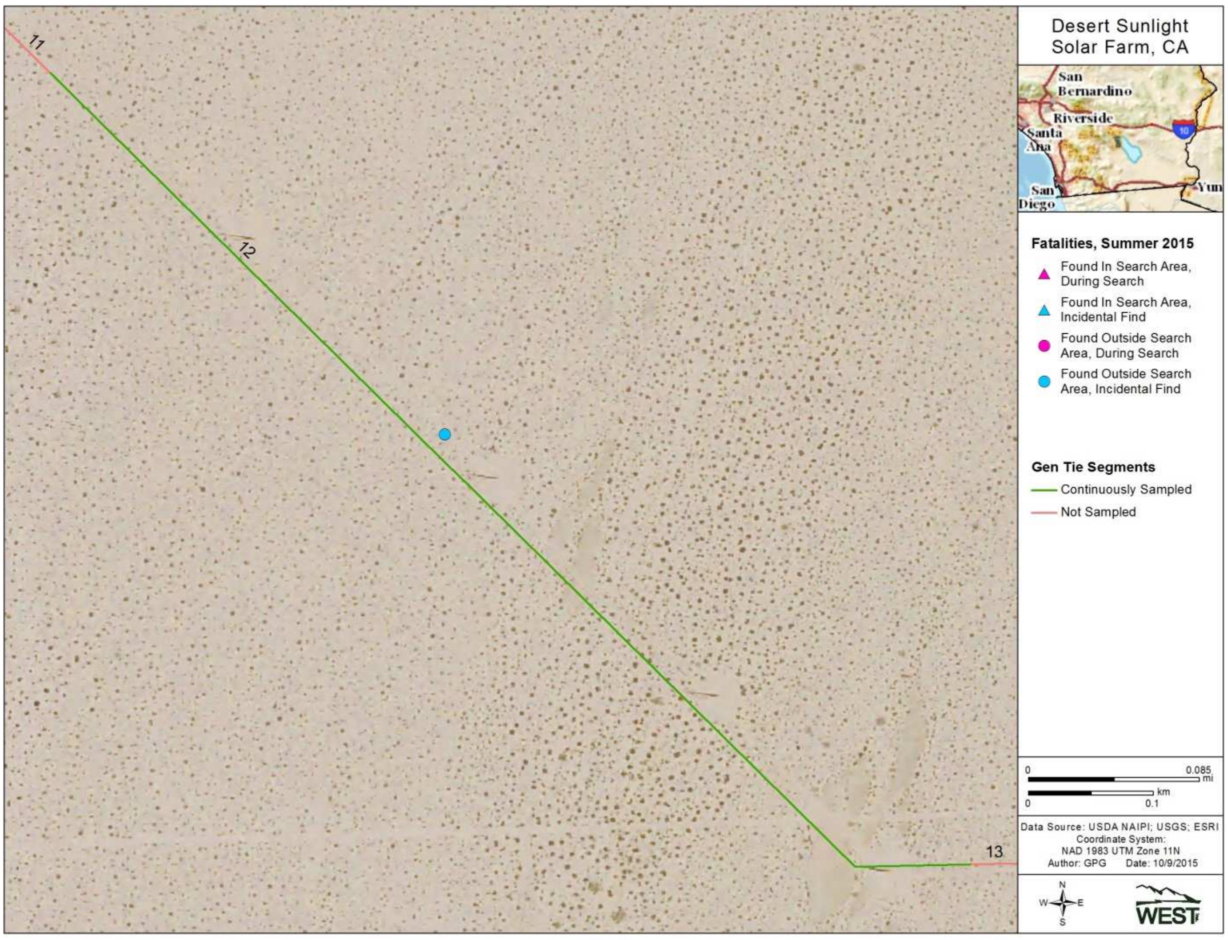


Figure A-3. Detailed map of a carcass location along the generation tie line at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015. This carcass was > 15 m from the gen-tie line, and was therefore excluded from the fatality estimate based on location.

Appendix B. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during Summer (June 01 – August 30) 2015

Table B-1. Weather conditions and body weights associated with avian detections estimated to be less than 24 hours old during summer (June 01 – August 30) 2015 at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hrs)	Species	Weight (g)	Weather Summary for Preceding 24 hrs
071715-SORA-GENTIE-06-01	7/17/2015	0-8hrs	sora	63	AVERAGE WIND SPEED OF 9MPH TO THE SOUTH, CLEAR 10 MILE VISIBILITY, MAX TEMPERATURE IS 107 DEGREES, MINIMUM IS 79 DEGREES, NEW MOON 1% ILLUMINATED
062415-HOWR-01-16MVOH-02	6/24/2015	8-24hrs	house wren	7	JUN 23, MAX TEMP 114, AVG WIND SPEED 10MPH-SSW, MAX WIND SPEED 16MPH. MAX GUST 21MPH. VIS 10 MILES, CLEAR UNTIL 3PM THEN PARTLY CLOUDY UNTIL 7PM, THEN CLEAR THROUGH NOGHT. MOON PHASE: WAXING CRESENT. CLEAR ALL DAY 6/24. TEMP 99 DEG F WHEN BIRD FOUND

Appendix C. Correction Factors and Bird Fatality Rates at the Desert Sunlight Solar Farm Project during Summer (June 01 – August 30) 2015.

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during summer (June 01 – August 30) 2015. *Distribution of easy and difficult visibility on the gen-tie line was about 70% and 30%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

	Small birds		**Medium birds**		**Large birds**		**Unknown size**	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Proportion of area searched by component								
Gen-tie line	0.479	-	0.479	-	0.479	-	0.479	-
Fence	0.744	-	0.744	-	0.744	-	0.744	-
Solar arrays	0.295	-	0.295	-	0.295	-	0.295	-
Searcher efficiency by component and visibility class								
Gen-tie line: Easy vis.*	0.583	0.417 - 0.750	0.952	0.857 - 1.000	0.8	0.600 - 1.000	0.583	0.417 - 0.750
Gen-tie line: Difficult vis.*	0.435	0.261 - 0.609	0.706	0.529 - 0.882	0.6	0.300 - 0.800	0.435	0.261 - 0.609
Gen-tie line: Weighted avg.*	0.539	0.419 - 0.665	0.878	0.794 - 0.947	0.74	0.570 - 0.880	0.539	0.419 - 0.665
Gen-tie line	0.662	0.519 - 0.815	0.954	0.869 - 1.000	0.999	1.000 - 1.000	0.662	0.519 - 0.815
Fence	0.875	0.733 - 1.000	0.987	0.943 - 1.000	1.000	1.000 - 1.000	0.875	0.733 - 1.000
Solar arrays	0.599	0.524 - 0.669	0.866	0.794 - 0.927	0.981	0.945 - 1.000	0.599	0.524 - 0.669
Average probability of carcass persistence through the effective search interval								
Gen-tie line	0.215	0.138 - 0.260	0.596	0.372 - 0.735	0.215	0.138 - 0.260	0.215	0.138 - 0.260
Solar arrays & fence:	0.633	0.478 - 0.757	0.733	0.548 - 0.863	1.000	1.000 - 1.000	0.633	0.478 - 0.757
Adjustment for effective search interval (proportion of nominal search interval)								
Gen-tie line: Summer effective search interval	0.278	0.202 – 0.355	1.00	-	0.175	0.122 – 0.223	0.278	0.202 – 0.355
Solar arrays & fence: Summer effective search interval	1.00	-	1.00	-	1.00	-	1.00	-
Carcass counts by component								
Gen-tie line	1	0 - 3	0	-	1	0 - 3	0	-
Fence	0	-	0	-	0	-	0	-
Solar arrays	2	0 - 4	0	-	5	1 - 10	1	0 - 3
Average Probability of Carcass Availability and Detected (Searcher efficiency * average probability of carcass persistence)								
Gen-tie line	0.040	0.020 - 0.054	0.569	0.357 - 0.713	0.038	0.020 - 0.050	0.040	0.020 - 0.054
Fence	0.554	0.406 - 0.683	0.723	0.527 - 0.851	1.000	1.000 - 1.000	0.554	0.406 - 0.683
Solar arrays	0.379	0.278 - 0.462	0.379	0.472 - 0.757	0.981	0.945 - 0.999	0.379	0.278 - 0.462
Adjusted Fatality Estimates (Fatalities /Season; values in italics are considered unreliable due to low counts of carcasses: carcass count / (proportion of area searched * average probability of carcass availability and detected)**								
Gen-tie line	*50.8*	*(1) - 200.2*	*0*	-	*53.5*	*(1) - 223.8*	*0*	-
Fence	*0*	-	*0*	-	*0*	-	*0*	-

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during summer (June 01 – August 30) 2015. *Distribution of easy and difficult visibility on the gen-tie line was about 70% and 30%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	Mean	CI	Mean	90% CI	Mean	90% CI	Mean	90% CI
Solar arrays	*17.9*	*(2) - 41.5*	*0*	*-*	*17.3*	*(5) - 34.5*	*8.9*	*(1) - 27.8*
Facility	*68.7*	*(3) - 212.1*	*0*	*-*	*70.8*	*(6) - 238.4*	*8.9*	*(1) - 27.8*

Post-Construction Monitoring at the Desert Sunlight Solar Project Riverside County, California

---

2015 Summer Report

Prepared for:

Desert Sunlight 250, LLC and
Desert Sunlight 300, LLC
700 Universe Blvd.,
Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.
415 West 17th Street, Suite 2000
Cheyenne, Wyoming

October 15, 2015

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from June 01 to August 30, 2015 (the reporting period) at Desert Sunlight Solar Farm Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). For logistical reasons, fall monitoring began on Monday, August 31, 2015. Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the second seasonal report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS.

Included in this report are data from standardized carcass searches conducted during the summer season at the Project, defined as June 01 to August 30, 2015. Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 29.5% sample of solar photovoltaic (PV) panels, 2) along inner portions of the fenceline, resulting in 74.4% of the length of the perimeter fence, and 3) along 47.9% of the total length of generation-tie (gen-tie) line from the Project fence to the Red Bluff Substation located south of Interstate 10 (I-10). Searches conducted within the summer season had intervals of approximately 21 days.

All bird and bat fatalities and injuries that were discovered by observers, referred to as "detections" in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, 15 avian detections were made, and there were no detections of bats.

According to specifications of the BBCS, avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were applied to a fatality estimator model (Huso 2010) to provide a preliminary estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias. The estimate is considered preliminary because the annual report may pool information from bias trials and other data across seasons which could affect seasonal estimates.

During the reporting period, carcass persistence was influenced by carcass size and Project component. Small carcasses (0-100 g) in the arrays and along the fence (combined) had a 63% chance (90% confidence interval [CI]: 48 – 76%) of persisting through the effective search interval, medium carcasses (101 – 999 g) had a 73% (55 – 86%) chance, and large carcasses (1000+ g) had a 100% chance because no removal was observed. Mean removal time within the arrays for small and medium carcasses was 15.5, and 19.2 days, respectively; mean removal time was not estimated for large carcasses because no removal was observed. Along the generation tie-line, chances of persistence for small, medium, and large carcasses were 22% (14 – 26%), 60% (37 – 74%), and 22% (14 – 26%), respectively; mean removal time for small, medium, and large carcasses was, 1.4, 14.8, and 0.9 days, respectively. Within the solar arrays, searcher efficiency was influenced by carcass size: 60.0% for small birds, 86.6% for

Comentado [FWS1]: Please explain why carcass persistence is influenced by project component.

Comentado [FWS2]: Please report median removal times and a figure showing the curve of # remaining over time.

Comentado [FWS3]: Is this the searcher efficiency averaged for all observers? What is n?

medium birds, and 98.1% for large birds. Along the fence, searcher efficiency ranged from 87.5% to 100% depending on carcass size class. Along the generation tie-line, searcher efficiency ranged from 43.5% to 100%.

Composition of detections during summer 2015 included eight avian guilds. Corvids comprised the majority of detections (n = 3): there were two detections each within the doves/pigeons, rails/coots, and waterbirds/waterfowl guilds. No bats have been detected since monitoring began at the Project.

Using the Huso (2010) fatality estimator model, during summer 2015, there were an estimated total 148 carcasses (90% CI: 10 – 365) at the Project. Of these, 44 carcasses (27.5%; 90% CI: 8 – 64) were estimated for the solar arrays and 104 carcasses (66.9%; 90% CI: 2 – 339) were estimated for the gen-tie line. While we are required to report the gen-tie estimates per the approved BBCS, these estimates are not reliable due to the high rates of scavenging that were observed during the limited trials at the gen-tie and the low number of carcasses detected (n = 2 in the fatality analysis). No carcasses were estimated for the perimeter fenceline because there were no detections made along the fence. All of these estimates should be interpreted with caution because variance estimates are in general unreliable when carcass counts are low (< 5 per category). ~~Other projects (e.g. Ivanpah) are not reporting estimates when carcass counts are less than or equal to five. However, t~~The TAG has asked for both the estimates and confidence intervals for this project with the appropriate caveat added. There were an estimated 0.017 fatalities per acre (within the solar field only; 44 estimated carcasses/2,585 acres) and an estimated 0.08 fatalities per nameplate MW (44 estimated carcasses/550 MW) within the solar field.

Comentado [FWS4]: IMPORTANT: WEST has said that it modified the Huso estimator, and despite several requests, those modifications have not been shared with the agencies. Until we understand what changes to the code were made, we are reserving judgment on these results.

Comentado [FWS5]: This supports increased frequency for this component.

Comentado [FWS6]: Is this relevant? Please delete.

All projects are reporting all mortalities via SPUT reporting regardless of how many.

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Tracey Johnson	Research Biologist
Paul Rabie	Statistician
Pamela Bullard	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2015. Post-construction monitoring at the Desert Sunlight Solar Farm Project, Riverside County, California. 2015 Summer Report. 25 pp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Project Background

Desert Sunlight 250, LLC and Desert Sunlight 300, LLC (collectively, Desert Sunlight) constructed and operates the Desert Sunlight Solar Farm Project (referred to in this report as "Project"), which consists of two main components: 1) a 550-megawatt (MW) photovoltaic (PV) generating facility; and 2) a 220-kilovolt (kV) generation interconnection (gen-tie) line. The Project comprises approximately 1,700 hectares (ha; 4,200 acres) of land administered by the Bureau of Land Management (BLM) six miles north of Desert Center in Riverside County, California (Figure 1).

1.2 Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (2014; “BBCS”) was prepared by the Project proponent in collaboration with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and BLM to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency approval of the BBCS occurred in December 2014. Amendments to the sampling protocol along some portions of the Project fenceline were made by Desert Sunlight and approved by the BLM on February 11, 2015.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Desert Sunlight in collaboration with the USFWS, CDFW, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with solar arrays, overhead lines including the gen-tie line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near panels on the edge of the arrays vs. the interior area of the arrays).
3. Provide information that will assist the BLM in consultation with the USFWS in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the BLM in consultation with the USFWS may make comparisons with other solar sites.

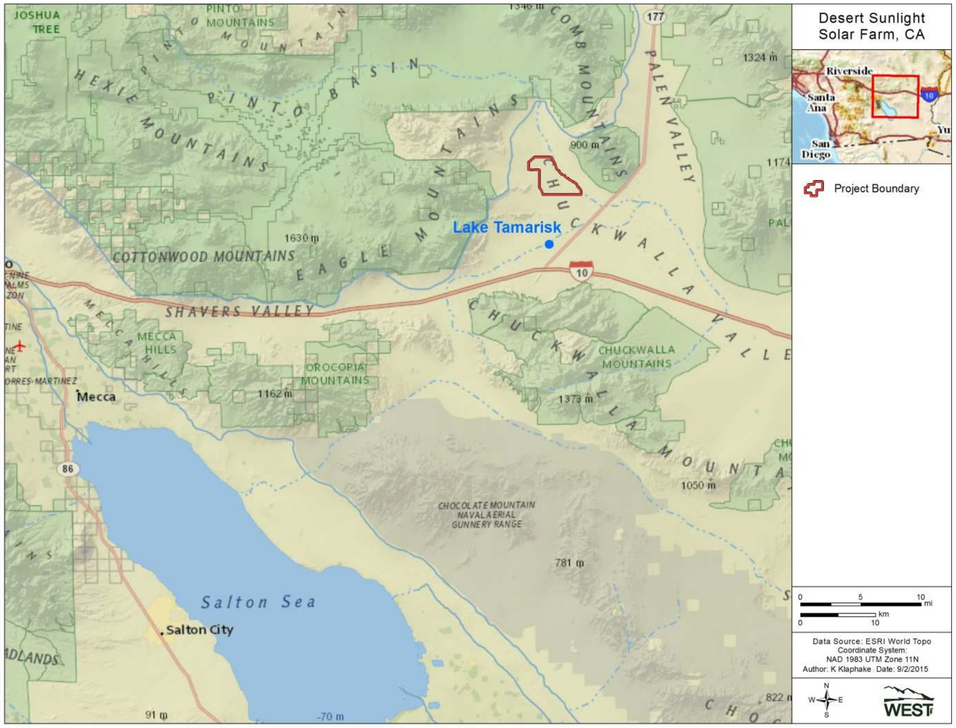


Figure 1. Desert Sunlight Solar Farm Project vicinity map, Riverside County, California.

1.3 Purpose of This Report

This report represents the second seasonal report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS. This report covers the period June 01 to August 30, 2015, or the 2015 summer season. For logistical reasons, fall monitoring began on Monday, August 31, 2015. All carcasses and injuries that were discovered by observers are referred to as “detections” in this report. As stated in the approved BBCS, this seasonal report includes the observed detections for likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and suspected causes of death. Species composition of detections and the results of the bias trials are also reported. This report presents information related to the spatial distribution of detections, but no formal statistical analysis of the spatial distribution of carcasses will be conducted until the end of the monitoring year, given the limited data presently available.

2.0 METHODS

The BBCS describes the methods by which monitoring and certain analyses, including compilation of the overall fatality estimate, will occur. Below is an abridged description (see BBCS for detailed methods).

2.1 Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. Dead or injured birds and bats are called detections in this report to provide consistency in naming. This section also describes the methods for conducting carcass removal and searcher efficiency trials; how data were reported and analyzed; and the methods for producing fatality estimates for the Project.

2.1.1 *Areas Surveyed*

Standardized carcass searches were conducted at sampling units, which include the solar arrays (Table 1, 2; Figure 2); the "fenceline" defined as the perimeter fence for the Project (Table 1, Figure 2); and the gen-tie line (from the Project fence to the Red Bluff Substation on the south side of I-10; Table 1, Figure 3). Some overhead lines co-occur with solar arrays (medium voltage overhead lines [MVOH]). The MVOH were part of standardized carcass searches to the extent that they co-occured with solar arrays included in the sample (Table 2; Figure 2).

Table 1. Areas included in standardized carcass searches at the Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

Project Component	Total Size	Units	% of Component Searched
Solar arrays	1045.9	Hectares	29.5[1]
Fence	16.7	Kilometers	99.0[2]
Gen-tie line	19.2	Kilometers	47.9[3]

[1] Percent area that was searched in summer 2015. Slightly less than 30% total because of unequally-sized arrays.

[2] 74.4% of the fence is fully accessible and surveyed following the standard protocol, while approximately 25% of the fence is surveyed from a distance. Fatality rates estimated for sections of the fence that are sampled were extrapolated to sections of the fence where the standard monitoring protocol cannot be used, as described in section 4.2.6 of the approved Desert Sunlight BBCS. A very short segment near the gate is not sampled due to restoration activities.

[3] 52.1% of the gen-tie will be sampled in 2016.

Comentado [FWS7]: Please describe how detectability is being handled for the 25% being surveyed from a distance.

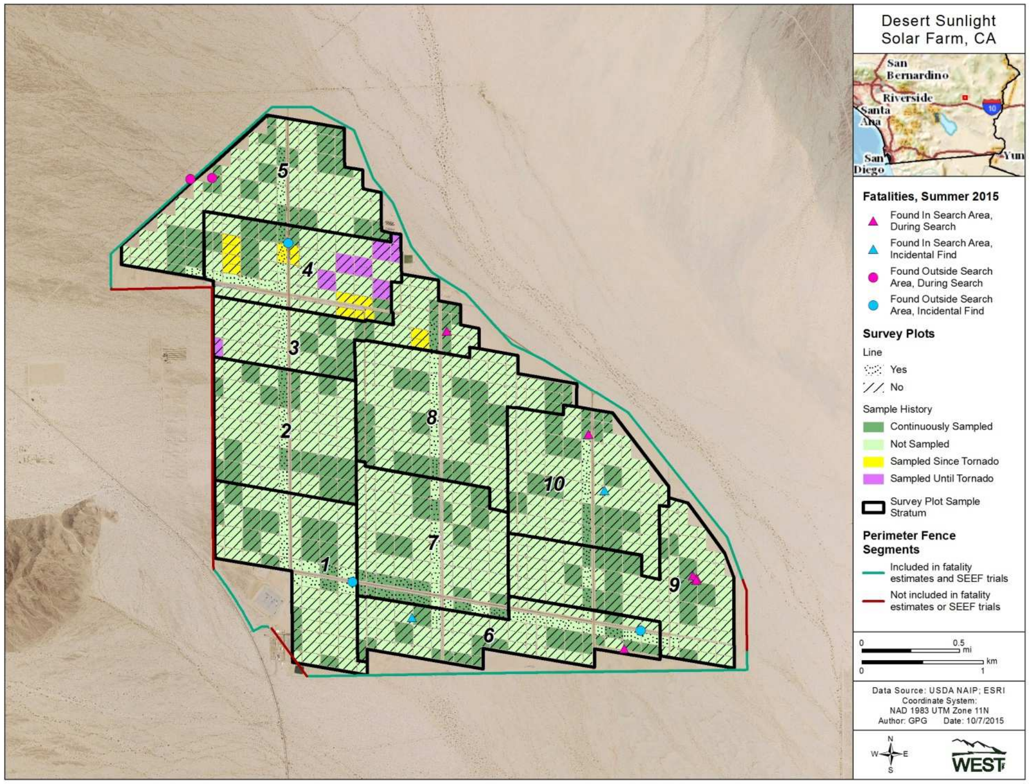


Figure 2. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at the solar field, fence, and overhead lines within the fence at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

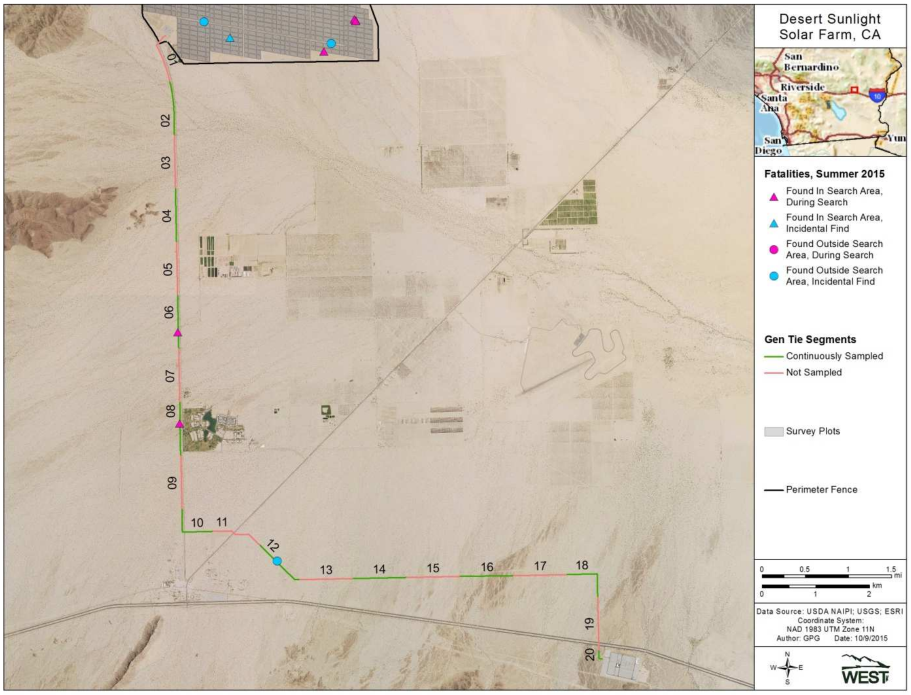


Figure 3. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance activities) along the generation tie line at the Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015. Detailed maps of detections along the line are presented in Appendix A.

To ensure a balanced distribution of sample units in the solar field (defined as the collection of all photovoltaic [PV] solar panels), the entire field was divided into ten strata, and individual sampling units were randomly selected within each stratum to compose an approximately 30% sample. This sampling design ensures that units included in the sample were not spatially clumped within the solar field. The solar field consists of arrays of solar panels (referred to as a solar array) that are either 70-m or 140-m wide. The sample includes 133 of each type of array. There are 2,580 70-m rows, and 3,900 140-m rows in the sample.

2.1.1 *Search Frequency and Timing*

Standardized searches occurred during the summer survey season, which includes the period from June 01 through August 30, 2015. All project components included in standardized searches were surveyed four times during summer. All searches took place during daylight hours from 06:30 to 17:00.

Comentado [FWS8]: Please record and report data on the time of the surveys. This will help determine if the surveys can be used to predict nocturnal vs. diurnal mig behavior.

Raw data sheets and GIS files should be submitted with each report.

As specified in the approved Desert Sunlight BBCS, the average search interval for all Project components included in standardized carcass searches during summer was 21.0 days (median 21.0 days). Slight variation in search interval was anticipated due to weather and logistical delays.

Comentado [FWS9]: Please discuss the effect of the long search interval in relation to the carcass persistence trial data.

Table 2. Area and proportion of solar arrays that are and are not associated with overhead lines at the Desert Sunlight Solar Farm Project, Riverside County, CA.

	Line-associated[1]	Not line-associated	Proportion line-associated
Entire facility	89.4 ha	956.5 ha	0.09
Standardized searches	32.2 ha	291.0 ha	0.10

[1] Line-associated area was estimated as the area of any array that fell within the 30-m strip transect below the MVOH.

2.1.2 *Search Methods*

Standardized carcass searches were performed by BLM-approved biologists, in accordance with methods outlined in the BBCS.

Within the solar field, arrays of solar panels were surveyed by observers traveling on foot. A distance sampling approach was used, whereby biologists slowly walked a transect line along the ends of rows of solar panels in a direction perpendicular to the rows, searching ahead and to the side within the array for bird and bat detections. Biologists scanned out to a maximum perpendicular distance of approximately 70 m from the transect. Biologists carried binoculars to allow them to verify the presence of a detection versus rocks or vegetation. Once a detection was confirmed, the distance of the detection to the transect line was estimated using laser range finders. Each array included in the sample was searched by observers walking two transects – one on the west side and one on the east side of the array with observers looking toward the center of the array.

Once a carcass was detected, it was photographed, and data were recorded according to specifications outlined in section 7.2.5 of the approved Desert Sunlight BBCS. Carcasses were then retrieved from their location on the ground, labeled, and placed in a freezer on site.

Comentado [FWS10]: Please explain details about how/when the processing occurred in relation to when carcasses were detected.

Most (74.4%) of the length of fenceline (approximately 10 miles) was searched from a vehicle using the standard protocol (Figure 2). Biologists searched a 6-m wide strip transect centered on the fence from the inner perimeter. Travel speed was below five miles per hour (mph) while searching. Some sections along the fence cannot be driven close to the fence line. The fence line along the western edge of the Project is drivable but the road is approximately 15 m away from the fence and the road and fence are separated by a drainage ditch. The fence along this section is covered with a tan tarp and trees and shrubs have been planted to reduce visibility of the project from the west. Additions of vegetation and the tarp likely reduce potential for bird collision with the fence. This section of the fence was driven to document carcasses, but detections along this portion of the fence are not included in adjusted fatality estimates because detection rates are likely very low. As specified in section 4.2.6 in the approved Desert Sunlight BBCS, we assume that fatality rates are similar between the portion of fence that was searched and the portion that was not. A separate section of the fence in the southeastern corner of the Project cannot be driven because the eastern edge of the berm that bounded construction ponds is too narrow for a vehicle. Along this portion of the fence, the observer stopped at both north and south ends of the berm and used binoculars to search for carcasses. Finally, the road along a portion of the southwest fence line near the entrance gate is approximately 30 to 50 m from the road and is separated from the fence by an area that has recently undergone vegetation restoration. This area was eliminated from sampling. Fatality rates estimated for sections of the fence that were sampled were adjusted to account for the proportion of fence not sampled with the standard monitoring protocol, as specified in section 4.2.6 of the approved Desert Sunlight BBCS.

Comentado [FWS11]: The Service is still concerned that this section of the fence is not being adequately sampled. Mortality rates may be different along this section of the fence.

The gen-tie line was searched using a 30-m wide strip transect (i.e., 15 m of ground on either side of the overhead line). Sample units along the gen-tie line were chosen by dividing the total length of line from the Project fence south to the Red Bluff Substation just south of I-10 into 1-km segments. Thus, a 47.9% sample of the total length of the line was searched (Figure 3). Biologists slowly walked every other 1-km segment of the line, meandering the width of the strip transect, scanning for dead or injured birds or bats within 15 m (49.2 ft) of the overhead line.

For each detection, a suspected cause of death or injury was assigned based on evidence available from the detection, evidence available on Project infrastructure, and proximity of the detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it cannot be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is substantial uncertainty associated with cause of death assignments because no events were directly observed. Detections assigned to the “unknown” category were included in fatality estimates if they were located within standardized carcass search areas, and all detections made during the summer season are reported here.

Comentado [FWS12]: The Servicde disagrees with this assumption. If it’s under the line, the better assumption is that it was caused by the line and a scavenger subsequently discovered the carcass.

2.2 Carcass Persistence Trials

Carcass persistence trials were conducted throughout the summer period. Carcasses from three size classes (small [0-100 g], medium [101-999], and large [1000+ g]) were used for trials. The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), chukar (*Alectoris chukar*), and older coturnix quail, and the large size class comprised hen mallard (*Anas platyrhynchos*) and hen ring-necked pheasant (*Phasianus colchicus*).

2.2.1 *Carcass Persistence Data Collection*

To quantify carcass persistence rates, 15 small, 10 medium, and 5 large carcasses were randomly placed and monitored along the gen-tie line during summer 2015. Within the solar arrays and along the perimeter fence, the same numbers of each size category were placed, for a total of 60 carcass persistence trials at Desert Sunlight during the summer season, as specified in the approved Desert Sunlight BBCS. By placing carcasses inside (within arrays and along inner perimeter of the fence) and outside (along the gen-tie) the project fence, the possibility that there are different carcass persistence rates inside and outside the project fence is accounted for. Fifteen carcasses within the Project fence (within solar arrays and along the fence) were monitored using motion-triggered digital trail cameras, while the remaining carcasses were visited on foot, for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality. No carcasses along the gen-tie line were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as “feeding stations”, trail cameras were installed five days before specimens were placed, and two fake cameras without bias trial carcasses were also placed within the Project fence and periodically moved to new locations within the fence. Periodic ground-based checking of carcasses with trail cameras also occurred to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera’s field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire Project, not just in areas subject to standard searches, and trials were initiated in smaller numbers on three different dates throughout the summer season.

Comentado [FWS13]: This number of carcasses is extremely low. The Service recommends increasing the number of trial carcasses to help reduce the confidence intervals on estimates.

Comentado [FWS14]: With such a low number of carcasses this is unlikely to be a problem.

2.2.2 *Estimating Carcass Persistence Times*

Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g. days a carcass is present before being removed) may not be known exactly, but is known to be within a finite range. For example, suppose a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass became unavailable at some point between 7 and 10 days. This carcass would be considered “interval censored”. Similarly, if a carcass lasts the entire 30-day trial period, that carcass is “right censored”— it is known that the carcass lasted at least 30 days, but it may have persisted longer. Because carcass persistence data were censored, persistence was analyzed using methods that can accommodate censored data and still produce unbiased estimates of the probability of persistence (Therneau 2015, Therneau and Grambsch 2000).

Comentado [FWS15]: Please describe the interval that carcasses were checked. Is there a reason that they are not checked daily, particularly during the first week?

Comentado [FWS16]: Please clarify how censored data were analyzed and how the analytical methods affected the results. The referenced book is not available to the reader; please provide citation to the agencies. How does the method affect the effective search interval?

Con formato: Punto de tabulación: 8,25 cm, Centrado

USGS-developed fatality estimator software (Huso et al 2012) was used to fit survival models to the censored carcass persistence data. The USGS software used to estimate carcass persistence calculates the period over which there is less than a 1% chance for a carcass to persist. The 'effective search interval' is defined as the shorter of the period during which there is less than a 1% probability that a carcass persists, and the actual search interval (Huso 2010). The probability of persistence is given for the effective search interval, and the probability that a carcass persists through the actual search interval is equal to p (persist through effective search interval) * effective search interval / actual search interval.

There were four distributions implemented in survival models used to estimate the probability a carcass is unscavenged and available to be found at the end of the search interval (*r*): exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike's Information Criterion adjusted for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model with combinations of the covariates carcass size, Project component, season, and visibility, to observed carcass persistence data.

2.3 Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the summer period. Carcasses from three size classes (small, medium, and large) were used for trials. The small size class comprised house sparrows and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons, chukar, and older coturnix quail, and the large size class comprised hen mallards and hen ring-necked pheasants.

2.3.1 *Searcher Efficiency Data Collection*

Training of biologists on the Project-specific protocol and early assessments of habitat conditions within the solar arrays suggested that the amount of cobble present in the soil may be an important factor influencing searcher efficiency. To satisfy requirements regarding consideration of visibility class per the BBCS and address the influence of cobble cover on searcher efficiency, sample units in the solar arrays and along the gen-tie were stratified by cobble cover and assigned to one of two classes (<15% and >15% cobble cover). Classes were determined by making ocular estimates of cobble cover at each sample unit and then evaluating the frequency histogram of sample units across the range of estimated cobble cover (Figure 4). A natural break point was identified at 15% cobble cover, so the same value was chosen as the break point that defined the two cobble cover classes. Thus, in the solar arrays, two sets of searcher efficiency trials were conducted (one set in each cobble cover class; *n* for each trial = 15 small birds, 10 medium birds, and 5 large birds as agreed upon in section 7.4 of the approved Desert Sunlight BBCS). Along the gen-tie, visibility was expected to be related to vegetation and rock cover. Thus, searcher efficiency trials along the gen-tie occurred in two visibility classes (*n* for each class = 15 small birds, 10 medium birds, and 5 large birds (easy: ≥90% bare ground, vegetation <6" tall; and more difficult: <90% bare ground, vegetation ≥6" tall). Inadvertently, one large carcass was not placed and one extra small carcass was placed during summer, so total sample size for large carcasses along the gen-tie was nine, and for small carcasses was 31. Thirty searcher efficiency trials (*n* = 15 small birds, 10 medium birds, and 5 large birds) occurred along the fence in the only visibility class present on the fence (easy visibility). Thus, during summer, a total of 150 searcher efficiency trials occurred at the Project. Locations for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches.

Comentado [FWS17]: The Service proposed larger sample sizes for carcass persistence and searcher efficiency trials. Hence, has this been evaluated as adequate to determine searcher efficiency for a single strata? Please provide justification for small sample size.

Comentado [FWS18]: The terminology here is inconsistent with above. Each carcass counts as a trial or a trial consist of n carcasses?

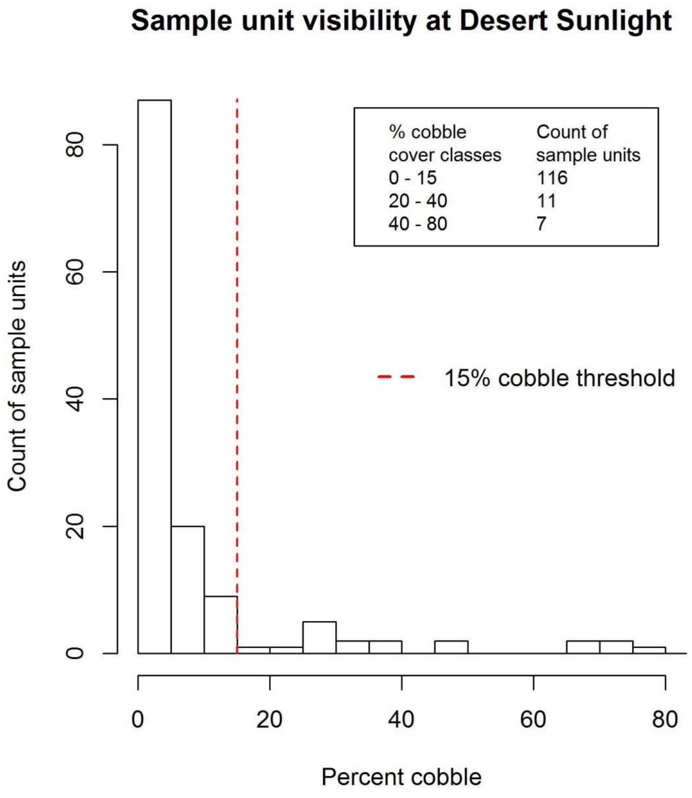


Figure 4. Frequency histogram of sample units (in the arrays only) at Desert Sunlight Solar Farm Project by estimates of cobble cover. Based on this distribution, each sample unit was assigned to one of two classes of cobble cover (<15%; >15%).

2.3.2 *Estimating Searcher Efficiency*

Comentado [FWS19]: Is searcher efficiency tested for each observer? Please provide these results along with an indication of variation in searcher efficiency across observers.

Searcher efficiency at Desert Sunlight was estimated separately for linear features (the project fence and the generation tie line), and the solar arrays, reflecting the different search methods used on arrays and linear features. For linear features, logistic regression models were fit to searcher efficiency data and AICc was used to compare models. Models including effects of carcass size (three classes), visibility (two classes; gen-tie only), and season were compared to each other and the null model. Model selection indicated that the best model included main effects of Project component, carcass size, and season. Once the best model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, p, was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from the summer 2015 season.

For the solar arrays, searcher efficiency was evaluated using a distance sampling approach (Buckland et al. 1993). Distance sampling assumes perfect detection on the transect line (at distance = 0), an assumption that is likely valid in the solar arrays given the relatively flat & vegetation-free nature of the soil surface. A curve is fitted to the observed carcass data that predicts probability of detection as a function of distance from the transect line. The mean value of this function over a specified distance, *w,* is equal to the average searcher efficiency for a transect of width *w*. The mean value of the detection curve is the integral of the detection function calculated between 0-m and the maximum survey distance (*w;* half the width of the solar array row), divided by the maximum survey distance:

$$p = \frac{\int_0^w f(x)dx}{w},$$

Con formato: Resaltar

where f(x) is the detection function evaluated at distance, *x*.

One departure in the methods used here, relative to the methods presented in Buckland et al. (1993), was that for this study the detection function was estimated using trial carcasses, which meant that there were both presence (detected) and absence (not detected) data available to fit the detection function (Figure 5). The availability of both presence and absence data means that the detection function can be estimated using only trial carcasses whose distribution is known. Therefore the detection function, the average searcher efficiency among the arrays and the final fatality estimate within the arrays are all insensitive to the spatial distribution of carcasses within individual arrays, and the overall searcher efficiency estimate is valid even if the distribution of carcasses among the arrays is not uniform.

Distances of trial carcasses (trials both found and missed) from the transect line were used to fit a half-normal detection function for searches among the arrays (Figure 5). The half-normal detection function is a commonly used function for distance sampling surveys (Buckland et al. 1993). The detection function was fit with and without covariates (carcass size, visibility index, or no covariates) and AICc indicated that the best among these models included only carcass size as a covariate.

Comentado [FWS20]: Please provide an analysis that the sample size is adequate to detect a difference between visibility categories. This result seems to be an artifact of the low sample size.

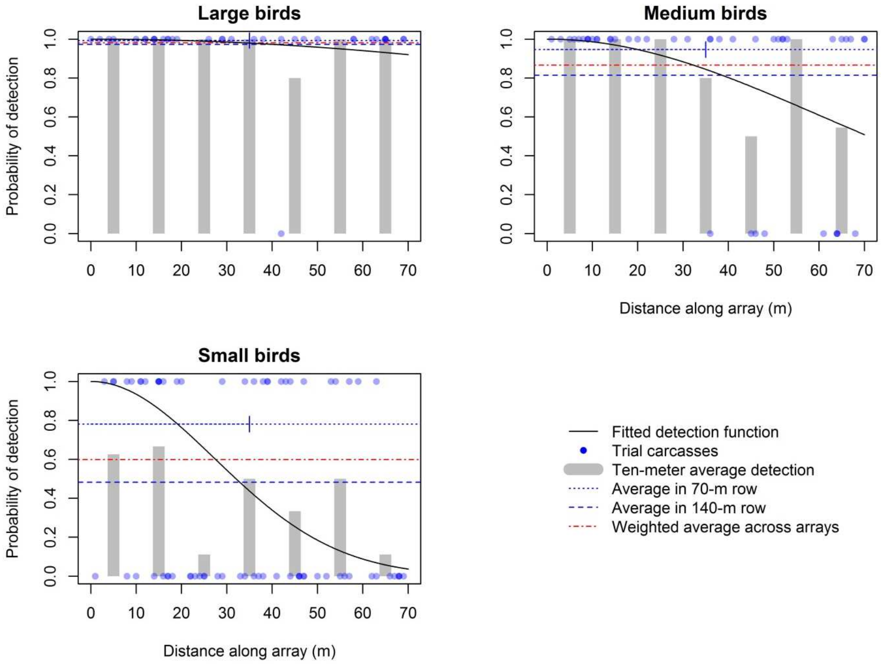


Figure 5. **Estimated detection probabilities for bird carcasses by size class during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. Distance sampling was used when searching solar arrays only. Average probability of detection over 70-m (arrays relying on a 35-m viewshed) and 140-m (arrays relying on a 70-m viewshed) panel rows in solar arrays are presented.**

Comentado [FWS21]: Please explain the dots in the figure. The number of dots is greater than the number of trial carcasses.

Because the solar arrays were surveyed by searchers who walked down both sides of the rows of panels, the width of the search transect was specified as half the width of the rows of panels. For larger birds, there is almost certainly a non-zero detection probability beyond this distance but the bias that occurs by ignoring this non-zero detection probability is conservative (i.e. the searcher efficiency is underestimated). Some solar arrays have row widths of 70 m (search transect width of 35 m) and some have row widths of 140 m (search transect width of 70 m). The weighted average searcher efficiency is calculated based on the number of panel rows of each length in the survey sample:

$$p_{weighted\ average} = \frac{n_{70}}{n} \times \int_0^{35} f(x)dx + \frac{n_{140}}{n} \times \int_0^{70} f(x)dx,$$

Comentado [FWS22]: The denominator (w) from the equation for p (from page 12 equation) is missing from this equation. Is this a typo or was the equation modified for a reason? If so, please explain.

where n_{70} is the number of 70-m rows in the sample, n_{140} is the number of 140-m rows in the sample, and *n* is the total number of rows in the sample. Searcher efficiency was higher for the arrays with a width of 70 m, and overall searcher efficiency was estimated as a weighted average based on the proportions of 70-m arrays and 140-m arrays in the sample units.

Comentado [FWS23]: Please provide the values for n_{70} and n_{140}.

2.4 Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots are also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie line versus cleared areas beneath solar panels). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where F is the total number of fatalities, C is the number fatalities detected and included in fatality estimation, r is the probability a carcass is unscavenged and available to be found at the end of the search interval, and p is the probability of detecting a carcass (Huso 2010).

Comentado [FWS24]: Is this the weighted average probability from above?

All fatality estimates were calculated using the Huso estimator, as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates were used. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

Comentado [FWS25]: Please describe what was bootstrapped and how. The table in the appendix is difficult to understand without a better understanding of the bootstrapping methods.

2.5 Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by WEST avian biologists and operational personnel and were considered “incidental” detections. When found by operational personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the Desert Sunlight SPUT Avian Injury and Mortality Report Forms June – August 2015. All detections made in search areas during the reporting period were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

3.0 MONITORING RESULTS

3.1 Summary of Avian Detections

During summer 2015, a total of 15 avian detections (including incidentals) of 11 identified species were recorded (Table 3). The most common identified species was common raven (*Corvus corax*) with three detections. Most detections (n = 11, or 73.3% of total detections) occurred in the solar arrays (Figures 2 and 3; Tables 4, 5, and 6). Ten (66.7%) detections were made during standardized carcass searches and five (33.3%) were documented as incidentals. No bats were detected during the summer season. For fresh carcasses, body weights and weather conditions the preceding nights are described in Appendix B.

Table 3. Number of individual bird detections, by species, during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. LA = line-associated; NLA = non-line associated.

Common Name	Scientific Name	Migration Behavior*	Guild	LA Solar Array	NLA Solar Array	Fence	Gen-tie Line	Total
common raven	*Corvus corax*	resident	Corvids	-	2	1	-	3
white-winged dove	*Zenaida asiatica*	variable	Doves/Pigeons	-	-	-	1	1
black-throated sparrow	*Amphispiza bilineata*	diurnal	Grassland/ Sparrows	-	-	-	1	1
sora	*Porzana carolina*	nocturnal	Rails/Coots	-	-	-	1	1
Virginia rail	*Rallus limicola*	nocturnal	Rails/Coots	1	-	-	-	1
house wren	*Troglodytes aedon*	nocturnal	Wrens	1	-	-	-	1
mourning dove	*Zenaida macroura*	variable	Doves/Pigeons	-	1	-	-	1
Say's phoebe	*Sayornis saya*	diurnal	Flycatchers	-	1	-	-	1
northern rough-winged swallow	*Stelgidopteryx serripennis*	diurnal	Swallows	-	1	-	-	1
unidentified bird (small)	-	-	Unidentified Birds	-	1	-	-	1
unidentified bird (unknown size)	-	-	Unidentified Birds	-	1	-	-	1
unidentified grebe	-	-	Waterbirds/ Waterfowl	-	1	-	-	1
western grebe	*Aechmophorus occidentalis*	nocturnal	Waterbirds/ Waterfowl	-	1	-	-	1
Total				**2**	**9**	**1**	**3**	**15**

* See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in Birds of North America (BNA) Online (http://bna.birds.cornell.edu/bna/); where information on migration behavior was lacking in BNA accounts, Newton (2008) or Murray (2004) were used.

Comentado [FWS26]: Aechmophorus species or a different genus?

Table 4. Total avian detections by Project component and detection category during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California. Only carcasses found within search areas were included in fatality estimates.

	Inside carcass search area		Outside carcass search area	
Project Component	**Carcass search**	**Incidental**	**Carcass search**	**Incidental**
Fence	0	0	1	0
O&M Building	0	0	0	0
Gen-tie line	2	0	0	1
Solar arrays				
Line-associated	0	0	0	2
Non-line associated	7	1	0	1

Table 5. Total avian detections (including incidentals) by Project component and suspected cause of death during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

	Suspected Cause of Death*				
Project Component	**Collision**	**Predation**	**Other**	**Unknown**	**Percent of Total**
Fence	0	0	1	0	6.7
O&M building	0	0	0	0	0
Gen-tie line	2	0	1	0	20
Solar arrays					
Line-associated	1	0	1	0	13.3
Non-line associated	1	0	5	3	60
Percent of Total	**26.7**	**0**	**53.3**	**20.0**	**100.0**

* Suspected cause of death was assigned based on evidence available on the detection, evidence available on Project infrastructure, and proximity of detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as "unknown" because it can't be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) had a suspected cause of death attributed to the respective Project component. However, in the absence of a completed necropsy, there is ~~substantial~~ some uncertainy associated with cause of death assignments because no events were directly observed.

Comentado [FWS27]: Was proximity to project features evaluated? Please describe how this information was utilized. Proximity distances may provide insights into which features may pose the greatest risks.

Comentado [FWS28]: Since scavenger rates are so high, this definition too easily categorizes carcasses as unknown. Low levels of scavenging should not exclude birds from a more thoughtful evaluation of the cause of the mortality. Other criteria should be considered, including patterns of disturbed dust on solar panels, proximity to a feature with collision risk. Such a blanket categorization, probably masks useful information.

3.2 Temporal Patterns of Avian Detections

The number of detections recorded daily during the reporting period ranged from zero to three (Figure 6). One detection was found per day with the exception of June 24 when three detections occurred. The number of detections per day represents those discovered during standardized carcass searches and incidentally.

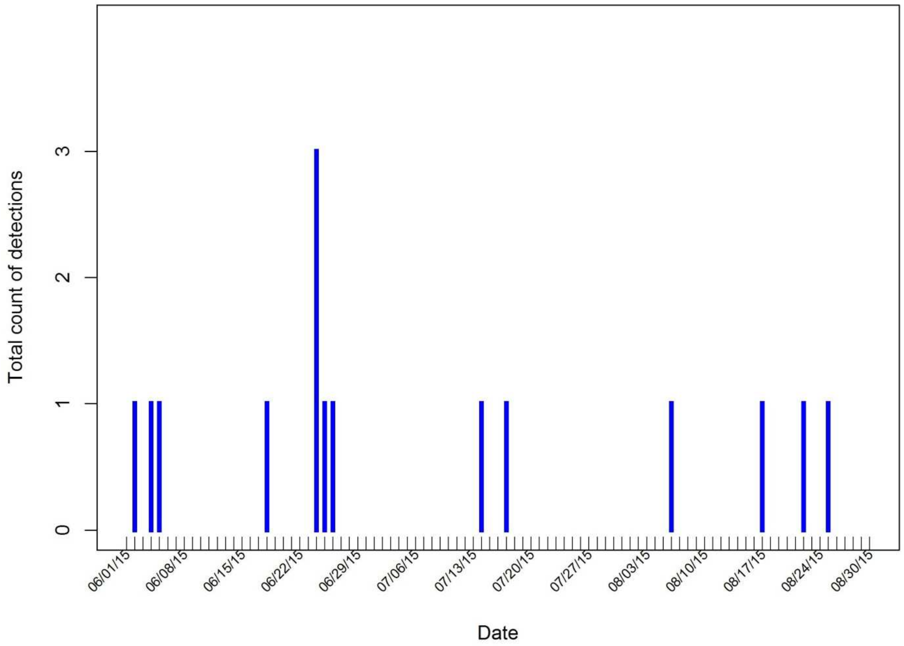


Figure 6. Total number of detections by date during summer (June 01 – August 30) 2015 at the Desert Sunlight Solar Farm Project, Riverside County, California.

3.3 Spatial Distribution of Avian Detections

Comentado [FWS29]: Spatial distribution of different taxonomic groups should be discussed, particularly as more data come in.

3.3.1 *Detections by Project Component*

During the reporting period, detections were documented from the solar arrays, the northern section of the perimeter fence, and the gen-tie line; no detections occurred at the O&M building (Tables 3, 4, and 5). Of the 11 detections within the solar arrays, 18.2% (2) were associated either with overhead lines or arrays that co-occurred with overhead lines.

3.3.2 *Feather Spot Detections*

Five (33.3%) of the 15 detections consisted only of feather spots. Along the gen-tie, one of three detections (33.3%) was a feather spot. No detections along the fence were a feather spot. Four of 11 detections (36.4%) in the solar arrays were feather spots.

3.4 Detections of Injured Birds

No injured birds were detected during the summer 2015 season.

3.5 Summary of Bat Detections

No bats were detected during the summer 2015 season.

3.6 Carcass Persistence Trials

Data from carcass persistence trials were available from late winter, spring, and summer at the solar field and gen-tie line (n = 154 total). Based on carcass persistence data from late winter, spring, and summer 2015, survival models were compared for relative quality using the corrected AICc score, as suggested in Huso (2010). The AICc score provides a relative measure of model fit and parsimony among a selection of candidate models, and provides a framework for testing hypotheses regarding which factors contribute to carcass persistence rates. Carcass size was tested as a potentially important variable, as larger carcasses tend to persist longer and may be more likely to leave feather spots which persist for long durations, whereas smaller carcasses may be more likely to be completely removed. Project component (solar arrays/fence, generation-tie line) was also included as a potentially important variable, as was season.

Comentado [FWS30]: This is not clear. Are you suggesting that feather spots from large carcasses last longer than feather spots from small carcasses? Or are you suggesting that large carcasses are more likely to produce feather spots than small carcasses and feather spots in general (large or small) persist for long durations? Please clarify and provide a rationale for the assertion and describe how it might affect the analysis.

The model with lowest AICc score is typically chosen as the "best" model relative to other models tested; however, any model within two AICc points of the best model is considered competitive with the best model (Burnham and Anderson 2004). The best model included main effects of season, carcass size, Project component, and interactions of Project component × season and Project component × size with a Weibull-distributed removal time. Given the main effect of season, further modeling efforts were restricted to data collected in summer only. The best model using only the summer data suggested an interaction between carcass size and Project component. Estimates of carcass removal time and persistence probabilities are reported in Table 6 from the best model, and estimates of proportion of carcasses remaining as a function of days since carcass placement are provided in Figure 7.

Comentado [FWS31]: Is there enough data to do a good analysis?

Table 6. Mean carcass removal time and probability of a carcass persisting through the effective search interval during the summer season (June 01 – August 30) at the Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass size	Project component	Mean removal time (days)	Probability of persistence
Small	Arrays/fence	15.53	0.63
Small	~~Overhead~~ Gen-Tie lines	1.37	0.22
Medium	Arrays/fence	19.2	0.73
Medium	~~Overhead~~ Gen-Tie lines	14.75	0.60
Large	Arrays/fence	-*	1.00
Large	~~Overhead~~ Gen-Tie lines	0.9	0.22

* Mean removal time was not estimated because no removal was observed for large carcasses within the solar field.

Comentado [FWS32]: Please include the timeframe for the persistence trails for ease of reference (30 days?).

Comentado [FWS33]: This looks like there may be an effect on persistence time from being outside the fence. This may be due to differences in the scavenger community. Was this tested?

Comentado [FWS34]: This is the Gen-Tie, right? Better to refer to this as the Gen-Tie to distinguish it from the internal overhaed lines above the panels.

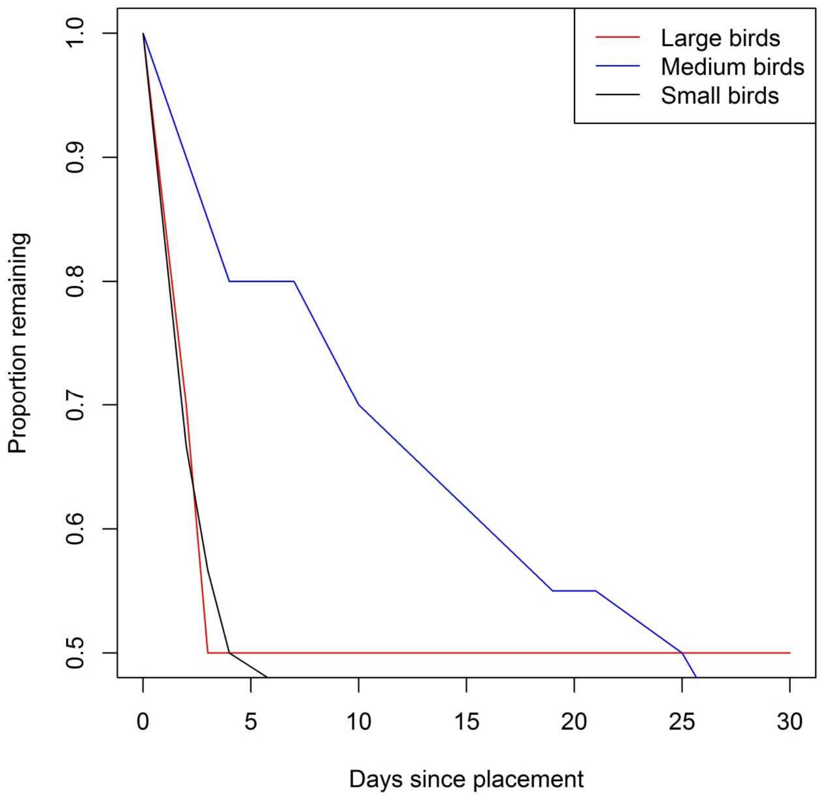


Figure 7. Proportion of trial carcasses remaining as a function of days since placement and carcass size class (n = 30, 20, and 10 for small, medium, and large size classes, respectively) during the summer (June 01 – August 30) 2015 season at the Desert Sunlight Solar Farm Project, Riverside County, California.

Comentado [FWS35]: The y-axis is cut off at 0.5. This obscures data for small and med bird size categories. Please provide the Figure with a y-axis range from 0.0-1.0.

3.7 Searcher Efficiency Trials

During the reporting period, a total of 150 searcher efficiency trials were placed at the Project. Most trials were available to be found, but some disappeared before or during the trial. Overall, 60 trials were placed in the solar arrays and 44 were available to be found; 30 trials were placed along the perimeter fence (inner perimeter only) and 30 were available to be found; and 60 trials were placed along the gen-tie line and 55 were available to be found.

Comentado [FWS36]: How was this broken down by visibility categories and size classes? See Appendix C?

In the solar arrays, the model that included an effect of carcass size was chosen as the best model to estimate searcher efficiency. Within the solar arrays, searcher efficiency was: 60.0% for small birds, 86.6% for medium birds, and 98.1% for large birds (Figure 5).

For linear Project components, the model that included an effect of carcass size, Project component, and season was chosen as the best model to estimate searcher efficiency. Along the fence, searcher efficiency ranged from 87.5% to 100% depending on carcass size class. Along overhead lines, searcher efficiency ranged from 43.5% to 100%. Detailed estimates of searcher efficiency estimates specific to each component and carcass size are reported in Appendix C.

3.8 Fatality Estimates

Fatality estimates were calculated separately for each component (solar arrays, fence, and overhead lines). Ultimately, five detections were excluded from the fatality analysis because they were found outside standardized search areas. All 15 detections made during summer are reported in Table 3.

Comentado [FWS37]: Please provide an additional summary tables with the following information for each component and for the entire facility: carcasses detected, estimated fatalities; 90% CI. An additional table with the same information for each size category is also requested.

During summer 2015, there were an estimated total 148 carcasses (90% CI: 10 – 365) at the Project. Of these, 44 carcasses (27.5%; 90% CI: 8 – 64) were estimated for the solar arrays and 104 carcasses (66.9%; 90% CI: 2 – 339) were estimated for the gen-tie line. While we are required to report the gen-tie estimates per the approved BBCS, these estimates are not reliable due to the high rates of scavenging that were observed during the limited trials at the gen-tie and the low number of carcasses detected (n = 2 in the fatality analysis). No carcasses were estimated for the perimeter fenceline because there were no detections made along the fence. All of these estimates should be interpreted with caution because variance estimates are in general unreliable when carcass counts are low (< 5 per category). ~~Other projects (e.g. Ivanpah) are not reporting estimates when carcass counts are less than or equal to five. However, t~~The TAG has asked for both the estimates and confidence intervals for this project with the appropriate caveat added. There were an estimated ~~0.0~~17 fatalities per 1000 acres (within the solar field only; 44 estimated carcasses/2,585 acres) and an estimated 0.08 fatalities per nameplate MW (44 estimated carcasses/550 MW) within the solar field. A complete list of estimates for each Project component and carcass size class with confidence intervals is presented in Appendix C.

Comentado [FWS38]: The Service continues to recommend 95% CI, but even at 90% the CI is still too wide to be useful.

Comentado [FWS39]: Given the size of utility scale projects “per 1000 acres seems more appropriate.

4.0 DISCUSSION

The 2015 summer season represented the second full season of standardized monitoring at Desert Sunlight per the BBCS. Searcher efficiency trials and carcass removal trials were conducted concurrently at the solar arrays, fencelines, and along the gen-tie line. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. Although these estimates were produced from a statistically robust sample, only limited inference may be drawn from two seasons of data. These results should be considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. As more data are collected throughout the monitoring year (and additional quality assurance/quality control measures occur, for example characterizing feather spots to species or size class), data from all seasons may be pooled. At that time, data will be tested for seasonal differences retrospectively, but because seasonal estimates will be produced from the much larger annual data set, they may differ from what is reported here because they are based on a larger, more informative sample.

4.1 Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Thus, rates of carcass persistence reported here should be interpreted cautiously as they may change over the coming months.

Searcher efficiency was influenced by Project component, carcass size, and season. In the solar arrays, searcher efficiency was high (> 0.5) for all carcass size classes and this is likely influenced by the limited vegetation cover beneath solar panels. Beneath the gen-tie line, vegetation cover is higher in some portions of the strip transects, but results reported here support the hypothesis that visibility class is not a factor in searcher efficiency along the lines during summer.

Comentado [FWS40]: Given the low number of trial carcasses, you can detect a difference between visibility classes.

For the current analysis, searcher efficiency in the solar arrays was assumed to be best predicted by a half-normal distribution. For future analyses, AICc will be used to compare and choose the best among multiple detection functions.

4.2 Distribution of Fatalities and Fatality Estimates

The number of detections was more or less evenly distributed across the summer season, and there were no clear associations between number of detections and date. Given the small number of detections overall, it is premature to draw any conclusions about the spatial distribution of carcasses.

Composition of detections during summer 2015 included eight avian guilds. Corvids comprised the majority of detections (n = 3): there were two detections each within the doves/pigeons, rails/coots, and waterbirds/waterfowl guilds. No bats have been detected since monitoring began at the Project.

Detections attributed to an unknown cause accounted for 20.0% of all detections during the reporting period, and all those attributed to an unknown cause were found in the solar arrays. Of the 11 detections made in the solar arrays, 36.4% were feather spots. Determining a cause of mortality from a feather spot is challenging because there is rarely visible evidence available on which to determine a cause of death. Thus, feather spots with an unknown cause of mortality could be encountered anywhere birds occur, and an unknown cause of a sizeable proportion of the carcasses is not unique to the Project. Further, the relatively large proportion of feather spots (33.3%) among the detections for the Project as a whole may inflate the fatality estimate when unknown cause detections are included based on the potential for multiple feather spots resulting from one fatality, feather spots resulting from predation not associated with the facility, or other causes. However, feather spots are included in the analysis here to provide a more conservative estimate of fatality.

Comentado [FWS41]: What fraction of these unknown detections are feather spots?

Comentado [FWS42]: We don't agree with this statement. This is unknown. Feather spots may be more mobile, but as far as I know there have been no studies on whether they "multiply" and cause bias. If there has, please provide a reference. It is possible that feather spots could accumulate along fences, but in general, they are just as likely to migrate into a survey area as they are to leave. If this is a significant problem, then I recommend shorter search intervals and more complete coverage of the project site.

5.0 LITERATURE CITED

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in 2nd International Symposium on Information Theory (B. N. Petran and F. Csaki, Eds.). Akademiai Kiado, Budapest, Hungary.

Ammon, Elisabeth M. and William M. Gilbert. 1999. Wilson's warbler (*Cardellina pusilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/478

Boarman, William I. and Bernd Heinrich. 1999. Common raven (*Corvus corax*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/476 doi:10.2173/bna.476

Buckland, S, D.R. Anderson, K. P. Burnham, and J.L. Laake. 1993. Distance sampling: estimating abundance of biological populations. Chapman & Hall, London. 446 pp.

Burnham, K.P., and D.R. Anderson. 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociological Methods & Research 33: 261-304.

Evers, David C., James D. Paruk, Judith W. Mcintyre and Jack F. Barr. 2010. Common loon (*Gavia immer*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/313 doi:10.2173/bna.313

Hudon, Jocelyn. 1999. Western tanager (*Piranga ludoviciana*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/432 doi:10.2173/bna.432

Hughes, Janice M. 2011. Greater roadrunner (*Geococcyx californianus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/244 doi:10.2173/bna.244

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. doi: 10.1002/env.1052

Huso, Manuela, Som, Nicholas, and Ladd, Lew, 2012, Fatality estimator user's guide: U.S. Geological Survey Data Series 729, 22 p.

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A new method to determine bird and bat fatality at wind energy turbines from carcass searches. Wildlife Biology 17: 350-363.

Lowther, Peter E. and Janet McI. Williams. 2011. Nashville warbler (*Oreothlypis ruficapilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/205 doi:10.2173/bna.205

Manly, B.F.J.1997. Randomization, bootstrap and Monte Carlo methods in biology. Second Edition. CRC Press, LLC, Boca Raton, Florida, 455 pp.

Melvin, Scott M. and James P. Gibbs. 2012. Sora (*Porzana carolina*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/250 doi:10.2173/bna.250

Muller, Martin J. and Robert W. Storer. 1999. Pied-billed grebe (*Podilymbus podiceps*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/410 doi:10.2173/bna.410

Murray, J. 2004. Nocturnal flight call analysis as a method for monitoring density and species composition of migratory songbirds (Order Passeriformes) across southern Vancouver Island, British Columbia in 2004. Rocky Point Bird Observatory, 16 pp.

Newton, I. 2008. The migration ecology of birds. Academic Press, London.

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine-cause avian fatality estimates. Journal of Wildlife Management 74(5): 1089-1096.

Smallwood, K. S. 2013. Comparing bird and bat ratality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37(1): 19-33.

Therneau, T. 2015. _A Package for Survival Analysis in S. version 2.38, <URL: http://CRAN.R-project.org/package=survival>.

Therneau, T.M. and P. M. Grambsch 2000. Modeling Survival Data: Extending the Cox Model. Springer, New York. ISBN 0-387-98784-3.

Western Ecosystems Technology (WEST), Inc. 2014. Bird and bat conservation strategy, Desert Sunlight Solar Farm Project, Riverside County, California. 57 pp.

Wheelwright, N. T. and J. D. Rising. 2008. Savannah sparrow (*Passerculus sandwichensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/045 doi:10.2173/bna.45

Appendix A. Detailed Areas of Carcass Locations along the Generation Tie Line of the Desert Sunlight Solar Farm Project during Summer (June 01 – August 30) 2015

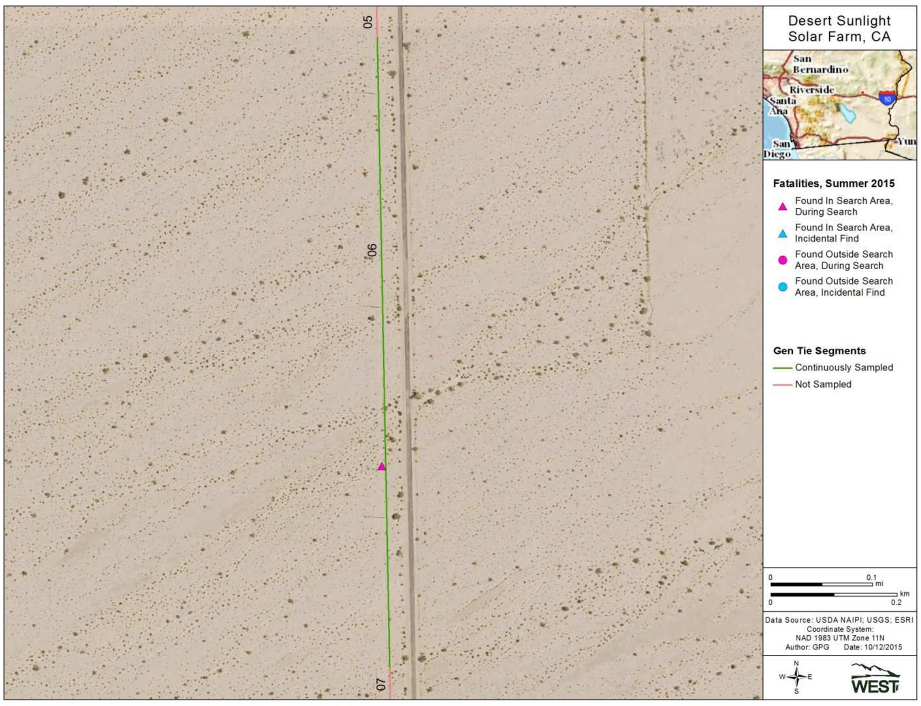


Figure A-1. Detailed map of a carcass location along the generation tie line at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

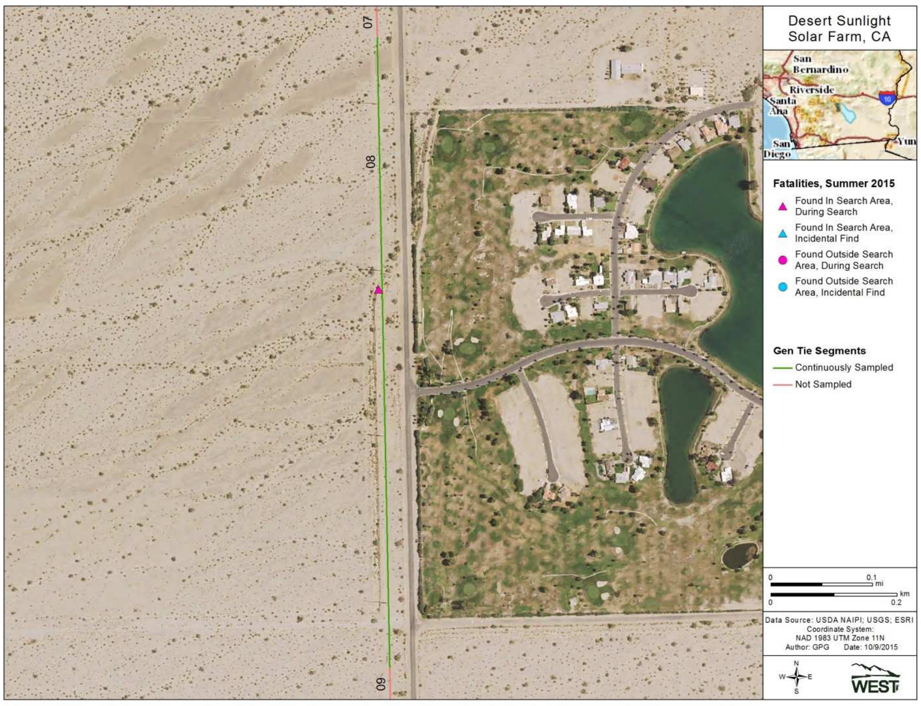


Figure A-2. Detailed map of a carcass location along the generation tie line at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015.

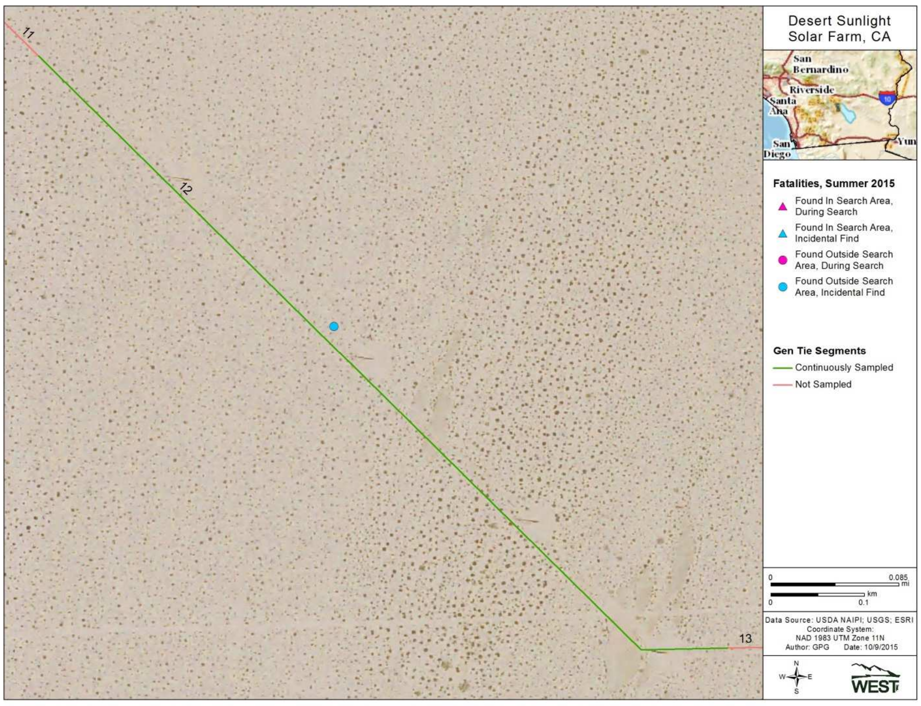


Figure A-3. Detailed map of a carcass location along the generation tie line at Desert Sunlight Solar Farm Project during summer (June 01 – August 30) 2015. This carcass was > 15 m from the gen-tie line, and was therefore excluded from the fatality estimate based on location.

Appendix B. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during Summer (June 01 – August 30) 2015

Table B-1. Weather conditions and body weights associated with avian detections estimated to be less than 24 hours old during summer (June 01 – August 30) 2015 at Desert Sunlight Solar Farm Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hrs)	Species	Weight (g)	Weather Summary for Preceding 24 hrs
071715-SORA-GENTIE-06-01	7/17/2015	0-8hrs	sora	63	AVERAGE WIND SPEED OF 9MPH TO THE SOUTH, CLEAR 10 MILE VISIBILITY, MAX TEMPERATURE IS 107 DEGREES, MINIMUM IS 79 DEGREES, NEW MOON 1% ILLUMINATED
062415-HOWR-01-16MVOH-02	6/24/2015	8-24hrs	house wren	7	JUN 23, MAX TEMP 114, AVG WIND SPEED 10MPH-SSW, MAX WIND SPEED 16MPH. MAX GUST 21MPH. VIS 10 MILES, CLEAR UNTIL 3PM THEN PARTLY CLOUDY UNTIL 7PM, THEN CLEAR THROUGH NOGHT. MOON PHASE: WAXING CRESENT. CLEAR ALL DAY 6/24. TEMP 99 DEG F WHEN BIRD FOUND

Appendix C. Correction Factors and Bird Fatality Rates at the Desert Sunlight Solar Farm Project during Summer (June 01 – August 30) 2015.

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during summer (June 01 – August 30) 2015. *Distribution of easy and difficult visibility on the gen-tie line was about 70% and 30%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

Comentado [FWS43]: This table/appendix requires more explanation.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Proportion of area searched by component								
Gen-tie line	0.479	-	0.479	-	0.479	-	0.479	-
Fence	0.744	-	0.744	-	0.744	-	0.744	-
Solar arrays	0.295	-	0.295	-	0.295	-	0.295	-
Searcher efficiency by component and visibility class								
Gen-tie line: Easy vis.*	0.583	0.417 - 0.750	0.952	0.857 - 1.000	0.8	0.600 - 1.000	0.583	0.417 - 0.750
Gen-tie line: Difficult vis.*	0.435	0.261 - 0.609	0.706	0.529 - 0.882	0.6	0.300 - 0.800	0.435	0.261 - 0.609
Gen-tie line: Weighted avg.*	0.539	0.419 - 0.665	0.878	0.794 - 0.947	0.74	0.570 - 0.880	0.539	0.419 - 0.665
Gen-tie line	0.662	0.519 - 0.815	0.954	0.869 - 1.000	0.999	1.000 - 1.000	0.662	0.519 - 0.815
Fence	0.875	0.733 - 1.000	0.987	0.943 - 1.000	1.000	1.000 - 1.000	0.875	0.733 - 1.000
Solar arrays	0.599	0.524 - 0.669	0.866	0.794 - 0.927	0.981	0.945 - 1.000	0.599	0.524 - 0.669
Average probability of carcass persistence through the effective search interval								
Gen-tie line	0.215	0.138 - 0.260	0.596	0.372 - 0.735	0.215	0.138 - 0.260	0.215	0.138 - 0.260
Solar arrays & fence:	0.633	0.478 - 0.757	0.733	0.548 - 0.863	1.000	1.000 - 1.000	0.633	0.478 - 0.757
Adjustment for effective search interval (proportion of nominal search interval)								
Gen-tie line: Summer effective search interval	0.278	0.202 – 0.355	1.00	-	0.175	0.122 – 0.223	0.278	0.202 – 0.355
Solar arrays & fence: Summer effective search interval	1.00	-	1.00	-	1.00	-	1.00	-
Carcass counts by component								
Gen-tie line	1	0 - 3	0	-	1	0 - 3	0	-
Fence	0	-	0	-	0	-	0	-
Solar arrays	2	0 - 4	0	-	5	1 - 10	1	0 - 3
Average Probability of Carcass Availability and Detected (Searcher efficiency * average probability of carcass persistence)								
Gen-tie line	0.040	0.020 - 0.054	0.569	0.357 - 0.713	0.038	0.020 - 0.050	0.040	0.020 - 0.054
Fence	0.554	0.406 - 0.683	0.723	0.527 - 0.851	1.000	1.000 - 1.000	0.554	0.406 - 0.683
Solar arrays	0.379	0.278 - 0.462	0.379	0.472 - 0.757	0.981	0.945 - 0.999	0.379	0.278 - 0.462
Adjusted Fatality Estimates (Fatalities /Season; values in italics are considered unreliable due to low counts of carcasses: carcass count / (proportion of area searched * average probability of carcass availability and detected)**								
Gen-tie line	*50.8*	*(1) - 200.2*	*0*	-	*53.5*	*(1) - 223.8*	*0*	-
Fence	*0*	-	*0*	-	*0*	-	*0*	-

Table C-1. Correction factors and bird fatality rates at the Desert Sunlight Solar Facility during summer (June 01 – August 30) 2015. *Distribution of easy and difficult visibility on the gen-tie line was about 70% and 30%, respectively. **For adjusted fatalities, lower bounds in parentheses are actual counts; bootstrap analysis indicated a lower bound of zero.

Comentado [FWS43]: This table/appendix requires more explanation.

	Small birds		Medium birds		Large birds		Unknown size	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Solar arrays	*17.9*	*(2) - 41.5*	*0*	*-*	*17.3*	*(5) - 34.5*	*8.9*	*(1) - 27.8*
Facility	*68.7*	*(3) - 212.1*	*0*	*-*	*70.8*	*(6) - 238.4*	*8.9*	*(1) - 27.8*

Post-Construction Monitoring at the Genesis Solar Energy Project Riverside County, California

2015 Summer Report

Prepared for:

Genesis Solar LLC

700 Universe Blvd.,
Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.

415 West 17th Street, Suite 2000
Cheyenne, Wyoming

October 15, 2015

WEST Inc.

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from June 01 to August 30, 2015 (the summer season; for logistical reasons, fall monitoring started on Monday, August 31, 2015) at Genesis Solar Energy Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the second seasonal report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS.

Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 30% sample of solar troughs of both Project units, 2) at each evaporation pond, 3) along the perimeter of each power block and beneath each air condensed cooling (ACC) unit, 4) along inner and outer portions of the "fenceline", resulting in 100% of the length of the perimeter fence surveyed, and 5) along 25% of the total length of generation-tie (gen-tie) and distribution lines (collectively, overhead lines) from the southernmost Project fence to Wiley's Well reststop, which co-occur with the Project access road. Searches were conducted within the summer season at intervals of approximately 21 days, and all components were searched four times.

All bird and bat fatalities and injuries that were discovered by observers, referred to as "detections" in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, 55 avian detections and five bat detections were made.

According to specifications of the BBCS, avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were input into a fatality estimator model (Huso 2010) to provide a preliminary estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias. The estimate is considered preliminary because the annual report may pool information from bias trials and other data across seasons which could affect seasonal estimates.

Carcass persistence was influenced by Project component, carcass size, and, in the solar field (solar collector troughs + perimeter fence), season. In the solar field, small carcasses (0-100 g) had a 52% (90% confidence interval [CI]: 45 – 64%) chance of persisting through the 21-day search interval, medium carcasses (101 – 999 g) had an 92% (90% CI: 76 – 96%) chance, and large carcasses (1000+ g) had a 100% chance. Mean removal time for small, medium, and large carcasses in the solar field was 8.0 and 35.1 days for small and medium carcasses, respectively. Mean removal time for large carcasses in the solar field was not estimated because no removal of large carcasses was observed. Along overhead lines, small carcasses had a 14% (90% CI: 9 – 20%) chance of persisting through the 21-day search interval, medium carcasses had a 59% (90% CI: 42 – 74%) chance, and large carcasses had a 41% (90% CI: 26

Comentado [FWS1]: 30% of the entire project, not 30% of each unit, correct?

Comentado [FWS2]: FWS still asserts that 25% of the utility lines is too little given that transmission appears to be having significant effects on birds.

Comentado [FWS3]: Time of survey matters as to whether or not one can draw any conclusions about this. Please provide a summary of when surveys were conducted.

Comentado [FWS4]: IMPORTANT: WEST has said that it modified the Huso estimator, and despite several requests, those modifications have not been shared with the agencies. Until we understand what changes to the code were made, we are reserving judgment on these results.

Comentado [FWS5]: Please explain how carcass persistence is influenced by project component.

Comentado [FWS6]: Is the fence being tested? The carcass persistence section only mentions trials in the SCA and the Gen-Tie.

Comentado [FWS7]: Please report median removal times and a figure showing the curve of # remaining over time.

– 58%) chance. Mean removal time along overhead lines for small, medium, and large carcasses was 0.8, 12.8, and 4.6 days, respectively.

Comentado [FWS8]: This supports increased frequency for this component.

In the solar field, searcher efficiency was 92% (86 – 98%) and there was no effect of carcass size, visibility class, or season. Along overhead lines, searcher efficiency was influenced by carcass size: 54% (90% CI: 39 – 68%) for small birds, 100% for medium birds, and 100% for large birds.

Comentado [FWS9]: Is this the searcher efficiency averaged for all observers? What is n?

Composition of summer detections included species from 13 avian guilds. No single guild comprised a large number of detections: the most common was blackbirds/orioles (eight detections). Shorebirds and waterbirds/waterfowl were represented by six and seven detections, respectively. Summer was the first season in which bats were detected.

Using the Huso (2010) fatality estimator model, during the summer period 2015, there were an estimated total 100 carcasses (90% CI: 81 - 145) at the Project. Of these, 53 carcasses (53%) were estimated for the SCAs, 8 carcasses (8%) were estimated for the fence, 9 carcasses (9%) were estimated for evaporation ponds, 23 carcasses (23%) were estimated for power blocks, and 7 carcasses (7%; 90% CI: 6 - 21) were estimated for the overhead lines and project road. An estimated 93 (93% CI: 66 - 126) carcasses (0.05/acre, 0.37/nameplate MW) occurred for all components associated with both solar units (SCAs, power block, evaporation ponds, and along the perimeter fence, combined).

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Tracey Johnson	Research Biologist/Field Supervisor
Paul Rabie	Statistician
Pamela Bullard	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2015. Post-construction monitoring at the Genesis Solar Energy Project, Riverside County, California. 2015 Summer Report. 32 pp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Project Background

The Genesis Solar Energy Project (referred to in this report as "Project") consists of two solar power electrical generating facilities (Units 1 and 2) with a combined net capacity of 250 megawatts. The Project facility consists collectively of two power blocks, power generating equipment (solar collector assemblies [SCAs] of mirrored parabolic troughs [solar troughs or troughs]), support facilities, and evaporation ponds. Linear facilities include a transmission line, distribution line, natural gas pipeline, and a main access road that are mostly co-located for approximately 10.5 km (6.5 miles). The Project comprises approximately 1,800 acres (728 hectares [ha]). The solar field and associated structures comprise 1,727 acres (699 ha) and linear facilities comprise 93 acres (38 ha). The Project is located on land managed by the Bureau of Land Management (BLM) 25 miles (40 kilometers [km]) west of Blythe, in Riverside County, California (Figure 1).

1.2 Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (2015; “BBCS”) was prepared by the Project proponent in collaboration with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), California Energy Commission (CEC), and Bureau of Land Management (BLM) to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency acceptance of the BBCS occurred in March 2015.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Genesis Solar in collaboration with the USFWS, CDFW, CEC, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with SCAs, overhead lines including the generation (gen-tie) line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near SCAs on the edge of the solar field versus the interior area of the solar field).
3. Provide information that will assist the CEC and BLM, in consultation with the USFWS and the CDFW, in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the CEC and BLM, in consultation with the USFWS and CDFW, may make comparisons with other solar sites.

1.3 Purpose of This Report

This report represents the second seasonal report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS and as required by CEC Condition of Certification BIO-16. This report covers the 2015 summer season, which includes the period from June 01 to August 30, 2015. For logistical reasons, fall monitoring started on Monday, August 31, 2015. As stated in the approved BBCS, this seasonal report includes the observed fatality rates broken out by likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and suspected causes of death. Species composition of carcasses and the results of the bias trials are also reported. This report presents information related to the spatial distribution of carcasses, but no formal statistical analysis will be conducted until the end of the monitoring year, given the limited data presently available.

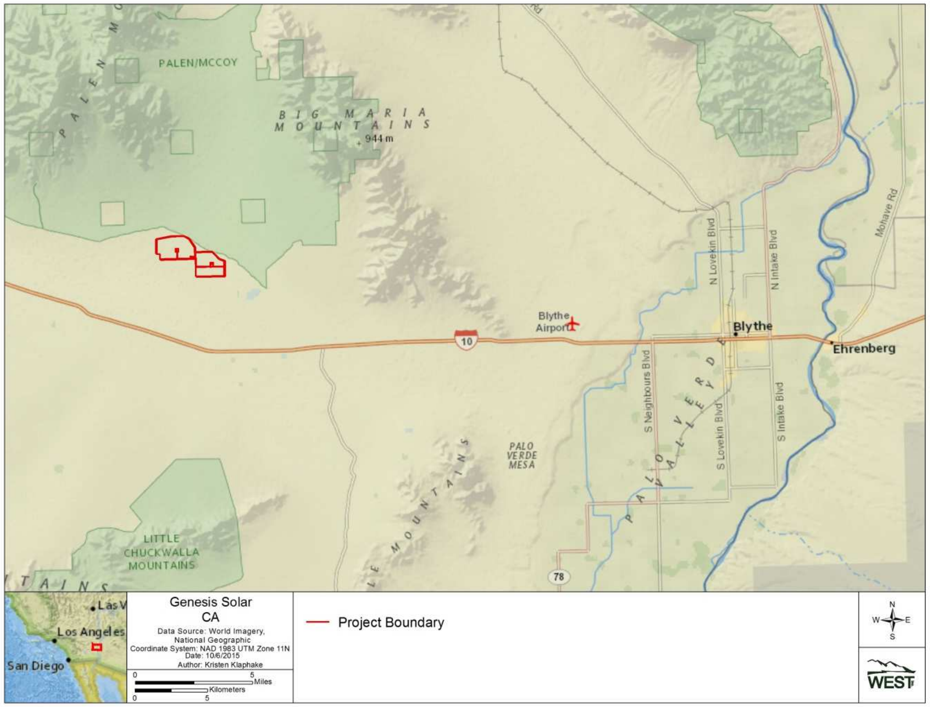


Figure 1. Genesis Solar Energy Project vicinity map, Riverside County, California.

2.0 METHODS

The BBCS describes the methods by which monitoring and certain analyses, including compilation of the overall fatality estimate, will occur. Below is an abridged description (see BBCS for detailed methods).

2.1 Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. This section also describes the methods for conducting carcass removal and searcher efficiency trials; how data were reported and analyzed; and the methods for producing fatality estimates for the Project.

2.1.1 Areas Surveyed

Standardized carcass searches were conducted at a sample of the solar collector assemblies in each unit; the perimeter of each power block (including the area below each air condensed cooling [ACC] unit; Figures 2 and 3); the “fenceline” defined as the perimeter fences for each unit (100% of the total length of fence; Figures 2 and 3); and the gen-tie and distribution lines (25% of the total length of each line from the Project fence to Wiley’s Well rest stop; Figure 4). Table 1 provides the total area of each component as well as the percent of each component that was searched.

To ensure a balanced distribution of plots in solar collector assemblies, each unit was divided into blocks, and each block was sampled using a systematic sample of 30% of pairs of rows with a random starting point. This sampling design ensures that survey plots were not spatially clumped.

2.1.2 Search Frequency and Timing

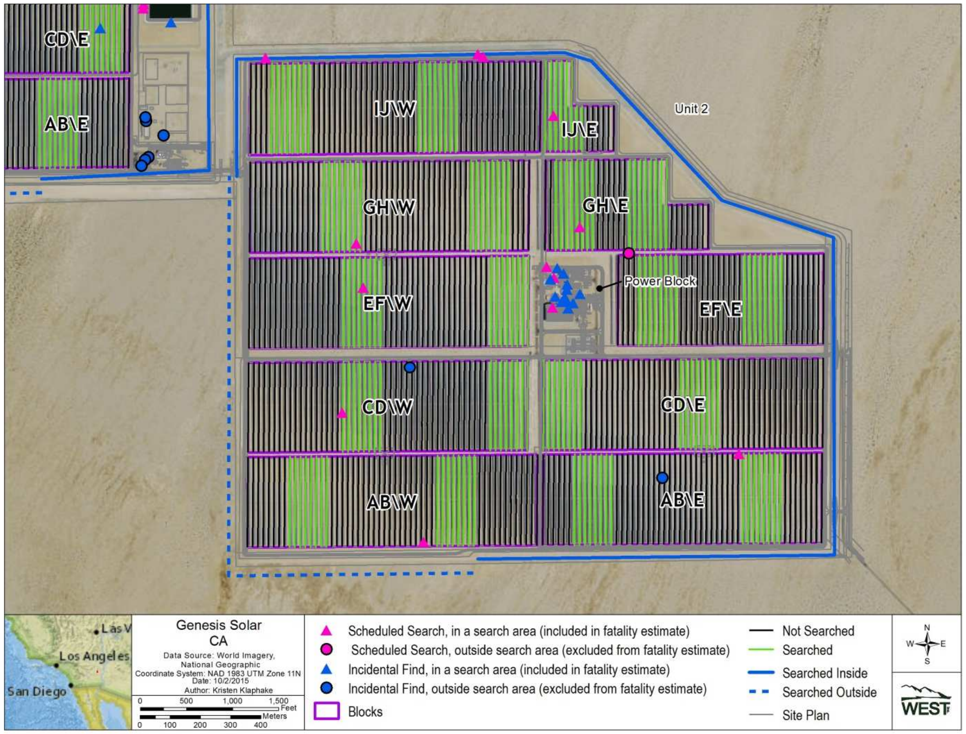
Comentado [FWS10]: Please record and report data on the time of the surveys. This will help determine if the surveys can be used to predict nocturnal vs. diurnal mig behavior.

The summer survey season includes the period from June 01 through August 30, 2015. Standardized searches occurred at 21-day intervals beginning June 01, 2015. All project components included in standardized searches were surveyed four times.

The average summer search interval was 18.9 days (median 21 days) for all Project components included in standardized carcass searches. Slight variation in search interval was anticipated due to weather and logistical delays.

Comentado [FWS11]: Please discuss the effect of the long search interval in relation to the carcass persistence trial data.

Figure 2. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at Unit 1 of the Genesis Solar Energy Project summer (June 01 – August 30) 2015.



Data Source: World Imagery, National Geographic
Coordinate System: NAD 1983 UTM Zone 11N
Date: 10/2/2015
Author: Kristen Klaphake

Figure 3. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at Unit 2 of the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

Table 1. Areas included in standardized carcass searches at the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

Project Component	Total Size	Units	Percent of Component Searched
SCAs	920	rows of solar troughs	30.4
Unit 1	460	rows of solar troughs	27.8
Unit 2	460	rows of solar troughs	33.0
ACC units	0.9	hectares	100
Power block (perimeter)	0.8	kilometers	100 of perimeter
Evaporation ponds	3.1	hectares	100
Distribution line	8.4	kilometers	25.0
Generation Tie line	8.4	kilometers	25.0
Fence	14.5	kilometers	100

Comentado [FWS12]: While 100% of the power block perimeter is being searched, the number of incidentals documented inside the structures indicate actual surveys should take place inside the perimeter. This is somewhat misleading to say 100% is surveyed.

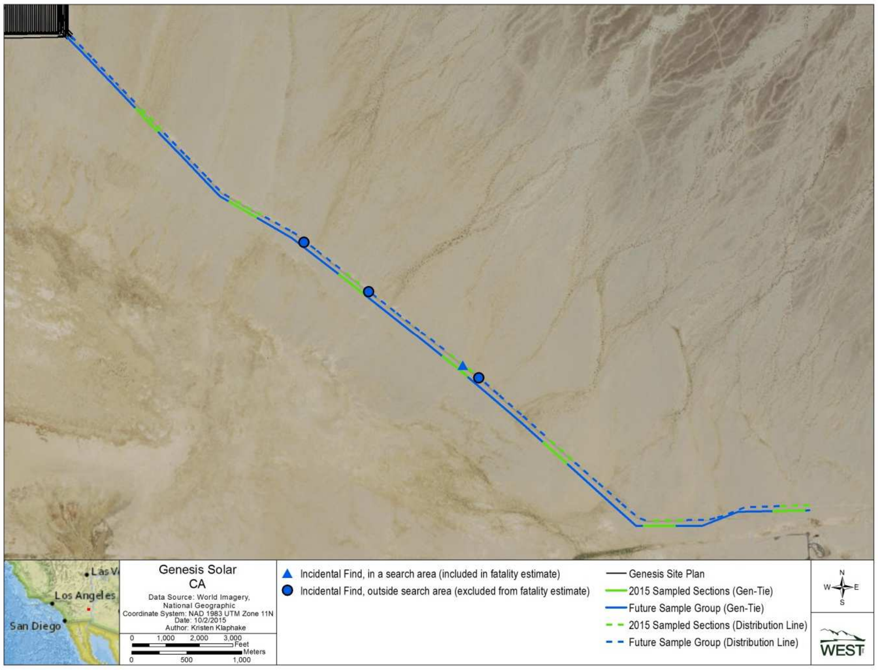


Figure 4. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance activities) along the distribution and generation tie lines and Project access road at the Genesis Solar Energy Project during summer (June 01 – August 30) 2015. Detailed maps of detections are presented in Appendix C.

2.1.3 Search Methods

Standardized carcass searches were performed by CEC- and BLM-approved biologists, in accordance with methods outlined in the BBCS.

Within the solar collector assemblies, 280 solar troughs (30.4% of the total number of troughs) were surveyed by vehicle. Biologists slowly drove (≤5 mph) parallel to troughs and centered between rows, searching ahead and to the driver's side of the vehicle for bird and bat carcasses. Biologists scanned out to a perpendicular distance of approximately 30 m, or the ground area encompassing two rows of solar troughs.

At each power block, biologists slowly walked around the entire perimeter looking for dead and injured birds and bats, and used binoculars to scan interior portions of the powerblock. Beneath ACC units, biologists walked four evenly-spaced transects (approx. 15-m apart) through the gravel. The search area for the power block is defined as the 0.8-km perimeter of each power block, and the area of the interior power block that was available for visual inspection from the periphery.

At each evaporation pond, biologists walked the entire perimeter looking for dead and injured birds and bats on the ground, in the netting, and in the pond below the netting. Binoculars or a spotting scope were used to scan across the top of the netting and the surface of each pond.

The entire length of fenceline (approximately 12 miles) was searched by vehicle. Biologists searched an approximately 1.5 to 2.5 miles (2.4 km) along drivable sections of the outside of the fence, and the remaining 9.5 to 10.5 miles (16.9 km) were surveyed from the inside of the fence (Figures 2 and 3). Travel speed was below five mph while searching.

The gen-tie and distribution lines were each surveyed using a 30-m wide strip transect (i.e., 15 m of ground on either side of the overhead line). A 25% sample of both lines from the Project fence to the Project outer gate located near the Wiley's Well Road rest stop were searched for carcasses. Biologists slowly walked every fourth 300-ft segment of each line, scanning for dead or injured birds or bats within 15 m (49.2 ft) of the transect line. Given the location of the lines relative to the road, detections found in the strip transects below overhead lines could be caused by collision with an overhead line, vehicles along the road, or some combination of both.

Once a carcass was detected, it was then photographed, and data were recorded according to specifications outlined in section 6.7 of the approved Genesis BBCS. Carcasses were then retrieved from their location on the ground, labeled, and placed in a freezer on site.

Suspected cause of death was assigned based on evidence available on the detection, evidence available on the Project infrastructure, and proximity of a detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as "unknown" because it can't be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact

Comentado [FWS13]: Please explain details about how/when the processing occurred in relation to when carcasses were detected – especially with regard to unknown identifications.

Comentado [FWS14]: The Servicde disagrees with this assumption. If it's under the line, the better assumption is that it was caused by the line and a scavenger subsequently discovered the carcass.

(i.e., no evidence of scavenging), located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines), and had evidence of injury on the detection had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is uncertainty associated with cause of death assignments because no events were directly observed.

2.2 Carcass Persistence Trials

Carcass persistence trials were conducted throughout the summer period. Carcasses from three size classes (small [0-100 g], medium [101-999], and large [1000+ g]) were used for trials. Carcass persistence results from small birds were used as a proxy for bat carcass persistence. The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), chukar (*Alectoris chukar*) and older coturnix quail, and the large size class comprised hen mallard (*Anas platyrhynchos*) and hen ring-necked pheasant (*Phasianus colchicus*).

2.2.1 Carcass Persistence Data Collection

To quantify carcass persistence rates, 15 small, 10 medium, and five large carcasses were randomly placed and monitored within the solar field (SCA's and the fence line), and the same number of each size class were placed along the gen-tie and distribution lines, for a total of 60 carcass persistence trials at Genesis during the summer 2015 season, as specified in section 6.5 of the approved Genesis BBCS. Fifteen carcasses within the Project fence (within SCAs and along the fence and perimeter of power blocks) and four carcasses along the gen-tie and distribution lines were monitored using motion-triggered digital trail cameras, while the remaining carcasses were visited on foot, for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality (i.e., a feather spot). Fewer carcasses along the gen-tie and distribution lines were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as "feeding stations", trail cameras were installed five days before specimens were placed, and fake cameras without bias trial carcasses were also placed (eight within the Project fence, and four along the gen-tie and distribution lines). Periodic ground-based checking of carcasses with trail cameras also occured to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera's field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire Project, not just in areas subject to standard searches, and trials were initiated in small numbers on four different dates throughout the spring season.

Comentado [FWS15]: This number of carcasses is extremely low. The Service recommends increasing the number of trial carcasses to help reduce the confidence intervals on estimates.

Comentado [FWS16]: With such a low number of carcasses this is unlikely to be a problem.

2.2.2 Estimating Carcass Persistence Times

Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g. days a carcass is present before being removed) may not be known exactly, but is known to be within a finite range. For example, suppose a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass became unavailable at some point between 7 and 10 days. This carcass would be considered "interval censored". Similarly, if a carcass lasts the entire 30-day trial period, that carcass is "right censored"— it is known that the carcass lasted at least 30 days, but it may have persisted longer. Because carcass persistence data were censored, persistence was analyzed using methods that can accommodate censored data and still produce unbiased estimates of the probability of persistence (Therneau 2015, Thernaur and Grambsch 2000).

Comentado [FWS17]: Please describe the interval that carcasses were checked. Is there a reason that they are not checked daily, particularly during the first week?

Comentado [FWS18]: Please clarify how censored data were analyzed and how the analytical methods affected the results. The referenced book is not available to the reader. How does the method affect the effective search interval?

USGS-developed fatality estimator software (Huso et al. 2012) was used to fit survival models to the censored carcass persistence data. There were four distributions implemented in survival models used to estimate the probability a carcass is unscavenged and available to be found at the end of the search interval (*r)*: exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike's Information Criterion adjusted for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model to censored carcass persistence data.

2.3 Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the summer period. Carcasses from three size classes (small, medium, and large) were used for trials. Searcher efficiency results from small birds were used as a proxy for bat detection. The small size class comprised house sparrows and 2-3 week old coturnix quail, the medium size class comprised rock pigeons, chukar, and older coturnix quail, and the large size class comprised hen mallards and hen ring-necked pheasants.

2.3.1 Searcher Efficiency Data Collection

A total of 60 searcher efficiency trials (15 small birds, 10 medium birds, and five large birds within SCAs, power blocks, and along the perimeter fence, and the same number of each size class along the gen-tie and distribution lines) were placed at the Project during the 2015 summer season, as specified in section 6.4 of the approved Genesis BBCS. Locations for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches. Trials were placed in various vegetation heights and in areas that had different soil and vegetation colors and values to represent the range of conditions under which searches occur. They were placed in all areas where standardized searches occur except the evaporation ponds.

Comentado [FWS19]: The Service proposed larger sample sizes for carcass persistence and searcher efficiency trials. Hence, has this been evaluated as adequate to determine searcher efficiency for a single strata? Please provide justification for small sample size.

2.3.2 Estimating Searcher Efficiency

Comentado [FWS20]: Is searcher efficiency tested for each observer? Please provide these results along with an indication of variation in searcher efficiency across observers.

There were not sufficient data for the summer season to assess whether searcher efficiency differed by Project component (e.g., SCAs/fence/power block [solar field] versus gen-tie/distribution line [overhead lines]), so searcher efficiency was assumed to differ between the two areas and was estimated separately for the solar field and overhead lines. The nearly complete lack of vegetation cover in the solar field suggests that searcher efficiency may be higher in the solar field than along the overhead lines where vegetation cover is greater. If this hypothesis is true, accounting for this difference in searcher efficiency across Project components will be important for producing accurate fatality estimates at the end of the monitoring year.

To evaluate hypotheses regarding differences in carcass detectability among carcass size and visibility classes, logistic regression models were fit to searcher efficiency data and AICc was used to compare models. Models including effects of carcass size (3 classes), season (spring, summer) and visibility index (2 classes) were compared to each other and a null model. The two visibility classes present at the Project site are: easy (defined as ≥ 90% bare ground [BG]; vegetation <6" tall) and moderate (defined as 26-89% BG; vegetation <6" tall). However, within the solar field the moderate visibility class has a very limited spatial extent (approximately 10%) due to management aimed at minimizing vegetation cover and thus, was represented by only two trial carcasses during the reporting period. Rather than eliminating the two carcasses in the moderate class from the analysis of searcher efficiency, we assumed there were no differences in searcher efficiency between the two visibility classes in the solar field this summer, and the set of candidate models for searcher efficiency (within the solar field only) did not include tests of the hypothesis that searcher efficiency varied between visibility classes. The spatial extent of the moderate visibility class in the solar field is roughly equal to its representation in the summer sample of searcher efficiency carcasses (8 of 60 or 13.3%).

Comentado [FWS21]: In the Spring report, this was going to be tested with further samples. Please explain the plan to address potential differences in detectability due to visibility class. We are concerned that injured or stranded birds may seek out areas with more cover as a limited shelter. This could result in bias if the moderate visibility class is not adequately tested for searcher efficiency.

Comentado [FWS22]: This seems to be changing over time. Conditions had changed considerably during our last visit from my previous visit last summer. How is this being tracked? Please explain how changing conditions will be addressed in future surveys.

Once the best model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, *p,* was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from the spring and summer 2015 season, because model selection results indicated no differences in searcher efficiency by season.

2.4 Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots are also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie and distribution lines versus cleared areas beneath SCAs). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where F is the total number of fatalities, C is the number fatalities detected and included in fatality estimation, r is the probability a carcass is unscavenged and available to be found at the end of the search interval, and p is the probability of detecting a carcass (Huso 2010).

All fatality estimates were calculated using the Huso estimator, as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates were used. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

Comentado [FWS23]: Please describe what was bootstrapped and how. The table in the appendix is difficult to understand without a better understanding of the bootstrapping methods.

2.5 Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by WEST avian biologists and operational personnel and were considered “incidental” detections. When found by operational personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the SPUT Avian Injury and Mortality Report Forms June – August 2015. All detections made in search areas were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

3.0 MONITORING RESULTS

3.1 Summary of Avian Detections

During summer 2015, a total of 60 detections (including stranded birds, incidental detections, and bats) of 32 identified species were recorded (Table 2). The most numerous detection of an identified species was of brown-headed cowbird (*Molothrus ater*), and greater roadrunner (*Geococcyx californianus*), each with five detections. Most detections (n = 22, or 36.7% of total detections) occurred at powerblocks (Figures 2, 3; Tables 2, 3, and 4). Twenty-four (40.0%) detections were made during standardized carcass searches and 36 (60.0%) were documented as incidentals with most of these (n = 17) in the powerblock.

Table 2. Number of individual detections (those made during standardized carcass searches and incidentally), by species and component, during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California. SCA = solar collector trough.

Common Name	Scientific Name	SCA	Powerblock	Ponds	Fence	Gen-tie line	Other	Total Count
Avian								
brown-headed cowbird	*Molothrus ater*	2	2	-	-	-	1	5
greater roadrunner	*Geococcyx californianus*	1	3	-	-	1	-	5
unidentified bird (small)	-	3	1	-	1	-	-	5
mourning dove	*Zenaida macroura*	-	1	-	-	2	-	3
unidentified bird (unknown size)	-	1	1	-	1	-	-	3
cinnamon teal	*Anas cyanoptera*	1	-	1	-	-	-	2
red-winged blackbird	Agelaius phoeniceus	1	-	-	1	-	-	2
unidentified duck	-	2	-	-	-	-	-	2
white-winged dove	*Zenaida asiatica*	-	2	-	-	-	-	2
American kestrel	*Falco sparverius*	-	1	-	-	-	-	1
bank swallow	*Riparia riparia*	-	1	-	-	-	-	1
belted kingfisher	*Ceryle alcyon*	-	1	-	-	-	-	1
black phoebe	*Sayornis nigricans*	-	1	-	-	-	-	1
California gull	*Larus californicus*	1	-	-	-	-	-	1
cliff swallow	*Petrochelidon pyrrhonota*	-	1	-	-	-	-	1
common nighthawk	*Chordeiles minor*	-	-	1	-	-	-	1
eared grebe	*Podiceps nigricollis*	-	-	1	-	-	-	1
Eurasian collared-dove	*Streptopelia decaocto*	-	-	-	-	-	1	1
Gambel's quail	*Callipepla gambelii*	-	-	-	1	-	-	1
lesser nighthawk	*Chordeiles acutipennis*	-	-	-	-	1	-	1
loggerhead shrike	*Lanius ludovicianus*	1	-	-	-	-	-	1
long-billed curlew	*Numenius americanus*	1	-	-	-	-	-	1
ruddy duck	*Oxyura jamaicensis*	-	-	1	-	-	-	1
snowy egret	*Egretta thula*	-	1	-	-	-	-	1

Table 2. Number of individual detections (those made during standardized carcass searches and incidentally), by species and component, during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California. SCA = solar collector trough.

Common Name	Scientific Name	SCA	Powerblock	Ponds	Fence	Gen-tie line	Other	Total Count
spotted sandpiper	*Actitis macularia*	1	-	-	-	-	-	1
Townsend's warbler	*Setophaga townsendi*	-	1	-	-	-	-	1
tree swallow	*Tachycineta bicolor*	-	-	1	-	-	-	1
unidentified bird (medium)	-	-	-	1	-	-	-	1
unidentified sandpiper	-	-	1	-	-	-	-	1
western gull	*Larus occidentalis*	1	-	-	-	-	-	1
western kingbird	*Tyrannus verticalis*	-	-	-	-	-	1	1
western sandpiper	*Calidris mauri*	-	-	1	-	-	-	1
yellow-billed cuckoo	*Coccyzus americanus*	-	1	-	-	-	-	1
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	-	-	1	-	-	-	1
yellow warbler	*Setophaga petechia*	-	-	-	-	-	1	1
Bats								
canyon bat	*Pipistrellus hesperus*	-	-	-	-	-	2	2
unidentified bat	-	-	2	-	-	-	-	2
Mexican free-tailed bat	*Tadarida brasiliensis*	-	1	-	-	-	-	1
Total		16	22	8	4	4	6	60

3.2 Temporal Patterns of Avian Detections

The number of detections recorded daily during summer 2015 ranged from zero to five (Figure 5). The period from June 01 to August 30 was characterized by peaks in detections with highs on June 29, July 2, and August 17. The fewest detections in any calendar month was July. The number of detections per day represents those discovered during standardized carcass searches and incidentally.

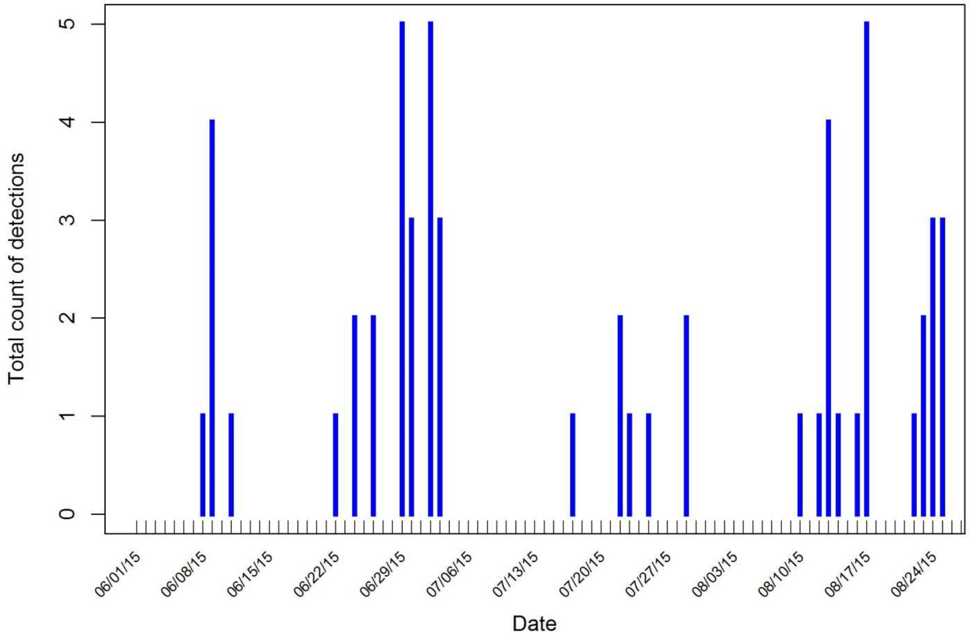


Figure 5. Total number of detections by date during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California.

3.3 Spatial Distribution of Avian Detections

Comentado [FWS24]: Spatial distribution of different taxonomic groups should be discussed, particularly as more data come in.

3.3.1 Detections by Project Component

During summer 2015, detections were documented from Project buildings, the perimeter fence, gen-tie and distribution lines (overhead lines), the power block or ACC unit within the power block, evaporation ponds, and SCAs (Tables 2, 3, and 4). Of the 60 detections within the solar units, 21 (35.0%) were detected in Unit 1, and 29 (48.3%) were detected in Unit 2.

Comentado [FWS25]: This doesn't add up. There were 55 avian detections and 5 bat detections. Should the name of this section be different?

Table 3. Total detections by Project component and detection category during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California.

Project Component	Carcass search	Incidental	Percent of Total
Buildings	0	6	10.0
Fence	4	0	6.7
Overhead lines	0	4	6.7
Ponds	5	3	13.3
Power Block	5	17	36.7
SCA	10	6	26.7
Percent of Total	40.0	60.0	100.0

Table 4. Total detections (including incidentals) by Project component and suspected cause of death during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California.

	Suspected Cause of Death*						
Project Component	**Collision**	**Drowned**	**Entangled**	**Other**	**Predation**	**Unknown**	**% of Total**
Fence	0	0	0	2	0	2	6.7
Other	1	0	0	1	0	4	10.0
Overhead lines/road	2	0	0	1	0	1	6.7
Pond	1	0	2	3	0	2	13.3
Powerblock	7	1	0	8	0	6	36.7
SCA	4	0	0	8	1	3	26.7
% of Total	25.0	1.7	3.3	38.3	1.7	30.0	100.0

* Suspected cause of death was assigned based on evidence available on the detection, evidence available on Project infrastructure, and proximity of detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as "unknown" because it can't be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) and had evidence of injury on the detection had a suspected cause of death attributed to the respective Project component. However, ~~it should be noted that~~in the absence of completed necropsy, there is ~~substantial~~ some uncertainty associated with cause of death assignments because no events were directly observed.

Comentado [FWS26]: Was proximity to project features evaluated? Please describe how this information was utilized. Proximity distances may provide insights into which features may pose the greatest risks.

Comentado [FWS27]: This blanket categorization is problematic. Other visual evidence may allow determination of a suspected cause of death despite evidence of scavenging (i.e., smudge on mirror). The presence of some scavenging should lead to an automatic categorization. Small levels of scavenging can be easily distinguished as not the cause of death (i.e., arthropod scavenging and minimal raven scavenging). Also, other indicators of the cause of mortality should also be considered (dust smudges, species identification, etc). This should not be a blanket categorization.

3.3.2 Feather Spot Detections

Twelve (20.0%) of the 60 detections made during summer 2015 consisted only of feather spots. Along the fence, three of four total detections (75.0%) were feather spots. No detections along the overhead lines and road or the evaporation ponds were feather spots. Three of 22 total detections (13.6%) at the powerblocks were feather spots. Six of 16 total detections (37.5%) at SCA's were feather spots.

3.4 Detections of Stranded Birds

There were no detections of stranded or injured birds during the 2015 summer season.

3.5 Summary of Bat Detections

Five bats were detected during the summer season. Idenitified species included Mexican free-tailed (*Tadarida brasilinesis*; 1), and canyon bat (*Pipistrellus hesperus*; 2; Table 2).

3.6 Carcass Persistence Trials

Data from carcass persistence trial carcasses were available from spring and summer at the solar field and overhead lines (n = 30 each or 120 total). Of these, only seven trials were not in easy visibility habitats, so visibility was not included as a covariate in the carcass removal models. Preliminary analysis using AICc suggested that both season and location (lines vs. solar field) were important predictors of carcass persistence, but when the data were separated by location, season was only important for carcasses within the solar field. Therefore, two carcass persistence models were fitted to two different sets of data: 60 carcasses from spring and summer were used to estimate carcass persistence along overhead lines, and 30 carcasses from summer only were used to estimate carcass persistence within the solar field.

Comentado [FWS28]: The searcher efficiency results suggest that carcass persistence may be lower along the fence.

Using carcass persistence data from 2015 spring and summer seasons as outlined above, survival models were compared for relative quality using the corrected AICc score, as suggested in Huso (2010). The AICc score provides a relative measure of model fit and parsimony among a selection of candidate models. The model with lowest AICc is typically chosen as the "best" model relative to other models tested; however, any model within two AICc points of the best model is considered competitive with the best model (Burnham and Anderson 2004).

For data collected at SCAs, the top two models had ΔAICc values <2. Ultimately, the loglogistic model that included an effect of carcass size was chosen as the most parsimonious of the top models. The chosen model predicted that 52% (45 – 64%) of small carcasses, 92% (76 – 96%) of medium carcasses, and 100% of large carcasses persisted for a standard 21-day search interval. Mean removal time for small carcasses in the SCAs was 8.0 days, 35.1 days for medium carcasses, and was not estimated for large carcasses given the nearly perfect persistence rate (no removal was observed; Figure 6).

Comentado [FWS29]: Please provide the median removal time along with a figure showing the removal curve produced by the model.

For data collected along the overhead lines, the top six models had ∆AICc values <2. Ultimately the lognormal model with an effect of carcass size was chosen as the most parsimonious top model. The chosen model predicted that 14% (9 – 20%) of small carcasses, 59% (42 – 74%) of medium carcasses, and 41% (26 – 58%) of large carcasses persisted for a standard 21-day search interval. Mean removal time along overhead lines for small carcasses was 0.8 days, for medium carcasses was 12.8 days, and for large carcasses was 4.6 days (Figure 6).

Comentado [FWS30]: See above.

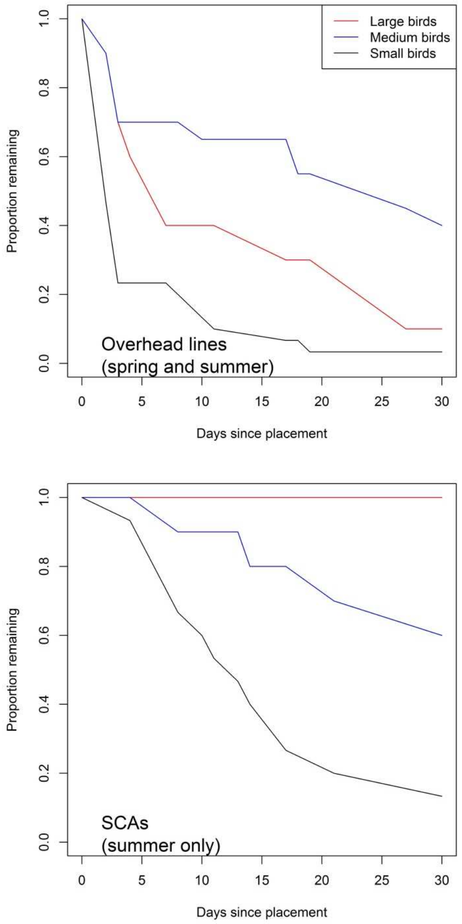


Figure 6. Proportion of trial carcasses remaining as a function of days since placement and carcass size class during the summer 2015 season at the Genesis Solar Energy Project, Riverside County, California. Modeling of carcass persistence data from overhead lines suggested no effect of season, so sample size used to produce the overhead lines panel was n = 30, 20, and 10 for small, medium, and large size classes, respectively. Modeling of carcass persistence data from the solar field (SCAs) suggested an effect of season, so sample size used to produce the SCA panel was n = 15, 10, and 5 for small, medium, and large size classes, respectively.

3.7 Searcher Efficiency Trials

During the 2015 summer season, a total of 60 searcher efficiency trials (30 small, 20 medium, and 10 large birds) were placed at the Project. Overall, 21 trials were placed in the SCAs, six trials were placed along perimeter fences (inner and outer perimeters), and three trials were placed at power blocks (along perimeter and beneath ACC units). Fifteen trials were placed along the gen-tie and 15 were placed along the distribution lines. Fifty-one trials were available to be found, and nine trials disappeared before the searcher efficiency trial began (three in the SCAs, four along the fence, one along the distribution line, and one along the gen-tie line).

Comentado [FWS31]: This section is difficult to follow. It's not clear what was done and how the "unavailability of carcasses" is affecting the results. Please clarify and provide a suggestion on how to address the carcass removal problem.

Comentado [FWS32]: How was this broken down by project component, visibility categories and size classes? Please provide a table to make it easier to understand to the numbers in the text.

Comentado [FWS33]: Only three at the power blocks, combined? This is an issue given all of the incidentals at these components.

Con formato: Resaltar

Con formato: Resaltar

Con formato: Resaltar

Comentado [FWS34]: How much time elapsed between setting out the carcasses and the trials. This seems like another issue that is not corrected for.

What sizes were the nine that disappeared?

Searcher efficiency may be high, but it persistence is not, then data are being missed/lost. It seems impossible to determine if the carcass that were missing disappeared before or after the searcher did their searches.

There seems to be differential carcass persistence that may be affecting the searcher efficiency trials.

In the solar field (SCAs + fence + powerblocks), the null model was chosen as the best model to estimate searcher efficiency, suggesting no effect of carcass size, season, or visibility class. Thus, data from spring and summer searcher efficiency trials, all carcass class sizes, and both visibility classes were pooled for the following estimate of searcher efficiency. Searcher efficiency rate in the solar field was 91.8% (86.0 – 98.0%), or 45 found of 49 available to be found.

Con formato: Resaltar

Along overhead lines, the model that included an effect of carcass size, but not season or visibility class, was chosen as the best model. Thus, data from spring and summer trials and both visibility classes were pooled for the following estimates of searcher efficiency along overhead lines: 53.6% for small birds (39.0 – 68.0%; 15 found of 28 available to be found), 100% for medium birds (19 found of 19 available), and 100% for large birds (10 found of 10 available). Although carcass size influenced searcher efficiency, searcher efficiency was relatively high over all carcass size classes (77.1%).

Comentado [FWS35]: Does this make sense statistically?

Con formato: Resaltar

Comentado [FWS36]: The highlighted numbers don't add up.

3.8 Fatality Estimates

Fatality estimates were calculated separately for each component (SCAs, power blocks, fence, evaporation ponds, and overhead lines/road). Ultimately, no detection was excluded from the fatality analysis because it was estimated to be older than the 21-day search interval (Huso 2010), and 16 detections were excluded because they were found outside standardized search areas. Of the 36 detections that were found incidentally, 14 were in a standardized search area and included in the fatality analysis, so 22 incidental detections were excluded from the fatality analysis. However, all detections made during summer are reported in Table 2.

Comentado [FWS37]: Please provide an additional summary tables with the following information for each component and for the entire facility: carcasses detected, estimated fatalities; 90% CI. An additional table with the same information for each size category is also requested.

Using the Huso (2010) fatality estimator model, during the summer period 2015, there were an estimated total 100 carcasses (90% CI: 81 - 145) at the Project. Of these, 53 carcasses (53%) were estimated for the SCAs, 8 carcasses (8%) were estimated for the fence, 9 carcasses (9%) were estimated for evaporation ponds, 23 carcasses (23%) were estimated for power blocks, and 7 carcasses (7%; CI: 6 – 21) were estimated for the overhead lines and project road. An estimated 93 (93%; CI: 66-126) carcasses (~~0.0~~50/1000 acres, 0.37/nameplate MW) occurred for all components associated with both solar units (SCAs, power block, evaporation ponds, and along the perimeter fence, combined). A complete list of estimates for each Project component and carcass size class with confidence intervals is presented in Appendix B.

Comentado [FWS38]: Given the size of utility scale projects "per 1000 acres seems more appropriate.

4.0 DISCUSSION

The 2015 summer season represented the second season of standardized monitoring at Genesis per the BBCS. Searcher efficiency trials and carcass removal trials were conducted concurrently at the SCAs, power blocks, fencelines, and along the gen-tie and distribution lines. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. Although these estimates were produced from a statistically robust sample, only limited inference may be drawn from a single season of data. These results should be considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. As more data are collected throughout the monitoring year (and additional quality assurance/quality control measures occur, for example characterizing feather spots to species or size class), data from all seasons may be pooled. At that time, data will be tested for seasonal differences retrospectively using an information-theoretic approach, but because seasonal estimates will be produced from the much larger annual data set, they may differ from what is reported here because they are based on a larger, more informative sample.

Comentado [FWS39]: This is counter-intuitive. If there are inadequate samples to give a seasonal estimate for searcher efficiency, how will this be possible from the complete annual dataset. The number of carcasses should probably be increased based on a power analysis, so that seasonal estimates can be completed.

4.1 Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Thus, rates of carcass persistence reported here should be interpreted cautiously as they may change over the coming months.

Searcher efficiency was influenced by carcass size, but it is not yet clear if there may be an effect of habitat visibility class due to limited sample sizes. In the SCA's, searcher efficiency was high regardless of carcass size and this is likely influenced by the limited vegetation cover beneath solar troughs. Beneath overhead lines outside the Project fence vegetation cover is higher, but our analysis did not support the hypothesis that visibility class is a factor in searcher efficiency along the lines. Carcass size influenced searcher efficiency, but searcher efficiency was relatively high over all carcass size classes (77.1%).

Comentado [FWS40]: This supports putting out more trials.

Searcher efficiency trials for this Project will be repeated seasonally. The desert landscape in which this Project is located generally changes little with the seasons, save for brief periods following winter and spring rains when floods may occur and blooming plants may flourish. A recent meta-analysis involving data from more than 70 wind-energy projects suggested that including habitat visibility class as a predictive variable generally eliminated any otherwise

Comentado [FWS41]: Summer monsoons.

apparent seasonal effects on searcher efficiency (Smallwood 2013). Further, the possibility exists that searcher efficiency varies seasonally in some cover types but not others. Data from searcher efficiency trials conducted over the coming seasons will therefore continue to be tested for effects of habitat visibility class rather than effects of season.

4.2 Distribution of Fatalities and Fatality Estimates

The number of detections was highest during the early and late summer monitoring period and lowest during July. However, because this report includes detections made during carcass searches and incidental detections reported by Genesis site personnel between searches, patterns may reflect the 21-day search interval during summer more than any patterns in bird activity at the Project.

Comentado [FWS42]: This suggests that the Spring and Fall search periods are too short and the migratory seasons extend into the Summer search period. The low carcass persistence suggests that the search interval should be weekly year round to provide better estimates of carcass persistence.

Composition of summer detections included avian species from 13 guilds. No single guild comprised a large number of detections: the most common was blackbirds/orioles (eight detections or 14.5% of all avian detections). Shorebirds and waterbirds/waterfowl were represented by six (10.9%) and seven (12.7%) detections, respectively. Summer was the first season in which bats were detected.

Con formato: Derecha

Detections attributed to an unknown cause accounted for approximately 30% of all detections during the 2015 summer season, and the distribution of the unknown cause detections varied by project component with the highest percentage of unknowns (66.7%, or 4 of 6 total detections) occurring in association with Project components that are not included in standardized carcass searches (e.g., buildings). Of the 18 detections attributed to an unknown cause, 4 (22.2%) were feather spots. Determining a cause of mortality from a feather spot is challenging because there is rarely visible evidence available on which to determine a cause of death. Thus, feather spots with an unknown cause of mortality could be encountered anywhere birds occur, and an unknown cause of a sizeable proportion of the carcasses is not unique to the Project. Further, the presence of feather spots among the detections for the Project may inflate the fatality estimate based on the potential for multiple feather spots resulting from one fatality to be counted separately if feathers are blown around the site or scattered by predators (e.g., plucking by ravens), feather spots resulting from predation not associated with the facility, or other causes. However, feather spots are included in the analysis here to provide a more conservative estimate of fatality.

Comentado [FWS43]: What fraction of these unknown detections are feather spots?

Comentado [FWS44]: We don't agree with this statement. This is unknown. Feather spots may be more mobile, but as far as I know there have been no studies on whether they "multiply" and cause bias. If there has, please provide a reference. It is possible that feather spots could accumulate along fences, but in general, they are just as likely to migrate into a survey area as they are to leave. If this is a significant problem, then I recommend shorter search intervals and more complete coverage of the project site.

5.0 LITERATURE CITED

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in 2nd International Symposium on Information Theory (B. N. Petran and F. Csaki, Eds.). Akademiai Kiado, Budapest, Hungary.

Brigham, R. M., Janet Ng, R. G. Poulin and S. D. Grindal. 2011. Common Nighthawk (Chordeilesminor), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/213 doi:10.2173/bna.213

Brown, Charles R. and Mary B. Brown. 1995. Cliff Swallow (Petrochelidon pyrrhonota), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/149 doi:10.2173/bna.149

Brua, Robert B. 2002. Ruddy Duck (Oxyura jamaicensis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/696 doi:10.2173/bna.696

Burnham, K.P., and D.R. Anderson. 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociological Methods & Research 33: 261-304.

Cullen, S. A., J. R. Jehl Jr. and G. L. Nuechterlein. 1999. Eared Grebe (Podiceps nigricollis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/433 doi:10.2173/bna.433

Evans, W.R., and D.K. Mellinger. 1999. Monitoring grassland birds in nocturnal migration. Studies in Avian Biology 19: 219-229.

Gamble, Lawrence R. and Timothy M. Bergin. 2012. Western Kingbird (Tyrannus verticalis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/227 doi:10.2173/bna.227

Gammonley, James H. 2012. Cinnamon Teal (Anas cyanoptera), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/209 doi:10.2173/bna.209

Gee, Jennifer, David E. Brown, Julie C. Hagelin, Mark Taylor and Jill Galloway. 2013. Gambel's Quail (Callipepla gambelii), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:doi:10.2173/bna.321

Hughes, J. M. 2011. Greater Roadrunner (Geococcyx californianus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/244 doi:10.2173/bna.244

Hughes, J. M. 2015. Yellow-billed Cuckoo (Coccyzus americanus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/418 doi:10.2173/bna.418

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. doi: 10.1002/env.1052

Huso, M., N. Som, and L. Ladd. 2012. Fatality estimator user’s guide: U.S. Geological Survey Data Series 729, 22 pp.

Kelly, Jeffrey F., Eli S. Bridge and Michael J. Hamas. 2009. Belted Kingfisher (Megaceryle alcyon), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/084 doi:10.2173/bna.84

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A New Method to Determine Bird and Bat Fatality at Wind Energy Turbines from Carcass Searches. Wildlife Biology 17: 350-363.

Latta, Steven C. and Michael E. Baltz. 2012. Lesser Nighthawk (Chordeiles acutipennis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/314 doi:10.2173/bna.314

Lowther, Peter E. 1993. Brown-headed Cowbird (Molothrus ater), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/047 doi:10.2173/bna.47

Lowther, P. E., C. Celada, N. K. Klein, C. C. Rimmer and D. A. Spector. 1999. Yellow Warbler (*Setophaga petechia*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/454 doi:10.2173/bna.454

Manly, B.F.J.1997. Randomization, Bootstrap and Monte Carlo Methods in Biology. Second Edition. CRC Press, LLC, Boca Raton, FL., 455 pp.

Murray, J. 2004. Nocturnal flight call analysis as a method for monitoring density and species composition of migratory songbirds (Order Passeriformes) across southern Vancouver Island, British Columbia in 2004. Rocky Point Bird Observatory, 16 pp.

Newton, I. 2008. The Migration Ecology of Birds. Academic Press, London.

Otis, David L., John H. Schulz, David Miller, R. E. Mirarchi and T. S. Baskett. 2008. Mourning Dove (*Zenaida macroura*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/117 doi:10.2173/bna.117

Parsons, Katharine C. and Terry L. Master. 2000. Snowy Egret (Egretta thula), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/489 doi:10.2173/bna.489

Pierotti, Raymond J. and Cynthia A. Annett. 1995. Western Gull (Larus occidentalis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/174 doi:10.2173/bna.174

Reed, J. Michael, Lewis W. Oring and Elizabeth M. Gray. 2013. Spotted Sandpiper (Actitismacularius), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/289

Romagosa, Christina Margarita. 2012. Eurasian Collared-Dove (*Streptopelia decaocto*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/630 doi:10.2173/bna.630

Schwertner, T. W., H. A. Mathewson, J. A. Roberson, M. Small and G. L. Waggerman. 2002. White-winged Dove (Zenaida asiatica), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/710 doi:10.2173/bna.710

Smallwood, John A. and David M. Bird. 2002. American Kestrel (*Falco sparverius*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/602 doi:10.2173/bna.602

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine-cause avian fatality estimates. Journal of Wildlife Management 74(5): 1089-1096.

Smallwood, K. S. 2013. Comparing bird and bat ratality-rate Estimates among North American wind-energy projects. Wildlife Society Bulletin 37(1): 19-33.

Therneau, T. 2015. _A Package for Survival Analysis in S. version 2.38, <URL: http://CRAN.R-project.org/package=survival>.

Therneau, T.M. and P. M. Grambsch 2000. Modeling Survival Data: Extending the Cox Model. Springer, New York. ISBN 0-387-98784-3.

Twedt, Daniel J. and Richard D. Crawford. 1995. Yellow-headed Blackbird (Xanthocephalusxanthocephalus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/192 doi:10.2173/bna.192

Winkler, David W., Kelly K. Hallinger, Daniel R. Ardia, R. J. Robertson, B. J. Stutchbury and R. R. Cohen. 2011. Tree Swallow (Tachycineta bicolor), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/011 doi:10.2173/bna.11

Winkler, David W. 1996. California Gull (Larus californicus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/259 doi:10.2173/bna.259

Wolf, Blair O. 1997. Black Phoebe (Sayornis nigricans), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/268 doi:10.2173/bna.268

Yasukawa, Ken and William A. Searcy. 1995. Red-winged Blackbird (Agelaius phoeniceus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/184 doi:10.2173/bna.184

Yosef, Reuven. 1996. Loggerhead Shrike (Lanius ludovicianus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/231 doi:10.2173/bna.231

Appendix A. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during summer (June 01 – August 30) 2015

Table A-1. Weather conditions and body weights associated with avian detections estimated to be less than 24 hours old during summer 2015 at Genesis Solar Energy Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hrs)	Species	Weight (g)	Weather Summary for Preceding 24 hrs
081315-TRES-EVAPPOND-N-01	8/13/2015	8-24hrs	tree swallow	13	6-16 MPH SE wind, Temp 109F, waning crescent moon. Clear through 1pm 8/12, partly to mostly cloudy through 9pm, then clear.
061115-GRRO-GENTIE16-1	6/11/2015	8-24hrs	greater roadrunner	240	-
060915-ECDO-OMBUILDING-STAIRCASE-1	6/9/2015	0-8hrs	Eurasian collared-dove	150	-
062615-GRRO-1-W-G/H-62-01	6/26/2015	8-24hrs	greater roadrunner	165	AVG WIND SPD: 11MPH, MAX WIND SPD: 17MPH, WIND DIRECTION: SOUTH, CLEAR SKY, MOON PHASE: WANING GIBBOUS
062915-SNEG-2-POWERBLOCK-INSIDE-02	6/29/2015	8-24hrs	snowy egret	-	MAX WIND SPD. 17MPH, AVG WIND SPD: 8MPH, DIRECTION: S/SW, CONDITIONS: CLEAR WITH THUNDERSTORMS, MOON PHASE: WAXING GIBBOUS
062215-CAGU-1-E-C/D-53-1	6/22/2015	8-24hrs	California gull	350	HIGH TEMP: 107.1, LOW TEMP: 70.9, MAX WIND SPD: 8.3MPH, AVG WIND SPD: 7.6MPH, DIRECTION: SOUTH, CLEAR SKY, MOON PHASE: WAXING CRESENT
072915-LENI-GENTIE-13-01	7/29/2015	0-8hrs	lesser nighthawk	43	wind S @ 7-14 mph, waxing gibbous moon, clear, 10 mi visibility
081715-MODO-2-POWERBLOCK-02	8/17/2015	8-24hrs	mourning dove	-	9-21mph S wind. Waxing crescent moon, clear through 12 noon, partly to mostly cloudy through 11pm then clear
081715-MODO-GENTIE-17-01	8/17/2015	8-24hrs	mourning dove	-	9-21mph S wind, waxing crescent moon, clear through 12 noon, partly to mostly cloudy through 11pm, then clear
082815-BHCO-1-W-G/H-44-03	8/28/2015	8-24hrs	brown-headed cowbird	21	5-21MPH SSW wind, waxing gibbous moon, thunderstrom in the area
082215-UNBA-ADMINBUILDING-01	8/22/2015	0-8hrs	canyon bat	2	12-20 MPH S wind, waxing crescent moon, clear
082415-UNBA-ASSEMBLYLINEBUILDING-FREEZER-02	8/24/2015	8-24hrs	canyon bat	-	8-14 MPH S-SW wind, waxing gibbous moon, partly cloudy to clear to cloudy
082315-TOWA-2-POWERBLOCK-OVERFLOWPUMP-B-01	8/23/2015	8-24hrs	Townsend's warbler	6	12-20 S wind, temp 107, waxing crescent moon, clear until 1500, partly cloudy until 2000, then clear until bird found
082315-MODO-GENTIE-10-03	8/23/2015	8-24hrs	mourning dove	99	12-20mph S wind, temp 107, waxing crescent moon, clear until 1500,

082815-CITE-EVAPPOND-N-01	8/28/2015	8-24hrs	cinnamon teal	345	partly cloudy until 2000, then clear until bird found 5-21 mph SSW wind, waxing gibbous moon, thunderstorm in area

Appendix B. Correction Factors and Bird Fatality Rates at the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

Table B-1. Correction factors and estimated numbers of carcasses at the Genesis Solar Energy Generation Facility during summer of 2015. *Counts of fatalities on the power block and ponds have no variance because all components at the facility were searched.

	Small birds		Medium birds		Large birds		Unknown size		Bats	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Proportion of area searched by component										
Overhead lines	0.25	-	0.25	-	0.25	-	0.25	-	0.25	-
Fence	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
SCAs	0.30	-	0.30	-	0.30	-	0.30	-	0.30	-
Powerblock	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
Ponds	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
Searcher efficiency by component and visibility class										
Overhead lines	0.54	0.39 - 0.68	1.00	-	1.00	-	0.54	0.39 - 0.68	0.54	0.39 - 0.68
All other components	0.92	0.86 - 0.98	0.92	0.86 - 0.98	0.92	0.86 - 0.98	0.92	0.86 - 0.98	0.92	0.86 - 0.98
Average probability of carcass persistence to the next search										
Overhead lines	0.140	0.09 - 0.2	0.588	0.42 - 0.74	0.409	0.26 - 0.58	0.140	0.09 - 0.2	0.143	0.09 - 0.21
Fence	0.462	0.38 - 0.56	0.940	0.84 - 0.99	1	-	0.462	0.33 - 0.61	0.462	0.37 - 0.63
SCAs	0.520	0.45 - 0.64	0.925	0.76 - 0.96	1	-	0.520	0.34 - 0.6	0.520	0.37 - 0.63
Powerblock	0.504	0.4 - 0.56	0.851	0.79 - 0.9	1	-	0.504	0.33 - 0.58	0.504	0.41 - 0.56
Ponds	0.504	0.42 - 0.56	0.851	0.73 - 0.93	1	-	0.504	0.37 - 0.64	0.504	0.37 - 0.63
Carcass counts by component										
Overhead lines	0	-	1	0 - 3	0	-	0	-	0	-
Fence	2	0 - 6	1	0 - 3	0	-	1	0 - 3	0	-
SCAs	5	2 - 9	3	0 - 6	0	-	1	0 - 3	0	-
Powerblock*	3	-	6	-	0	-	1	-	3	-
Ponds*	3	-	2	-	0	-	0	-	0	-
Average Probability of Carcass Availability and Detected (Searcher efficiency * average probability of carcass persistence)										
Overhead lines	0.08	0.04 - 0.12	0.59	0.42 - 0.74	0.41	0.26 - 0.58	0.08	0.04 - 0.12	0.08	0.04 - 0.12
Fence	0.42	0.35 - 0.52	0.86	0.76 - 0.94	0.92	0.86 - 0.98	0.42	0.3 - 0.57	0.42	0.34 - 0.59
SCAs	0.48	0.41 - 0.59	0.85	0.69 - 0.9	0.92	0.86 - 0.98	0.48	0.31 - 0.56	0.48	0.34 - 0.59
Powerblock	0.46	0.36 - 0.52	0.78	0.71 - 0.86	0.92	0.86 - 0.98	0.46	0.3 - 0.54	0.46	0.37 - 0.52
Ponds	0.46	0.38 - 0.53	0.78	0.66 - 0.88	0.92	0.86 - 0.98	0.46	0.34 - 0.59	0.46	0.34 - 0.59
Adjusted Fatality Estimates (Fatalities /Season; values in italics are considered unreliable due to low counts of carcasses: carcass count / (proportion of area searched * average probability of carcass availability and detected))**										
Overhead lines	0	-	*6.81*	*5.62 - 21.03*	0	-	0	0	0	0

Comentado [FWS45]: This table/appendix requires more explanation.

Comentado [FWS46]: Only 100% of the power block perimeter was searched. Other areas were scanned using binoculars and unless visibility is excellent, this area should not be treated as 100% searched.

Table B-1. Correction factors and estimated numbers of carcasses at the Genesis Solar Energy Generation Facility during summer of 2015. *Counts of fatalities on the power block and ponds have no variance because all components at the facility were searched.

	Small birds		Medium birds		Large birds		Unknown size		Bats	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Fence	*4.72*	*3.92 - 14.57*	*1.16*	*1.07 - 3.61*	0	-	*2.36*	*1.85 - 8.26*	0	0
SCAs	*34.39*	*12.18 - 56.61*	*11.61*	*3.98 - 25.48*	0	-	*6.88*	*6.15 - 24.15*	0	0
Powerblock	*6.48*	*5.82 - 8.27*	7.67	7.01 - 8.49	0	-	*2.16*	*1.84 - 3.3*	*6.48*	*5.74 - 8.13*
Ponds	*6.48*	*5.82 - 8.27*	*2.56*	*2.34 - 2.83*	0	-	0	-	0	-

Comentado [FWS45]: This table/appendix requires more explanation.

Comentado [FWS46]: Only 100% of the power block perimeter was searched. Other areas were scanned using binoculars and unless visibility is excellent, this area should not be treated as 100% searched.

Appendix C. Detailed Areas of Standardized Searches and Carcass Locations along the Distribution and Generation Tie Lines of the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

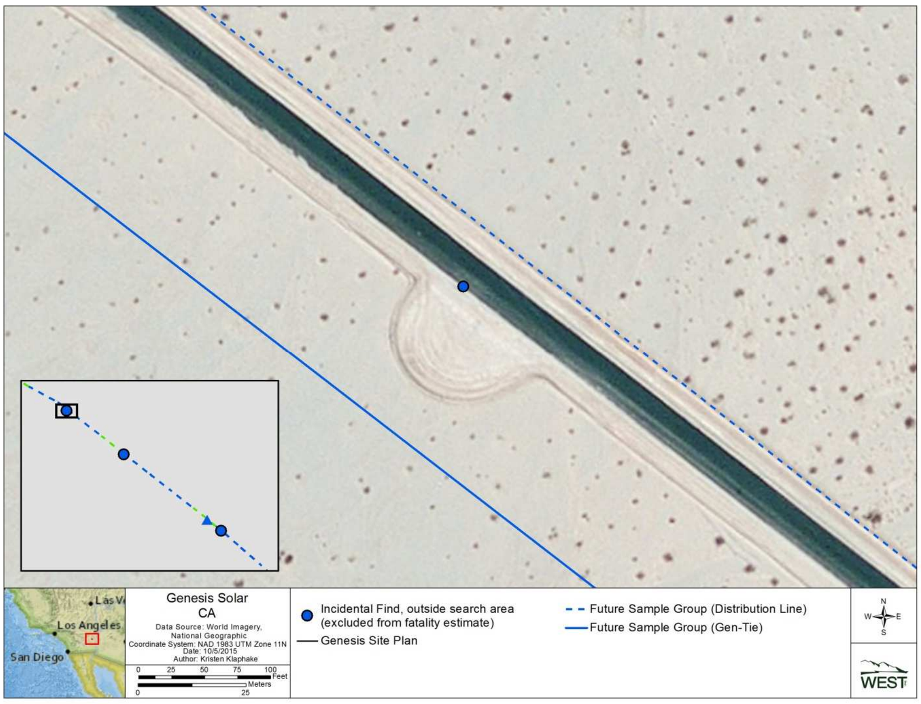


Figure C-1. Detailed map sections of detections along the distribution and generation tie lines of the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

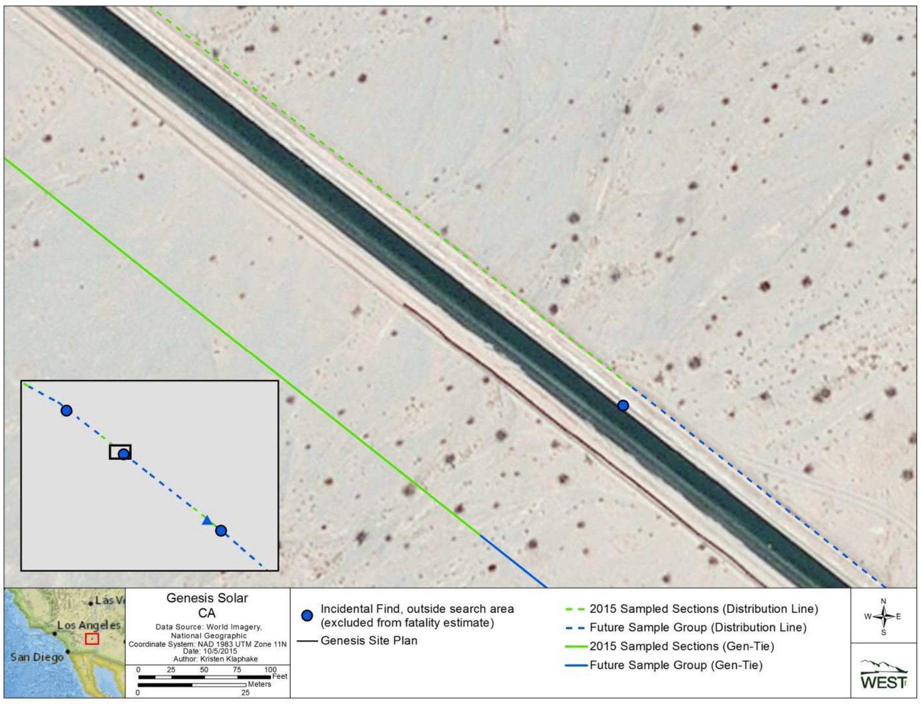


Figure C-2. Detailed map sections of detections along the distribution and generation tie lines of the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

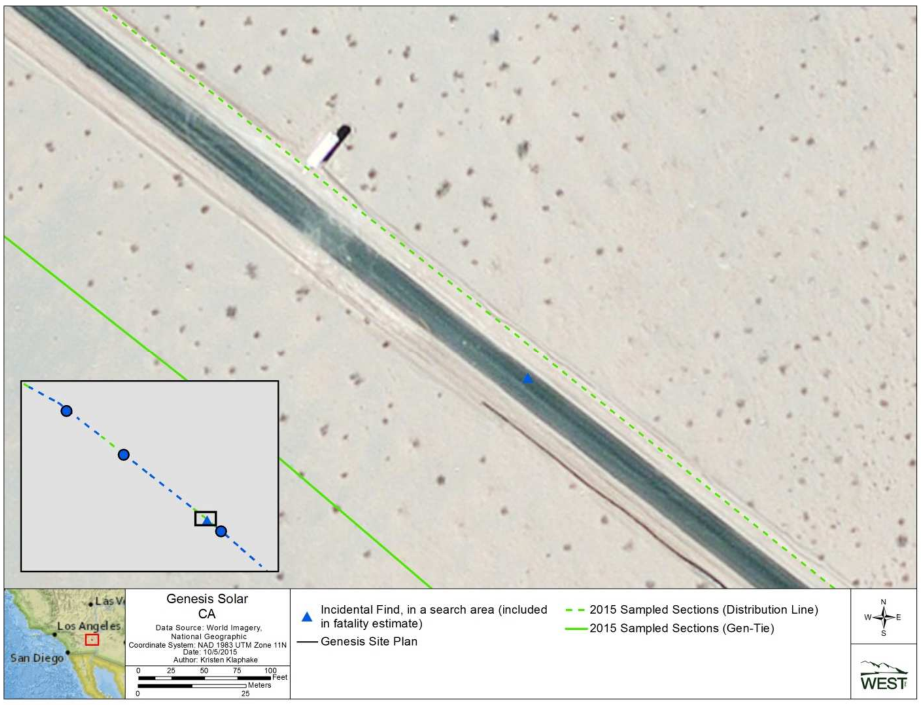


Figure C-3. Detailed map sections of detections along the distribution and generation tie lines of the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

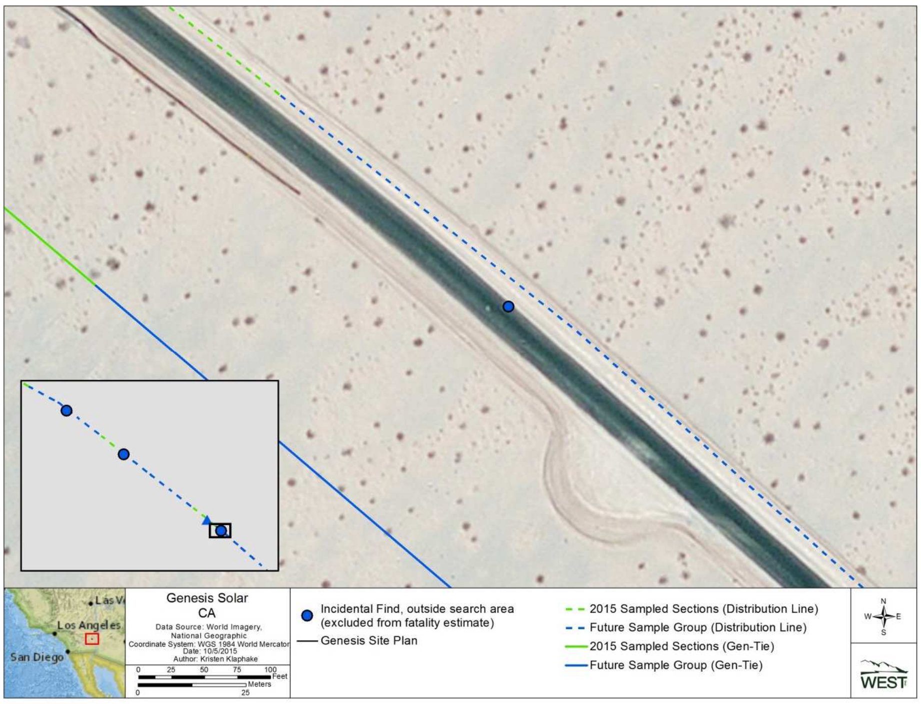


Figure C-4. Detailed map sections of detections along the distribution and generation tie lines of the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

Appendix D. Individual detections made during standardized carcass searches and incidentally, by species, during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California. SCA = Solar collector trough.

Table D-1. Number of individual detections (those made during standardized carcass searches and incidentally), by species, during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California. SCA = Solar collector trough.

Common Name	Scientific Name	Migration Behavior*	Guild	Count	Project Component
American kestrel	*Falco sparverius*	resident	Falcons	1	Powerblock
bank swallow	*Riparia riparia*	diurnal	Swallows	1	Powerblock
belted kingfisher	*Ceryle alcyon*	nocturnal	Kingfishers	1	Powerblock
black phoebe	*Sayornis nigricans*	variable	Flycatchers	1	Powerblock
brown-headed cowbird	*Molothrus ater*	diurnal	Blackbirds/Orioles	1	Other
				2	Powerblock
				2	SCA
California gull	*Larus californicus*	diurnal	Shorebirds	1	SCA
canyon bat	*Pipistrellus hesperus*	nocturnal	Bats	2	Other
cinnamon teal	*Anas cyanoptera*	nocturnal	Waterbirds/Waterfowl	1	Pond
				1	SCA
cliff swallow	*Petrochelidon pyrrhonota*	diurnal	Swallows	1	Powerblock
common nighthawk	*Chordeiles minor*	variable	Goatsuckers	1	Pond
eared grebe	*Podiceps nigricollis*	nocturnal	Waterbirds/Waterfowl	1	Pond
Eurasian collared-dove	*Streptopelia decaocto*	resident	Doves/Pigeons	1	Other
Gambel's quail	*Callipepla gambelii*	resident	Upland Game Birds	1	Fence
greater roadrunner	*Geococcyx californianus*	resident	Cuckoos	1	Overhead lines
				3	Powerblock
				1	SCA
lesser nighthawk	*Chordeiles acutipennis*	diurnal	Goatsuckers	1	Overhead lines
loggerhead shrike	*Lanius ludovicianus*	diurnal	Shrikes	1	SCA
long-billed curlew	*Numenius americanus*	nocturnal	Shorebirds	1	SCA
Mexican free-tailed bat	*Tadarida brasiliensis*	nocturnal	Bats	1	Powerblock
mourning dove	*Zenaida macroura*	variable	Doves/Pigeons	2	Overhead lines
				1	Powerblock
red-winged blackbird	Agelaius phoeniceus	diurnal	Blackbirds/Orioles	1	Fence
				1	SCA
ruddy duck	*Oxyura jamaicensis*	nocturnal	Waterbirds/Waterfowl	1	Pond

Table D-1. Number of individual detections (those made during standardized carcass searches and incidentally), by species, during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California. SCA = Solar collector trough.

Common Name	Scientific Name	Migration Behavior*	Guild	Count	Project Component
snowy egret	*Egretta thula*	nocturnal	Waterbirds/Waterfowl	1	Powerblock
spotted sandpiper	*Actitis macularia*	both	Shorebirds	1	SCA
Townsend's warbler	*Setophaga townsendi*	unresolved	Warblers	1	Powerblock
tree swallow	*Tachycineta bicolor*	diurnal	Swallows	1	Pond
unidentified bat	-	-	Bats	2	Powerblock
unidentified bird (medium)	-	-	Unidentified Birds	1	Pond
unidentified bird (small)	-	-	Unidentified Birds	1	Fence
				1	Powerblock
				3	SCA
unidentified bird (unknown size)	-	-	Unidentified Birds	1	Fence
				1	Powerblock
				1	SCA
unidentified duck	-	-	Waterbirds/Waterfowl	2	SCA
unidentified sandpiper	-	-	Shorebirds	1	Powerblock
western gull	*Larus occidentalis*	resident	Shorebirds	1	SCA
western kingbird	*Tyrannus verticalis*	diurnal	Flycatchers	1	Other
western sandpiper	*Calidris mauri*	both	Shorebirds	1	Pond
white-winged dove	*Zenaida asiatica*	variable	Doves/Pigeons	2	Powerblock
yellow-billed cuckoo	*Coccyzus americanus*	nocturnal	Cuckoos	1	Powerblock
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	diurnal	Blackbirds/Orioles	1	Pond
yellow warbler	*Setophaga petechia*	nocturnal	Warblers	1	Other
Total				**60**	

* See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in Birds of North America (BNA) Online (http://bna.birds.cornell.edu/bna/); where information on migration behavior was lacking in BNA accounts, Evans and Mellinger (1999), Newton (2008), or Murray (2004) were used.

ABENGOA SOLAR
Mojave Solar LLC
11500 West 13th Avenue Phone: 303-928-8500
Lakewood, CO. 80215 Fax: 303-233-2738

Subject:	**09-AFC-5C**
Condition Number:	**BIO 17**
Description:	**Bird Monitoring Study - Draft**
Submittal Number:	**BIO17-00-01**

12.16.2013

Dale Rundquist, CPM
(09-AFC-5C)
California Energy Commission
1516 Ninth Street (MS-2000)
Sacramento, CA 95814
drundqui@energy.state.ca.us

Dear Mr. Rundquist,

Attached is a draft Bird Monitoring Study plan.

Please let me know if you have any questions.

Trey Bassette

ABENGOA SOLAR LLC
42134 Harper Lake Rd
Hinkley, CA 94104
Cell:720-289-2938
Office: 636-728-0508 x86250

Draft
Bird Monitoring Study
Mojave Solar Project
San Bernardino County, California

Mojave Solar LLC
13911 Park Avenue, Suite 206
Victorville, California 92392

December 2013

Table of Contents

Section **Page**

List of Appendices

List of Figures

Figure **Page**

List of Tables

Table **Page**

1.0 Introduction

This draft Bird Monitoring Study was prepared for the Mojave Solar Project (MSP or project) to address potential impacts to birds from operation of the project, and to be in compliance with the California Energy Commission's (CEC) Conditions of Certification (COC). Specifically, COC BIO-17 states that the project owner shall prepare and implement a study to monitor the death and injury of birds from collisions with facility features such as reflective mirror-like surfaces, from heat, and from bright light from concentrated sunlight (CEC, 2010). This study, therefore, addresses potential avian mortalities during MSP operation.

The U.S. Fish and Wildlife Service (USFWS) established methods and guidelines for monitoring bird mortalities at solar power facilities (Nicolai et al., 2011). These methods and guidelines are incorporated into this study and modified to establish a protocol for data acquisition and carcass collection that achieves a 100 percent study area survey.

1.1 Purpose

The purpose of this study is to outline a scientific and repeatable method to monitor the potential impact of parabolic trough solar technology on birds. Therefore, the methods presented in this plan will be used in a controlled study of deaths of and injuries to birds as a result of their interaction with project features. Replicable data acquisition procedures and carcass collection protocols, including a proposed schedule of carcass searches are outlined in this plan. These measures are designed to conform to the requirements of COC BIO-17:

> COC BIO-17: The project owner shall prepare and implement a Bird Monitoring Study to monitor the death and injury of birds from collisions with facility features such as reflective mirror-like surfaces and from heat, and bright light from concentrating sunlight. The study design shall be approved by the CPM in consultation with CDFG and USFWS, and shall be incorporated into the project's BRMIMP and implemented. The Bird Monitoring Study shall include detailed specifications on data and carcass collection protocol and a rationale justifying the proposed schedule of carcass searches. The study shall also include seasonal trials to assess bias from carcass removal by scavengers as well as searcher bias.

This study includes adaptive management approaches to reduce the potential for negative impacts due to changing situations (e.g. seasonal fluctuations in bird use). Once approved by the CEC's Compliance Project Manager (CPM) and Staff, in consultation with the California Department of Fish and Wildlife [CDFW] and USFWS, this study will be implemented and incorporated into the project's Biological Resources Mitigation Implementation and Monitoring Plan (BRMIMP) (CEC, 2010).

1.2 Project Background

The MSP is a solar electric generating facility located in San Bernardino County, California, approximately 20 miles west of Barstow, California (Figure 1). Site access is from Harper Lake Road off of Highway 58. The project sits on private property historically occupied by the Lockhart Ranch complex that once served as an agricultural and cattle center.

The MSP uses solar parabolic trough technology to warm a heat transfer fluid (HTF) which converts water to steam to power a steam turbine electrical generator at twin solar fields—Alpha, approximately 950 acres, and Beta, approximately 815 acres. Solar fields comprise approximately 70% of the total project area while power blocks comprise about 3% of the area. The remainder of the project area consists of drainage improvements, evaporation ponds, a substation, and other shared elements. Tortoise-exclusion and security fencing have been installed around the entire project perimeter.

The electrical output from each solar field will join at an onsite transmission line interconnection substation.

The expected operating life of the project is between 30 and 40 years. Whenever the facility is closed, whether temporarily or permanently, the closure procedures outlined in the CEC Decision (CEC, 2010) will ensure compliance with applicable laws, ordinances, regulations, and standards (LORS).

2.0 Roles and Responsibilities

MSP will be responsible for implementing the methods presented in this study. MSP will obtain all applicable state and federal permits and adhere to their requirements. The current reporting requirements for the temporary "Migratory Bird Special Purpose Utility Salvage Permit - Solar," issued August 15, 2013, are summarized in Appendix A.

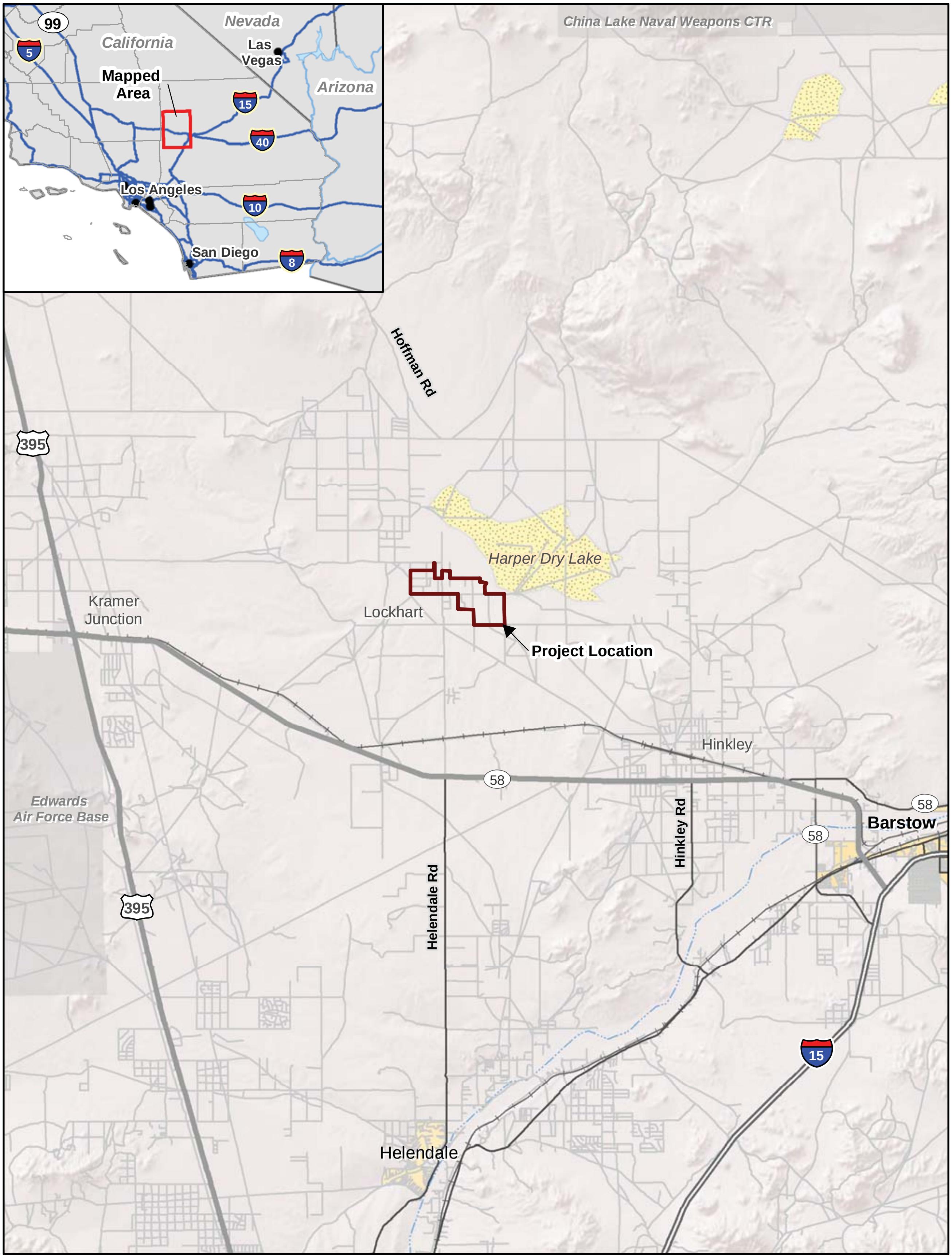
3.0 Regulatory Framework

This section identifies applicable LORS, and the protected avian species that have the potential to occur on the project site

3.1 Protected Species

Special-status and sensitive biological resources include animal species that have special recognition by federal, state, and/or local conservation agencies and organizations as endangered, threatened, rare, or otherwise of concern.

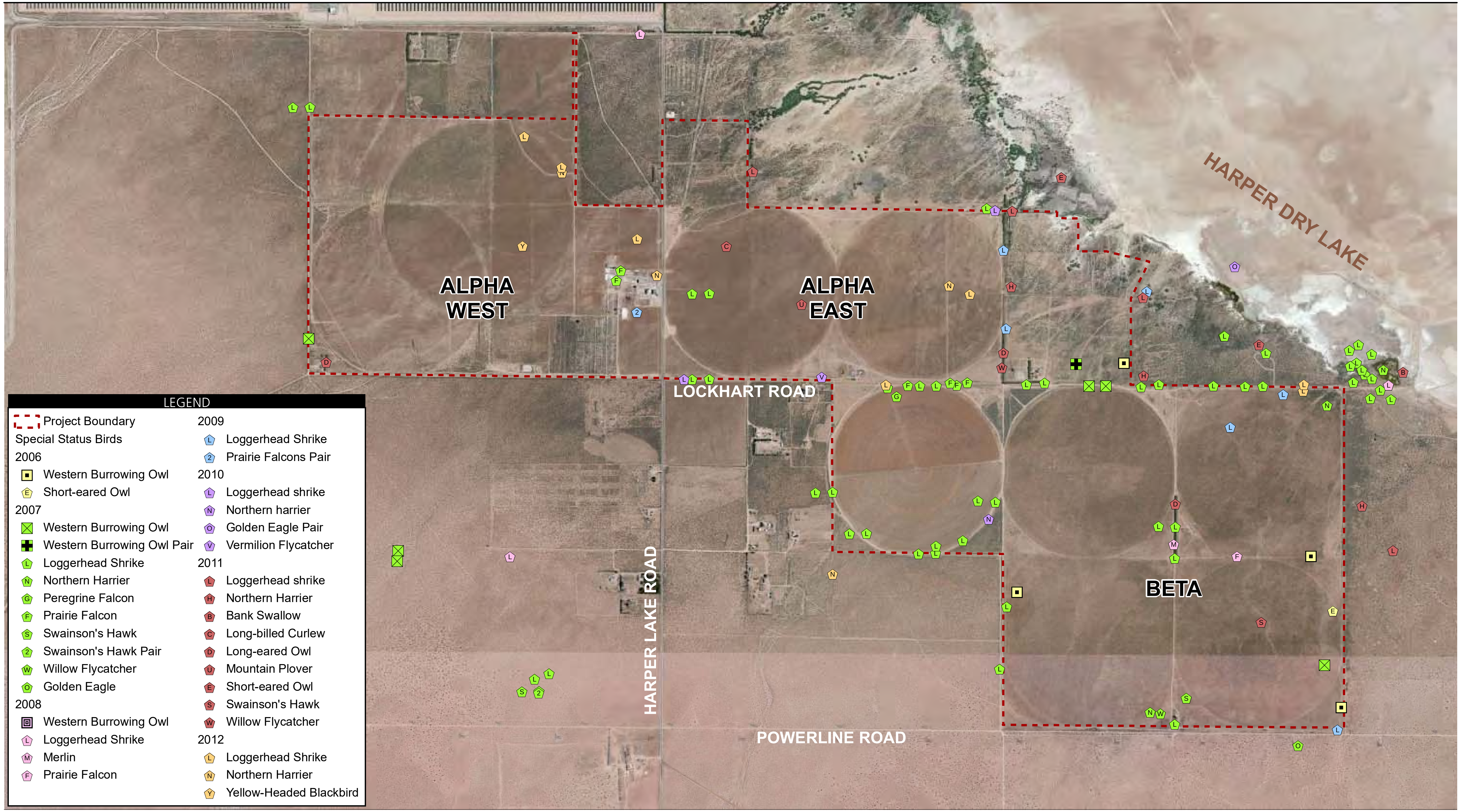
The birds listed in Table 1 are protected by state or federal regulations (CDFW, 2013a; Mojave Solar LLC, 2009; USFWS, 1973), or are recognized as sensitive or of concern due to declining or limited populations (USFWS, 2008). The presence of year-round water at the Harper Dry Lake Watchable Wildlife Area, adjacent to and north of the MSP Beta Solar Field boundary, attracts a number of the bird species listed in Table 1. Preconstruction and construction surveys have detected sensitive avian species at the MSP site (Figure 2). However, it should be noted that the vegetation within the MSP site proper has been removed during construction, presumably greatly reducing the potential of the project area to attract many avian species. It is also noted that most observations listed in Table 1 are historical and likely do not represent current bird occupancy of the MSP and vicinity.



LEGEND

🟥 Project Boundary

FIGURE 1
Vicinity Map
Abengoa Mojave Solar Project
San Bernardino County, California



Source: AECOM 2012; Mojave Solar, LLC 2011; Microsoft 2010

1,500 750 0 1,500 Feet

Scale:1 = 18,000; 1 inch = 1,500 feet

Figure 2
Sensitive Avian Species Detected at MSP

Mojave Solar Project - Monitoring Impacts of Solar Collection Technology on Birds
Path: P:\2012\60249161\06GIS\6.3_Layout\Solar_Bird_Monitoring\Sensitive Avian Species.mxd, 7/24/2012, irelandm

Table 1
Special-Status Bird Species at or in the Vicinity of MSP

Species	**Sensitivity Status**[a]	**Breeding Confirmed at MSP and Nearby Vicinity**	**Potential To Occur at MSP and Vicinity**[b]
American white pelican (*Pelecanus erythrorhynchos*)	CDFW-SSC (nesting colony)	No	Observed at the adjacent Harper Dry Lake
Double-crested cormorant (*Phalacrocorax auritus*)	CDFW-WL (nesting colony)	No	Observed at the adjacent Harper Dry Lake
White-faced ibis (*Plegadis chihi*)	CDFW-WL (nesting colony)	No	Observed at the adjacent Harper Dry Lake
Sharp-shinned hawk (*Accipiter striatus*)	CDFW-WL (nesting)	No	Observed wintering at MSP
Cooper's hawk (*Accipiter cooperii*)	CDFW-WL (nesting)	No	Observed wintering at MSP
White-tailed kite (*Elanus leucurus*)	CDFW-FP (nesting)	No	High potential to occur during migration; however, species not observed to date
Northern harrier (*Circus cyaneus*)	CDFW-SSC (nesting)	Yes	Breeding confirmed during spring 2011
Swainson's hawk (*Buteo swainsoni*)	CESA-Threatened, USFWS-BCC, USFS-S (nesting)	No	Observed migrating through MSP
Ferruginous hawk (*Buteo regalis*)	USFWS-BCC, CDFW-WL (wintering)	No	Observed wintering at MSP
Golden eagle (*Aquila chrysaetos*)	BGEPA, CDFW-FP, BLM-S, CDFW-WL, USFWS-BCC (nesting and wintering)	Yes	Observed known breeding pair north of MSP; pair foraged around MSP

Table 1
Special-Status Bird Species at or in the Vicinity of MSP

Species	Sensitivity Status[a]	Breeding Confirmed at MSP and Nearby Vicinity	Potential To Occur at MSP and Vicinity[b]
Osprey (*Pandion haliaetus*)	CDFW-WL (nesting)	No	Observed at the adjacent Harper Dry Lake
Merlin (*Falco columbarius*)	CDFW-WL (wintering)	No	Observed wintering at MSP
American peregrine falcon (*Falco pereginus anatum*)	CDFW-FP, USFWS-BCC (nesting)	No	Observed wintering at MSP
Prairie falcon (*Falco mexicanus*)	USFWS-BCC, CDFW-WL (nesting)	No	Observed foraging at MSP; confirmed nesting offsite to north
Mountain plover (*Charadrius montanus*)	FESA- Proposed Threatened, CDFW-SSC, USFWS-BCC, BLM-S (wintering)	No	Observed wintering at MSP
Long-billed curlew (*Numenius americanus*)	USFWS-BCC, CDFW-WL (nesting)	No	Observed migrating through MSP
Caspian tern (*Sterna caspia*)	USFWS-BCC (nesting colony)	No	Observed at the adjacent Harper Dry Lake
California gull (*Larus californicus*)	CDFW-WL (nesting colony)	No	Observed at the adjacent Harper Dry Lake
Western burrowing owl (*Athene cunicularia hypugea*)	CDFW-SSC, USFWS-BCC, BLM-S (burrow sites and some winter sites)	Yes	Observed from 2006 to 2008; however, none have been observed since 2008
Long-eared owl (*Asio otus*)	CDFW-SSC (nesting)	Yes	Breeding confirmed during spring 2011
Short-eared owl (*Asio flammeus*)	CDFW-SSC (nesting)	No	Observed migrating through MSP

Table 1
Special-Status Bird Species at or in the Vicinity of MSP

Species	Sensitivity Status[a]	Breeding Confirmed at MSP and Nearby Vicinity	Potential To Occur at MSP and Vicinity[b]
Vaux's swift (*Chaetura vauxi*)	CDFW-SSC (nesting)	No	Observed migrating through MSP
Olive-sided flycatcher (*Contopus cooperi*)	CDFW-SSC, USFWS-BCC (nesting)	No	Observed migrating through MSP
Willow flycatcher (*Empidonax traillii*)	CESA-Endangered, USFWS-BCC (nesting)	No	Observed migrating through MSP
Vermilion flycatcher (*Pyrocephalus rubinus*)	CDFW-SSC (nesting)	Unknown	Observed during the breeding season; however, nesting could not be confirmed
Loggerhead shrike (*Lanius ludovicianus*)	CDFW-SSC, USFWS-BCC (nesting)	Yes	Breeding confirmed during spring 2011
Bank swallow (*Riparia riparia*)	CESA-Threatened (nesting)	No	Observed migrating through MSP
Yellow warbler (*Dendroica petechia breswteri*)	CDFW-SSC; USFWS-BCC (nesting)	No	Observed migrating through MSP
Brewer's sparrow (*Spizella breweri*)	USFWS BCC (nesting)	No	Observed migrating through MSP
Yellow-headed blackbird (*Xanthocephalus xanthocephalus*)	CDFW SSC (nesting)	No	Observed at the adjacent Harper Dry Lake

Table 1
Special-Status Bird Species at or in the Vicinity of MSP

Species	Sensitivity Status[a]	Breeding Confirmed at MSP and Nearby Vicinity	Potential To Occur at MSP and Vicinity[b]
Tricolored blackbird (*Agelaius tricolor*)	CDFW-SSC, BLM-S, USFWS-BCC (nesting colony)	No	Observed at the adjacent Harper Dry Lake

Adapted from Final Environmental Assessment (2011, USDOE)

[a] Sensitivity status taken from CNDDB 2011. In most instances, the sensitivity status only applies when the species is nesting or wintering.

[b] The vegetation within MSP project boundaries has been removed during construction, substantially decreasing potential nesting or wintering locations.

Following are acronyms used to identify the sensitivity status of birds listed in Table 1:

BGEPA: Bald and Golden Eagle Protection Act
BLM-S: Bureau of Land Management – Sensitive Species
CDFW-FP: California Department of Fish and Wildlife – Fully Protected Species
CDFW-SSC: California Department of Fish and Wildlife – Species of Special Concern
CDFW-WL: California Department of Fish and Game – Watch List
CESA: California Endangered Species Act
FESA: Federal Endangered Species Act
USFWS-BCC: U.S. Fish and Wildlife Service – Birds of Conservation Concern

3.2 Applicable Federal and State Regulations

The following state and federal laws and regulations apply to the "take" and/or mortality of a bird species that could occur during project operations. The term "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to collect, or attempt to engage in any such conduct directed toward a listed species (50 Code of Federal Regulations [CFR] Section 10.12.).

3.2.1 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) (Title 16, United States Code [USC], Part 703) implements the provisions of treaties between the United States, Great Britain, Mexico, Japan, and the (former) Soviet Union. In addition, the MBTA enables the U.S. Secretary of the Interior to protect and regulate the taking of migratory birds, determine seasons and bag limits for hunted species, and protect migratory birds' occupied nests and eggs (16 USC 703, 50 CFR 21, 50 CFR 10). Violations of the MBTA typically result from the taking or possession (permanent or temporary) of a protected species or its parts.

For most avian species, the anthropogenic environment is unavoidable and poses species-specific risks and benefits (Erickson et al., 2005; Kristan and Boarman, 2007). Consequently, guidelines have been developed to circumvent such impacts (e.g., APLIC and USFWS, 2005), and failure to comply with these guidelines may result in MBTA permitting violations (Lilley and Firestone, 2008; CEC, 2010).

3.2.2 Federal Endangered Species Act

The Federal Endangered Species Act (FESA) requires maintenance of lists of threatened and endangered species, while affording them protections. An endangered listed species is at risk of extinction throughout all or a significant portion of its range (FESA Section 3[6]), while a threatened listed species is likely to become endangered within the near future (FESA Section 3[19]). The take of any FESA-listed endangered fish or wildlife species and most threatened species is prohibited. Take, as defined by the FESA, means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 USC Section 1531 et seq.). Harm is defined as any act that kills or injures the species, including significant habitat modification (16 USC Section 1531 et seq.).

Exceptions to Section 9 take prohibitions exist under certain circumstances. For non-federal projects, Section 10 allows for the issuance of a 10(a)(1)(b) permit to take FESA-listed species during otherwise lawful activities. Without the permits or authorization by USFWS, fatality of FESA-listed species from collision, could result in enforcement action.

3.2.3 Bald and Golden Eagle Protection Act

The Bald Eagle and Golden Eagle Protection Act forbids the taking or possession of bald and golden eagles, with limited exceptions (16 USC Section 668). It is a violation to take, possess, sell, purchase, barter, offer to sell, transport, export or import, at any time or in any manner, any bald eagle, commonly known as the American eagle, or golden eagle, alive or dead, or any part, nest, or egg thereof (16 USC Section 668). Take is defined to include pursuing, shooting, shooting at, poisoning, wounding, killing, capturing, trapping, collecting, molesting, or disturbing (16 USC Section 668).

3.2.4 California Endangered Species Act

The California Endangered Species Act (CESA) prohibits take of threatened or endangered wildlife listed by the California Fish and Wildlife Commission. Under the CESA, take is defined as any action or attempt to hunt, pursue, catch, capture, or kill (California Fish and Game Code Section 2050 et seq.). Similarly, CESA allows exceptions to the take prohibition for take that occurs during otherwise lawful activities. Incidental take of CESA listed species may be authorized if an applicant submits an approved plan that minimizes and fully mitigates the impacts of the take (California Fish and Game Code Section 2050 et seq.).

3.2.5 California Fully Protected Bird Species

Before CESA was enacted, the California Legislature identified bird species for specific protection under the California Fish and Game Code. These species are fully protected and may not be taken or possessed at any time. Besides collecting for necessary scientific research and relocation of the bird species for the protection of livestock, no permits or licenses can be issued for their take. Fully protected bird species are described in Title 14, Section 3511 of the California Fish and Game Code, which states that no provision of this code or any other law shall be construed to authorize the issuance of permits or licenses to take any fully protected species.

3.2.6 California Species of Special Concern

To maintain viable populations of all native species, CDFW has designated certain vertebrate species as Species of Special Concern due to declining population levels, range limitations, and/or continuing threats that have made them vulnerable to extinction. The Species of Special Concern designation is intent on halting or reversing a species decline by calling attention to its plight and addressing concern early enough to secure its long-term viability. Species may be in initial decline or have already reached the point where they meet the criteria for listing under the CESA and/or FESA.

3.2.7 California Fish and Game Code 3503.5 (Birds of Prey)

Without CDFW authorization, Section 3503.5 bans the take, possession or destruction of any birds of prey or their nests or eggs.

4.0 Risk Assessment

Collisions with mirror arrays and interactions with evaporation ponds are aspects of the project anticipated to be the primary sources of potential mortality to birds. Collisions with buildings and electrocution are lesser potential mortality sources. These last, however, are either commonplace features on other developments (building collisions), or are pre-existing hazards (transmission lines, electrocution). Therefore, these potential hazards will not be addressed in this document, but will be incidentally recorded by project staff or the Designated Biologist.

4.1 Avian Mortality

Scant information exists about the interactions of solar facilities and bird populations (Lovich and Ennen, 2011). In general, the relationship of bird mortality to utility facilities is affected by, among other things, topography, habitat type, availability of natural perches, food and water abundance (Lovich and Ennen, 2011; McCrary et al., 1986) and facility design. Incidental avian mortality data from an adjacent facility, NextEra Solar Electric Generating Systems (SEGS), has been summarized by CEC staff between 1990 and 2012. According to the CEC, the average avian mortality per year at the SEGS facility is 8 birds (range: 0 to 110 birds).

4.1.1 Mirror Arrays

Reflective surfaces are recognized to be a greater hazard to birds than structures because: "Analysis of experimental results and observations under a multitude of conditions suggest that birds hit windows because they fail to recognize clear or reflective glass surfaces as barriers," (Klem, 1989).

Unlike the a central receiver arrangement, the parabolic troughs used by the MSP concentrate solar energy on a collector tube located only a few feet in front of the mirror, located in the focal point of the parabolic reflector. More than 99% (intercept factor) of the incoming rays are reflected on the inner site of the receiver facing the parabola, eliminating the potential to burn birds flying overhead, or even a few feet away. Collisions with mirrors and other structures appear to be the principle potential hazard on MSP.

4.1.2 Evaporation Ponds

The MSP will include four evaporation ponds (approximately 5 acres each) that have the potential to attract migratory birds. Wastewater discharged to evaporation ponds potentially contains contaminants (AECOM, 2011b) known to be harmful to birds (Duawe et al., 2000; Hui 2002; Ohlendorf and Heinz, 2011), and/or become hypersalinic through pond evaporation (René et al., 1999). As such, adaptive management actions developed through this study and an Evaporation Pond Monitoring and Adaptive Management Plan will be used to discourage or prevent birds from coming in contact with the water in the evaporation ponds (CEC, 2010).

5.0 Impact Reduction and Mitigation Measures

The CEC Decision (CEC, 2010) includes several COCs with an avian protection component. In accordance with project design, COC BIO-07 requires the project to limit disturbance during construction and operation, and to implement management and mitigation measures to counter potential adverse impacts.

5.1 Project Setting

The MSP is located mostly on previously disturbed, abandoned agricultural fields, historically used for crop production, cattle ranching, and dairy farming. The intent of choosing disturbed habitat for the project site was, in part, to limit impacts to natural vegetation that could provide habitat for wildlife, including avian species.

5.2 Avoidance and Minimization Measures

A number of measures have been developed for the MSP to minimize the potential risk to birds during project operation. These actions are proactive, intent on preventing a potential impact rather than resorting to remedial compensations enacted after the fact.

Avoidance and minimization measures include, but are not limited to the following:

- Transmission lines and electrical components follow the established guidelines to reduce the likelihood of bird electrocutions and collisions (APLIC, 2006).
- Project lighting is shielded, directional, and the lowest intensity necessary to perform work to minimize lighting impacts to Harper Dry Lake marsh and avian inhabitants.
- Worker awareness training is provided that increases understanding of potential threats to avifauna. This training aims to enhance cooperation with MSP biologists and the understanding of the need to protect wildlife.
- All trash is contained in enclosed receptacles to prevent the introduction of subsidized food sources to predators.

- Any road-kill are promptly removed from the project site.
- Avoiding pooling if watering is used for dust suppression

5.3 Corporate Policy

Mojave Solar LLC's policy is to comply with all regulatory requirements; and management and employees are committed to reducing the detrimental effects of project - wildlife interactions.

To fulfill this policy commitment, the MSP will:

- Implement and comply with the provisions of this study, per COC BIO-17 (see Section 1.1).
- Ensure all actions comply with applicable LORS and permits.
- Document bird mortalities and problem structures through active compliance monitoring.
- Provide information and resources through training of specific operational staff with bird protection objectives and the specific requirements of this study.
- Evaluate methods and apply adaptive management principals to use information gained from operation of the project to improve protection of avian species.

5.4 Resource-specific Management Plans

The CEC Decision (CEC, 2010) required the development and implementation of management plans to minimize the direct or indirect impacts of the project operations to golden eagles, common ravens, and other birds. Although each plan is resource specific, multiple bird species are construed to benefit from the actions outlined in each plan. Only those plans pertaining to project operations are summarized here.

5.4.1 Golden Eagle Territory-specific Management Plan

Two golden eagle inventories were conducted during the breeding and non-breeding seasons to determine golden eagle territory occupancy within 10 miles of the MSP (excluding Black Mountain territory). On January 28, 2011, USFWS issued golden eagle measures that supplant the need for a Golden Eagle Territory-Specific Management Plan, and this was provided to CEC on March 17, 2011 (Abengoa Solar, 2011). These measures are:

- Compensatory Lands: Agriculture. The MSP acquired 128 acres of land to make available in perpetuity for productive agricultural use. This compensation land is located directly west of the project site and will provide suitable foraging habitat for golden eagles and other bird species found within the area.
- Compensatory Lands: Wildlife. The MSP acquired 118.2 acres of land suitable for desert tortoise, Mohave ground squirrel, and burrowing owl to compensate for project-related loss of habitat. This compensation land is located directly west of the project site and

will provide suitable foraging habitat for golden eagles and other bird species found within the area. Mojave Solar, LLC, will provide funding for the enhancement and long-term management of the compensation lands.

- Compensatory Funding: Mojave Solar, LLC, has provided funding into the Renewable Energy Action Team account established with the National Fish and Wildlife Foundation. This money will fund monitoring and other actions that USFWS, BLM, and the CEC determine to be beneficial to golden eagles located within a 10-mile radius of the MSP.
- Harper Dry Lake Area of Critical Environmental Concern: The MSP ensured continuity of water delivery to the Harper Dry Lake Area of Critical Environmental Concern (ACEC) by providing an alternate well able to effectively convey a minimum of 75 acre-feet per year of water to the Harper Dry Lake marsh. This measure will enhance and provide foraging habitat for birds within the project area.

These four mitigation measures agreed to by Mojave Solar, LLC ensure that potential impacts to golden eagles resulting from project operation will be mitigated.

5.4.2 Common Raven Monitoring, Management, and Control Plan

The *Common Raven, Monitoring, Management and Control Plan* (AECOM, 2010) outlines management actions for the construction site and related facilities to control raven populations. Such actions aim to mitigate cumulative and indirect impacts to desert tortoise associated with regional increase in raven numbers. To address indirect cumulative effects not fully eliminated by the Common Raven Monitoring, Management and Control Plan, Mojave Solar, LLC, paid $105 for each acre of land permanently disturbed by the project. The funds were placed in an account to be administered by the National Fish and Wildlife Foundation to implement measures for managing common ravens.

5.4.3 Evaporation Pond Management/Remediation Plan

An Evaporation Pond Management/Remediation Plan outlines measures to monitor water quality and bird use of the associated project evaporation ponds and adjacent Harper Dry Lake wetland (CEC, 2010). An adaptive framework will specify measures to discourage bird use and the circumstances under which they will be implemented.

5.5 Mitigation Measures

Several mitigation measures are in place as specified by the CEC Decision and its associated management plans (CEC, 2010). Mitigation measures aim to compensate for unavoidable negative impacts incurred by wildlife species as a result of the construction and operation of the MSP. Although some measures result from direct impacts to specific species, the mitigation benefits are construed to extend to other bird and wildlife species. These mitigation measures address both project construction and operations and are discussed in greater detail above:

- Acquisition of compensatory agricultural lands

- Acquisition of compensatory lands to serve as wildlife habitat
- Provide compensatory funding
- Provide an additional water source for Harper Dry Lake ACEC

6.0 Avian Mortality Monitoring and Reporting

COC BIO-17 (see Section 1.1) calls for the project owner to develop and implement a plan to determine the impacts of the MSP on bird species flying in the vicinity of the project site. To this end, this proposed plan presents survey methodologies to determine avian carcass densities.

6.1 Survey Design

An important aspect of this methodology is that MSP proposes to survey for bird carcasses across the entire facility daily, 365 days per year. This 100 percent coverage is made possible because MSP personnel will be conducting daily surveys of the entire facility. The avian component of these surveys will occur for one year (12 months) to determine the daily number and location of dead birds in the solar fields and evaporation ponds. Data will be assessed after one year with the option to implement an adaptive management framework including potential additional years of surveys.

Avian survey design generally follows USFWS recommendations (Nicolai et al., 2011) and has three elements: strata, routes, and analysis.

1. Strata: Conceptually, for this study, the project site is divided into two survey strata according to potential bird mortality hazard types:
   a. Two fields of parabolic trough arrays totaling about 1,765 acres
   b. Four evaporation ponds totaling about 20 acres

   A pre-existing transmission line provides power grid access and, because it is pre-existing, is not included as a stratum for purposes of this study.
2. Routes: Permanently established routes placed across 100 percent of each strata area. For mirror fields, the centerline of each route will be placed in the center of access roads between each mirror row and on perimeter roads. The distance between mirror rows is approximately 60 feet. This will afford observers a clear observation distance of 180 feet (90 feet to either side of route line). Clear observation distance along evaporation ponds is estimated to be 150 feet to either side of a route line. Routes will be surveyed daily, 365 days/year. Routes will not be surveyed during severe weather events (e.g. heavy rain), and will resume the day immediately following the event.
3. Analysis: A spatial and temporal (365 days/year) coverage of 100 percent provides for a complete survey of the strata areas, thereby negating the need to estimate and extrapolate carcass densities. Because surveys occur every 24 hours, scavenger affects will be negligible.

6.2 Route Layout

6.2.1 Solar Trough Array

The centerlines of routes in the solar fields will follow the center of all existing perimeter roads, and access roads between mirror rows—extending their full length. Because all access roads will be surveyed, 100 percent of the solar field will be observed, which exceeds the USFWS recommendations (10% to 30%; Nicolai et al., 2011).

6.2.2 Evaporation Ponds

Routes will follow evaporation pond perimeters and traverse all cardinal directions to account for the effects of wind in the dispersal of animals *post mortem*. Coverage of all perimeters provide for 100 percent coverage, which exceeds the USFWS recommendations (10% to 30%; Nicolai et al., 2011).

6.3 Surveys Along Routes

Routes will be searched by project personnel trained by the Designated Biologist in proper search techniques. Observers will drive routes in an open air vehicle traveling at a maximum of 10 miles per hour (mph) in the solar fields and adjacent to evaporation ponds while scanning away from the route centerline to search for bird carcasses (other animal carcasses will also be logged). For each occurrence, the observers will record date, time, global positioning system (GPS)-determined coordinates of the carcass, and other information on carcass situation (e.g., floating in pond) and condition (e.g., singed feathers). Appendix B provides a sample field data form. Casualties found will be photographed in situ upon initial discovery and reviewed for identification by an offsite, approved designated biologist. All carcasses will be marked, collected and preserved for disposal upon discovery (see section 6.4). The observer will resume the route survey and repeat this procedure for all encountered carcasses. All routes will be completed in a single day and repeated each day throughout the year.

Carcass condition will be assigned to one of the following classes at each encounter:

1. Fresh: eyes are still wet and not completely sunk into sockets
2. Medium: eyes are completely sunk into sockets and breast muscle and viscera still present
3. Desiccated carcass: a stiff carcass consisting of a dried complete carcass
4. Remnant: a dried and reduced carcass consisting of chiefly feather and bone

Additional information will be recorded about the presence or absence of evidence of superheating (singed feathers). To help identify raptor carcasses to species, searchers can use the raptor remains identification guide (CEC, 2005).

6.4 Carcass Disposal

All carcasses will be collected for disposal upon initial discovery. A copy of the field data form completed when the carcass was initially found will be kept with the carcass at all times. An incidental carcass[1] encounter form will be used to document incidental carcasses or injured animals found at the time of collection. A photograph and location information will be provided to the Designated Biologist. Species and cause of death will be determined (if possible) and a record maintained in a database. All carcasses will be labeled and retained or disposed of following guidance from CDFW and/or USFWS.

Injured native birds may be captured and transported by trained personnel to a designated rehabilitation center or veterinary clinic. Guidance for handling injured birds is provided in Appendix C. All appropriate collection permits will be obtained from USFWS and/or CDFW for handling and collecting protected species.

6.5 Analysis

The Designated Biologist, or agency-approved personnel, will maintain a database of survey information. Because strata are surveyed at 100 percent coverage, all dead birds are expected to be found on a daily basis. Observer error and carcasses scavenging should be minimal and fall within acceptable calculated error rates expected from a study design that uses a sampling and estimation approach. When a full year’s bird mortality survey is obtained, consideration will be made by the CEC and USFWS for the need to continue monitoring or protocol refinement.

6.6 Reporting

Reports will be submitted at least quarterly detailing survey results and all other project-related bird mortalities. The Designated Biologist will prepare annual reports detailing the monitoring results and project-related bird mortalities and make recommendations for adaptive management actions needed. Reports will be submitted to the CPM, CDFW, and USFWS and will continue as long as surveys occur. Surveys will occur for a minimum of one year and may continue longer as determined by the CEC and USFWS. At the conclusion of the study, the project owner or contractor will prepare a manuscript to be submitted to a peer-reviewed scientific journal.

6.7 Adaptive Management

Adaptive management is a means to address unforeseen conditions on the project site that affect wildlife through direct injury or mortality. The death or injury of wildlife from project operation is currently an unforeseen condition. Adaptive management measures will be developed to avoid or minimize bird injuries/deaths should project-related mortalities occur. The CPM, in consultation with CDFW and USFWS, will determine when and/or if the implementation of adaptive measures is warranted.

---

[1] An incidental carcass is any carcass found while not conducting carcass survey

Current measures are already in place to minimize project-related impacts to birds (USFWS Determination on Golden Eagle Territory-Specific Management Plan, Common Raven Monitoring and Control Plan Mojave Solar Project) (Abengoa Solar, 2011; AECOM, 2010; 2011b). If new measures are required, they would be based on the actual effect of the MSP on avian species and may include measures developed in consultation with individuals knowledgeable about the species of concern. At a minimum, measures will be developed in consultation with the CPM, the Designated Biologist, USFWS, CDFW, and the project owner's design team.

At this time, adaptive measures cannot be developed without knowledge of the project-related impacts that result in deaths or injuries to the species of concern. However, should they be necessary, future adaptive measures may include, but are not limited to the following:

- Installation of bird deterrents (e.g., artificial scarecrows)
- Modification of lighting that may attract insects (potential avian forage)
- Installation of noise deterrents such as predator calls or bird alarms, propane cannons, or high-frequency emitters

The Designated Biologist will implement and monitor any adaptive measures, and determine their effectiveness in consultation with the CPM, CDFW, and USFWS.

7.0 References

Abengoa Solar. 2011. USFWS Determination on Golden Eagle Territory-Specific Management Plan. CEC Submittal BIO9-02-00. March 14.

AECOM. 2010. Common Raven Monitoring and Control Plan Mojave Solar Project. Prepared for Mojave Solar I, LLC, Victorville, CA. September.

AECOM. 2011a. Ground Water Monitoring and Reporting Plan. Prepared for Mojave Solar LLC, Victorville, CA. June 7.

AECOM. 2011b. Burrowing Owl Monitoring and Mitigation Plan. Prepared for Mojave Solar LLC, Victorville, CA. March.

Avian Power Line Interaction Committee (APLIC) and the U.S. Fish and Wildlife Service (USFWS). 2005. Avian Protection Plan Guidelines. Available online at: http://www.aplic.org/index.php. April.

Avian Power Line Interaction Committee (APLIC). 2006. Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006. Edison Electric Institute, Avian Power Line Interaction Committee, and California Energy Commission, Washington, DC, and Sacramento, California.

Bureau of Land Management (BLM). 2008. BLM Manual 6840 – Special Status Species Management. Rel. 6-125. U.S. Department of the Interior. December 12.

California Department Fish and Wildlife (CDFW). 2013a. California Endangered Species Act. California Fish and Game Code 2050-2115.5. Available online at: http://www.dfg.ca.gov/habcon/cesa/

California Department of Fish and Wildlife (CDFW). 2013b. Laws and Regulations Directing Environmental Review and Species Take Programs. Available online at: http://www.dfg.ca.gov/wildlife/nongame/regcode.html

California Energy Commission (CEC). 1995. Avian Collision and Electrocution: An Annotated Bibliography. Publication Number P700-95-001. October.

California Energy Commission (CEC). 2005. Guide to Raptor Remains: A Photographic Guide for Identifying the 76 Remains of Selected Species of California Raptors. Available online at: www.energy.ca.gov/2005publications/CEC-500-2005-001/CEC-500-2005-001.PDF

California Energy Commission (CEC). 2010. Abengoa Mojave Solar Project Commission Decision. September. CEC-800-2010-008 - CMF

California Natural Diversity Database (CNDDB). 2011. Special Animals. Department of Fish and Game. January 2011. Available online at: http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/SPAnimals.pdf

Duawe, T., L. Bervoets, R. Blust, R. Pinxton, and M. Eens. 2000. Can Excrement and Feathers of Nesting Songbirds be Used as Biomonitors for Heavy Metal Pollutants? Environmental Contamination and Toxicology 39(4): 541-546.

Erickson, W.P., G.D. Johnson, and D.P. Young Jr. 2005. A Summary and Comparison of Bird Mortality from Anthropogenic Causes with an Emphasis on Collisions. Technical Report for USDA Forest Service. PSW-GTR-191. Pgs 1029-1042.

Hui, C.A. 2002. Concentrations of Chromium, Manganese, and Lead in Air and on Avian Eggs. Environmental Pollution 120(2):201-6.

Klem, D. Jr. 1989. Bird-Window Collisions. Wilson Bulletin 101(4), pp. 606-620.

Kristan, III, W. B., and W. I. Boarman 2007. Effects of Anthropogenic Developments on Common Ravens Nesting Biology in the Mojave Desert. Ecological Applications 17:1703–1713.

Lilley, M. B., and J. Firestone. 2008. Wind Power, Wildlife, and the Migratory Bird Treaty Act: A Way Forward. Environmental Law Vol 38, pp.1167, 1186-95.

Lovich, Jeffrey E., and Joshua R. Ennen. 2011. Wildlife Conservation and Solar Energy Development in the Desert Southwest, United States. BioScience 61(12): 982–992.

Lukacs, P. 2011. Closed Population Capture-Recapture Models In Program MARK: A Gentle Introduction. Available online at: http://www.phidot.org/software/mark/docs/ book/pdf/ chap14.pdf

McCrary, M. D., R. L. McKernan, R. W. Schreiber, W. D. Wagner, and T. C. Sciarrotta. 1986. Avian Mortality at a Solar Energy Power Plant. Journal of Field Ornithology 57(2):135–141.

Mojave Solar LLC. 2009. Application for Certification. August 10. Submitted to California Energy Commission.

Nicolai, C., S. Abele, H. Beeler, R. Doster, E. Kershner, and T. McCabe. 2011. Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach. U.S. Fish and Wildlife Service. May 2.

Ohlendorf, H. M., and G. H. Heinz. 2011. Selenium in Birds. In W. N. Beyer and J. P. Meador, eds, *Environmental Contaminants in Biota: Interpreting Tissue Concentrations*, Second edition. CRC Press, Boca Raton, FL.

René, T., E. P. Glenn, and D. Moore. 1999. Food Chain Organisms in Hypersaline, Industrial Evaporation Ponds. Water Environment Research 71(4): 494-505.

U.S. Department of Energy (USDOE). 2011. Final Environmental Assessment, Department of Energy. Abengoa's Solar Mojave Project [Near Barstow, California]: Department of Energy, 2011.

U.S. Fish and Wildlife Service (USFWS). 1973. Endangered Species Act of 1973. 108th Congress. Available online at: http://www.fws.gov/endangered/esa-library/pdf/ESAall.pdf

U.S. Fish and Wildlife Service (USFWS). 2008. Birds of Conservation Concern 2008. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Birds, Arlington, Virginia. 85 pp. December. Available online at: http://www.fws.gov/ migratory birds

Appendix A
USFWS SPUT Data Collection Requirements

Additional Documentation Attachment to Comment 2-F1
Attachment I-5

Data Collection Requirements

Species (alpha code)	Common Name	Genus Species	Sex	Age
Waypoint Code	Latitude	Longitude	Location	Collected (Yes/No)
Approximate Time Since Death	Location of Remains	Location: Anthropogenic	Location: Other	Trauma Present
Condition of Carcass	Finder/Collector and Contact Info	Within 20m of Structure?	What Structure	Structure: Other
Distance From Structure	Suspected Cause of Death	Suspected Cause of Death: Other Anthropogenic	Suspected Cause of Death: Other	Confirmed Cause of Death
Comments				

Appendix B
Example Field Forms

Additional Documentation Attachment to Comment 2-F1
Attachment I-5

MSP Migratory Bird Carcass Monitoring Form

Date:

Observer:

Transect #	Unique Carcass ID #	Species	UTM	Cause of Death	Transect #	Unique Carcass ID #	Species	UTM	Cause of Death

Appendix C
Injured Wildlife Procedures for Reporting and Care

Mojave Solar Project
Injured Wildlife Procedures for Reporting and Care

The following procedures apply to injured birds or other wildlife. Record data on an Incidental Carcass Encounter Form. However, the primary objective is to provide immediate care for the injured animal. Project personnel trained by the Designated Biologist may capture the animal by placing a dark cloth or blanket over it. By removing its ability to see, generally it will calm down and be more easily handled. Place the animal in a box that has a towel or other material for the animal to hide under or grasp on to. Personnel will use protective gloves and clothing when handling wildlife.

Quickly look around the immediate area for other injured animals as there may have been a flock or a pair. While capturing the animal, the biological monitor should assess the injury so he or she will know what to report to the wildlife rehabilitator or veterinarian. Do not provide additional stress. Keep the injured animal cool if it is a hot day and keep it slightly warm if it is a cool day by placing the box indoors in a darkened room if possible.

If it is a federally listed (Threatened, Endangered) or California State listed (Threatened, Endangered) species, the Designated Biologist or Environmental Manager will contact the appropriate agency.

- The contact information for CDFW Region 6 (Imperial, Inyo, Mono, Riverside, and San Bernardino Counties) is: 3602 Inland Empire Boulevard, Suite C220, Ontario, CA 91764 (telephone: (909) 484-0167; website: http://www.dfg.ca.gov/regions/6/).
- For federally listed species, the Environmental Manager or Designated Biologist should contact USFWS at: 2493 Portola Road, Suite B, Ventura, CA 93003 (telephone: (805) 644-1766; website: http://www.fws.gov/ventura/).

These calls should be made within 24 hours of discovery. Telephone the designated rehabilitation center (to be determined) for additional instructions. Describe the injury to the rehabilitation center and they will determine if it should go directly to a veterinary clinic.

Deliver the animal to the specified location as directed by the regulatory agencies or the clinic. The veterinarian should fill out the “Casualty Examination Form.” The clinic will make arrangements to deliver the animal to the designated rehabilitation center. MSP will pay for all veterinary bills.

CSOLAR IV SOUTH, LLC

14302 FNB Parkway
Omaha, Nebraska 68154
402-691-9500
www.tenaska.com

April 16, 2014

Pete Sorensen
U.S. Fish and Wildlife – Palm Springs Office
777 E. Tahquitz Canyon Way, Suite 208
Palm Springs, CA 92262

Peter E. Godfrey
Bureau of Land Management
22835 Calle San Juan De Los Lagos
Moreno Valley, CA 92553

Via Overnight Mail

RE: Imperial Solar Energy Center South
February 2014 Post-Construction Avian Mortality Monitoring Report

Mr. Sorensen and Mr. Godfrey:

In accordance with the Avian and Bat Protection Plan, enclosed is the February 2014 Post-Construction Avian Mortality Monitoring Report for Imperial Solar Energy Center South.

If you have any questions regarding this submittal, please do not hesitate to contact me at (402) 938-1662 or mzgoda@tenaska.com.

Sincerely,

CSOLAR IV SOUTH, LLC
A Delaware Limited Liability Company

Mary K Zgoda

Mary K. Zgoda
Environmental Compliance Specialist

Enclosure

cc: Andrew Trouette, Bureau of Land Management (with enclosure)
Magdalena Rodriguez, California Department of Fish and Wildlife (with enclosure)
Patricia Valenzuela, Imperial County Planning & Development Department (with enclosure)

Imperial Solar Energy Center South

Post-construction

Avian Mortality Monitoring Report

February 2014

Prepared for:

CSOLAR IV SOUTH, LLC

Prepared by:

UltraSystems
environmental•management•planning

16431 Scientific Way
Irvine, CA 92618

Prepared on:

April 10, 2014

REPORTING PERIOD: February 3 through February 10, 2014

REPORT: Avian Mortality Monitoring Report #4

This report summarizes the Avian Mortality Surveys conducted by UltraSystems biological staff at the Imperial Solar Energy Center (ISEC) South facility (private land). This is the fourth post-construction avian mortality monthly report for the ISEC South facility, and is prepared in accordance with the Avian and Bat Protection Plan, Imperial Solar Energy Center South (CH2MHill 2011) and conditions of the U.S. Fish and Wildlife Service–Pacific Southwest Region Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach (Nicolai, et al. 2011). Survey data sheets are included in **Appendix A**.

SURVEY METHODOLOGY

During the month of February 2014, avian mortality surveys were conducted in the solar panel fields and along the power collection system. These surveys were conducted in accordance with the methods described by the U.S. Fish and Wildlife Service (Nicolai, et al.), with the following modification: surveys were conducted by two observers in a vehicle traveling at a rate that did not exceed three miles per hour (approximately walking speed).

A systematic search pattern was selected using transects within the solar panel fields, as there are existing access roads that run north to south between the solar panels. There were 25 north-south transects used, as illustrated in **Figure 1**. In order for the survey area to be representative of the entire project site, either odd or even-numbered transect lines were selected at random. This insured that no part of the project area would be over or under-represented. A coin toss decided upon odd-numbered transect lines (see **Figure 2**). These transects are 1, 3, 5, 7, 11, 13, 17, 19, 21, 23, 27, 29 and 31. The entire power collection system line was surveyed, as well.

The Avian and Bat Protection Plan states to survey 10% of the solar facility. The ISEC South solar facility has a total of 946.6 acres. The odd transects that were selected account for 95 acres of the facility based on a 30-foot line of sight while driving the transect lines. Therefore, the 10% coverage requirement for these surveys is met, and not all transects need to be selected.

While driving these north-south transects, observers surveyed west and east down each solar panel row, viewing a minimum of 13 feet on each side of the vehicle. The average total width of each transect was a minimum of 95 feet. If a possible avian mortality was spotted, observers would verify the find using binoculars. Mortalities were recorded on two data forms; one for the solar panel field and the other for the power collection system line (see **Appendix 1**). The survey period was conducted for seven consecutive days, and at least 10% of the solar field was surveyed. Surveys were conducted beginning at 8 a.m. and were completed by 2 p.m. Surveys were only conducted on days with no rain or fog, and on days where wind velocities did not exceed 20 miles per hour.

Figure 1

IMPERIAL SOLAR ENERGY CENTER SOUTH – AVIAN MORTALITY MONITORING TRANSECT SURVEY AREA

Service Layer Credits: National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC, Copyright:© 2011 Esri, DeLorme, NAVTEQ, TomTom, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community; CSolar IV South, 2012/2013; UltraSystems Environmental Inc., 2013

October 28, 2013

Map Scale 1:10,800

0 400 800 1,200 Feet

0 100 200 300 Meters

N

Legend

★ Facility Location

🟥 30-Foot Line of Sight (Total Acres = 234.6)

▬ Belt Transect (Total Acres = 93.5)

▨ BLM- Managed Land

— Solar Panels

— Fencing Boundary

— Substation

● Collection System Structure

— Collection System Line

▭ Access Road

▭ Block Boundary Line

Imperial Solar Energy Center South

Avian Mortality Monitoring Transect Survey Area

UltraSystems
environmental management planning

Figure 2

IMPERIAL SOLAR ENERGY CENTER SOUTH – POST-CONSTRUCTION AVIAN MORTALITIES

Document Path: J:\Projects\5817_Tenaska_CSolar_Imperial_Solar_Energy_Center_South\MXDs\ISEC_South\TO_33_Avian_and_Bat_Protection_Plan\5817_ISEC_South_2014_02_February_Avian_Mortalities_11x17_2014_02_28.mxd
Service Layer Credits: National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC, Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community, Copyright:© 2013 Esri, DeLorme, NAVTEQ, TomTom, Copyright:© 2011 Esri, DeLorme, NAVTEQ, TomTom; CSolar IV South, 2012; UltraSystems Environmental Inc., 2013

February 28, 2014

Map Scale 1:10,800

0 400 800 1,200 Feet

0 100 200 300 Meters

N

Legend

★ Facility Location	▲ Avian Mortality	Substation	▭ Access Road
30-Foot Line of Sight (Total Acres = 95.0)	▨ BLM- Managed Land	● Collection System Structure	▭ Block Boundary Line
Belt Transect (Total Acres = 35.2)	Solar Panels	Collection System Line	
	Fencing Boundary		

Imperial Solar Energy Center South

Post-Construction
Avian Mortalities - February 2014

UltraSystems
environmental management planning

Data Collection Methods

Observers drove the transect lines in pairs (not exceeding three miles per hour), with each observer looking between solar panels along each respective row.

At each detection of an avian carcass the following information was recorded:

- Transect Number
- Unique carcass I.D.

Colored embroidery thread or similar material was used to uniquely identify each carcass. The embroidery thread was attached to legs as part of a unique identification, and the following information was recorded in the carcass I.D.

- Leg: L = Left; R = Right
- Color of thread: TN=Tan, GN=Green, BN=Brown, BK=Black, BE=Blue, CR=Copper
- Knots in the thread (number of birds of that specific species found, for that survey): 0=1, 1=2, 2=3, 3=4, 4=5, etc.

As an example, the code LCR00 indicates that the thread was attached to the left foot, the species code indicated by using the copper color thread, and there were no knots, meaning this was the first bird of that specific species found during the survey.

Additional information recorded includes:

- Panel strike Y/N or Line strike Y/N.
- Species (American Ornithologists' Union (AOU) 4-letter species code).
- Carcass Condition:
    - Fresh (eyes are still wet and not totally sunk into sockets)
    - Medium (eyes are totally sunk into sockets and breast muscle and viscera still present)
    - Non-scavenged carcass (a stiff carcass consisting of a dried complete carcass)
    - Remnant (a dried carcass consisting of non-edible parts)
- GPS Coordinates (NAD 83 Decimal Degrees).
- Cause of death will be determined and recorded if possible, otherwise it will be recorded as unknown. Examples of evidence that could help determine cause of death include: marks on panel where the bird struck, or bird directly below a line, etc.
- Vegetation percent and height estimate.
- Presence or absence of evidence of superheating (singed feathers).

Carcasses, if discovered, were to be left exactly as found.

James Castle (Senior Wildlife Biologist), Patrick Hord and Renee Owens (UltraSystems Biologists) conducted the surveys during February 2014.

AVIAN MORTALITIES DISCOVERED BY ULTRASYSTEMS

Table 1

Date	Transect Number	Unique Number	Species	GPS Coordinates (NAD 1983)
2/3/14	3	None	MODO[1,2]	32.65507°, –115.66932°
2/6/14	5	None	MODO[3]	32.66288°, –115.66788°

1. MODO is the four-letter bird species code for Mourning Dove.
2. This MODO was mostly feathers with some bone and bone fragments.
3. This MODO was mostly feathers with some bone and bone fragments.

AVIAN MORTALITIES DISCOVERED BY FACILITY PERSONNEL

Table 2

Date	Transect Number	Unique Number	Species	GPS Coordinates (NAD 1983)
2/17/14	8	None	CAEG[1,2]	32.66411°, –115.66915°

1. CAEG is the four-letter bird species code for Cattle Egret.
2. This CAEG was mostly head and feathers.

OTHER WILDLIFE

An injured juvenile Sora (SORA) was recovered in Block 3 on 2/9/2014. This bird was captured and transported to the Wild Bird Center in Coachella Valley, California. The SORA was alert and appeared to have an injury to the left eye and a small amount of blood on the beak. A follow-up concerning the condition of the bird will be made by UltraSystems Biologists.

REFERENCES

CH2MHill. 2011. Avian and Bat Protection Plan Imperial Solar Energy Center South, Final.

Dunn, J. and Alderfer, J. 2008. Field Guide to the Birds of Western North America. National Geographic Society, Washington D.C.

Nicolai, C., Abele, S., Beeler H., Doster, R., Kershner, E and McCabe, T. 2011. U.S. Fish and Wildlife Service–Pacific Southwest Region Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach.

APPENDIX 1

BIOLOGICAL MONITORING
DAILY DATA SHEETS

ISECS POST-CONSTRUCTION MONITORING - AVIAN MORTALITY FORM

Project Name: Imperial Solar Energy South City: Calexico County: Imperial Township/Range/Section: T:17S, R:13E, Sec:17, 20, & 21

Date (mm/dd/yyyy): 2/3/2014 Observer: J.Castle and C.Burge Weather: mostly cloudy 49-65 degrees

Time: Start/End	Solar Field (SF) Collection System (CS)	Transect #	Unique Carcass ID	Species	Carcass Condition	GPS Coordinates (NAD 83)
0800-1600	SF	3	None	MODO	4	32.65507, -115.66937

UltraSystems
environmental management planning

ISECS POST-CONSTRUCTION MONITORING - AVIAN MORTALITY FORM

Project Name: Imperial Solar Energy South City: Calexico County: Imperial Township/Range/Section: T:17S, R:13E, Sec:17, 20, & 21
Date (mm/dd/yyyy): 2/4/2014 Observer: J.Castle and C.Burge Weather: partly overcast, high clouds 50-70 degrees

Time: Start/End	Solar Field (SF) Collection System (CS)	Transect #	Unique Carcass ID	Species	Carcass Condition	GPS Coordinates (NAD 83)
0800-1530	SF	3	None	MODO	4	32.65507, -115.66937

ISECS POST-CONSTRUCTION MONITORING - AVIAN MORTALITY FORM

Project Name: Imperial Solar Energy South City: Calexico County: Imperial Township/Range/Section: T:17S, R:13E, Sec:17, 20, & 21
Date (mm/dd/yyyy): 2/5/2014 Observer: J.Castle and C.Burge Weather: Sunny 55-72 degrees

Time: Start/End	Solar Field (SF) Collection System (CS)	Transect #	Unique Carcass ID	Species	Carcass Condition	GPS Coordinates (NAD 83)
0750-1500	SF	3	None	MODO	4	32.65507, -115.66937

ISECS POST-CONSTRUCTION MONITORING - AVIAN MORTALITY FORM

Project Name: Imperial Solar Energy South City: Calexico County: Imperial Township/Range/Section: T:17S, R:13E, Sec:17, 20, & 21
Date (mm/dd/yyyy): 2/6/2014 Observer: H.Flores and G.Machal Weather: overcast 54 degrees

Time: Start/End	Solar Field (SF) Collection System (CS)	Transect #	Unique Carcass ID	Species	Carcass Condition	GPS Coordinates (NAD 83)
800	SF	3	None	MODO	4	32.66288, -115.66788
	SF	5	None	MODO	4	32.65507, - 115.66937

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

ISECS POST-CONSTRUCTION MONITORING - AVIAN MORTALITY FORM

Project Name: Imperial Solar Energy South   City: Calexico   County: Imperial   Township/Range/Section: T:17S, R:13E, Sec:17, 20, & 21
Date (mm/dd/yyyy): 2/7/2014   Observer: H.Flores and G.Machal   Weather: sunny, partly cloudy 64-75 degrees

Time: Start/End	Solar Field (SF) Collection System (CS)	Transect #	Unique Carcass ID	Species	Carcass Condition	GPS Coordinates (NAD 83)
0825-1440	SF	3	None	MODO	4	32.66288, -115.66788
	SF	5	None	MODO	4	32.65507, -115.66937

UltraSystems
environmental management planning

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

ISECS POST-CONSTRUCTION MONITORING - AVIAN MORTALITY FORM

Project Name: Imperial Solar Energy South City: Calexico County: Imperial Township/Range/Section: T:17S, R:13E, Sec:17, 20, & 21
Date (mm/dd/yyyy): 2/9/2014 Observer: J.Castle and C.Burge Weather: Clear, high clouds 52-78 degrees

Time: Start/End	Solar Field (SF) Collection System (CS)	Transect #	Unique Carcass ID	Species	Carcass Condition	GPS Coordinates (NAD 83)
0800-1700	SF	3	None	MODO	4	32.66288, -115.66788
	SF	5	None	MODO	4	32.65507, -115.66937

UltraSystems
environmental management planning

ISECS POST-CONSTRUCTION MONITORING - AVIAN MORTALITY FORM

Project Name: Imperial Solar Energy South City: Calexico County: Imperial Township/Range/Section: T:17S, R:13E, Sec:17, 20, & 21

Date (mm/dd/yyyy): 2/10/2014 Observer: J.Castle and C.Burge Weather: slight overcast, high clouds 65 degrees

Time: Start/End	Solar Field (SF) Collection System (CS)	Transect #	Unique Carcass ID	Species	Carcass Condition	GPS Coordinates (NAD 83)
0900-1600	SF	3	None	MODO	4	32.66288, -115.66788

UltraSystems
environmental management planning

AVIAN FATALITY MONITORING FORM

Directions: This form is to be completed per the obligations set in the ISEC South Avian and Bat Protection Plan, Section 6.1. The form should be completed when a fatality is sighted on the project site or adjacent properties. Each fatality observation made for the day should be reported on a separate form. At the end of each site visit day, forms should be submitted to CSolar IV South, LLC.

Project Name: Imperial Solar Energy Center South

Date (mm/dd/yyyy): 2/17/2014

Name of Monitor: Kris Halford

Start Time: 7am ☒ AM ☐ PM

End Time: 14:00 ☐ AM ☒ PM

GENERAL LOCATION

City: Calexico

County: Imperial

Township/Range/Section: T: 17S, R: 13E, Sec: 17, 20, & 21

1. SPECIES INFORMATION

Common Name: Cattle Egret

Condition of Bird? ☑ Dead ☐ Injured

Cause of Death/Injury: ☐ Panel Strike ☐ Linel Strike ☐ Electrocution ☑ Other

Is the species a Raptor*? ☐ Yes ☒ No

*Raptors are birds of prey - i.e. Hawks, Eagles, Falcons, Owls are characterized by large talons and hooked bills

****Raptor fatalities must be reported to CSolar immediately****
Contact: Mary Zgoda at 402-938-1662 (office) or 402-203-2357 (cell)

Evidence/Description of Injury:

Unable to tell what caused death, partially consumed by preditor

2. LOCATION OF FATALITY

Location Description (i.e. Block, Access Road, etc.): See below

Block 2 By PCS 3 and 6

GPS Location

Latitude (Decimal Degrees; e.g. 32.56832): N/A

Longitude (Decimal Degrees; e.g. -115.45448): N/A

GPS coordinate system to be used: WGS 84 N/A

Action Taken (Do Not Remove Bird): Took photos and left bird in place

COMMENTS
Include weather or other pertinent information

clear day - no storms in days previous

PHOTO ANGLE 1 (Include Description)

Photo Description

PHOTO ANGLE 2 (Include Description)

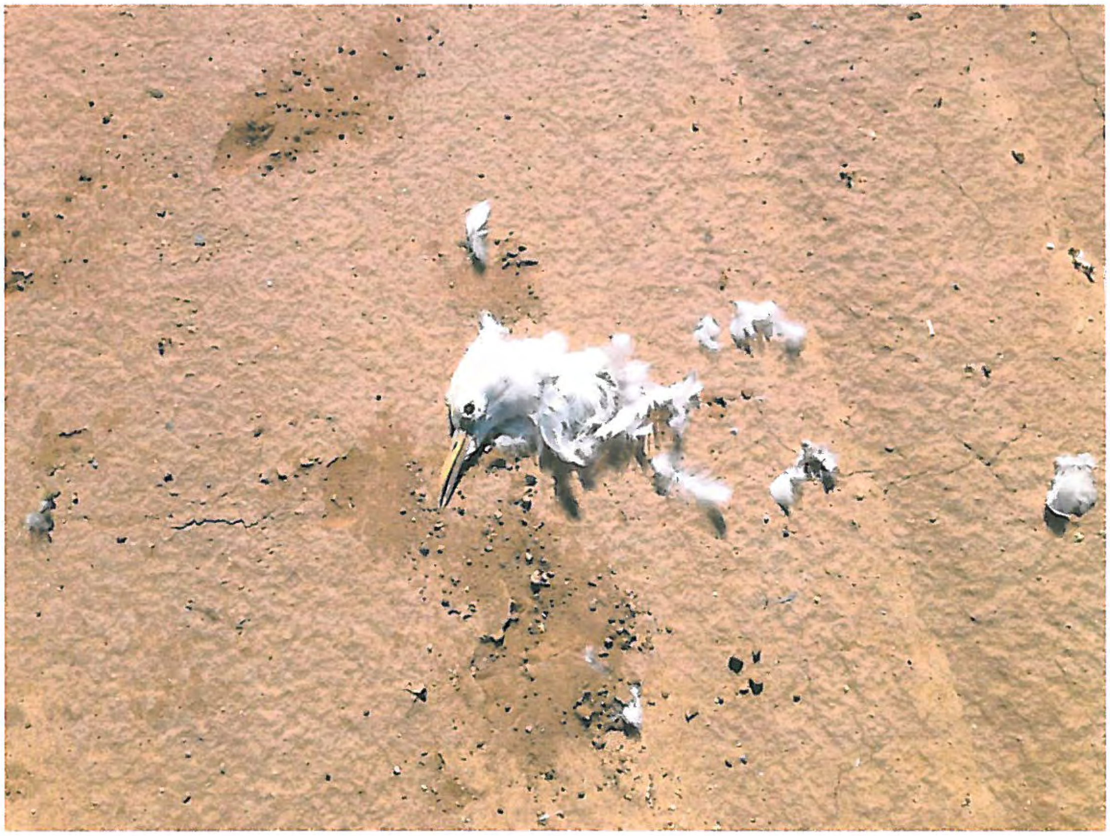
Photo Description:

Signature: Krystle Schwer Signed on behalf of Kris Halford

Date: 2/17/2014

UltraSystems
environmental management planning

16431 Scientific Way
Irvine, CA 92618-4355
Phone: (949)-788-4900 Fax: (949) 788-4901



This was found in the area of Block 2 PCS 3 & 6.

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

UPS CampusShip: View/Print Label

1. **Ensure there are no other shipping or tracking labels attached to your package.** Select the Print button on the print dialog box that appears. Note: If your browser does not support this function select Print from the File menu to print the label.

2. **Fold the printed sheet containing the label at the line so that the entire shipping label is visible. Place the label on a single side of the package and cover it completely with clear plastic shipping tape. Do not cover any seams or closures on the package with the label.** Place the label in a UPS Shipping Pouch. If you do not have a pouch, affix the folded label using clear plastic shipping tape over the entire label.

3. **GETTING YOUR SHIPMENT TO UPS**
   UPS locations include the UPS Store®, UPS drop boxes, UPS customer centers, authorized retail outlets and UPS drivers.
   Schedule a same day or future day Pickup to have a UPS driver pickup all your CampusShip packages.
   Hand the package to any UPS driver in your area.
   Take your package to any location of The UPS Store®, UPS Drop Box, UPS Customer Center, UPS Alliances (Office Depot® or Staples®) or Authorized Shipping Outlet near you. Items sent via UPS Return Services(SM) (including via Ground) are also accepted at Drop Boxes. To find the location nearest you, please visit the Resources area of CampusShip and select UPS Locations.

   Customers with a Daily Pickup
   Your driver will pickup your shipment(s) as usual.

FOLD HERE

DEE SVATOS
402-691-9561
TENASKA
14302 FNB PARKWAY
OMAHA NE 68154

0.0 LBS LTR 1 OF 1

SHIP TO:
MR. PETE SORENSEN
U.S. FISH AND WILDLIFE
SUITE 208
777 E. TAHQUITZ CANYON WAY
PALM SPRINGS OFFICE
PALM SPRINGS CA 92262-0100

CA 922 0-01

UPS NEXT DAY AIR SAVER 1P

TRACKING #: 1Z 58A E49 13 9665 9644

BILLING: P/P

Reference #1: 9017

CS 16.2.03. WNTIE90 48.0A 01/2014

9017

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Shipment Receipt

Transaction Date: 16 Apr 2014 **Tracking Number:** 1Z58AE491396659644

1 Address Information

Ship To:
U.S. Fish and Wildlife
Mr. Pete Sorensen
Palm Springs Office
777 E. Tahquitz Canyon Way
Suite 208
PALM SPRINGS CA 922620100

Ship From:
Tenaska
DEE SVATOS
14302 FNB Parkway
Omaha NE 68154
Telephone:402-691-9561

Return Address:
Tenaska
DEE SVATOS
14302 FNB Parkway
Omaha NE 68154
Telephone:402-691-9561

2 Package Information

	Weight	Dimensions / Packaging	Declared Value	Reference Numbers
1.	Letter (Letter billable)	UPS Letter		Reference #1 - 9017 Reference # 2 - Reference # 3 -

3 UPS Shipping Service and Shipping Options

Service:	UPS Next Day Air Saver
Guaranteed By:	3:00 PM Thursday, Apr 17, 2014
Shipping Fees Subtotal:	**33.02 USD**
Transportation	29.75 USD
Fuel Surcharge	3.27 USD

4 Payment Information

Bill Shipping Charges to: Shipper's Account 58AE49

Daily rates were applied to this shipment

Total Charged: **33.02 USD**

Note: Your invoice may vary from the displayed reference rates.

* For delivery and guarantee information, see the UPS Service Guide. To speak to a customer service representative, call 1-800-PICK-UPS for domestic services and 1-800-782-7892 for international services.

Additional Documentation Attachment to Comment 2-P1
Attachment I-6

Proof of Delivery

Close Window

Dear Customer,

This notice serves as proof of delivery for the shipment listed below.

Tracking Number:	1Z58AE491396659644
Reference Number(s):	9017
Service:	UPS Next Day Air Saver®
Shipped/Billed On:	04/16/2014
Delivered On:	04/17/2014 12:58 P.M.
Delivered To:	PALM SPRINGS, CA, US
Signed By:	JOSH
Left At:	Inside Delivery

Thank you for giving us this opportunity to serve you.

Sincerely,

UPS

Tracking results provided by UPS: 04/21/2014 10:57 A.M. ET

Print This Page Close Window

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

UPS CampusShip: View/Print Label

1. **Ensure there are no other shipping or tracking labels attached to your package.** Select the Print button on the print dialog box that appears. Note: If your browser does not support this function select Print from the File menu to print the label.

2. **Fold the printed sheet containing the label at the line so that the entire shipping label is visible. Place the label on a single side of the package and cover it completely with clear plastic shipping tape. Do not cover any seams or closures on the package with the label.** Place the label in a UPS Shipping Pouch. If you do not have a pouch, affix the folded label using clear plastic shipping tape over the entire label.

3. **GETTING YOUR SHIPMENT TO UPS**
   UPS locations include the UPS Store®, UPS drop boxes, UPS customer centers, authorized retail outlets and UPS drivers.
   Schedule a same day or future day Pickup to have a UPS driver pickup all your CampusShip packages.
   Hand the package to any UPS driver in your area.
   Take your package to any location of The UPS Store®, UPS Drop Box, UPS Customer Center, UPS Alliances (Office Depot® or Staples®) or Authorized Shipping Outlet near you. Items sent via UPS Return Services(SM) (including via Ground) are also accepted at Drop Boxes. To find the location nearest you, please visit the Resources area of CampusShip and select UPS Locations.

   Customers with a Daily Pickup
   Your driver will pickup your shipment(s) as usual.

FOLD HERE

DEE SVATOS
402-691-9561
TENASKA
14302 FNB PARKWAY
OMAHA NE 68154

0.0 LBS LTR 1 OF 1

SHIP TO:
MR. PETER E. GODFREY
BUREAU OF LAND MANAGEMENT
22835 CALLE SAN JUAN DE LOS LAGOS
MORENO VALLEY CA 92553-9046

CA 924 0-05

UPS NEXT DAY AIR SAVER 1P

TRACKING #: 1Z 58A E49 13 9997 6859

BILLING: P/P

Reference #1: 9017

CS 16 2.03. WNTIE90 48.0A 01/2014

™

9017

Shipment Receipt

Transaction Date: 16 Apr 2014 **Tracking Number:** 1Z58AE491399976859

1 Address Information

Ship To:
Bureau of Land Management
Mr. Peter E. Godfrey
22835 Calle San Juan De Los Lagos
MORENO VALLEY CA 925539046

Ship From:
Tenaska
DEE SVATOS
14302 FNB Parkway
Omaha NE 68154
Telephone:402-691-9561

Return Address:
Tenaska
DEE SVATOS
14302 FNB Parkway
Omaha NE 68154
Telephone:402-691-9561

2 Package Information

	Weight	Dimensions / Packaging	Declared Value	Reference Numbers
1.	Letter (Letter billable)	UPS Letter		Reference #1 - 9017 Reference # 2 - Reference # 3 -

3 UPS Shipping Service and Shipping Options

Service:	UPS Next Day Air Saver
Guaranteed By:	3:00 PM Thursday, Apr 17, 2014
Shipping Fees Subtotal:	**33.02 USD**
Transportation	29.75 USD
Fuel Surcharge	3.27 USD

4 Payment Information

Bill Shipping Charges to: Shipper's Account 58AE49

Daily rates were applied to this shipment

Total Charged: **33.02 USD**

Note: Your invoice may vary from the displayed reference rates.

* For delivery and guarantee information, see the UPS Service Guide. To speak to a customer service representative, call 1-800-PICK-UPS for domestic services and 1-800-782-7892 for international services.

Additional Documentation Attachment to Comment 2-F
Attachment I-6

Proof of Delivery

Close Window

Dear Customer,

This notice serves as proof of delivery for the shipment listed below.

Tracking Number: 1Z58AE491399976859
Reference Number(s): 9017
Service: UPS Next Day Air Saver®
Shipped/Billed On: 04/16/2014
Delivered On: 04/17/2014 11:15 A.M.
Delivered To: MORENO VALLEY, CA, US
Signed By: CINDY
Left At: Front Desk

Thank you for giving us this opportunity to serve you.

Sincerely,

UPS

Tracking results provided by UPS: 04/21/2014 10:58 A.M. ET

Print This Page Close Window

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

UPS CampusShip: View/Print Label

1. **Ensure there are no other shipping or tracking labels attached to your package.** Select the Print button on the print dialog box that appears. Note: If your browser does not support this function select Print from the File menu to print the label.

2. **Fold the printed sheet containing the label at the line so that the entire shipping label is visible. Place the label on a single side of the package and cover it completely with clear plastic shipping tape. Do not cover any seams or closures on the package with the label.** Place the label in a UPS Shipping Pouch. If you do not have a pouch, affix the folded label using clear plastic shipping tape over the entire label.

3. **GETTING YOUR SHIPMENT TO UPS**
   UPS locations include the UPS Store®, UPS drop boxes, UPS customer centers, authorized retail outlets and UPS drivers.
   Schedule a same day or future day Pickup to have a UPS driver pickup all your CampusShip packages.
   Hand the package to any UPS driver in your area.
   Take your package to any location of The UPS Store®, UPS Drop Box, UPS Customer Center, UPS Alliances (Office Depot® or Staples®) or Authorized Shipping Outlet near you. Items sent via UPS Return Services(SM) (including via Ground) are also accepted at Drop Boxes. To find the location nearest you, please visit the Resources area of CampusShip and select UPS Locations.

   Customers with a Daily Pickup
   Your driver will pickup your shipment(s) as usual.

FOLD HERE

DEE SVATOS
402-691-9561
TENASKA
14302 FNB PARKWAY
OMAHA NE 68154

0.0 LBS LTR 1 OF 1

SHIP TO:
MR. ANDREW TROUETTE
BUREAU OF LAND MANAGEMENT
1661 S 4TH STREET
EL CENTRO FIELD OFFICE
EL CENTRO CA 92243-4561

CA 922 1-01

UPS NEXT DAY AIR SAVER 1P

TRACKING #: 1Z 58A E49 13 9942 4463

BILLING: P/P

Reference #1: 9017

CS 16.2 03 WNTIE90 48 0A 01/2014

9017

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Shipment Receipt

Transaction Date: 16 Apr 2014 **Tracking Number:** 1Z58AE491399424463

1 Address Information

Ship To:	**Ship From:**	**Return Address:**
Bureau of Land Management	Tenaska	Tenaska
Mr. Andrew Trouette	DEE SVATOS	DEE SVATOS
El Centro Field Office	14302 FNB Parkway	14302 FNB Parkway
1661 S 4th Street	Omaha NE 68154	Omaha NE 68154
EL CENTRO CA 922434561	Telephone:402-691-9561	Telephone:402-691-9561

2 Package Information

	Weight	Dimensions / Packaging	Declared Value	Reference Numbers
1.	Letter (Letter billable)	UPS Letter		Reference #1 - 9017 Reference # 2 - Reference # 3 -

3 UPS Shipping Service and Shipping Options

Service: UPS Next Day Air Saver
Guaranteed By: 3:00 PM Thursday, Apr 17, 2014
Shipping Fees Subtotal: **33.02 USD**
Transportation 29.75 USD
Fuel Surcharge 3.27 USD

4 Payment Information

Bill Shipping Charges to: Shipper's Account 58AE49

Daily rates were applied to this shipment

Total Charged: **33.02 USD**

Note: Your invoice may vary from the displayed reference rates.

* For delivery and guarantee information, see the UPS Service Guide. To speak to a customer service representative, call 1-800-PICK-UPS for domestic services and 1-800-782-7892 for international services.

Proof of Delivery

Close Window

Dear Customer,

This notice serves as proof of delivery for the shipment listed below.

Tracking Number:	1Z58AE491399424463
Reference Number(s):	9017
Service:	UPS Next Day Air Saver®
Shipped/Billed On:	04/16/2014
Delivered On:	04/17/2014 2:58 P.M.
Delivered To:	EL CENTRO, CA, US
Signed By:	BLEVINS
Left At:	Receiver

Thank you for giving us this opportunity to serve you.

Sincerely,

UPS

Tracking results provided by UPS: 04/21/2014 10:58 A.M. ET

Print This Page Close Window

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

UPS CampusShip: View/Print Label

1. **Ensure there are no other shipping or tracking labels attached to your package.** Select the Print button on the print dialog box that appears. Note: If your browser does not support this function select Print from the File menu to print the label.

2. **Fold the printed sheet containing the label at the line so that the entire shipping label is visible. Place the label on a single side of the package and cover it completely with clear plastic shipping tape. Do not cover any seams or closures on the package with the label.** Place the label in a UPS Shipping Pouch. If you do not have a pouch, affix the folded label using clear plastic shipping tape over the entire label.

3. **GETTING YOUR SHIPMENT TO UPS**
   UPS locations include the UPS Store®, UPS drop boxes, UPS customer centers, authorized retail outlets and UPS drivers.
   Schedule a same day or future day Pickup to have a UPS driver pickup all your CampusShip packages.
   Hand the package to any UPS driver in your area.
   Take your package to any location of The UPS Store®, UPS Drop Box, UPS Customer Center, UPS Alliances (Office Depot® or Staples®) or Authorized Shipping Outlet near you. Items sent via UPS Return Services(SM) (including via Ground) are also accepted at Drop Boxes. To find the location nearest you, please visit the Resources area of CampusShip and select UPS Locations.

   Customers with a Daily Pickup
   Your driver will pickup your shipment(s) as usual.

FOLD HERE

DEE SVATOS
402-691-9561
TENASKA
14302 FNB PARKWAY
OMAHA NE 68154

0.0 LBS LTR 1 OF 1

SHIP TO:
MS. MAGDALENA RODRIGUEZ
CALIFORNIA DEPT OF FISH & WILDLIFE
SUITE C220
3602 INLAND EMPIRE BLVD
INLAND DESERTS REGION
ONTARIO CA 91764-4913

CA 916 9-13

UPS NEXT DAY AIR SAVER 1P

TRACKING #: 1Z 58A E49 13 9629 8472

BILLING: P/P

Reference #1: 9017

GS 16.2.03 WNTIE90 48.0A 01/2014

9017

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Shipment Receipt

Transaction Date: 16 Apr 2014 **Tracking Number:** 1Z58AE491396298472

1 Address Information

Ship To:
California Dept of Fish & Wildlife
Ms. Magdalena Rodriguez
Inland Deserts Region
3602 Inland Empire Blvd
Suite C220
ONTARIO CA 917644913

Ship From:
Tenaska
DEE SVATOS
14302 FNB Parkway
Omaha NE 68154
Telephone:402-691-9561

Return Address:
Tenaska
DEE SVATOS
14302 FNB Parkway
Omaha NE 68154
Telephone:402-691-9561

2 Package Information

	Weight	Dimensions / Packaging	Declared Value	Reference Numbers
1.	Letter (Letter billable)	UPS Letter		Reference #1 - 9017 Reference # 2 - Reference # 3 -

3 UPS Shipping Service and Shipping Options

Service:	UPS Next Day Air Saver
Guaranteed By:	3:00 PM Thursday, Apr 17, 2014
Shipping Fees Subtotal:	**33.02 USD**
Transportation	29.75 USD
Fuel Surcharge	3.27 USD

4 Payment Information

Bill Shipping Charges to: Shipper's Account 58AE49

Daily rates were applied to this shipment

Total Charged: **33.02 USD**

Note: Your invoice may vary from the displayed reference rates.

* For delivery and guarantee information, see the UPS Service Guide. To speak to a customer service representative, call 1-800-PICK-UPS for domestic services and 1-800-782-7892 for international services.

Additional Documentation Attachment to Comment 2-F-1
Attachment I-6

Proof of Delivery

Close Window

Dear Customer,

This notice serves as proof of delivery for the shipment listed below.

Tracking Number:	1Z58AE491396298472
Reference Number(s):	9017
Service:	UPS Next Day Air Saver®
Shipped/Billed On:	04/16/2014
Delivered On:	04/18/2014 11:26 A.M.
Delivered To:	ONTARIO, CA, US
Signed By:	BANDA
Left At:	Front Desk

Thank you for giving us this opportunity to serve you.

Sincerely,

UPS

Tracking results provided by UPS: 04/21/2014 10:59 A.M. ET

Print This Page Close Window

UPS CampusShip: View/Print Label

1. **Ensure there are no other shipping or tracking labels attached to your package.** Select the Print button on the print dialog box that appears. Note: If your browser does not support this function select Print from the File menu to print the label.

2. **Fold the printed sheet containing the label at the line so that the entire shipping label is visible. Place the label on a single side of the package and cover it completely with clear plastic shipping tape. Do not cover any seams or closures on the package with the label.** Place the label in a UPS Shipping Pouch. If you do not have a pouch, affix the folded label using clear plastic shipping tape over the entire label.

3. **GETTING YOUR SHIPMENT TO UPS**
   UPS locations include the UPS Store®, UPS drop boxes, UPS customer centers, authorized retail outlets and UPS drivers.
   Schedule a same day or future day Pickup to have a UPS driver pickup all your CampusShip packages.
   Hand the package to any UPS driver in your area.
   Take your package to any location of The UPS Store®, UPS Drop Box, UPS Customer Center, UPS Alliances (Office Depot® or Staples®) or Authorized Shipping Outlet near you. Items sent via UPS Return Services(SM) (including via Ground) are also accepted at Drop Boxes. To find the location nearest you, please visit the Resources area of CampusShip and select UPS Locations.

   Customers with a Daily Pickup
   Your driver will pickup your shipment(s) as usual.

FOLD HERE

DEE SVATOS
402-691-9561
TENASKA
14302 FNB PARKWAY
OMAHA NE 68154

0.0 LBS LTR 1 OF 1

SHIP TO:
MS. PATRICIA VALENZUELA
IMPERIAL COUNTY PLANNING & DEV DEPT
801 WEST MAIN STREET
EL CENTRO CA 92243-2811

CA 922 1-01

UPS NEXT DAY AIR SAVER 1P

TRACKING #: 1Z 58A E49 13 9793 4880

BILLING: P/P

Reference #1: 9017

CS 16.2.03. WNTIE90 48.0A 01/2014

9017

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Shipment Receipt

Transaction Date: 16 Apr 2014 **Tracking Number:** 1Z58AE491397934880

1 Address Information

Ship To:
Imperial County Planning & Dev Dept
Ms. Patricia Valenzuela
801 West Main Street
EL CENTRO CA 922432811

Ship From:
Tenaska
DEE SVATOS
14302 FNB Parkway
Omaha NE 68154
Telephone:402-691-9561

Return Address:
Tenaska
DEE SVATOS
14302 FNB Parkway
Omaha NE 68154
Telephone:402-691-9561

2 Package Information

	Weight	Dimensions / Packaging	Declared Value	Reference Numbers
1.	Letter (Letter billable)	UPS Letter		Reference #1 - 9017 Reference # 2 - Reference # 3 -

3 UPS Shipping Service and Shipping Options

Service:	UPS Next Day Air Saver
Guaranteed By:	3:00 PM Thursday, Apr 17, 2014
Shipping Fees Subtotal:	**33.02 USD**
Transportation	29.75 USD
Fuel Surcharge	3.27 USD

4 Payment Information

Bill Shipping Charges to: Shipper's Account 58AE49

Daily rates were applied to this shipment

Total Charged: **33.02 USD**

Note: Your invoice may vary from the displayed reference rates.
* For delivery and guarantee information, see the UPS Service Guide. To speak to a customer service representative, call 1-800-PICK-UPS for domestic services and 1-800-782-7892 for international services.

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Proof of Delivery

Close Window

Dear Customer,

This notice serves as proof of delivery for the shipment listed below.

Tracking Number:	1Z58AE491397934880
Reference Number(s):	9017
Service:	UPS Next Day Air Saver®
Shipped/Billed On:	04/16/2014
Delivered On:	04/17/2014 11:47 A.M.
Delivered To:	EL CENTRO, CA, US
Signed By:	SILLAS
Left At:	Office

Thank you for giving us this opportunity to serve you.

Sincerely,

UPS

Tracking results provided by UPS: 04/21/2014 10:59 A.M. ET

Print This Page Close Window

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

CSOLAR IV SOUTH, LLC

14302 FNB Parkway
Omaha, Nebraska 68154
402-691-9500
www.tenaska.com

April 17, 2014

Pete Sorensen
U.S. Fish and Wildlife – Palm Springs Office
777 E. Tahquitz Canyon Way, Suite 208
Palm Springs, CA 92262

Peter E. Godfrey
Bureau of Land Management
22835 Calle San Juan De Los Lagos
Moreno Valley, CA 92553

Via Overnight Mail

RE: Imperial Solar Energy Center South
March 2014 Post-Construction Avian Mortality Monitoring Report

Mr. Sorensen and Mr. Godfrey:

In accordance with the Avian and Bat Protection Plan, enclosed is the March 2014 Post-Construction Avian Mortality Monitoring Report for Imperial Solar Energy Center South.

If you have any questions regarding this submittal, please do not hesitate to contact me at (402) 938-1662 or mzgoda@tenaska.com.

Sincerely,

CSOLAR IV SOUTH, LLC
A Delaware Limited Liability Company

Mary K. Zgoda
Environmental Compliance Specialist

Enclosure

cc: Andrew Trouette, Bureau of Land Management (with enclosure)
Magdalena Rodriguez, California Department of Fish and Wildlife (with enclosure)
Patricia Valenzuela, Imperial County Planning & Development Department (with enclosure)

Imperial Solar Energy Center South

Post-construction

Avian Mortality Monitoring Report

March 2014

Prepared for:

CSOLAR IV SOUTH, LLC

Prepared by:

UltraSystems
environmental•management•planning

16431 Scientific Way
Irvine, CA 92618

Prepared on:

April 11, 2014

REPORTING PERIOD: March 3, 2014 through March 9, 2014

REPORT: Avian Mortality Monitoring Report #5

This report summarizes the Avian Mortality Surveys conducted by UltraSystems biological staff at the Imperial Solar Energy Center (ISEC) South facility (private land). This is the fifth post-construction avian mortality monthly report for the ISEC South facility, and is prepared in accordance with the Avian and Bat Protection Plan, Imperial Solar Energy Center South (CH2MHill 2011) and conditions of the U.S. Fish and Wildlife Service–Pacific Southwest Region Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach (Nicolai, et al. 2011). Survey data sheets are included in **Appendix A.**

SURVEY METHODOLOGY

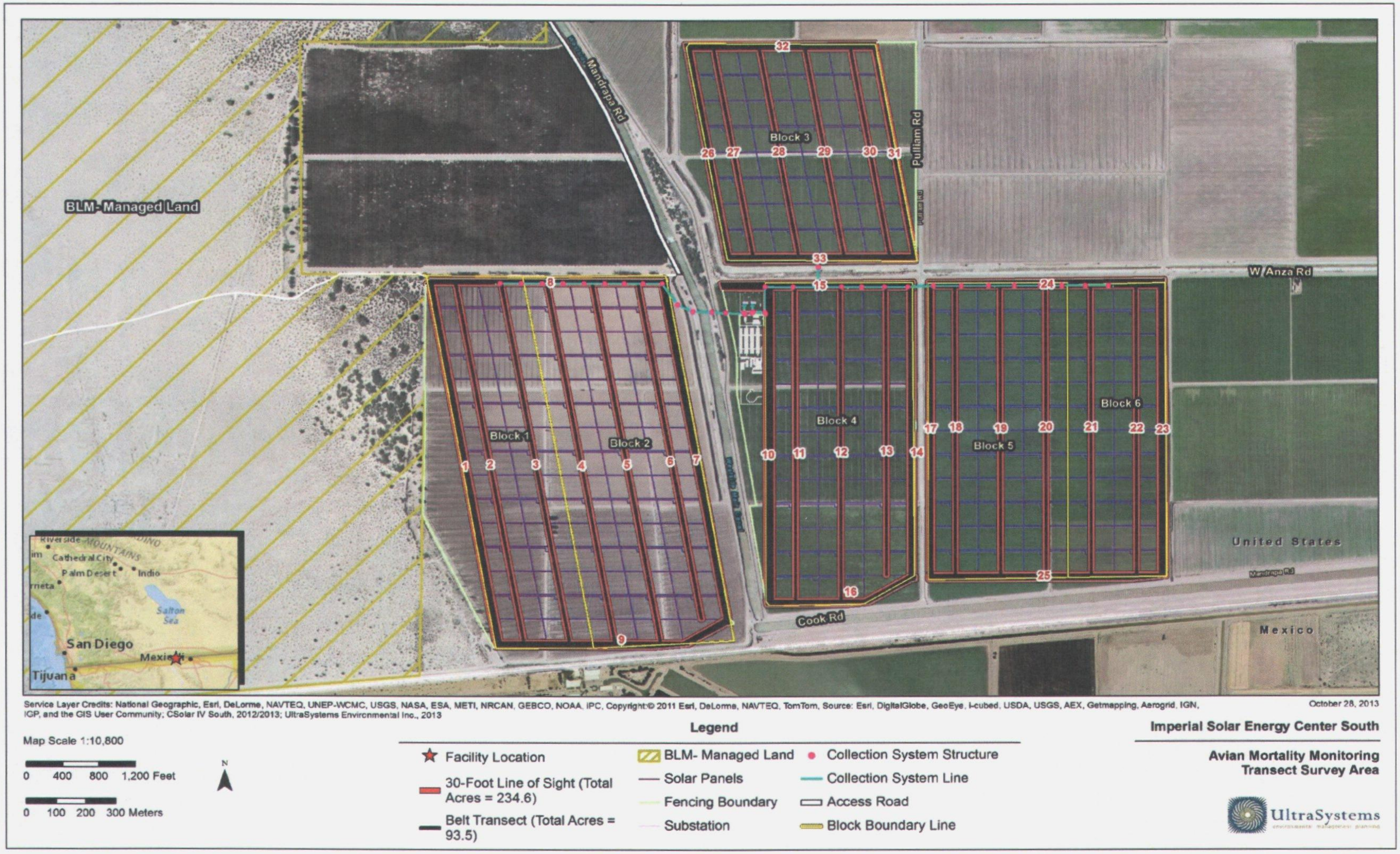
During the month of March 2014, avian mortality surveys were conducted in the solar panel fields and along the power collection system. These surveys were conducted in accordance with the methods described by the U.S. Fish and Wildlife Service (Nicolai, et al.), with the following modification: surveys were conducted by two observers in a vehicle traveling at a rate that did not exceed three miles per hour (approximately walking speed).

A systematic search pattern was selected using transects within the solar panel fields, as there are existing access roads that run north to south between the solar panels. There were 25 north-south transects used, as illustrated in **Figure 1.** In order for the survey area to be representative of the entire project site, either odd or even-numbered transect lines were selected at random. This insured that no part of the project area would be over or under-represented. A coin toss decided upon odd-numbered transect lines (see **Figure 2**). These transects are 1, 3, 5, 7, 11, 13, 17, 19, 21, 23, 27, 29 and 31. The entire power collection system line was surveyed, as well.

The Avian and Bat Protection Plan states to survey 10% of the solar facility. The ISEC South solar facility has a total of 946.6 acres. The odd transects that were selected account for 95 acres of the facility based on a 30-foot line of sight while driving the transect lines. Therefore, the 10% coverage requirement for these surveys is met, and not all transects need to be selected.

While driving these north-south transects, observers surveyed west and east down each solar panel row, viewing a minimum of 13 feet on each side of the vehicle. The average total width of each transect was a minimum of 95 feet. If a possible avian mortality was spotted, observers would verify the find using binoculars. Mortalities were recorded on two data forms; one for the solar panel field and the other for the power collection system line (see Appendix 1). The survey period was conducted for seven consecutive days, and at least 10% of the solar field was surveyed. Surveys were conducted beginning at 8 a.m. and were completed by 2 p.m. Surveys were only conducted on days with no rain or fog, and on days where wind velocities did not exceed 20 miles per hour.

Figure 1
IMPERIAL SOLAR ENERGY CENTER SOUTH – AVIAN MORTALITY MONITORING TRANSECT SURVEY AREA



Service Layer Credits: National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, IPC, Copyright© 2011 Esri, DeLorme, NAVTEQ, TomTom, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community; CSolar IV South, 2012/2013; UltraSystems Environmental Inc., 2013

October 28, 2013

Figure 2

IMPERIAL SOLAR ENERGY CENTER SOUTH – POST-CONSTRUCTION AVIAN MORTALITIES

Document Path: J:\Projects\5817_Tenaska_CSolar_Imperial_Solar_Energy_Center_South\MXDs\ISEC_South\TO_33_Avian_and_Bat_Protection_Plan\5817_ISEC_South_2014_03_March_Avian_Mortalities_11x17_2014_03_31.mxd

March 31, 2014

Service Layer Credits: National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC, Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community, Copyright:© 2013 Esri, DeLorme, NAVTEQ, TomTom, Copyright:© 2011 Esri, DeLorme, NAVTEQ, TomTom; CSolar IV South, 2012; UltraSystems Environmental Inc., 2013

Map Scale 1:10,800

0 400 800 1,200 Feet

0 100 200 300 Meters

N

Legend

- ★ Facility Location
- 🟥 30-Foot Line of Sight (Total Acres = 95.0)
- — Belt Transect (Total Acres = 35.2)
- ▲ Avian Mortality
- ▨ BLM- Managed Land
- — Solar Panels
- — Fencing Boundary
- — Substation
- ● Collection System Structure
- — Collection System Line
- ☐ Access Road
- — Block Boundary Line

Imperial Solar Energy Center South

Post-Construction
Avian Mortalities - March 2014

UltraSystems

Data Collection Methods

Observers drove the transect lines in pairs (not exceeding three miles per hour), with each observer looking between solar panels along each respective row.

At each detection of an avian carcass the following information was recorded:

- Transect Number
- Unique carcass I.D.

Colored embroidery thread or similar material was used to uniquely identify each carcass. The embroidery thread was attached to legs as part of a unique identification, and the following information was recorded in the carcass I.D.

- Leg: L = Left; R = Right
- Color of thread: TN=Tan, GN=Green, BN=Brown, BK=Black, BE=Blue, CR=Copper
- Knots in the thread (number of birds of that specific species found, for that survey): 0=1, 1=2, 2=3, 3=4, 4=5, etc.

As an example, the code LCR00 indicates that the thread was attached to the left foot, the species code indicated by using the copper color thread, and there were no knots, meaning this was the first bird of that specific species found during the survey.

Additional information recorded includes:

- Panel strike Y/N or Line strike Y/N.
- Species (American Ornithologists' Union (AOU) 4-letter species code).
- Carcass Condition:
    1. Fresh (eyes are still wet and not totally sunk into sockets)
    2. Medium (eyes are totally sunk into sockets and breast muscle and viscera still present)
    3. Non-scavenged carcass (a stiff carcass consisting of a dried complete carcass)
    4. Remnant (a dried carcass consisting of non-edible parts)
- GPS Coordinates (NAD 83 Decimal Degrees).
- Cause of death will be determined and recorded if possible, otherwise it will be recorded as unknown. Examples of evidence that could help determine cause of death include: marks on panel where the bird struck, or bird directly below a line, etc.
- Vegetation percent and height estimate.
- Presence or absence of evidence of superheating (singed feathers).

Carcasses, if discovered, were to be left exactly as found.

James Castle (UltraSystems Senior Wildlife Biologist), Charlene Burge, Mike Robinson and Gabriella Machal (UltraSystems Biologists) conducted the surveys during March 2014.

AVIAN MORTALITIES DISCOVERED BY ULTRASYSTEMS

There were two avian mortalities discovered by UltraSystems biologists during the March 2014 survey.

Table 1

Date	Transect Number	Unique Number	Species	GPS Coordinates (NAD 1983)
3/3/14	3	LGN00	SORA[1]	32.66246°, -115.67128°
3/3/14	29	LCR01	SORA	32.67078°, -115.65972°

1. SORA is the four-letter bird species code for Sora.

AVIAN MORTALITIES DISCOVERED BY FACILITY PERSONNEL

There were no avian mortalities discovered by facility personnel during the March 2014 reporting period.

REFERENCES

CH2MHill. 2011. Avian and Bat Protection Plan Imperial Solar Energy Center South, Final.

Dunn, J. and Alderfer, J. 2008. Field Guide to the Birds of Western North America. National Geographic Society, Washington D.C.

Nicolai, C., Abele, S., Beeler H., Doster, R., Kershner, E and McCabe, T. 2011. U.S. Fish and Wildlife Service–Pacific Southwest Region Monitoring Migratory Bird Take at Solar Power Facilities: An Experimental Approach.

APPENDIX 1

BIOLOGICAL MONITORING
DAILY DATA SHEETS

ISECS POST-CONSTRUCTION MONITORING - AVIAN MORTALITY FORM

Project Name: Imperial Solar Energy South City: Calexico County: Imperial Township/Range/Section: T:17S, R:13E, Sec:17, 20, & 21
Date (mm/dd/yyyy): 3/3/2014 Observer: J.Castle and C.Burge Weather:

Time: Start/End	Solar Field (SF) Collectiong System (CS)	Transect #	Unique Carcass ID	Species	Carcass Condition	GPS Coordinates (NAD 83)
0800-1300	SF	3	LGN00	SORA	1	32.66246 115.67128
	SF	29	LCR01	SORA	1	32.67078 115.65972

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

ISECS POST-CONSTRUCTION MONITORING - AVIAN MORTALITY FORM

Project Name: Imperial Solar Energy South City: Calexico County: Imperial Township/Range/Section: T:17S, R:13E, Sec:17, 20, & 21
Date (mm/dd/yyyy): 3/4/2014 Observer: J.Castle and C.Burge Weather:

Time: Start/End	Solar Field (SF) Collectiong System (CS)	Transect #	Unique Carcass ID	Species	Carcass Condition	GPS Coordinates (NAD 83)
0800-1300	SF	3	LGN00	SORA	1	32.66246 115.67128
	SF	29	LCR01	SORA	1	32.67078 115.65972

ISECS POST-CONSTRUCTION MONITORING - AVIAN MORTALITY FORM

Project Name: Imperial Solar Energy South City: Calexico County: Imperial Township/Range/Section: T:17S, R:13E, Sec:17, 20, & 21

Date (mm/dd/yyyy): 3/5/2014 Observer: J.Castle and C.Burge Weather:

Time: Start/End	Solar Field (SF) Collectiong System (CS)	Transect #	Unique Carcass ID	Species	Carcass Condition	GPS Coordinates (NAD 83)
0800-1300	SF	3	LGN00	SORA	1	32.66246 115.67128
	SF	29	LCR01	SORA	1	32.67078 115.65972

ISECS POST-CONSTRUCTION MONITORING - AVIAN MORTALITY FORM

Project Name: Imperial Solar Energy South City: Calexico County: Imperial Township/Range/Section: T:17S, R:13E, Sec:17, 20, & 21
Date (mm/dd/yyyy): 3/6/2014 Observer: Robinson/Machal Weather: Partly Cloudy/0-5mph/80-90F

Time: Start/End	Solar Field (SF) Collectiong System (CS)	Transect #	Unique Carcass ID	Species	Carcass Condition	GPS Coordinates (NAD 83)
9:00am	SF	3	L-GN-00	SORA	2	32.66246, 115.67128
4:00pm	SF	29	L-CR-01	SORA	2	32.67078, 115.65922

ISECS POST-CONSTRUCTION MONITORING - AVIAN MORTALITY FORM

Project Name: Imperial Solar Energy South City: Calexico County: Imperial Township/Range/Section: T:17S, R:13E, Sec:17, 20, & 21
Date (mm/dd/yyyy): 3/7/2014 Observer: Robinson/Machal Weather: Clear/5-10mph/75-90F

Time: Start/End	Solar Field (SF) Collectiong System (CS)	Transect #	Unique Carcass ID	Species	Carcass Condition	GPS Coordinates (NAD 83)
8:20am	SF	3	L-GN-00	SORA	2	32.66246, 115.67128
3:20pm	SF	29	L-CR-01	SORA	2	32.67078, 115.65922

ISECS POST-CONSTRUCTION MONITORING - AVIAN MORTALITY FORM

Project Name: Imperial Solar Energy South City: Calexico County: Imperial Township/Range/Section: T:17S, R:13E, Sec:17, 20, & 21

Date (mm/dd/yyyy): 3/8/2014 Observer: Robinson/Machal Weather: Clear/10-15mph/66-83F

Time: Start/End	Solar Field (SF) Collectiong System (CS)	Transect #	Unique Carcass ID	Species	Carcass Condition	GPS Coordinates (NAD 83)
8:30am	SF	3	L-GN-00	SORA	2	32.66246, 115.67128
3:30pm	SF	29	L-CR-01	SORA	2	32.67078, 115.65922

ISECS POST-CONSTRUCTION MONITORING - AVIAN MORTALITY FORM

Project Name: Imperial Solar Energy South City: Calexico County: Imperial Township/Range/Section: T:17S, R:13E, Sec:17, 20, & 21
Date (mm/dd/yyyy): 3/9/2014 Observer: Robinson/Machal Weather: Clear/5-10mph/59-82F

Time: Start/End	Solar Field (SF) Collectiong System (CS)	Transect #	Unique Carcass ID	Species	Carcass Condition	GPS Coordinates (NAD 83)
7:10am	SF	29	L-CR-01	SORA	2	32.67078, 115.65922
2:10pm						

UPS CampusShip: View/Print Label

1. **Ensure there are no other shipping or tracking labels attached to your package.** Select the Print button on the print dialog box that appears. Note: If your browser does not support this function select Print from the File menu to print the label.

2. **Fold the printed sheet containing the label at the line so that the entire shipping label is visible. Place the label on a single side of the package and cover it completely with clear plastic shipping tape. Do not cover any seams or closures on the package with the label.** Place the label in a UPS Shipping Pouch. If you do not have a pouch, affix the folded label using clear plastic shipping tape over the entire label.

3. **GETTING YOUR SHIPMENT TO UPS**
   UPS locations include the UPS Store®, UPS drop boxes, UPS customer centers, authorized retail outlets and UPS drivers.
   Schedule a same day or future day Pickup to have a UPS driver pickup all your CampusShip packages.
   Hand the package to any UPS driver in your area.
   Take your package to any location of The UPS Store®, UPS Drop Box, UPS Customer Center, UPS Alliances (Office Depot® or Staples®) or Authorized Shipping Outlet near you. Items sent via UPS Return Services(SM) (including via Ground) are also accepted at Drop Boxes. To find the location nearest you, please visit the Resources area of CampusShip and select UPS Locations.

   Customers with a Daily Pickup
   Your driver will pickup your shipment(s) as usual.

FOLD HERE

DEE SVATOS
402-691-9561
TENASKA
14302 FNB PARKWAY
OMAHA NE 68154

0.0 LBS LTR 1 OF 1

SHIP TO:
MR. PETE SORENSEN
U.S. FISH AND WILDLIFE
SUITE 208
777 E. TAHQUITZ CANYON WAY
PALM SPRINGS OFFICE
PALM SPRINGS CA 92262-0100

CA 922 0-01

UPS NEXT DAY AIR SAVER 1P

TRACKING #: 1Z 58A E49 13 9771 2931

BILLING: P/P

Reference #1: 9017

CS 16.2.03. WNTIE90 46.0A 01/2014

9017

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Shipment Receipt

Transaction Date: 17 Apr 2014 **Tracking Number:** 1Z58AE491397712931

1 Address Information

Ship To:
U.S. Fish and Wildlife
Mr. Pete Sorensen
Palm Springs Office
777 E. Tahquitz Canyon Way
Suite 208
PALM SPRINGS CA 922620100

Ship From:
Tenaska
DEE SVATOS
14302 FNB Parkway
Omaha NE 68154
Telephone:402-691-9561

Return Address:
Tenaska
DEE SVATOS
14302 FNB Parkway
Omaha NE 68154
Telephone:402-691-9561

2 Package Information

	Weight	Dimensions / Packaging	Declared Value	Reference Numbers
1.	Letter (Letter billable)	UPS Letter		Reference #1 - 9017 Reference # 2 - Reference # 3 -

3 UPS Shipping Service and Shipping Options

Service:	UPS Next Day Air Saver
Guaranteed By:	3:00 PM Friday, Apr 18, 2014
Shipping Fees Subtotal:	**33.02 USD**
Transportation	29.75 USD
Fuel Surcharge	3.27 USD

4 Payment Information

Bill Shipping Charges to: Shipper's Account 58AE49

Daily rates were applied to this shipment

Total Charged: **33.02 USD**

Note: Your invoice may vary from the displayed reference rates.

* For delivery and guarantee information, see the UPS Service Guide. To speak to a customer service representative, call 1-800-PICK-UPS for domestic services and 1-800-782-7892 for international services.

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Proof of Delivery

Close Window

Dear Customer,

This notice serves as proof of delivery for the shipment listed below.

Tracking Number:	1Z58AE491397712931
Reference Number(s):	9017
Service:	UPS Next Day Air Saver®
Shipped/Billed On:	04/17/2014
Delivered On:	04/18/2014 9:41 A.M.
Delivered To:	PALM SPRINGS, CA, US
Signed By:	ALLEN
Left At:	Office

Thank you for giving us this opportunity to serve you.

Sincerely,

UPS

Tracking results provided by UPS: 04/21/2014 11:02 A.M. ET

Print This Page Close Window

UPS CampusShip: View/Print Label

1. **Ensure there are no other shipping or tracking labels attached to your package.** Select the Print button on the print dialog box that appears. Note: If your browser does not support this function select Print from the File menu to print the label.

2. **Fold the printed sheet containing the label at the line so that the entire shipping label is visible. Place the label on a single side of the package and cover it completely with clear plastic shipping tape. Do not cover any seams or closures on the package with the label.** Place the label in a UPS Shipping Pouch. If you do not have a pouch, affix the folded label using clear plastic shipping tape over the entire label.

3. **GETTING YOUR SHIPMENT TO UPS**
   UPS locations include the UPS Store®, UPS drop boxes, UPS customer centers, authorized retail outlets and UPS drivers.
   Schedule a same day or future day Pickup to have a UPS driver pickup all your CampusShip packages.
   Hand the package to any UPS driver in your area.
   Take your package to any location of The UPS Store®, UPS Drop Box, UPS Customer Center, UPS Alliances (Office Depot® or Staples®) or Authorized Shipping Outlet near you. Items sent via UPS Return Services(SM) (including via Ground) are also accepted at Drop Boxes. To find the location nearest you, please visit the Resources area of CampusShip and select UPS Locations.

   Customers with a Daily Pickup
   Your driver will pickup your shipment(s) as usual.

FOLD HERE

DEE SVATOS
402-691-9561
TENASKA
14302 FNB PARKWAY
OMAHA NE 68154

0.0 LBS LTR 1 OF 1

SHIP TO:
MR. PETER E. GODFREY
BUREAU OF LAND MANAGEMENT
22835 CALLE SAN JUAN DE LOS LAGOS
MORENO VALLEY CA 92553-9046

CA 924 0-05

UPS NEXT DAY AIR SAVER 1P

TRACKING #: 1Z 58A E49 13 9881 9744

BILLING: P/P

Reference #1: 9016

CS 16.2.03. WNTIE90 48 0A 01/2014

9016

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Shipment Receipt

Transaction Date: 17 Apr 2014 **Tracking Number:** 1Z58AE491398819744

1 Address Information

Ship To:
Bureau of Land Management
Mr. Peter E. Godfrey
22835 Calle San Juan De Los Lagos
MORENO VALLEY CA 925539046

Ship From:
Tenaska
DEE SVATOS
14302 FNB Parkway
Omaha NE 68154
Telephone:402-691-9561

Return Address:
Tenaska
DEE SVATOS
14302 FNB Parkway
Omaha NE 68154
Telephone:402-691-9561

2 Package Information

	Weight	Dimensions / Packaging	Declared Value	Reference Numbers
1.	Letter (Letter billable)	UPS Letter		Reference #1 - ~~9016~~ 9017 Reference # 2 - Reference # 3 -

3 UPS Shipping Service and Shipping Options

Service:	UPS Next Day Air Saver
Guaranteed By:	3:00 PM Friday, Apr 18, 2014
Shipping Fees Subtotal:	**33.02 USD**
Transportation	29.75 USD
Fuel Surcharge	3.27 USD

4 Payment Information

Bill Shipping Charges to: Shipper's Account 58AE49

Daily rates were applied to this shipment

Total Charged: **33.02 USD**

Note: Your invoice may vary from the displayed reference rates.
* For delivery and guarantee information, see the UPS Service Guide. To speak to a customer service representative, call 1-800-PICK-UPS for domestic services and 1-800-782-7892 for international services.

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Proof of Delivery

Close Window

Dear Customer,

This notice serves as proof of delivery for the shipment listed below.

Tracking Number:	1Z58AE491398819744
Reference Number(s):	9016
Service:	UPS Next Day Air Saver®
Shipped/Billed On:	04/17/2014
Delivered On:	04/18/2014 12:12 P.M.
Delivered To:	MORENO VALLEY, CA, US
Signed By:	JASMINE
Left At:	Front Desk

Thank you for giving us this opportunity to serve you.

Sincerely,

UPS

Tracking results provided by UPS: 04/21/2014 11:02 A.M. ET

Print This Page Close Window

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

UPS CampusShip: View/Print Label

1. **Ensure there are no other shipping or tracking labels attached to your package.** Select the Print button on the print dialog box that appears. Note: If your browser does not support this function select Print from the File menu to print the label.

2. **Fold the printed sheet containing the label at the line so that the entire shipping label is visible. Place the label on a single side of the package and cover it completely with clear plastic shipping tape. Do not cover any seams or closures on the package with the label.** Place the label in a UPS Shipping Pouch. If you do not have a pouch, affix the folded label using clear plastic shipping tape over the entire label.

3. **GETTING YOUR SHIPMENT TO UPS**
   UPS locations include the UPS Store®, UPS drop boxes, UPS customer centers, authorized retail outlets and UPS drivers.
   Schedule a same day or future day Pickup to have a UPS driver pickup all your CampusShip packages.
   Hand the package to any UPS driver in your area.
   Take your package to any location of The UPS Store®, UPS Drop Box, UPS Customer Center, UPS Alliances (Office Depot® or Staples®) or Authorized Shipping Outlet near you. Items sent via UPS Return Services(SM) (including via Ground) are also accepted at Drop Boxes. To find the location nearest you, please visit the Resources area of CampusShip and select UPS Locations.

   Customers with a Daily Pickup
   Your driver will pickup your shipment(s) as usual.

FOLD HERE

DEE SVATOS
402-691-9561
TENASKA
14302 FNB PARKWAY
OMAHA NE 68154

0.0 LBS LTR 1 OF 1

SHIP TO:
MR. ANDREW TROUETTE
BUREAU OF LAND MANAGEMENT
1661 S 4TH STREET
EL CENTRO FIELD OFFICE
EL CENTRO CA 92243-4561

CA 922 1-01

UPS NEXT DAY AIR SAVER 1P
TRACKING #: 1Z 58A E49 13 9556 0957

BILLING: P/P

Reference #1: 9016

CS 16.2.03. WNTIE90 48.0A 01/2014

9016

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Shipment Receipt

Transaction Date: 17 Apr 2014 **Tracking Number:** 1Z58AE491395560957

1 Address Information

Ship To:	Ship From:	Return Address:
Bureau of Land Management Mr. Andrew Trouette El Centro Field Office 1661 S 4th Street EL CENTRO CA 922434561	Tenaska DEE SVATOS 14302 FNB Parkway Omaha NE 68154 Telephone:402-691-9561	Tenaska DEE SVATOS 14302 FNB Parkway Omaha NE 68154 Telephone:402-691-9561

2 Package Information

	Weight	Dimensions / Packaging	Declared Value	Reference Numbers
1.	Letter (Letter billable)	UPS Letter		Reference #1 - 9016 Reference # 2 - Reference # 3 - 9017

3 UPS Shipping Service and Shipping Options

Service: UPS Next Day Air Saver
Guaranteed By: 3:00 PM Friday, Apr 18, 2014
Shipping Fees Subtotal: **33.02 USD**
Transportation 29.75 USD
Fuel Surcharge 3.27 USD

4 Payment Information

Bill Shipping Charges to: Shipper's Account 58AE49

Daily rates were applied to this shipment

Total Charged: **33.02 USD**

Note: Your invoice may vary from the displayed reference rates.

* For delivery and guarantee information, see the UPS Service Guide. To speak to a customer service representative, call 1-800-PICK-UPS for domestic services and 1-800-782-7892 for international services.

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Proof of Delivery

Close Window

Dear Customer,

This notice serves as proof of delivery for the shipment listed below.

Tracking Number: 1Z58AE491395560957
Reference Number(s): 9016
Service: UPS Next Day Air Saver®
Shipped/Billed On: 04/17/2014
Delivered On: 04/18/2014 2:55 P.M.
Delivered To: EL CENTRO, CA, US
Signed By: BLEVINS
Left At: Receiver

Thank you for giving us this opportunity to serve you.

Sincerely,

UPS

Tracking results provided by UPS: 04/21/2014 11:03 A.M. ET

Print This Page Close Window

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

UPS CampusShip: View/Print Label

1. **Ensure there are no other shipping or tracking labels attached to your package.** Select the Print button on the print dialog box that appears. Note: If your browser does not support this function select Print from the File menu to print the label.

2. **Fold the printed sheet containing the label at the line so that the entire shipping label is visible. Place the label on a single side of the package and cover it completely with clear plastic shipping tape. Do not cover any seams or closures on the package with the label.** Place the label in a UPS Shipping Pouch. If you do not have a pouch, affix the folded label using clear plastic shipping tape over the entire label.

3. **GETTING YOUR SHIPMENT TO UPS**
   UPS locations include the UPS Store®, UPS drop boxes, UPS customer centers, authorized retail outlets and UPS drivers.
   Schedule a same day or future day Pickup to have a UPS driver pickup all your CampusShip packages.
   Hand the package to any UPS driver in your area.
   Take your package to any location of The UPS Store®, UPS Drop Box, UPS Customer Center, UPS Alliances (Office Depot® or Staples®) or Authorized Shipping Outlet near you. Items sent via UPS Return Services(SM) (including via Ground) are also accepted at Drop Boxes. To find the location nearest you, please visit the Resources area of CampusShip and select UPS Locations.

   Customers with a Daily Pickup
   Your driver will pickup your shipment(s) as usual.

FOLD HERE

DEE SVATOS
402-691-9561
TENASKA
14302 FNB PARKWAY
OMAHA NE 68154

0.0 LBS LTR 1 OF 1

SHIP TO:
MS. MAGDALENA RODRIGUEZ
CALIFORNIA DEPT OF FISH & WILDLIFE
SUITE C220
3602 INLAND EMPIRE BLVD
INLAND DESERTS REGION
ONTARIO CA 91764-4913

CA 916 9-13

UPS NEXT DAY AIR SAVER 1P

TRACKING #: 1Z 58A E49 13 9519 2560

BILLING: P/P

Reference #1: 9017

CS 16.2.03 WNTIE90 48.0A 01/2014

9017

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Shipment Receipt

Transaction Date: 17 Apr 2014 **Tracking Number:** 1Z58AE491395192560

1 Address Information

Ship To:	**Ship From:**	**Return Address:**
California Dept of Fish & Wildlife	Tenaska	Tenaska
Ms. Magdalena Rodriguez	DEE SVATOS	DEE SVATOS
Inland Deserts Region	14302 FNB Parkway	14302 FNB Parkway
3602 Inland Empire Blvd	Omaha NE 68154	Omaha NE 68154
Suite C220	Telephone:402-691-9561	Telephone:402-691-9561
ONTARIO CA 917644913		

2 Package Information

	Weight	Dimensions / Packaging	Declared Value	Reference Numbers
1.	Letter (Letter billable)	UPS Letter		Reference #1 - 9017 Reference # 2 - Reference # 3 -

3 UPS Shipping Service and Shipping Options

Service:	UPS Next Day Air Saver
Guaranteed By:	3:00 PM Friday, Apr 18, 2014
Shipping Fees Subtotal:	**33.02 USD**
Transportation	29.75 USD
Fuel Surcharge	3.27 USD

4 Payment Information

Bill Shipping Charges to: Shipper's Account 58AE49

Daily rates were applied to this shipment

Total Charged: **33.02 USD**

Note: Your invoice may vary from the displayed reference rates.

* For delivery and guarantee information, see the UPS Service Guide. To speak to a customer service representative, call 1-800-PICK-UPS for domestic services and 1-800-782-7892 for international services.

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Proof of Delivery

Close Window

Dear Customer,

This notice serves as proof of delivery for the shipment listed below.

Tracking Number:	1Z58AE491395192560
Reference Number(s):	9017
Service:	UPS Next Day Air Saver®
Shipped/Billed On:	04/17/2014
Delivered On:	04/18/2014 11:26 A.M.
Delivered To:	ONTARIO, CA, US
Signed By:	BANDA
Left At:	Front Desk

Thank you for giving us this opportunity to serve you.

Sincerely,

UPS

Tracking results provided by UPS: 04/21/2014 11:03 A.M. ET

Print This Page Close Window

UPS CampusShip: View/Print Label

1. **Ensure there are no other shipping or tracking labels attached to your package.** Select the Print button on the print dialog box that appears. Note: If your browser does not support this function select Print from the File menu to print the label.

2. **Fold the printed sheet containing the label at the line so that the entire shipping label is visible. Place the label on a single side of the package and cover it completely with clear plastic shipping tape. Do not cover any seams or closures on the package with the label.** Place the label in a UPS Shipping Pouch. If you do not have a pouch, affix the folded label using clear plastic shipping tape over the entire label.

3. **GETTING YOUR SHIPMENT TO UPS**
UPS locations include the UPS Store®, UPS drop boxes, UPS customer centers, authorized retail outlets and UPS drivers.
Schedule a same day or future day Pickup to have a UPS driver pickup all your CampusShip packages.
Hand the package to any UPS driver in your area.
Take your package to any location of The UPS Store®, UPS Drop Box, UPS Customer Center, UPS Alliances (Office Depot® or Staples®) or Authorized Shipping Outlet near you. Items sent via UPS Return Services(SM) (including via Ground) are also accepted at Drop Boxes. To find the location nearest you, please visit the Resources area of CampusShip and select UPS Locations.

Customers with a Daily Pickup
Your driver will pickup your shipment(s) as usual.

FOLD HERE

DEE SVATOS
402-691-9561
TENASKA
14302 FNB PARKWAY
OMAHA NE 68154

0.0 LBS LTR 1 OF 1

SHIP TO:
MS. PATRICIA VALENZUELA
IMPERIAL COUNTY PLANNING & DEV DEPT
801 W MAIN STREET
EL CENTRO CA 92243-2811

CA 922 1-01

UPS NEXT DAY AIR SAVER 1P

TRACKING #: 1Z 58A E49 13 9641 0572

BILLING: P/P

Reference #1: 9017

CS 16.2.03. WNTIE90 48.0A 01/2014

9017

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Shipment Receipt

Transaction Date: 17 Apr 2014 **Tracking Number:** 1Z58AE491396410572

1 Address Information

Ship To:
Imperial County Planning & Dev Dept
Ms. Patricia Valenzuela
801 W Main Street
EL CENTRO CA 922432811

Ship From:
Tenaska
DEE SVATOS
14302 FNB Parkway
Omaha NE 68154
Telephone:402-691-9561

Return Address:
Tenaska
DEE SVATOS
14302 FNB Parkway
Omaha NE 68154
Telephone:402-691-9561

2 Package Information

	Weight	Dimensions / Packaging	Declared Value	Reference Numbers
1.	Letter (Letter billable)	UPS Letter		Reference #1 - 9017 Reference # 2 - Reference # 3 -

3 UPS Shipping Service and Shipping Options

Service:	UPS Next Day Air Saver
Guaranteed By:	3:00 PM Friday, Apr 18, 2014
Shipping Fees Subtotal:	**33.02 USD**
Transportation	29.75 USD
Fuel Surcharge	3.27 USD

4 Payment Information

Bill Shipping Charges to: Shipper's Account 58AE49

Daily rates were applied to this shipment

Total Charged: **33.02 USD**

Note: Your invoice may vary from the displayed reference rates.
* For delivery and guarantee information, see the UPS Service Guide. To speak to a customer service representative, call 1-800-PICK-UPS for domestic services and 1-800-782-7892 for international services.

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Proof of Delivery

Close Window

Dear Customer,

This notice serves as proof of delivery for the shipment listed below.

Tracking Number:	1Z58AE491396410572
Reference Number(s):	9017
Service:	UPS Next Day Air Saver®
Shipped/Billed On:	04/17/2014
Delivered On:	04/21/2014 9:07 A.M.
Delivered To:	EL CENTRO, CA, US
Signed By:	SILLAS
Left At:	Office

Thank you for giving us this opportunity to serve you.

Sincerely,

UPS

Tracking results provided by UPS: 04/21/2014 2:08 P.M. ET

Print This Page

Close Window

Avian and Wildlife Reporting Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Observation Made During (circle one):

Evaporation Pond Monitoring / Scheduled Mortality Survey / [✓ Incidental]

Date: 6/10/2013 Observer: Ron Walker

Type of Incident (circle one): [✓ Injury] / Fatality / Nest

Condition (circle one): Intact Carcass / Dismembered Carcass / Feathers Only

Age of Remains (circle one): 1-5 (fluid filled eyes) / 6-30 (maggots) / 30+ (bones)

Photo No. ____________________

Carcass Condition Details, Behavior of Injured Animal or Nest Details: Injured brown pelican found in unit 2 in power block area under HTF overhead pipes, above power block access road. Pelican appeared to be suffering from heat stress. Pelican transported to wildlife rehabilitation center in Blythe, CA. It was reported later that the pelican recovered and was released uninjured.

LOCATION

DATUM: UTM Z11 NAD83 (m) UTM N: 3726434 UTM E: 686893

Found Near (circle one):

Solar Trough / Evaporation Pond / Road / Power Line / [✓ Other (explain below)]

Location Details: Unit 2, west side of power block, under HTF pipe overhead crossing

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)

Species (if unknown, write 'unknown'): Brown Pelican

Color/Markings: Brown, light underbelly

Sex (circle one): Male / Female / [✓ Unknown] Age (circle one): Adult / Juvenile / [✓ Unknown]

Is Animal Tagged? (circle one): Yes / [✓ No]

Identification Remarks: N/A

ENVIRONMENTAL CONDITION

Weather (circle one): [✓ Clear] / Fog / Cloudy / Rain

Approx. Temperature (circle one): [✓ °F] / °C: 109

Wind (circle one): Calm / [✓ Gusty] / Storm / Violent Storm

Habitat (circle all that apply):

Bare Ground / Creosote Bush Scrub / Sand Dunes

Sand Drifts over Playa / Ephemeral Wash / Desert Pavement

NOTIFICATION

Who was notified, and When? Designated biologist on 6/10/2013 4:30:00 PM

Actions Taken (e.g., left in place, taken to rehab): Brown pelican picked up and transported to wildlife rehabilitation center in Blythe CA

COMMENTS:

Injured brown pelican found in unit 2 in power block area under HTF overhead pipes, above power block access road. Pelican appeared to be suffering from heat stress. Pelican transported to wildlife rehabilitation center in Blythe, CA. It was reported later that the pelican recovered and was released uninjured.

* Turn in completed form and incident photos to the on-site Environmental Manager.

* Report any incidental observations of dead birds or other wildlife at the evaporation ponds to the Designated Biologist within one day of the detection of the carcass.

* Report any nests immediately to the on-site Environmental Manager.

Avian and Wildlife Reporting Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Observation Made During (circle one):

Evaporation Pond Monitoring / Scheduled Mortality Survey / [✓ Incidental]

Date: 7/10/2013 Observer: Eric German

Type of Incident (circle one): Injury / [✓ Fatality] / Nest

Condition (circle one): [✓ Intact Carcass] / Dismembered Carcass / Feathers Only

Age of Remains (circle one): [✓ 1-5 (fluid filled eyes)] / 6-30 (maggots) / 30+ (bones)

Photo No.

Carcass Condition Details, Behavior of Injured Animal or Nest Details: Bird had been seen at power block 2 at 1330 and was reported to be heat stressed. Observer saw bird fly nw at 1345. At 1515 report of bird mortality unit 1 block 5 mirror row 52. Carcass intact, no rigor, possible cervical dislocation noted when animal was removed.

LOCATION

DATUM: UTM Z11 NAD83 (m) UTM N: 3727672 UTM E: 685376

Found Near (circle one):

[✓ Solar Trough] / Evaporation Pond / Road / Power Line / Other (explain below)

Location Details: Shaded side of solar mirror. No heat from mirrors in location of bird mortality.

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)

Species (if unknown, write 'unknown'): Brown Pelican

Color/Markings: Gray brown body. Gray feet.

Sex (circle one): Male / Female / [✓ Unknown] Age (circle one): Adult / Juvenile / [✓ Unknown]

Is Animal Tagged? (circle one): Yes / [✓ No]

Identification Remarks: N/A

ENVIRONMENTAL CONDITION

Weather (circle one): Clear / Fog / [✓ Cloudy] / Rain

Approx. Temperature (circle one): [✓ °F] / °C: 109

Wind (circle one): [✓ Calm] / Gusty / Storm / Violent Storm

Habitat (circle all that apply):

Bare Ground / Creosote Bush Scrub / Sand Dunes
Sand Drifts over Playa / Ephemeral Wash / Desert Pavement

NOTIFICATION

Who was notified, and When? Compliance and DB notified. on 7/10/2013 1:30:00 PM

Actions Taken (e.g., left in place, taken to rehab): Bird was searched for when reported alive. Bird not found. Remains collected and disposed of by burial.

COMMENTS:

Bird had been seen flying prior to discovery in solar field.

* Turn in completed form and incident photos to the on-site Environmental Manager.

* Report any incidental observations of dead birds or other wildlife at the evaporation ponds to the Designated Biologist within one day of the detection of the carcass.

* Report any nests immediately to the on-site Environmental Manager.


Date & Time: Wed Jul 10 15:36:18 PDT 2013
Position: 11 N 685376 3727972
Altitude: 418ft
Azimuth/Bearing: 230° S50W 4089mils (True)
Elevation Angle: -67.3°
Horizon Angle: +14.5°
Zoom: 1X
pelican mortality


Date & Time: Wed Jul 10 15:38:59 PDT 2013
Position: 11 N 685377 3727970
Altitude: 432ft
Azimuth/Bearing: 253° S73W 4498mils (True)
Elevation Angle: -88.1°
Horizon Angle: -88.5°
Zoom: 1X
pelican mortality


Date & Time: Wed Jul 10 16:01:09 PDT 2013
Position: 11 N 680343 3726295
Altitude: 380ft
Azimuth/Bearing: 356° N04W 6329mils (True)
Elevation Angle: -55.6°
Horizon Angle: +02.9°
Zoom: 1X
pelican mortality

Avian and Wildlife Reporting Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Observation Made During (circle one):

Evaporation Pond Monitoring / Scheduled Mortality Survey / [✓ Incidental]

Date: 7/31/2013 Observer: Eric German

Type of Incident (circle one): Injury / [✓ Fatality] / Nest

Condition (circle one): [✓ Intact Carcass] / Dismembered Carcass / Feathers Only

Age of Remains (circle one): 1-5 (fluid filled eyes) / [✓ 6-30 (maggots)] / 30+ (bones)

Photo No. ________

Carcass Condition Details, Behavior of Injured Animal or Nest Details: Carcass appears older, beginning to disarticulate. Feathers worn with matting.

LOCATION

DATUM: UTM Z11 NAD83 (m) UTM N: 3727395 UTM E: 685704

Found Near (circle one):

Solar Trough / [✓ Evaporation Pond] / Road / Power Line / Other (explain below)

Location Details: North evaporation pond.

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)

Species (if unknown, write 'unknown'): American Kestrel

Color/Markings: Brownish red

Sex (circle one): Male / [✓ Female] / Unknown Age (circle one): [✓ Adult] / Juvenile / Unknown

Is Animal Tagged? (circle one): Yes / [✓ No]

Identification Remarks: N/A

ENVIRONMENTAL CONDITION

Weather (circle one): [✓ Clear] / Fog / Cloudy / Rain

Approx. Temperature (circle one): [✓ °F] / °C: 106

Wind (circle one): [✓ Calm] / Gusty / Storm / Violent Storm

Habitat (circle all that apply):

Bare Ground / Creosote Bush Scrub / Sand Dunes

Sand Drifts over Playa / Ephemeral Wash / Desert Pavement

NOTIFICATION

Who was notified, and When? USFWS on 7/31/2013 10:30:00 AM

Actions Taken (e.g., left in place, taken to rehab): Left in place.

COMMENTS:

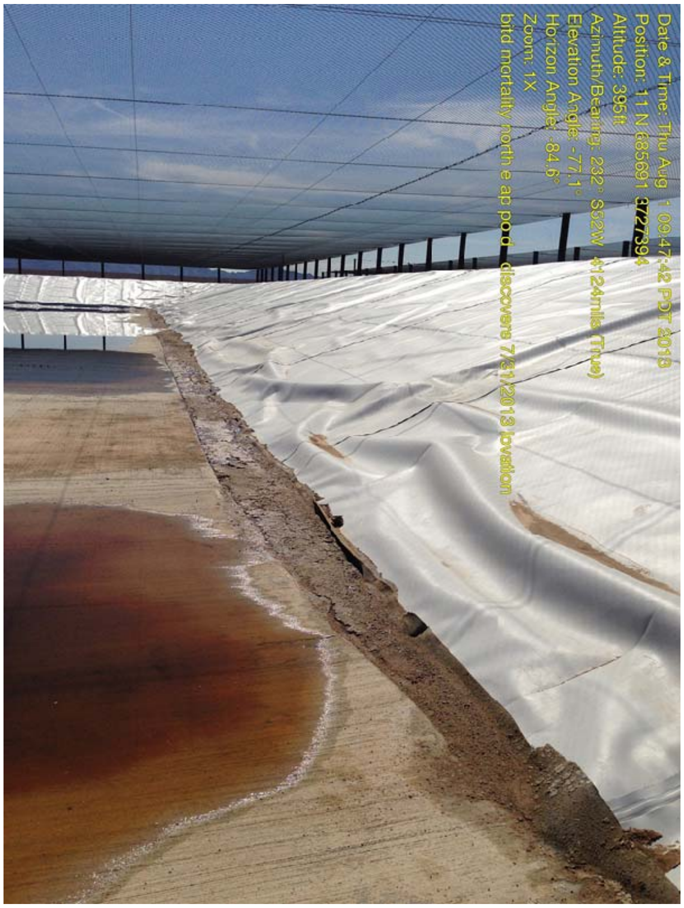
Mortality located within north evap pond. Location pictures taken 8/1/13.

* Turn in completed form and incident photos to the on-site Environmental Manager.

* Report any incidental observations of dead birds or other wildlife at the evaporation ponds to the Designated Biologist within one day of the detection of the carcass.

* Report any nests immediately to the on-site Environmental Manager.


Date & Time: Wed Jul 31 10:42:06 PDT 2013
Position: 11 N 685704 3727395
Altitude: 396ft
Azimuth/Bearing: 180° S00E 3200mils (True)
Elevation Angle: -71.5°
Horizon Angle: +26.0°
Zoom: 1X
birg mortality evaporation pond.


Date & Time: Thu Aug 1 09:47:42 PDT 2013
Position: 11 N 685691 3727394
Altitude: 395ft
Azimuth/Bearing: 232° S52W 4124mils (True)
Elevation Angle: -77.1°
Horizon Angle: -84.6°
Zoom: 1X
bitd mortality north e ap po d discovere 7/31/2013 lovation


Date & Time: Thu Aug 1 09:48:17 PDT 2013
Position: 11 N 685702 3727399
Altitude: 395ft
Azimuth/Bearing: 199° S19W 3538mils (True)
Elevation Angle: -06.9°
Horizon Angle: +02.2°
Zoom: 1X
bild mortality north e ap po d discovere 7/31/2013 location

Avian and Wildlife Reporting Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Observation Made During (circle one):

Evaporation Pond Monitoring / Scheduled Mortality Survey / [✓ Incidental]

Date: 8/19/2013 Observer: Eric German

Type of Incident (circle one): Injury / [✓ Fatality] / Nest

Condition (circle one): [✓ Intact Carcass] / Dismembered Carcass / Feathers Only

Age of Remains (circle one): [✓ 1-5 (fluid filled eyes)] / 6-30 (maggots) / 30+ (bones)

Photo No. ______

Carcass Condition Details, Behavior of Injured Animal or Nest Details: Carcass on back, no obvious signs of trauma

LOCATION

DATUM: UTM Z11 NAD83 (m) UTM N: 3726833 UTM E: 686881

Found Near (circle one):

Solar Trough / Evaporation Pond / [✓ Road] / Power Line / Other (explain below)

Location Details: Location of carcass near dirt road edge beneath pipe of crossover. Near NE corner on unit 2 block 2.

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)

Species (if unknown, write 'unknown'): To be determined flycatcher.

Color/Markings: Dark green back, whitish front with grey on breast, slight wing bars.

Sex (circle one): Male / Female / [✓ Unknown] Age (circle one): Adult / Juvenile / [✓ Unknown]

Is Animal Tagged? (circle one): Yes / [✓ No]

Identification Remarks: N/A

ENVIRONMENTAL CONDITION

Weather (circle one): Clear / Fog / [✓ Cloudy] / Rain

Approx. Temperature (circle one): [✓ °F] / °C: 108

Wind (circle one): [✓ Calm] / Gusty / Storm / Violent Storm

Habitat (circle all that apply):

Bare Ground / Creosote Bush Scrub / Sand Dunes

Sand Drifts over Playa / Ephemeral Wash / Desert Pavement

NOTIFICATION

Who was notified, and When? USFWS law enforcement on 8/20/2013 1:55:00 PM

Actions Taken (e.g., left in place, taken to rehab): Photographed 8/19. Contacted USFWS law enforcement 0900 (first notification). Guidance to salvage to preserve carcass; placed in freezer. 1355 contacted USFWS law enforcement to inform of need to further identify carcass.

COMMENTS:

Located near pipe crossover, piping over road, on bare ground.

* Turn in completed form and incident photos to the on-site Environmental Manager.

* Report any incidental observations of dead birds or other wildlife at the evaporation ponds to the Designated Biologist within one day of the detection of the carcass.

* Report any nests immediately to the on-site Environmental Manager.


Date & Time: Mon Aug 19 17:33:05 PDT 2013
Position: 11 N 686881 3726833
Altitude: 381ft
Azimuth/Bearing: 176° S04E 3129mils (True)
Elevation Angle: -88.6°
Horizon Angle: +82.4°
Zoom: 1X
bird mortality crossover unit 2 ne block 2


Date & Time: Mon Aug 19 17:37:10 PDT 2013
Position: 11 N 686881 3726832
Altitude: 394ft
Azimuth/Bearing: 092° S88E 1636mils (True)
Elevation Angle: -87.7°
Horizon Angle: +69.2°
Zoom: 1X
bird mortality crossover unit 2 ne block 2
8/19/13 17:35 108°
686881 3726833
NE CORNER BLOCK 2/CROSSOVER
piggly wiggly

Additional Documentation Attachment to Comment 2-F1
Attachment I-6

Avian and Wildlife Reporting Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Observation Made During (circle one):

Evaporation Pond Monitoring / Scheduled Mortality Survey / [✓ Incidental]

Date: 8/20/2013 Observer: Eric German

Type of Incident (circle one): Injury / [✓ Fatality] / Nest

Condition (circle one): [✓ Intact Carcass] / Dismembered Carcass / Feathers Only

Age of Remains (circle one): 1-5 (fluid filled eyes) / 6-30 (maggots) / 30+ (bones)

Photo No. __________

Carcass Condition Details, Behavior of Injured Animal or Nest Details: Unknown carcass age. Carcass water saturated in evap pond.

LOCATION

DATUM: UTM Z11 NAD83 (m) UTM N: 3727371 UTM E: 685760

Found Near (circle one):

Solar Trough / [✓ Evaporation Pond] / Road / Power Line / Other (explain below)

Location Details: Bird mostly submerged within south evaporation pond.

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)

Species (if unknown, write 'unknown'): Possible Sora

Color/Markings: Large feet, other sora found previously.

Sex (circle one): Male / Female / [✓ Unknown] Age (circle one): Adult / Juvenile / [✓ Unknown]

Is Animal Tagged? (circle one): Yes / [✓ No]

Identification Remarks: N/A

ENVIRONMENTAL CONDITION

Weather (circle one): [✓ Clear] / Fog / Cloudy / Rain

Approx. Temperature (circle one): [✓ °F] / °C: 102

Wind (circle one): [✓ Calm] / Gusty / Storm / Violent Storm

Habitat (circle all that apply):

Bare Ground / Creosote Bush Scrub / Sand Dunes

Sand Drifts over Playa / Ephemeral Wash / Desert Pavement

NOTIFICATION

Who was notified, and When? USFWS law enforcement on 8/20/2013 11:13:00 AM

Actions Taken (e.g., left in place, taken to rehab): Removed from pond and placed in freezer.

COMMENTS:

N/A

* Turn in completed form and incident photos to the on-site Environmental Manager.

* Report any incidental observations of dead birds or other wildlife at the evaporation ponds to the Designated Biologist within one day of the detection of the carcass.

* Report any nests immediately to the on-site Environmental Manager.

Date & Time: Tue Aug 20 11:29:09 PDT 2013
Position: 11 N 685760 3727371
Altitude: 387ft
Azimuth: -108° -1920mils
Elevation Angle: +09.5°
Horizon Angle: +79.2°
Zoom: 1X
bird mortality south evap pond

Avian and Wildlife Reporting Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Observation Made During (circle one):

[✓ Evaporation Pond Monitoring] / Scheduled Mortality Survey / Incidental

Date: 9/3/2013 Observer: Eric German

Type of Incident (circle one): Injury / [✓ Fatality] / Nest

Condition (circle one): Intact Carcass / [✓ Dismembered Carcass] / Feathers Only

Age of Remains (circle one): 1-5 (fluid filled eyes) / [✓ 6-30 (maggots)] / 30+ (bones)

Photo No. ______

Carcass Condition Details, Behavior of Injured Animal or Nest Details: Carcass missing head, legs and feathers intact.

LOCATION

DATUM: UTM Z11 NAD83 (m) UTM N: 3727385 UTM E: 685600

Found Near (circle one):

Solar Trough / [✓ Evaporation Pond] / Road / Power Line / Other (explain below)

Location Details: Outside of north evaporation pond, west of gate approximately 5 meters.

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)

Species (if unknown, write 'unknown'): Unknown Grebe

Color/Markings: Black grebe-like feet. Light breast, brownish/blackish back

Sex (circle one): Male / Female / [✓ Unknown] Age (circle one): Adult / Juvenile / [✓ Unknown]

Is Animal Tagged? (circle one): Yes / [✓ No]

Identification Remarks: N/A

ENVIRONMENTAL CONDITION

Weather (circle one): Clear / Fog / [✓ Cloudy] / Rain

Approx. Temperature (circle one): [✓ °F] / °C: 82

Wind (circle one): [✓ Calm] / Gusty / Storm / Violent Storm

Habitat (circle all that apply):

[✓ Bare Ground] / Creosote Bush Scrub / Sand Dunes
Sand Drifts over Playa / Ephemeral Wash / Desert Pavement

NOTIFICATION

Who was notified, and When? USFWS Law Enforcement on 9/3/2013 9:51:00 AM

Actions Taken (e.g., left in place, taken to rehab): Salvaged and placed in freezer per USFWS guidance.

COMMENTS:

There had been a pied billed grebe that was entangled by its neck in central part of net, reported May 1, 2013. The bird no longer appears to be in netting. This grebe has the possibility of being same bird reported May 1.

* Turn in completed form and incident photos to the on-site Environmental Manager.

* Report any incidental observations of dead birds or other wildlife at the evaporation ponds to the Designated Biologist within one day of the detection of the carcass.

* Report any nests immediately to the on-site Environmental Manager.


Date & Time: Tue Sep 3 09:16:00 PDT 2013
Position: 11 N 686800 3727085
Altitude: 390ft
Azimuth/Bearing: 005° N05E 0089mils (True)
Elevation Angle: -84.2°
Horizon Angle: +35.7°
Zoom: 1X
bird mortality carcass

Avian and Wildlife Reporting Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Observation Made During (circle one):

[✓ Evaporation Pond Monitoring] / Scheduled Mortality Survey / Incidental

Date: 9/17/2013 Observer: Eric German

Type of Incident (circle one): Injury / [✓ Fatality] / Nest

Condition (circle one): [✓ Intact Carcass] / Dismembered Carcass / Feathers Only

Age of Remains (circle one): 1-5 (fluid filled eyes) / [✓ 6-30 (maggots)] / 30+ (bones)

Photo No. __________

Carcass Condition Details, Behavior of Injured Animal or Nest Details: Carcass floating in north evaporation. Not accessible. Feet and beak shape able to be seen. Appears to be a water bird.

LOCATION

DATUM: UTM Z11 NAD83 (m) UTM N: 3727429 UTM E: 685679

Found Near (circle one):

Solar Trough / [✓ Evaporation Pond] / Road / Power Line / Other (explain below)

Location Details: Within water of north evaporation pond. Mostly submerged. No photo - observed by designated biologist and on-site biologist.

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)

Species (if unknown, write 'unknown'): Unknown submerged water bird

Color/Markings: Dark feet and bill. Estimated 12 inches.

Sex (circle one): Male / Female / [✓ Unknown] Age (circle one): Adult / Juvenile / [✓ Unknown]

Is Animal Tagged? (circle one): Yes / No

Identification Remarks: N/A

ENVIRONMENTAL CONDITION

Weather (circle one): [✓ Clear] / Fog / Cloudy / Rain

Approx. Temperature (circle one): [✓ °F] / °C: 90

Wind (circle one): [✓ Calm] / Gusty / Storm / Violent Storm

Habitat (circle all that apply):

Bare Ground / Creosote Bush Scrub / Sand Dunes

Sand Drifts over Playa / Ephemeral Wash / Desert Pavement

NOTIFICATION

Who was notified, and When? USFWS Law Enforcement on 9/17/2013 9:35:00 AM

Actions Taken (e.g., left in place, taken to rehab): Left in place.

COMMENTS:

N/A

* Turn in completed form and incident photos to the on-site Environmental Manager.

* Report any incidental observations of dead birds or other wildlife at the evaporation ponds to the Designated Biologist within one day of the detection of the carcass.

* Report any nests immediately to the on-site Environmental Manager.

Avian and Wildlife Reporting Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Observation Made During (circle one):

[✓ Evaporation Pond Monitoring] / Scheduled Mortality Survey / Incidental

Date: 9/18/2013 Observer: Eric German

Type of Incident (circle one): Injury / [✓ Fatality] / Nest

Condition (circle one): [✓ Intact Carcass] / Dismembered Carcass / Feathers Only

Age of Remains (circle one): [✓ 1-5 (fluid filled eyes)] / 6-30 (maggots) / 30+ (bones)

Photo No. ____

Carcass Condition Details, Behavior of Injured Animal or Nest Details: Entangled in south evaporation pond netting. Head extended through top netting.

LOCATION

DATUM: UTM Z11 NAD83 (m) UTM N: 3727348 UTM E: 685639

Found Near (circle one):

Solar Trough / [✓ Evaporation Pond] / Road / Power Line / Other (explain below)

Location Details: Netting above south evaporation pond. Northwest quadrant.

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)

Species (if unknown, write 'unknown'): Grebe species (horned).

Color/Markings: Appears to have whitish beak tip and thicker bill.

Sex (circle one): Male / Female / [✓ Unknown] Age (circle one): Adult / Juvenile / [✓ Unknown]

Is Animal Tagged? (circle one): Yes / No

Identification Remarks: No bands observed.

ENVIRONMENTAL CONDITION

Weather (circle one): [✓ Clear] / Fog / Cloudy / Rain

Approx. Temperature (circle one): [✓ °F] / °C: 100

Wind (circle one): [✓ Calm] / Gusty / Storm / Violent Storm

Habitat (circle all that apply):

Bare Ground / Creosote Bush Scrub / Sand Dunes

Sand Drifts over Playa / Ephemeral Wash / Desert Pavement

NOTIFICATION

Who was notified, and When? USFWS Law Enforcement on 9/18/2013 2:15:00 PM

Actions Taken (e.g., left in place, taken to rehab): Left in place.

COMMENTS:

N/A

* Turn in completed form and incident photos to the on-site Environmental Manager.

* Report any incidental observations of dead birds or other wildlife at the evaporation ponds to the Designated Biologist within one day of the detection of the carcass.

* Report any nests immediately to the on-site Environmental Manager.

Date & Time: Thu Sep 19 12:27:51 PDT 2013
Position: 11 N 685616 3727348
Altitude: 389ft
Azimuth/Bearing: 118° S62E 2098mils (True)
Elevation Angle: +05.1°
Horizon Angle: -02.4°
Zoom: 4X
south evap pond 9/18/13 mortality

Avian and Wildlife Reporting Form

***** All Fields Must Be Filled Out. Do Not Leave Any Field Blank. *****

INCIDENT DETAILS

Observation Made During (circle one):

Evaporation Pond Monitoring / Scheduled Mortality Survey / [✓ Incidental]

Date: 10/28/2013 Observer: Eric German

Type of Incident (circle one): Injury / [✓ Fatality] / Nest

Condition (circle one): [✓ Intact Carcass] / Dismembered Carcass / Feathers Only

Age of Remains (circle one): [✓ 1-5 (fluid filled eyes)] / 6-30 (maggots) / 30+ (bones)

Photo No. ____

Carcass Condition Details, Behavior of Injured Animal or Nest Details: Carcass intact, appears to be entangled in evaporation pond netting. Anterior side resting on netting.

LOCATION

DATUM: UTM Z11 NAD83 (m) UTM N: 3727427 UTM E: 685768

Found Near (circle one):

Solar Trough / [✓ Evaporation Pond] / Road / Power Line / Other (explain below)

Location Details: Located on netting of north evaporation pond, center of eastern half.

IDENTIFICATION

[✓ Bird] / Bat / Unknown / Other (circle one)

Species (if unknown, write 'unknown'): Grebe (Clark's)

Color/Markings: Dark greyish back and back of head, light colored underside, appears to have orange beak, grebe feet.

Sex (circle one): Male / Female / [✓ Unknown] Age (circle one): Adult / Juvenile / [✓ Unknown]

Is Animal Tagged? (circle one): Yes / [✓ No]

Identification Remarks: No tag observed. Difficult to see bird.

ENVIRONMENTAL CONDITION

Weather (circle one): Clear / Fog / [✓ Cloudy] / Rain

Approx. Temperature (circle one): [✓ °F] / °C: 75

Wind (circle one): Calm / [✓ Gusty] / Storm / Violent Storm

Habitat (circle all that apply):

Bare Ground / Creosote Bush Scrub / Sand Dunes

Sand Drifts over Playa / Ephemeral Wash / Desert Pavement

NOTIFICATION

Who was notified, and When? USFWS LE on 10/28/2013 3:35:00 PM

Actions Taken (e.g., left in place, taken to rehab): Left in place.

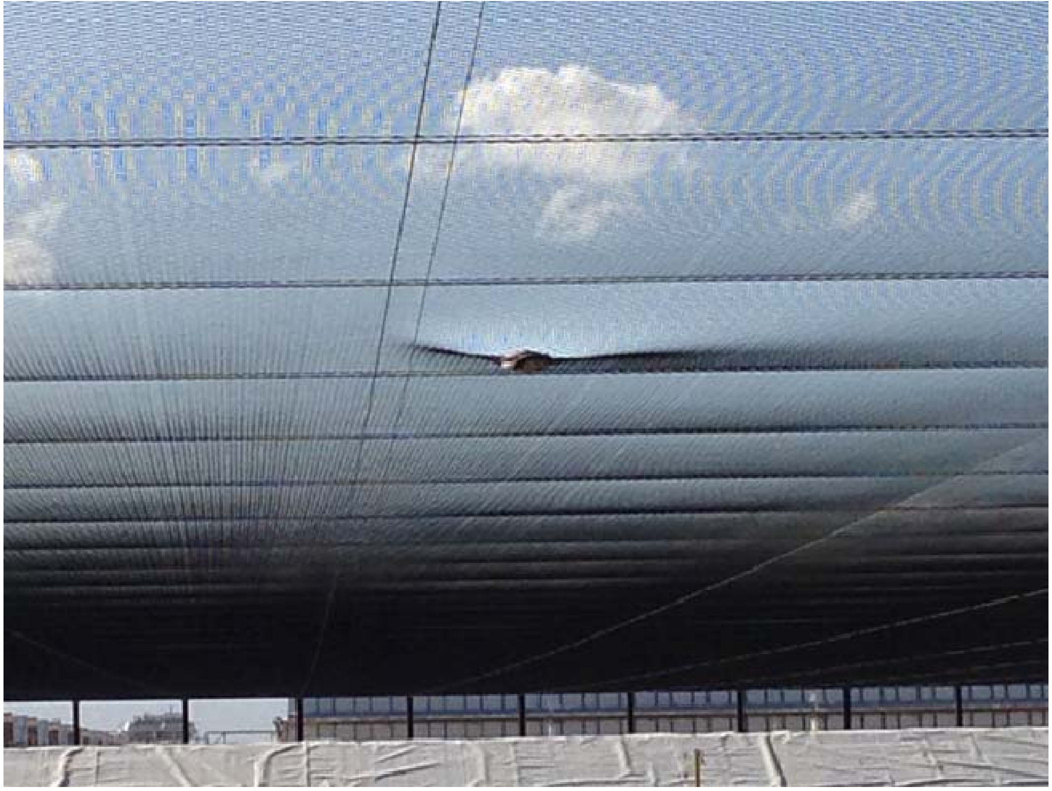
COMMENTS:

N/A

* Turn in completed form and incident photos to the on-site Environmental Manager.

* Report any incidental observations of dead birds or other wildlife at the evaporation ponds to the Designated Biologist within one day of the detection of the carcass.

* Report any nests immediately to the on-site Environmental Manager.




Date & Time: Mon Oct 28 12:17:38 PDT 2013
Position: 11 N 685773 3727419
Altitude: 364ft
Azimuth/Bearing: 074° N74E 1316mils (True)
Elevation Angle: +82.2°
Horizon Angle: -01.7°
Zoom: 1X
bird mortality north evap pond

Additional Documentation Attachment to Comment 2-F1
Attachment I-7

County of San Bernardino
Office of the District Attorney
MICHAEL A. RAMOS, District Attorney

September 16, 2015

NRG Energy
100 California Street
Suite 650
San Francisco, CA 94111

Attention: John Chillemi

Dear Mr. Chillemi,

A case has been submitted to this office for review and filing consideration concerning alleged violations of the California Fish & Game Code at the Ivanpah solar plant. Prior to any filing decision, we would like to discuss the issues involved and this letter is sent with the intent to open that dialogue. We are interested in learning more about the program(s) that have been put in place to mitigate any harm to wildlife on or around the Ivanpah facility.

Please call or email at your earliest convenience and thank you for your attention to this matter,

Douglas Poston
Lead Deputy District Attorney
San Bernardino County
Consumer & Environmental Protection Unit
909-382-7749
dposton@sbcda.org

303 West Third Street, San Bernardino, California 92415 (909) 382-7748
E-mail address: dposton@sbcda.org Web site: www.district-attorney.org

UltraSystems
environmental management planning

Wildlife Mortality Report
Imperial Solar Energy Center West

To: Nicollee Gaddis (BLM), Magdalena Rodriguez (CDFW), Pete Sorenson (USFWS), Jody Fraser (USFWS), Tom Dietsch (USFWS) and David Black (Imperial County)

From: Michael Robinson, Lead Designated Biologist (UltraSystems)

Date: 02-23-2015

Re: Burrowing Owl Mortality – Imperial Solar Energy Center (ISEC) West

---

Occurrence:

On February 23, 2015 at 2:30 p.m., Fern Hoffman (UltraSystems biologist) found the remains of a burrowing owl (BUOW) (*Athene cunicularia*) during transect surveys on the ISECW project on private land. The BUOW is a Bureau of Land Management (BLM) Sensitive Species and a California Species of Special Concern.

Ms. Hoffman found a feather spot that consisted of both body and flight feathers. The spot diameter was over 15 feet due to wind scatter though the primary feather spot was about 1 foot by 2 feet. The BUOW appeared to have been scavenged; however, the cause of death was indeterminate. The weathering on the feathers led Ms. Hoffman to conclude that the feathers were more than two weeks old, but less than a month. The feathers were found near a rodent complex and were about 20 feet away from a suitable BUOW burrow. Weather conditions at the time of discovery were sunny with scattered clouds, 70 degrees Fahrenheit, with winds at 4 to 13 miles per hour.

The BUOW feathers and location were photographed (see Attachment A), and information regarding the occurrence was recorded. While there was no carcass found, the amount of body and flight feathers determine it was one adult BUOW.

GPS Location: this BUOW was found at GPS coordinates 32.76315, -115.78596.

Should you have any questions, please contact me at (949) 939-8814.

Sincerely,

Michael Robinson

Michael Robinson, Lead Designated Biologist

Attachment A: Photographs

BUOW Discovery

BUOW Feathers

BUOW Feathers

Close Up of BUOW Feathers

Location Looking South

Genesis Solar Avian Injury and Mortality Response

Meeting Notes

July 22, 2013

Attendees

- NextEra/Genesis
  - Jennifer Field – Permitting and Compliance
  - Janine Bacquie – Wildlife Permitting
  - Bill Watson – Genesis Director of Compliance
- AECOM
  - Jennifer Guigliano – Biology Compliance PM
  - Eric German – Designated Biologist
- USFWS
  - Erin Dean – USFWS Resident Agent (Law Enforcement)
  - Edwardo Nieves – CDFW Special Agent (Law Enforcement)
  - Tom Dietsch – Migratory Birds, Carlsbad
  - Tera Baird – Project Biologist
- CDFW
  - Magdalena Rodriguez – Project Biologist

1. <u>Current process</u>: Calling biologists to report the mortalities, not handling, and getting direction via email from either CDFW/USFWS
2. USFWS appreciates efforts to date to share information and coordinate
3. Letter was going to be issued from law enforcement; however no longer doing a letter. Now expecting to issue a short term SPUT (good for 6 months) which is based upon the current APP and will identify how to handle mortalities, injuries, etc.
   a. Fill out normal SPUT application and send to the Attention of Heather Beeler; cc to Tom Dietsch
4. Following the temporary SPUT, a permanent SPUT will be issued that would be effective for the operational life of the project (USFWS to confirm this is for life of project or just 3 years as is typical of SPUT permits) and would be based upon a new BBCP…which will actually be an amendment to the current APP through the CEC.
5. Erin Dean, Law Enforcement questioned how we proceed until temp SPUT issued. From today on, Edwardo Nieves will be contacted for any mortality or injury and Ed will provide verbal instruction. Ed will provide written follow-up after the verbal is issued (via email).
6. Tom indicated processing the SPUT permit would only be a couple weeks. Until then, we will continue to call Edwardo.
7. Tom/USFWS is updating a spreadsheet for mortality monitoring. Should be able to update our tracking system with the requested information by updating fields. Tom will provide that information before SPUT is issued to so that we can modify our database as necessary.
8. Freezer has been ordered, should be onsite by approximately 2 weeks. Note - Freezer needs to have a lock to prevent access to evidence

9. Ed has requested to come out to provide training to Eric and Ron on the collection and logging of bird mortalities.
10. SPUTs (temporary and permanent) will cover NexEra, Genesis, and any persons employed by or contracted by NextEra. Tom to clarify this language/coverage as well as the term length for the permit (3 year renewal period).
11. AECOM will continue to use our current data processing and collection system for avian injuries and mortalities and summarizing them in a tabular format. The spreadsheet as well as backup forms are provided in the MCRs and will continue to be. Tom asked for the data to be submitted separately on a monthly basis to the USFWS. AECOM to send the spreadsheet to USFWS monthly (send to Tera and Tom).
12. Magdalena discussed the use of SCPs for avian species. Without a State SCP with salvage permit…cannot collect at all. CDFW concern about directing “takings” of protecting fully protected species and strigiformes/falconiformes. Federal law enforcement stated that there is no issue with state if they are directed by federal law enforcement. As long as law enforcement is contacted directly, take issue is covered…including T&E (federally).
13. Magdalena circling with Regional Manager and Law Enforcement with CDFW (Lt. King), mainly with listed species or fully protected. Wants to verify the direction. Erin Dean (USFWS) knows Lt. King and will follow up with him as well.
14. Magdalena will talk to Blythe to see if we can continue to have them collect birds and put in freezer.
15. May use coolers and ice. Is a chain of custody protocol for bird collection and will be trained by Ed N.

ACTION ITEMS

- ☐ Prepare application for temporary SPUT. Submit with fees.
- ☐ Freezer is being acquired for Genesis site.
- ☐ Do not handle birds. Contact Ed, USFWS Law Enforcement for verbal and written direction. Birds will be managed following receipt/confirmation via written form.

  310-328-1516 (Office)
  310-612-4744 (Cell)
  eduardo_nieves@fws.gov

- ☐ Ed to train Eric and Ron regarding collection and logging for bird mortalities (and injuries) .
- ☐ USFWS, CDFW to confirm with law enforcement both sides that no separate state permits, letters, or direction is necessary to proceed with bird injury/mortality reporting/collection.
- ☐ Submit the avian injury/mortality reporting summary table separately to Tera and Tom when MCR is submitted to CEC.
- ☐ Tom to provide updated data collection information to facilitate update to AECOM data collection.
- ☐ Revision to APP coordinated through CEC with USFWS and CDFW.
- ☐ Long-term SPUT to be applied for and issued following concurrence on final APP amendment.

California Valley Solar Ranch Project

Avian Fatality Quarterly Report
During Construction January – March 2013


(C) HTH


(C) USGS


(C) RArtView

Prepared By:

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

983 University Avenue, Building D
Los Gatos, CA 95032

Prepared for:

HPR II, LLC
5790 Fleet St., Suite 200
Carlsbad, CA 92008
Attention: Ray Kelly

30 April 2013

Table of Contents

Tables

Contributors

Brian B. Boroski, Ph.D., Vice President, Senior Wildlife Ecologist
Julie L. Klingmann, M.S., Associate Wildlife Ecologist

Section 1. Introduction

Through adoption of Resolution #2011-119, the Board of Supervisors of the County of San Luis Obispo (County) approved the California Valley Solar Ranch Project (CVSR Project) Conditional Use Permit (DRC2008-00097) on 19 April 2011. The Conditional Use Permit is subject to the Conditions of Approval (COAs) set forth in Exhibit 6 attached to the Resolution.

The Conditional Use Permit allows the Applicant (High Plains Ranch II, LLC, and any successor in interest for the life of the CVSR Project) to construct and operate a 250-megawatt (MW) photovoltaic solar power plant on an approximately 4685 acre (ac) site, located mostly south of State Route (SR) 58, about 4 miles east of Soda Lake Road, immediately north of the California Valley subdivision, in the Shandon-Carrizo planning area in San Luis Obispo County (CVSR site).

COA #58 of the CVSR Project Conditional Use Permit requires an Avian Fatality Monitoring Plan (Plan) for the CVSR Project and a quarterly report detailing any project-related bird deaths or injuries detected during the monitoring study or at any other time. To satisfy COA #58 of the CVSR Project Conditional Use Permit, the Applicant has prepared this *Avian Fatality Quarterly Report,* which documents the number of avian mortalities detected during project construction from January through March 2013. Results of studies detailed in the Plan for post-construction monitoring in operational portions of the Project site are covered in separate *Avian Fatality Quarterly Reports* timed to coincide with seasonal patterns of avian occurrence on the site. The first of these Plan reports covered the period from 16 August – 15 November 2012.

Section 2. Monitoring Methodology

Per COA #58, the Plan requires monitoring the death and injury of birds associated with facility features such as feeder/distribution lines, solar panels, fences, and evaporation ponds. This Report documents avian mortality detected during construction activities from January through March 2013.

Monitoring of avian mortalities occurred during standard pre-activity surveys and construction monitoring 6–7 days per week throughout the quarter. Avian mortality data is collected within daily construction monitoring data sheets and includes date, location, and details of each observation.

Section 3. Results

From January through March 2013, 4 on-site avian fatalities were observed during construction monitoring (Table 1). Cause of death for all 4 avian fatalities is unknown.

Table 1. Avian Fatalities Detected during Construction-related Activities from January through March 2013.

Date	Species	No.	Location	Observation Details
1/17/13	House finch (*Carpodacus mexicanus*)	1	MVOH Segment 4B UTM: 11S 0234700 3913059	Found dead on a giant kangaroo rat precinct underneath power lines at 2:00 PM.
3/11/13	Mourning dove (*Zenaida macroura*)	1	Western Array 7 UTM 11S 0237568 3911433	Pile of feathers found under panels in western array at 10:30 AM.
3/13/13	Common raven (*Corvus corax*)	1	Ruskovich Well UTM: 10S 0772133 3912664	Found dead with no external injuries under a private transmission line just east of the fence along the east side of the houses at the Ruskovich property at 3:00 PM.
3/16/13	House finch	1	Array 2 UTM: 11S 0234322 3914513	Notified by a construction worker of a dead/dying bird at Production Well-3 at 10:30 AM. Biologist found the bird deceased, with no external injuries, lying on the ground next to a reflective, silver-colored box adjacent to the well, ~10 ft from solar panels. Workers observed bird hopping around the well, sometimes taking short flights, earlier in the morning, but did not see it fly into any panels, equipment, or the well. They reported that it walked to the area next to the silver box where it looked sickly and later died.

Post-Construction Monitoring at the Genesis Solar Energy Project Riverside County, California

2015 Summer Quarterly Interim Report

Prepared for:

Genesis Solar LLC

700 Universe Blvd.,
Juno Beach, Florida 33408

Prepared by:

Western EcoSystems Technology, Inc.

415 West 17th Street, Suite 2000
Cheyenne, Wyoming

February 2, 2016

EXECUTIVE SUMMARY

Avian and bat monitoring surveys were conducted from June 01 to August 30, 2015 (the summer season; for logistical reasons, fall monitoring started on Monday, August 31, 2015) at Genesis Solar Energy Project (Project) in accordance with the Project's Bird and Bat Conservation Strategy (BBCS). Specifically, standardized carcass searches, searcher efficiency trials, and carcass persistence trials were conducted. This report represents the second seasonal report for the first year of monitoring, and summarizes monitoring methods and results for those surveys based on the procedures and requirements specified in the BBCS. This report and the other interim quarterly reports are considered preliminary summaries of data and information for the seasonal monitoring periods. Final information from all four quarterly monitoring periods will be included in a comprehensive final annual report.

Standardized carcass searches were conducted 1) in the solar field, consisting of a random stratified 30% sample of solar troughs of both Project units, 2) at each evaporation pond, 3) along the perimeter of each power block and beneath each air condensed cooling (ACC) unit, 4) along inner and outer portions of the "fenceline", resulting in 100% of the length of the perimeter fence surveyed, and 5) along 25% of the total length of generation-tie (gen-tie) and distribution lines (collectively, overhead lines) from the southernmost Project fence to Wiley's Well reststop, which co-occur with the Project access road. Searches were conducted within the summer season at intervals of approximately 21 days, and all components were searched four times. All searches took place during daylight hours from approximately 06:30 to 17:00.

All bird and bat fatalities and injuries that were discovered by observers, referred to as "detections" in this report, including those found incidentally and during standardized carcass searches, were documented. During the reporting period, 55 avian detections and five bat detections were made.

According to specifications of the BBCS, avian detections were categorized by likely diurnal or nocturnal migration behavior, ecological guild (e.g., raptors, songbirds, etc.), facility component, and suspected cause of death. These standardized carcass search results, along with searcher efficiency and carcass persistence rates from bias trials conducted on site, were input into a fatality estimator model (Huso 2010) to provide a preliminary estimate of the number of fatalities that occurred at the Project during the reporting period adjusted for sources of bias. The estimate is considered preliminary because the annual report may pool information from bias trials and other data across seasons which could affect seasonal estimates.

Carcass persistence was influenced by Project component, carcass size, and, in the solar field (solar collector assemblies + perimeter fence), season. In the solar field, small carcasses (0-100 g) had a 52% (90% confidence interval [CI]: 45 – 64%) chance of persisting through the 21-day search interval, medium carcasses (101 – 999 g) had an 92% (90% CI: 76 – 96%) chance, and large carcasses (1000+ g) had a 100% chance. Mean (median) removal time in the solar field was 8.0 (9.0) and 35.1 (30.0) days for small and medium carcasses, respectively. Mean and median removal times for large carcasses in the solar field were not estimated because no removal of large carcasses was observed. Along overhead lines, small carcasses had a 14% (90% CI: 9 – 20%) chance of persisting through the 21-day search interval, medium carcasses had a 59% (90% CI: 42 – 74%) chance, and large carcasses had a 41% (90% CI: 26 – 58%) chance. Mean (median) removal time along overhead lines for small, medium, and large carcasses was 0.8 (0.5), 12.8 (30.0), and 4.6 (3.5) days, respectively. The difference in carcass removal times between Project components is because scavengers likely occur in higher densities outside the perimeter fence.

In the solar field, searcher efficiency averaged over all observers was 92% (86 – 98%) and there was no effect of carcass size, visibility class, or season (n =). Along overhead lines, searcher efficiency averaged over all observers was influenced by carcass size: 54% (90% CI: 39 – 68%) for small birds, 100% for medium birds, and 100% for large birds (n =).

Composition of summer detections included species from 13 avian guilds. No single guild comprised a large number of detections: the most common was blackbirds/orioles (eight detections). Shorebirds and waterbirds/waterfowl were represented by six and seven detections, respectively. Summer was the first season in which bats were detected.

Using the Huso (2010) fatality estimator model, during the summer period 2015, there were an estimated total 100 carcasses (90% CI: 81 - 145) at the Project. Of these, 53 carcasses (53%) were estimated for the SCAs, 8 carcasses (8%) were estimated for the fence, 9 carcasses (9%) were estimated for evaporation ponds, 23 carcasses (23%) were estimated for power blocks, and 7 carcasses (7%; 90% CI: 6 - 21) were estimated for the overhead lines and project road. An estimated 93 (93% CI: 66 - 126) carcasses (50/1000 acres, 0.37/nameplate MW) occurred for all components associated with both solar units (SCAs, power block, evaporation ponds, and along the perimeter fence, combined).

STUDY PARTICIPANTS

Western EcoSystems Technology

Wallace Erickson	Project Manager/Senior Statistician
Tracey Johnson	Research Biologist/Field Supervisor
Paul Rabie	Statistician
Pamela Bullard	Designated Biologist

REPORT REFERENCE

Western Ecosystems Technology, Inc. (WEST). 2015. Post-construction monitoring at the Genesis Solar Energy Project, Riverside County, California. 2015 Summer Interim Report. 31 pp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Appendix A. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during summer (June 01 – August 30) 2015

Appendix B. Correction Factors and Bird Fatality Rates at the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

Appendix C. Detailed Areas of Standardized Searches and Carcass Locations along the Distribution and Generation Tie Lines of the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

Appendix D. Individual detections made during standardized carcass searches and incidentally, by species, during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California. SCA = Solar collector trough.

1.0 INTRODUCTION

1.1 Project Background

The Genesis Solar Energy Project (referred to in this report as "Project") consists of two solar power electrical generating facilities (Units 1 and 2) with a combined net capacity of 250 megawatts. The Project facility consists collectively of two power blocks, power generating equipment (solar collector assemblies [SCAs] of mirrored parabolic troughs [solar troughs or troughs]), support facilities, and evaporation ponds. Linear facilities include a transmission line, distribution line, natural gas pipeline, and a main access road that are mostly co-located for approximately 10.5 km (6.5 miles). The Project comprises approximately 1,800 acres (728 hectares [ha]). The solar field and associated structures comprise 1,727 acres (699 ha) and linear facilities comprise 93 acres (38 ha). The Project is located on land managed by the Bureau of Land Management (BLM) 25 miles (40 kilometers [km]) west of Blythe, in Riverside County, California (Figure 1).

1.2 Monitoring Plan Overview and Goals

A Bird and Bat Conservation Strategy (2015; “BBCS”) was prepared by the Project proponent in collaboration with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), California Energy Commission (CEC), and Bureau of Land Management (BLM) to guide comprehensive monitoring of impacts to birds and bats associated with operation of the Project. Final agency acceptance of the BBCS occurred in March 2015.

The BBCS details post-construction monitoring to be conducted and the data analysis and reporting processes that will be implemented by Genesis Solar in collaboration with the USFWS, CDFW, CEC, and BLM. As identified in the BBCS, they are:

1. Estimate overall annual avian fatality rate and species composition associated with the Project infrastructure. This estimate will include mortality associated with SCAs, overhead lines including the generation (gen-tie) line, perimeter fence and other features of the Project that may result in injury and fatality.
2. Determine whether there are spatial and temporal/seasonal patterns of mortality associated with project infrastructure (e.g., different fatality rates near SCAs on the edge of the solar field versus the interior area of the solar field).
3. Provide information that will assist the CEC and BLM, in consultation with the USFWS and the CDFW, in understanding which species and potentially which regional populations are at risk.
4. Collect data in such a way that the CEC and BLM, in consultation with the USFWS and CDFW, may make comparisons with other solar sites.

1.3 Purpose of This Report

This report represents the second seasonal report for the first year of monitoring summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the approved BBCS and as required by CEC Condition of Certification BIO-16. This report covers the 2015 summer season, which includes the period from June 01 to August 30, 2015. For logistical reasons, fall monitoring started on Monday, August 31, 2015. This report and the other interim quarterly reports are considered preliminary summaries of data and information for the seasonal monitoring periods. Final information from all four quarterly monitoring periods will be included in a comprehensive final annual report. As stated in the approved BBCS, this seasonal report includes the observed fatality rates broken out by likely diurnal, and likely nocturnal species, and for ecological guilds of interest (e.g., raptors, water-associated birds, passerines), for each of the facility types and suspected causes of death. Species composition of carcasses and the results of the bias trials are also reported. This report presents information related to the spatial distribution of carcasses, but no formal statistical analysis will be conducted until the end of the monitoring year, given the limited data presently available.

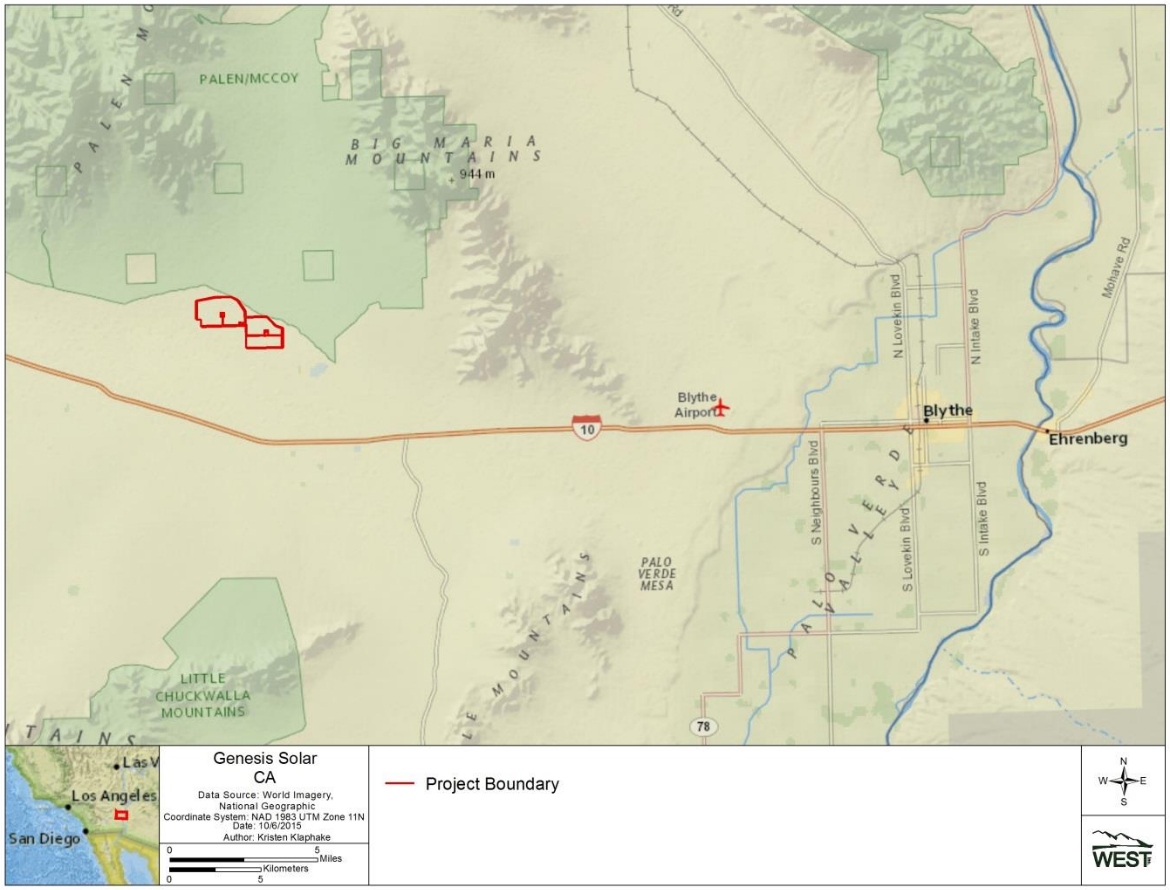


Figure 1. Genesis Solar Energy Project vicinity map, Riverside County, California.

2.0 METHODS

The BBCS describes the methods by which monitoring and certain analyses, including compilation of the overall fatality estimate, will occur. Below is an abridged description (see BBCS for detailed methods).

2.1 Standardized Carcass Searches

This section describes areas surveyed, the timing and frequency of searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats at the Project. This section also describes the methods for conducting carcass removal and searcher efficiency trials; how data were reported and analyzed; and the methods for producing fatality estimates for the Project.

2.1.1 Areas Surveyed

Standardized carcass searches were conducted at a sample of the solar collector assemblies in each unit; the perimeter of each power block (including the area below each air condensed cooling [ACC] unit; Figures 2 and 3); the “fenceline” defined as the perimeter fences for each unit (100% of the total length of fence; Figures 2 and 3); and the gen-tie and distribution lines (25% of the total length of each line from the Project fence to Wiley’s Well rest stop; Figure 4). Table 1 provides the total area of each component as well as the percent of each component that was searched.

To ensure a balanced distribution of plots in solar collector assemblies, each unit was divided into blocks, and each block was sampled using a systematic sample of 30% of pairs of rows with a random starting point. This sampling design ensures that survey plots were not spatially clumped.

2.1.2 Search Frequency and Timing

The summer survey season includes the period from June 01 through August 30, 2015. Standardized searches occurred at 21-day intervals beginning June 01, 2015. All project components included in standardized searches were surveyed four times. All searches took place during daylight hours from 06:30 to 17:00.

The average summer search interval was 18.9 days (median 21 days) for all Project components included in standardized carcass searches. Slight variation in search interval was anticipated due to weather and logistical delays.

Figure 2. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at Unit 1 of the Genesis Solar Energy Project summer (June 01 – August 30) 2015.

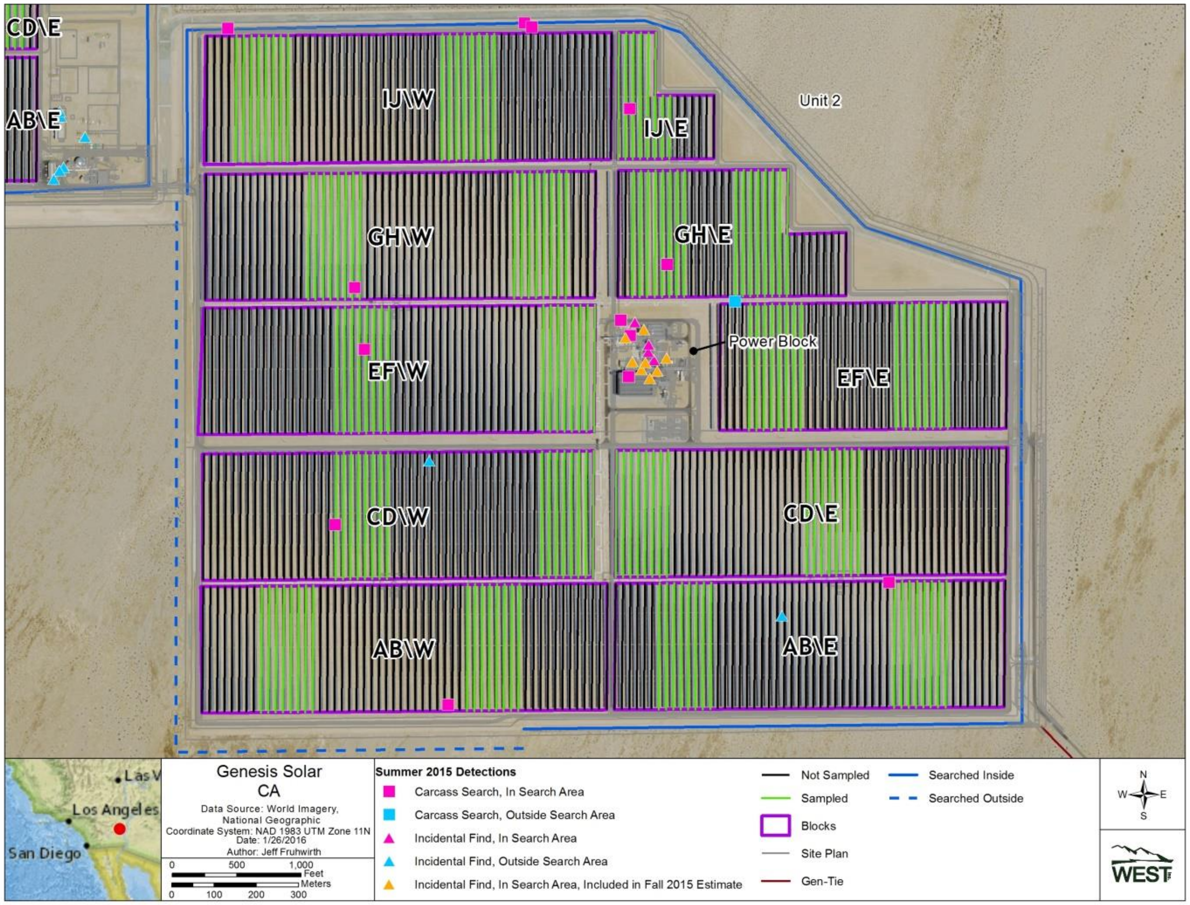


Figure 3. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance) at Unit 2 of the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

Table 1. Areas included in standardized carcass searches at the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

Project Component	Total Size	Units	Percent of Component Searched
SCAs	920	rows of solar troughs	30.4
Unit 1	460	rows of solar troughs	27.8
Unit 2	460	rows of solar troughs	33.0
ACC units	0.9	hectares	100
Power block (perimeter)	0.8	kilometers	100 of perimeter
Evaporation ponds	3.1	hectares	100
Distribution line	8.4	kilometers	25.0
Generation Tie line	8.4	kilometers	25.0
Fence	14.5	kilometers	100

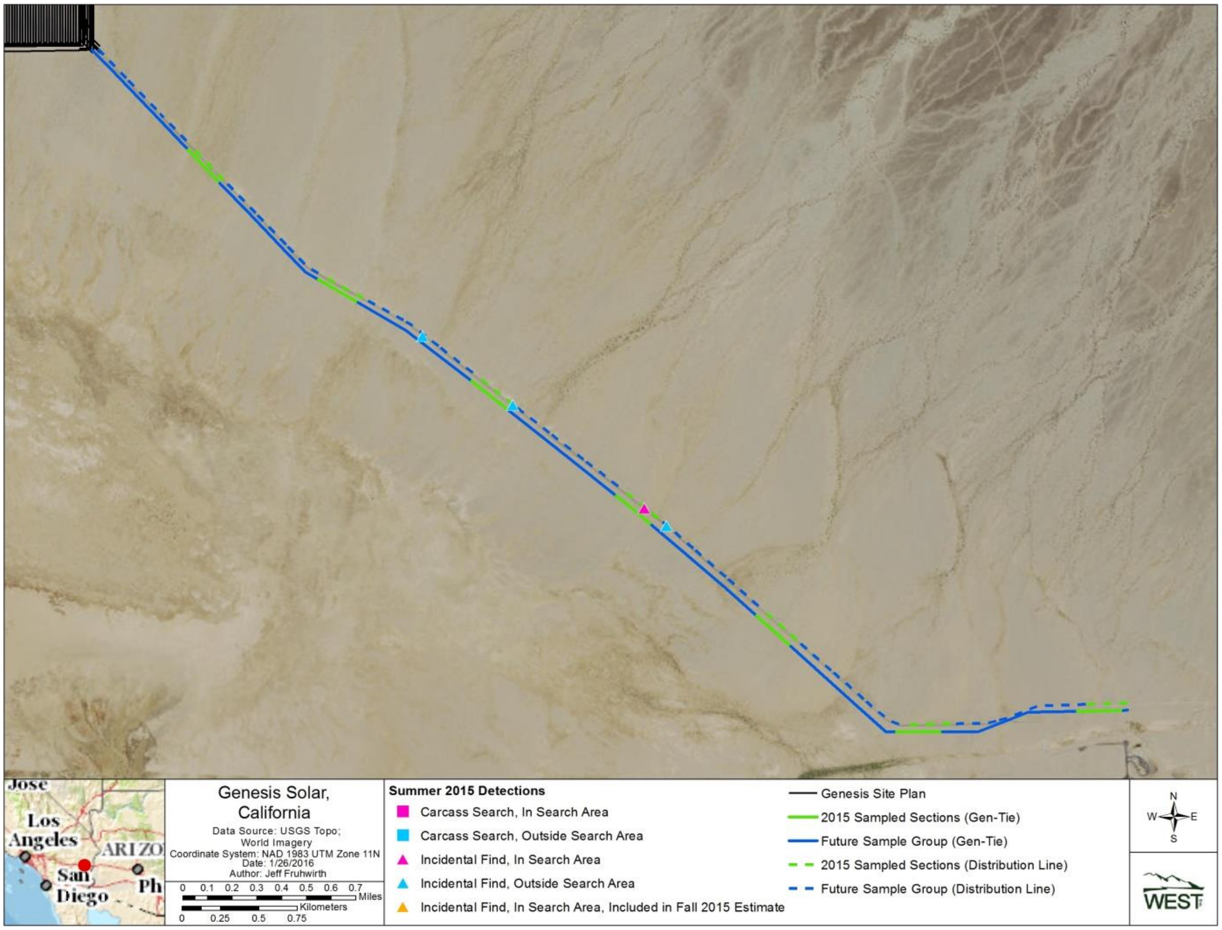


Figure 4. Areas of standardized searches and detections (those made during searches and those made incidental to operations and maintenance activities) along the distribution and generation tie lines and Project access road at the Genesis Solar Energy Project during summer (June 01 – August 30) 2015. Detailed maps of detections are presented in Appendix C.

2.1.3 Search Methods

Standardized carcass searches were performed by CEC- and BLM-approved biologists, in accordance with methods outlined in the BBCS.

Within the solar collector assemblies, 280 solar troughs (30.4% of the total number of troughs) were surveyed by vehicle. Biologists slowly drove (≤5 mph) parallel to troughs and centered between rows, searching ahead and to the driver's side of the vehicle for bird and bat carcasses. Biologists scanned out to a perpendicular distance of approximately 30 m, or the ground area encompassing two rows of solar troughs.

At each power block, biologists slowly walked around the entire perimeter looking for dead and injured birds and bats, and used binoculars to scan interior portions of the powerblock. Per site safety rules, the biologists are not allowed to walk in the interior of the powerblock. However, site personnel do safety inspections and other maintenance on a daily basis within the powerblock. Correction factors for the powerblock Beneath ACC units, biologists walked four evenly-spaced transects (approx. 15-m apart) through the gravel. The search area for the power block is defined as the 0.8-km perimeter of each power block, and the area of the interior power block that was available for visual inspection from the periphery.

At each evaporation pond, biologists walked the entire perimeter looking for dead and injured birds and bats on the ground, in the netting, and in the pond below the netting. Binoculars or a spotting scope were used to scan across the top of the netting and the surface of each pond.

The entire length of fenceline (approximately 12 miles) was searched by vehicle. Biologists searched an approximately 1.5 to 2.5 miles (2.4 km) along drivable sections of the outside of the fence, and the remaining 9.5 to 10.5 miles (16.9 km) were surveyed from the inside of the fence (Figures 2 and 3). Travel speed was below five mph while searching.

The gen-tie and distribution lines were each surveyed using a 30-m wide strip transect (i.e., 15 m of ground on either side of the overhead line). A 25% sample of both lines from the Project fence to the Project outer gate located near the Wiley's Well Road rest stop were searched for carcasses. Biologists slowly walked every fourth 300-ft segment of each line, scanning for dead or injured birds or bats within 15 m (49.2 ft) of the transect line. Given the location of the lines relative to the road, detections found in the strip transects below overhead lines could be caused by collision with an overhead line, vehicles along the road, or some combination of both.

As soon as a carcass was detected, it was then photographed, and data were recorded according to specifications outlined in section 6.7 of the approved Genesis BBCS. Carcasses were then immediately retrieved from their location on the ground, labeled, and placed in a freezer on site.

Suspected cause of death was assigned based on evidence available on the detection, evidence available on the Project infrastructure, and proximity of a detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as “unknown” because it can’t be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging), located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines), and had evidence of injury on the detection had a suspected cause of death attributed to the respective Project component. However, it should be noted that there is uncertainty associated with cause of death assignments because no events were directly observed.

2.2 Carcass Persistence Trials

Carcass persistence trials were conducted throughout the summer period. Carcasses from three size classes (small [0-100 g], medium [101-999], and large [1000+ g]) were used for trials. Carcass persistence results from small birds were used as a proxy for bat carcass persistence. The small size class comprised house sparrows (*Passer domesticus*) and 2-3 week old coturnix quail (*Coturnix coturnix*), the medium size class comprised rock pigeons (*Columba livia*), chukar (*Alectoris chukar*) and older coturnix quail, and the large size class comprised hen mallard (*Anas platyrhynchos*) and hen ring-necked pheasant (*Phasianus colchicus*).

2.2.1 Carcass Persistence Data Collection

To quantify carcass persistence rates, 15 small, 10 medium, and five large carcasses were randomly placed and monitored within the solar field (SCA’s and the fence line), and the same number of each size class were placed along the gen-tie and distribution lines, for a total of 60 carcass persistence trials at Genesis during the summer 2015 season, as specified in section 6.5 of the approved Genesis BBCS. Fifteen carcasses within the Project fence (within SCAs and along the fence and perimeter of power blocks) and four carcasses along the gen-tie and distribution lines were monitored using motion-triggered digital trail cameras, while the remaining carcasses were visited on foot, for 30 days or until the carcass had deteriorated to a condition at which it would no longer qualify as a documentable fatality (i.e., a feather spot). Fewer carcasses along the gen-tie and distribution lines were monitored with cameras because of theft and vandalism concerns. Carcasses without trail cameras were visited and photographed once per day for the first four days, and then every three to five days until the end of the monitoring period. To avoid training scavengers to recognize cameras as “feeding stations”, trail cameras were installed five days before specimens were placed, and fake cameras without bias trial carcasses were also placed (eight within the Project fence, and four along the gen-tie and distribution lines). Periodic ground-based checking of carcasses with trail cameras also occured to guard against misleading indicators of carcass removal, such as wind blowing the carcass out of the camera’s field of view. To minimize potential bias caused by scavenger swamping (Smallwood 2007, Smallwood et al. 2010), carcass-persistence specimens were distributed across the entire Project, not just in areas subject to standard searches, and trials were initiated in small numbers on four different dates throughout the spring season.

2.2.2 Estimating Carcass Persistence Times

Carcass persistence trials were checked daily during the first four days and then every three to five days until the 30-day trial length was reached. Measurements of carcass persistence rates were subject to censoring. In this context, censoring refers to the instance when a value (e.g. days a carcass is present before being removed) may not be known exactly, but is known to be within a finite range. For example, suppose a carcass was checked on day 7 and was present, and was checked again on day 10, but was found to be missing. The exact time until removal is unknown; however, it is known that the carcass became unavailable at some point between 7 and 10 days. This carcass would be considered “interval censored”. Similarly, if a carcass lasts the entire 30-day trial period, that carcass is “right censored”— it is known that the carcass lasted at least 30 days, but it may have persisted longer. Because carcass persistence data were censored, persistence was analyzed using methods that can accommodate censored data and still produce unbiased estimates of the probability of persistence (Therneau 2015, Thernaur and Grambsch 2000). It is beyond the scope of this document to provide statistical foundations of censored-data survival models but functions identical to those provided with the USGS-developed fatality estimator software (Huso et al 2012) were used to fit survival models to the censored carcass persistence data, and some background is available in the documentation provided with that software.

USGS-developed fatality estimator software (Huso et al. 2012) was used to fit survival models to the censored carcass persistence data. There were four distributions implemented in survival models used to estimate the probability a carcass is unscavenged and available to be found at the end of the search interval (*r*): exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying degrees of flexibility in order to model a wide variety of distributions of persistence time. Akaike’s Information Criterion adjusted for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model to censored carcass persistence data.

2.3 Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the summer period. Carcasses from three size classes (small, medium, and large) were used for trials. Searcher efficiency results from small birds were used as a proxy for bat detection. The small size class comprised house sparrows and 2-3 week old coturnix quail, the medium size class comprised rock pigeons, chukar, and older coturnix quail, and the large size class comprised hen mallards and hen ring-necked pheasants.

2.3.1 Searcher Efficiency Data Collection

A total of 60 searcher efficiency trials (15 small birds, 10 medium birds, and five large birds within SCA’s, power blocks, and along the perimeter fence, and the same number of each size class along the gen-tie and distribution lines) were placed at the Project during the 2015 summer season, as specified in section 6.4 of the approved Genesis BBCS. Locations for trials were chosen by taking a randomized sample of all locations included in standardized carcass searches. Trial carcasses were placed in various vegetation heights and in areas that had different soil and vegetation colors and values to represent the range of conditions under which searches occur. They were placed in all areas where standardized searches occur except the evaporation ponds. Trial carcasses were placed in selected search areas the same morning that a search is scheduled to occur in that area. Trial carcasses were retrieved the same day, either by the searcher who found them, or for missed carcasses, by the observer who conducted the searcher efficiency trial.

2.3.2 Estimating Searcher Efficiency

There were not sufficient data for the summer season to assess whether searcher efficiency differed by Project component (e.g., SCAs/fence/power block [solar field] versus gen-tie/distribution line [overhead lines]), so searcher efficiency was assumed to differ between the two areas and was estimated separately for the solar field and overhead lines. The nearly complete lack of vegetation cover in the solar field suggests that searcher efficiency may be higher in the solar field than along the overhead lines where vegetation cover is greater. If this hypothesis is true, accounting for this difference in searcher efficiency across Project components will be important for producing accurate fatality estimates at the end of the monitoring year.

To evaluate hypotheses regarding differences in carcass detectability among carcass size and visibility classes, logistic regression models were fit to searcher efficiency data and AICc was used to compare models. Models including effects of carcass size (3 classes), season (spring, summer) and visibility index (2 classes) were compared to each other and a null model. The two visibility classes present at the Project site are: easy (defined as ≥ 90% bare ground [BG]; vegetation <6” tall) and moderate (defined as 26-89% BG; vegetation <6” tall). However, within the solar field the moderate visibility class has a very limited spatial extent (approximately 10%) due to management aimed at minimizing vegetation cover and thus, was represented by only two trial carcasses during the reporting period. Rather than eliminating the two carcasses in the moderate class from the analysis of searcher efficiency, we assumed there were no differences in searcher efficiency between the two visibility classes in the solar field this summer, and the set of candidate models for searcher efficiency (within the solar field only) did not include tests of the hypothesis that searcher efficiency varied between visibility classes. The spatial extent of the moderate visibility class in the solar field is roughly equal to its representation in the summer sample of searcher efficiency carcasses (8 of 60 or 13.3%).

Once the best model was chosen and appropriate classes identified, searcher efficiency, or the proportion of carcasses detected, *p,* was calculated for each class using the following equation:

$$p = \frac{Number\ of\ Carcasses\ Observed}{Number\ of\ Carcasses\ Available}$$

The data for this analysis included all searcher efficiency trial carcasses from the spring and summer 2015 season, because model selection results indicated no differences in searcher efficiency by season.

2.4 Fatality Estimator

Fatality rate estimation is a complex task due to several variables inherent to every fatality monitoring study. Carcasses may persist for variable amounts of time due to local scavenger activity or environmental conditions leading to carcass degradation over time. Carcasses and feather spots are also detected with varying levels of success based on carcass characteristics and ground cover (e.g., vegetated areas underneath the gen-tie and distribution lines versus cleared areas beneath SCAs). For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where F is the total number of fatalities, C is the number fatalities detected and included in fatality estimation, r is the probability a carcass is unscavenged and available to be found at the end of the search interval, and p is the probability of detecting a carcass (Huso 2010).

All fatality estimates were calculated using the Huso estimator, as well as 90% confidence using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. A total of 1,000 bootstrap replicates were used for each variable including searcher efficiency (p), probability of a carcass persisting to the next search ($\hat{r}$), adjusted search interval and observed fatalities. From these bootstraps, the probability of available and detected was calculated and applied to the bootstrapped observed fatalities. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates provide estimates of the lower limit and upper limit of an approximate 90% confidence interval on all estimates.

2.5 Incidental Reporting

Some detections were outside standardized search areas, or were within search areas but not observed during standardized searches. Such detections were found by WEST avian biologists and operational personnel and were considered “incidental” detections. When found by operational personnel, these detections were reported to WEST avian biologists for documentation. Data on incidental detections are reported here, as well as in the SPUT Avian Injury and Mortality Report Forms June – August 2015. All detections made in search areas were included in fatality estimates, regardless of whether they were detected incidentally or during searches.

3.0 MONITORING RESULTS

3.1 Summary of Avian Detections

During summer 2015, a total of 60 detections (including stranded birds, incidental detections, and bats) of 32 identified species were recorded (Table 2). The most numerous detection of an identified species was of brown-headed cowbird (*Molothrus ater*), and greater roadrunner (*Geococcyx californianus*), each with five detections. Most detections (n = 22, or 36.7% of total detections) occurred at powerblocks (Figures 2, 3; Tables 2, 3, and 4). Twenty-four (40.0%) detections were made during standardized carcass searches and 36 (60.0%) were documented as incidentals with most of these (n = 17) in the powerblock.

Table 2. Number of individual detections (those made during standardized carcass searches and incidentally), by species and component, during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California. SCA = solar collector trough.

Common Name	Scientific Name	SCA	Powerblock	Ponds	Fence	Gen-tie line	Other	Total Count
Avian								
brown-headed cowbird	*Molothrus ater*	2	2	-	-	-	1	5
greater roadrunner	*Geococcyx californianus*	1	3	-	-	1	-	5
unidentified bird (small)	-	3	1	-	1	-	-	5
mourning dove	*Zenaida macroura*	-	1	-	-	2	-	3
unidentified bird (unknown size)	-	1	1	-	1	-	-	3
cinnamon teal	*Anas cyanoptera*	1	-	1	-	-	-	2
red-winged blackbird	Agelaius phoeniceus	1	-	-	1	-	-	2
unidentified duck	-	2	-	-	-	-	-	2
white-winged dove	*Zenaida asiatica*	-	2	-	-	-	-	2
American kestrel	*Falco sparverius*	-	1	-	-	-	-	1
bank swallow	*Riparia riparia*	-	1	-	-	-	-	1
belted kingfisher	*Ceryle alcyon*	-	1	-	-	-	-	1
black phoebe	*Sayornis nigricans*	-	1	-	-	-	-	1
California gull	*Larus californicus*	1	-	-	-	-	-	1
cliff swallow	*Petrochelidon pyrrhonota*	-	1	-	-	-	-	1
common nighthawk	*Chordeiles minor*	-	-	1	-	-	-	1
eared grebe	*Podiceps nigricollis*	-	-	1	-	-	-	1
Eurasian collared-dove	*Streptopelia decaocto*	-	-	-	-	-	1	1
Gambel's quail	*Callipepla gambelii*	-	-	-	1	-	-	1
lesser nighthawk	*Chordeiles acutipennis*	-	-	-	-	1	-	1
loggerhead shrike	*Lanius ludovicianus*	1	-	-	-	-	-	1
long-billed curlew	*Numenius americanus*	1	-	-	-	-	-	1
ruddy duck	*Oxyura jamaicensis*	-	-	1	-	-	-	1
snowy egret	*Egretta thula*	-	1	-	-	-	-	1

Table 2. Number of individual detections (those made during standardized carcass searches and incidentally), by species and component, during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California. SCA = solar collector trough.

Common Name	Scientific Name	SCA	Powerblock	Ponds	Fence	Gen-tie line	Other	Total Count
spotted sandpiper	*Actitis macularia*	1	-	-	-	-	-	1
Townsend's warbler	*Setophaga townsendi*	-	1	-	-	-	-	1
tree swallow	*Tachycineta bicolor*	-	-	1	-	-	-	1
unidentified bird (medium)	-	-	-	1	-	-	-	1
unidentified sandpiper	-	-	1	-	-	-	-	1
western gull	*Larus occidentalis*	1	-	-	-	-	-	1
western kingbird	*Tyrannus verticalis*	-	-	-	-	-	1	1
western sandpiper	*Calidris mauri*	-	-	1	-	-	-	1
yellow-billed cuckoo	*Coccyzus americanus*	-	1	-	-	-	-	1
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	-	-	1	-	-	-	1
yellow warbler	*Setophaga petechia*	-	-	-	-	-	1	1
Bats								
canyon bat	*Pipistrellus hesperus*	-	-	-	-	-	2	2
unidentified bat	-	-	2	-	-	-	-	2
Mexican free-tailed bat	*Tadarida brasiliensis*	-	1	-	-	-	-	1
Total		16	22	8	4	4	6	60

3.2 Temporal Patterns of Avian Detections

The number of detections recorded daily during summer 2015 ranged from zero to five (Figure 5). The period from June 01 to August 30 was characterized by peaks in detections with highs on June 29, July 2, and August 17. The fewest detections in any calendar month was July. The number of detections per day represents those discovered during standardized carcass searches and incidentally.

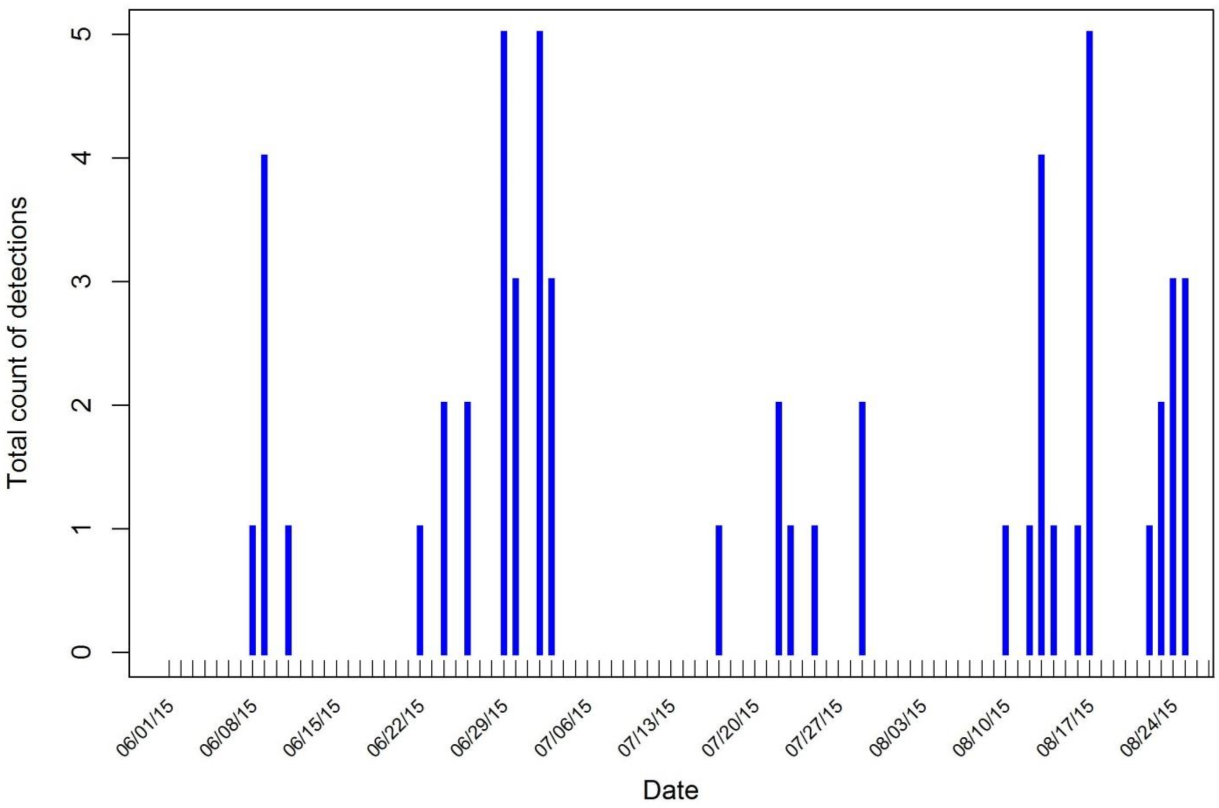


Figure 5. Total number of detections by date during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California.

3.3 Spatial Distribution of Avian Detections

3.3.1 Detections by Project Component

During summer 2015, detections were documented from Project buildings, the perimeter fence, gen-tie and distribution lines (overhead lines), the power block or ACC unit within the power block, evaporation ponds, and SCAs (Tables 2, 3, and 4). Of the 56 detections within the solar units, 27 (48.2%) were detected in Unit 1, and 29 (51.8%) were detected in Unit 2.

Table 3. Total detections by Project component and detection category during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California.

Project Component	Carcass search	Incidental	Percent of Total
Buildings	0	6	10.0
Fence	4	0	6.7
Overhead lines	0	4	6.7
Ponds	5	3	13.3
Power Block	5	17	36.7
SCA	10	6	26.7
Percent of Total	40.0	60.0	100.0

Table 4. Total detections (including incidentals) by Project component and suspected cause of death during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California.

	Suspected Cause of Death*						
Project Component	**Collision**	**Drowned**	**Entangled**	**Other**	**Predation**	**Unknown**	**% of Total**
Fence	0	0	0	2	0	2	6.7
Other	1	0	0	1	0	4	10.0
Overhead lines/road	2	0	0	1	0	1	6.7
Pond	1	0	2	3	0	2	13.3
Powerblock	7	1	0	8	0	6	36.7
SCA	4	0	0	8	1	3	26.7
% of Total	25.0	1.7	3.3	38.3	1.7	30.0	100.0

* Suspected cause of death was assigned based on evidence available on the detection, evidence available on Project infrastructure, and proximity of detection to Project infrastructure. Detections that had evidence of scavenging and lacked evidence on Project infrastructure were assigned as "unknown" because it can't be determined whether the event was caused by predation or interaction with project infrastructure. Detections that were intact (i.e., no evidence of scavenging) and located in close proximity to Project infrastructure (e.g., found directly beneath overhead lines) and had evidence of injury on the detection had a suspected cause of death attributed to the respective Project component. However, in the absence of completed necropsy, there is some uncertainty associated with cause of death assignments because no events were directly observed.

3.3.2 Feather Spot Detections

Twelve (20.0%) of the 60 detections made during summer 2015 consisted only of feather spots. Along the fence, three of four total detections (75.0%) were feather spots. No detections along the overhead lines and road or the evaporation ponds were feather spots. Three of 22 total detections (13.6%) at the powerblocks were feather spots. Six of 16 total detections (37.5%) at SCA's were feather spots.

3.4 Detections of Stranded Birds

There were no detections of stranded or injured birds during the 2015 summer season.

3.5 Summary of Bat Detections

Five bats were detected during the summer season. Idenitified species included Mexican free-tailed (*Tadarida brasilinesis*; 1), and canyon bat (*Pipistrellus hesperus*; 2; Table 2).

3.6 Carcass Persistence Trials

Data from carcass persistence trial carcasses were available from spring and summer at the solar field (SCA's, powerblocks, and perimeter fence) and overhead lines (n = 30 each or 120 total). Of these, only seven trials were not in easy visibility habitats, so visibility was not included as a covariate in the carcass removal models. Preliminary analysis using AICc suggested that both season and location (lines vs. solar field) were important predictors of carcass persistence, but when the data were separated by location, season was only important for carcasses within the solar field. Therefore, two carcass persistence models were fitted to two different sets of data: 60 carcasses total from spring and summer were used to estimate carcass persistence along overhead lines, and 30 carcasses total from summer only were used to estimate carcass persistence within the solar field.

Using carcass persistence data from 2015 spring and summer seasons as outlined above, survival models were compared for relative quality using the corrected AICc score, as suggested in Huso (2010). The AICc score provides a relative measure of model fit and parsimony among a selection of candidate models. The model with lowest AICc is typically chosen as the "best" model relative to other models tested; however, any model within two AICc points of the best model is considered competitive with the best model (Burnham and Anderson 2004).

For data collected at SCAs, the top two models had ∆AICc values <2. Ultimately, the loglogistic model that included an effect of carcass size was chosen as the most parsimonious of the top models. The chosen model predicted that 52% (45 – 64%) of small carcasses, 92% (76 – 96%) of medium carcasses, and 100% of large carcasses persisted for a standard 21-day search interval. Mean (median) removal time for small carcasses in the solar field was 8.0 (9.0) days, 35.1 (30.0) days for medium carcasses, and was not estimated for large carcasses given the nearly perfect persistence rate (no removal was observed; Figure 6).

For data collected along the overhead lines, the top six models had ∆AICc values <2. Ultimately the lognormal model with an effect of carcass size was chosen as the most parsimonious top model. The chosen model predicted that 14% (9 – 20%) of small carcasses, 59% (42 – 74%) of medium carcasses, and 41% (26 – 58%) of large carcasses persisted for a standard 21-day search interval. Mean (median) removal time along overhead lines for small carcasses was 0.8 (0.5) days, for medium carcasses was 12.8 (30.0) days, and for large carcasses was 4.6 (3.5) days (Figure 6). The difference in carcass removal times between Project components is because scavengers likely occur in higher densities outside the perimeter fence.

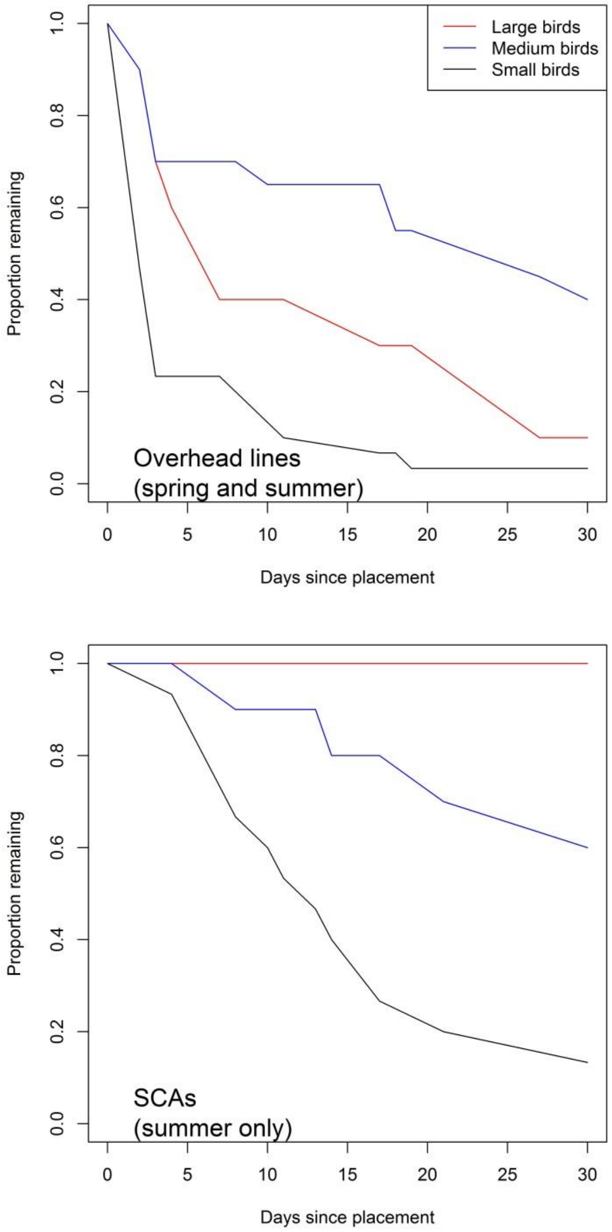


Figure 6. Proportion of trial carcasses remaining as a function of days since placement and carcass size class during the summer 2015 season at the Genesis Solar Energy Project, Riverside County, California. Modeling of carcass persistence data from overhead lines suggested no effect of season, so sample size used to produce the overhead lines panel was n = 30, 20, and 10 for small, medium, and large size classes, respectively. Modeling of carcass persistence data from the solar field (SCAs) suggested an effect of season, so sample size used to produce the SCA panel was n = 15, 10, and 5 for small, medium, and large size classes, respectively.

3.7 Searcher Efficiency Trials

During the 2015 summer season, a total of 60 searcher efficiency trials (30 small, 20 medium, and 10 large birds) were placed at the Project. Details regarding the number of searcher efficiency trial carcasses placed, removed, and available to be found by Project component are provided in Table 5. All carcasses removed by scavengers during searcher efficiency trials are assumed to have been removed before the observer had a chance to detect the trial carcass. Our analysis assumes the trial carcasses are removed at random and that the remaining carcasses provide a fair indication of our searcher efficiency.There was one observer at Genesis during summer; Sarah Nichols was tested throughout the summer season, and there were 51 trial carcasses available for her to find.

Table 5. Searcher efficiency trial carcass locations by Project component during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California.

Project Component	Placed	Removed	Available to be detected
Fence	6	4	2
Gen-tie line	15	1	14
Distribution line	15	1	14
Powerblocks	3	0	3
SCA's	21	3	18
Total	60	9	51

In the solar field (SCAs + fence + powerblocks), the null model was chosen as the best model to estimate searcher efficiency, suggesting no effect of carcass size, season, or visibility class. Thus, data from spring and summer searcher efficiency trials, all carcass class sizes, and both visibility classes were pooled for the following estimate of searcher efficiency. Searcher efficiency rate in the solar field was 91.8% (86.0 – 98.0%), or 45 found of 49 available to be found.

Along overhead lines, the model that included an effect of carcass size, but not season or visibility class, was chosen as the best model. Thus, data from spring and summer trials and both visibility classes were pooled for the following estimates of searcher efficiency along overhead lines: 53.6% for small birds (39.0 – 68.0%; 15 found of 28 available to be found), 100% for medium birds (19 found of 19 available), and 100% for large birds (10 found of 10 available). Although carcass size influenced searcher efficiency, searcher efficiency was relatively high over all carcass size classes (77.1%).

3.8 Fatality Estimates

Fatality estimates were calculated separately for each component (SCAs, power blocks, fence, evaporation ponds, and overhead lines/road). Ultimately, no detection was excluded from the fatality analysis because it was estimated to be older than the 21-day search interval (Huso 2010). Of the 60 detections that occurred in summer, 16 were excluded from the summer fatality estimate because they were found outside standardized search areas, and 12 were excluded because they were found after the last standardized search in summer (to be included in fall 2015 estimates; Table 6, Appendix B).. However, all detections that occurred during summer are reported in Table 2. Detections used in the analysis, bias corrections, summer fatality estimates, and 90% confidence intervals for summer fatality estimates are detailed in Appendix B.

Table 6. Status of detections during the summer (June 01 – August 30) 2015 season at the Genesis Solar Energy Project, Riverside County, California. All detections outside the search area were excluded from the fatality analysis, regardless of whether they occurred during a standardized carcass search or incidentally.

	Carcass search	Incidental detection	*Pushed to next season's fatality estimate	*Pulled from previous season's fatality estimate
Inside search area	22	10	12	0
Outside search area	2	14	0	0

* Incidental detections occurring after the last standardized carcass search in a season are considered for inclusion in the fatality analysis for the following season. This is consistent with the assumption we make throughout the monitoring seasons; that carcasses found incidentally would have been available to be found on the next scheduled search. This assumption may result in some carcasses found during one season but considered in the following season's fatality analysis. Once a carcass has been moved to a different season's analysis it is still subject to the same criteria for inclusion or exclusion based on location (in versus out of a searched area) and carcass age (greater than versus less than the search interval).

Using the Huso (2010) fatality estimator model, during the summer period 2015, there were an estimated total 100 carcasses (90% CI: 81 - 145) at the Project. Of these, 53 carcasses (53%) were estimated for the SCAs, 8 carcasses (8%) were estimated for the fence, 9 carcasses (9%) were estimated for evaporation ponds, 23 carcasses (23%) were estimated for power blocks[1], and 7 carcasses (7%; CI: 6 – 21) were estimated for the overhead lines and project road. An estimated 93 (93%; CI: 66-126) carcasses (0.050/acre, (50/1000 acres, 0.37/nameplate MW)

---

[1] Estimate is based on adjusted mortality from the powerblock perimeter surveys and adding in the incidentals found by operations staff in the interior of the powerblock. The carcasses found by staff in the interior of the powerblock are not adjusted for biases because no trials are conducted in those areas (biologists are not allowed in that area for safety reasons). However, daily surveys are conducted throughout the interior of the powerblock by operations staff for equipment inspections, and several personnel spend time in those areas on a daily basis.

occurred for all components associated with both solar units (SCAs, power block, evaporation ponds, and along the perimeter fence, combined). A complete list of estimates for each Project component and carcass size class with confidence intervals is presented in Appendix B.

4.0 DISCUSSION

The 2015 summer season represented the second season of standardized monitoring at Genesis per the BBCS. Searcher efficiency trials and carcass removal trials were conducted concurrently at the SCAs, power blocks, fencelines, and along the gen-tie and distribution lines. Data from these trials were used to produce fatality estimates adjusted for searcher efficiency and carcass persistence bias. Although these estimates were produced from a statistically robust sample, only limited inference may be drawn from a single season of data. These results should be considered preliminary because estimating carcass persistence, searcher efficiency, and adjusted numbers of fatalities within each season represents information based on a limited sample size. As more data are collected throughout the monitoring year (and additional quality assurance/quality control measures occur, for example characterizing feather spots to species or size class), data from all seasons may be pooled. At that time, data will be tested for seasonal differences retrospectively using an information-theoretic approach, but because seasonal estimates will be produced from the much larger annual data set, they may differ from what is reported here because they are based on a larger, more informative sample.

4.1 Carcass Persistence and Searcher Efficiency Trials

The degree to which carcasses persist on the landscape depends on a variety of factors reflecting seasonal and inter-annual variation in habitat, climate, and the scavenger community. The composition and activity patterns of the scavenger community often vary seasonally as birds migrate, new juvenile birds and mammals join the local population, and mammalian scavengers variably hibernate or estivate. The scavenger community may also vary substantially from year to year because of variation in annual reproduction and survival related to changes in landscape condition. Climatic conditions that vary seasonally and annually also may contribute to variation in carcass decay and removal rates due to variation in temperatures, solar insolation, wind patterns, and the frequency of flooding events. Thus, rates of carcass persistence reported here should be interpreted cautiously as they may change over the coming months.

Fatality estimates are influenced by the relationship between carcass removal dynamics and search intervals. In practical terms, longer search intervals reduce average probability that a carcass persists until the next search. In terms of the analysis, this can manifest as a lower probability of persistence through the effective search interval, or an effective search interval that is shorter than the nominal search interval. In either case, the adjustment to carcass counts due to carcass removal dynamics is calculated as

$$\frac{length\ of\ effective\ search\ interval}{\begin{array}{c} length\ of\ nominal\ search\ interval * average\ probability\ of\ persistence \\ through\ the\ effective\ search\ interval \end{array}}$$

The adjustment to estimated fatality for carcass removal increases with longer search intervals, and the variance in the estimate may increase, also.

Searcher efficiency was influenced by carcass size, but it is not yet clear if there may be an effect of habitat visibility class due to limited sample sizes. In the SCA's, searcher efficiency was high regardless of carcass size and this is likely influenced by the limited vegetation cover beneath solar troughs. Beneath overhead lines outside the Project fence vegetation cover is higher, but our analysis did not support the hypothesis that visibility class is a factor in searcher efficiency along the lines. Carcass size influenced searcher efficiency, but searcher efficiency was relatively high over all carcass size classes (77.1%).

Searcher efficiency trials for this Project will be repeated seasonally. The desert landscape in which this Project is located generally changes little with the seasons, save for brief periods following seasonal rains when floods may occur and blooming plants may flourish. A recent meta-analysis involving data from more than 70 wind-energy projects suggested that including habitat visibility class as a predictive variable generally eliminated any otherwise apparent seasonal effects on searcher efficiency (Smallwood 2013). Further, the possibility exists that searcher efficiency varies seasonally in some cover types but not others. Data from searcher efficiency trials conducted over the coming seasons will therefore continue to be tested for effects of habitat visibility class rather than effects of season.

4.2 Distribution of Fatalities and Fatality Estimates

The number of detections was highest during the early and late summer monitoring period and lowest during July. However, because this report includes detections made during carcass searches and incidental detections reported by Genesis site personnel between searches, patterns may reflect the 21-day search interval during summer more than any patterns in bird activity at the Project.

Composition of summer detections included avian species from 13 guilds. No single guild comprised a large number of detections: the most common was blackbirds/orioles (eight detections or 14.5% of all avian detections). Shorebirds and waterbirds/waterfowl were represented by six (10.9%) and seven (12.7%) detections, respectively. Summer was the first season in which bats were detected.

Detections attributed to an unknown cause accounted for approximately 30% of all detections during the 2015 summer season, and the distribution of the unknown cause detections varied by project component with the highest percentage of unknowns (66.7%, or 4 of 6 total detections) occurring in association with Project components that are not included in standardized carcass searches (e.g., buildings). Of the 18 detections attributed to an unknown cause, 4 (22.2%) were feather spots. Determining a cause of mortality from a feather spot is challenging because there is rarely visible evidence available on which to determine a cause of death. Thus, feather spots with an unknown cause of mortality could be encountered anywhere birds occur, and an unknown cause of a sizeable proportion of the carcasses is not unique to the Project. Further, game cameras trained on carcasses for carcass persistence trials at the Project have documented multiple feather spots originating from a single trial carcass. Ravens and turkey vultures, and possibly roadrunners, dislodge feathers from their attachment to the skin during the scavenging process. There are a very large number of potential feather spots present on a single bird carcass (because a feather spot is defined as at least two or more primary flight feathers, at least five or more tail feathers, or two primaries within five m (16.4 ft) or less of each other, or a total of 10 or more feathers of any type concentrated together in an area of three square m). Thus, the presence of feather spots among the detections for the Project may inflate the fatality estimate based on the potential for multiple feather spots resulting from one fatality to be counted separately if feathers are blown around the site or scattered by predators (e.g., plucking by ravens), feather spots resulting from predation not associated with the facility, or other causes. However, feather spots are included in the analysis here to provide a more conservative estimate of fatality.

5.0 LITERATURE CITED

Akaike, H., 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 in 2nd International Symposium on Information Theory (B. N. Petran and F. Csaki, Eds.). Akademiai Kiado, Budapest, Hungary.

Brigham, R. M., Janet Ng, R. G. Poulin and S. D. Grindal. 2011. Common Nighthawk (Chordeilesminor), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/213 doi:10.2173/bna.213

Brown, Charles R. and Mary B. Brown. 1995. Cliff Swallow (Petrochelidon pyrrhonota), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/149 doi:10.2173/bna.149

Brua, Robert B. 2002. Ruddy Duck (Oxyura jamaicensis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/696 doi:10.2173/bna.696

Burnham, K.P., and D.R. Anderson. 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociological Methods & Research 33: 261-304.

Cullen, S. A., J. R. Jehl Jr. and G. L. Nuechterlein. 1999. Eared Grebe (Podiceps nigricollis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/433 doi:10.2173/bna.433

Evans, W.R., and D.K. Mellinger. 1999. Monitoring grassland birds in nocturnal migration. Studies in Avian Biology 19: 219-229.

Gamble, Lawrence R. and Timothy M. Bergin. 2012. Western Kingbird (Tyrannus verticalis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/227 doi:10.2173/bna.227

Gammonley, James H. 2012. Cinnamon Teal (Anas cyanoptera), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/209 doi:10.2173/bna.209

Gee, Jennifer, David E. Brown, Julie C. Hagelin, Mark Taylor and Jill Galloway. 2013. Gambel's Quail (Callipepla gambelii), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:doi:10.2173/bna.321

Hughes, J. M. 2011. Greater Roadrunner (Geococcyx californianus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/244 doi:10.2173/bna.244

Hughes, J. M. 2015. Yellow-billed Cuckoo (Coccyzus americanus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/418 doi:10.2173/bna.418

Huso, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. doi: 10.1002/env.1052

Huso, M., N. Som, and L. Ladd. 2012. Fatality estimator user's guide: U.S. Geological Survey Data Series 729, 22 pp.

Kelly, Jeffrey F., Eli S. Bridge and Michael J. Hamas. 2009. Belted Kingfisher (Megaceryle alcyon), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/084 doi:10.2173/bna.84

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A New Method to Determine Bird and Bat Fatality at Wind Energy Turbines from Carcass Searches. Wildlife Biology 17: 350-363.

Latta, Steven C. and Michael E. Baltz. 2012. Lesser Nighthawk (Chordeiles acutipennis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/314 doi:10.2173/bna.314

Lowther, Peter E. 1993. Brown-headed Cowbird (Molothrus ater), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/047 doi:10.2173/bna.47

Lowther, P. E., C. Celada, N. K. Klein, C. C. Rimmer and D. A. Spector. 1999. Yellow Warbler (*Setophaga petechia*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/454 doi:10.2173/bna.454

Manly, B.F.J.1997. Randomization, Bootstrap and Monte Carlo Methods in Biology. Second Edition. CRC Press, LLC, Boca Raton, FL., 455 pp.

Murray, J. 2004. Nocturnal flight call analysis as a method for monitoring density and species composition of migratory songbirds (Order Passeriformes) across southern Vancouver Island, British Columbia in 2004. Rocky Point Bird Observatory, 16 pp.

Newton, I. 2008. The Migration Ecology of Birds. Academic Press, London.

Otis, David L., John H. Schulz, David Miller, R. E. Mirarchi and T. S. Baskett. 2008. Mourning Dove (*Zenaida macroura*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/117 doi:10.2173/bna.117

Parsons, Katharine C. and Terry L. Master. 2000. Snowy Egret (Egretta thula), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/489 doi:10.2173/bna.489

Pierotti, Raymond J. and Cynthia A. Annett. 1995. Western Gull (Larus occidentalis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/174 doi:10.2173/bna.174

Reed, J. Michael, Lewis W. Oring and Elizabeth M. Gray. 2013. Spotted Sandpiper (Actitismacularius), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/289

Romagosa, Christina Margarita. 2012. Eurasian Collared-Dove (*Streptopelia decaocto*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/630 doi:10.2173/bna.630

Schwertner, T. W., H. A. Mathewson, J. A. Roberson, M. Small and G. L. Waggerman. 2002. White-winged Dove (Zenaida asiatica), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/710 doi:10.2173/bna.710

Smallwood, John A. and David M. Bird. 2002. American Kestrel (*Falco sparverius*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/602 doi:10.2173/bna.602

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71: 2781-2791.

Smallwood, K.S., D.A. Bell, S.A. Snyder, and J.E. DiDonato. 2010. Novel scavenger removal trials increase wind turbine-cause avian fatality estimates. Journal of Wildlife Management 74(5): 1089-1096.

Smallwood, K. S. 2013. Comparing bird and bat ratality-rate Estimates among North American wind-energy projects. Wildlife Society Bulletin 37(1): 19-33.

Therneau, T. 2015. _A Package for Survival Analysis in S. version 2.38, <URL: http://CRAN.R-project.org/package=survival>.

Therneau, T.M. and P. M. Grambsch 2000. Modeling Survival Data: Extending the Cox Model. Springer, New York. ISBN 0-387-98784-3.

Twedt, Daniel J. and Richard D. Crawford. 1995. Yellow-headed Blackbird (Xanthocephalusxanthocephalus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/192 doi:10.2173/bna.192

Winkler, David W., Kelly K. Hallinger, Daniel R. Ardia, R. J. Robertson, B. J. Stutchbury and R. R. Cohen. 2011. Tree Swallow (Tachycineta bicolor), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/011 doi:10.2173/bna.11

Winkler, David W. 1996. California Gull (Larus californicus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/259 doi:10.2173/bna.259

Wolf, Blair O. 1997. Black Phoebe (Sayornis nigricans), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/268 doi:10.2173/bna.268

Yasukawa, Ken and William A. Searcy. 1995. Red-winged Blackbird (Agelaius phoeniceus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/184 doi:10.2173/bna.184

Yosef, Reuven. 1996. Loggerhead Shrike (Lanius ludovicianus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/231 doi:10.2173/bna.231

Appendix A. Weather Conditions and Body Weights Associated with Avian Detections Estimated to be Less Than 24 Hours Old during summer (June 01 – August 30) 2015

Table A-1. Weather conditions and body weights associated with avian detections estimated to be less than 24 hours old during summer 2015 at Genesis Solar Energy Project, Riverside County, California.

Carcass ID	Date	Estimated time since death (hrs)	Species	Weight (g)	Weather Summary for Preceding 24 hrs
081315-TRES-EVAPPOND-N-01	8/13/2015	8-24hrs	tree swallow	13	6-16 MPH SE wind, Temp 109F, waning crescent moon. Clear through 1pm 8/12, partly to mostly cloudy through 9pm, then clear.
061115-GRRO-GENTIE16-1	6/11/2015	8-24hrs	greater roadrunner	240	-
060915-ECDO-OMBUILDING-STAIRCASE-1	6/9/2015	0-8hrs	Eurasian collared-dove	150	-
062615-GRRO-1-W-G/H-62-01	6/26/2015	8-24hrs	greater roadrunner	165	AVG WIND SPD: 11MPH, MAX WIND SPD: 17MPH, WIND DIRECTION: SOUTH, CLEAR SKY, MOON PHASE: WANING GIBBOUS
062915-SNEG-2-POWERBLOCK-INSIDE-02	6/29/2015	8-24hrs	snowy egret	-	MAX WIND SPD. 17MPH, AVG WIND SPD: 8MPH, DIRECTION: S/SW, CONDITIONS: CLEAR WITH THUNDERSTORMS, MOON PHASE: WAXING GIBBOUS
062215-CAGU-1-E-C/D-53-1	6/22/2015	8-24hrs	California gull	350	HIGH TEMP: 107.1, LOW TEMP: 70.9, MAX WIND SPD: 8.3MPH, AVG WIND SPD: 7.6MPH, DIRECTION: SOUTH, CLEAR SKY, MOON PHASE: WAXING CRESENT
072915-LENI-GENTIE-13-01	7/29/2015	0-8hrs	lesser nighthawk	43	wind S @ 7-14 mph, waxing gibbous moon, clear, 10 mi visibility
081715-MODO-2-POWERBLOCK-02	8/17/2015	8-24hrs	mourning dove	-	9-21mph S wind. Waxing crescent moon, clear through 12 noon, partly to mostly cloudy through 11pm then clear
081715-MODO-GENTIE-17-01	8/17/2015	8-24hrs	mourning dove	-	9-21mph S wind, waxing crescent moon, clear through 12 noon, partly to mostly cloudy through 11pm, then clear
082815-BHCO-1-W-G/H-44-03	8/28/2015	8-24hrs	brown-headed cowbird	21	5-21MPH SSW wind, waxing gibbous moon, thunderstrom in the area
082215-UNBA-ADMINBUILDING-01	8/22/2015	0-8hrs	canyon bat	2	12-20 MPH S wind, waxing crescent moon, clear
082415-UNBA-ASSEMBLYLINEBUILDING-FREEZER-02	8/24/2015	8-24hrs	canyon bat	-	8-14 MPH S-SW wind, waxing gibbous moon, partly cloudy to clear to cloudy
082315-TOWA-2-POWERBLOCK-OVERFLOWPUMP-B-01	8/23/2015	8-24hrs	Townsend's warbler	6	12-20 S wind, temp 107, waxing crescent moon, clear until 1500, partly cloudy until 2000, then clear until bird found
082315-MODO-GENTIE-10-03	8/23/2015	8-24hrs	mourning dove	99	12-20mph S wind, temp 107, waxing crescent moon, clear until 1500,

082815-CITE-EVAPPOND-N-01	8/28/2015	8-24hrs	cinnamon teal	345	partly cloudy until 2000, then clear until bird found 5-21 mph SSW wind, waxing gibbous moon, thunderstorm in area

Appendix B. Correction Factors and Bird Fatality Rates at the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

Table B-1. Correction factors and estimated numbers of carcasses at the Genesis Solar Energy Generation Facility during summer of 2015. *Counts of fatalities on the power block and ponds have no variance because all components at the facility were searched.

	Small birds		Medium birds		Large birds		Unknown size		Bats	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Proportion of area searched by component										
Overhead lines	0.25	-	0.25	-	0.25	-	0.25	-	0.25	-
Fence	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
SCAs	0.30	-	0.30	-	0.30	-	0.30	-	0.30	-
Powerblock[1]	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
Ponds	1.00	-	1.00	-	1.00	-	1.00	-	1.00	-
Searcher efficiency by component and visibility class										
Overhead lines	0.54	0.39 - 0.68	1.00	-	1.00	-	0.54	0.39 - 0.68	0.54	0.39 - 0.68
All other components	0.92	0.86 - 0.98	0.92	0.86 - 0.98	0.92	0.86 - 0.98	0.92	0.86 - 0.98	0.92	0.86 - 0.98
Average probability of carcass persistence to the next search										
Overhead lines	0.140	0.09 - 0.2	0.588	0.42 - 0.74	0.409	0.26 - 0.58	0.140	0.09 - 0.2	0.143	0.09 - 0.21
Fence	0.462	0.38 - 0.56	0.940	0.84 - 0.99	1	-	0.462	0.33 - 0.61	0.462	0.37 - 0.63
SCAs	0.520	0.45 - 0.64	0.925	0.76 - 0.96	1	-	0.520	0.34 - 0.6	0.520	0.37 - 0.63
Powerblock	0.504	0.4 - 0.56	0.851	0.79 - 0.9	1	-	0.504	0.33 - 0.58	0.504	0.41 - 0.56
Ponds	0.504	0.42 - 0.56	0.851	0.73 - 0.93	1	-	0.504	0.37 - 0.64	0.504	0.37 - 0.63
Carcass counts by component										
Overhead lines	0	-	1	0 - 3	0	-	0	-	0	-
Fence	2	0 - 6	1	0 - 3	0	-	1	0 - 3	0	-
SCAs	5	2 - 9	3	0 - 6	0	-	1	0 - 3	0	-
Powerblock*	3	-	6	-	0	-	1	-	3	-
Ponds*	3	-	2	-	0	-	0	-	0	-
Average Probability of Carcass Availability and Detected (Searcher efficiency * average probability of carcass persistence)										
Overhead lines	0.08	0.04 - 0.12	0.59	0.42 - 0.74	0.41	0.26 - 0.58	0.08	0.04 - 0.12	0.08	0.04 - 0.12
Fence	0.42	0.35 - 0.52	0.86	0.76 - 0.94	0.92	0.86 - 0.98	0.42	0.3 - 0.57	0.42	0.34 - 0.59
SCAs	0.48	0.41 - 0.59	0.85	0.69 - 0.9	0.92	0.86 - 0.98	0.48	0.31 - 0.56	0.48	0.34 - 0.59
Powerblock	0.46	0.36 - 0.52	0.78	0.71 - 0.86	0.92	0.86 - 0.98	0.46	0.3 - 0.54	0.46	0.37 - 0.52
Ponds	0.46	0.38 - 0.53	0.78	0.66 - 0.88	0.92	0.86 - 0.98	0.46	0.34 - 0.59	0.46	0.34 - 0.59
Adjusted Fatality Estimates (Fatalities /Season; values in italics are considered unreliable due to low counts of carcasses: carcass count / (proportion of area searched * average probability of carcass availability and detected))**										
Overhead lines	0	-	*6.81*	*5.62 - 21.03*	0	-	0	0	0	0

Table B-1. Correction factors and estimated numbers of carcasses at the Genesis Solar Energy Generation Facility during summer of 2015. *Counts of fatalities on the power block and ponds have no variance because all components at the facility were searched.

	Small birds		Medium birds		Large birds		Unknown size		Bats	
Parameter	**Mean**	**CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**	**Mean**	**90% CI**
Fence	*4.72*	*3.92 - 14.57*	*1.16*	*1.07 - 3.61*	0	-	*2.36*	*1.85 - 8.26*	0	0
SCAs	*34.39*	*12.18 - 56.61*	*11.61*	*3.98 - 25.48*	0	-	*6.88*	*6.15 - 24.15*	0	0
Powerblock	*6.48*	*5.82 - 8.27*	7.67	7.01 - 8.49	0	-	*2.16*	*1.84 - 3.3*	*6.48*	*5.74 - 8.13*
Ponds	*6.48*	*5.82 - 8.27*	*2.56*	*2.34 - 2.83*	0	-	0	-	0	-

[1] Estimate is based on adjusted mortality from the powerblock perimeter surveys and adding in the incidentals found by operations staff in the interior of the powerblock. The carcasses found by staff in the interior of the powerblock are not adjusted for biases because no trials are conducted in those areas (biologists are not allowed in that area for safety reasons). However, daily surveys are conducted throughout the interior of the powerblock by operations staff for equipment inspections, and several personnel spend time in those areas on a daily basis.

Table B-2. Carcasses excluded from the summer 2015 fatality analysis at the Genesis Solar Energy Project.

Parameter	Small birds	Medium birds	Large birds	Unknown size	Bats
Buildings	3	1	0	0	2
Overhead lines	0	3	0	0	0
SCAs	3	3	1	0	0
Pond	0	3	0	0	0
Powerblock	6	3	0	0	0

Appendix C. Detailed Areas of Standardized Searches and Carcass Locations along the Distribution and Generation Tie Lines of the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

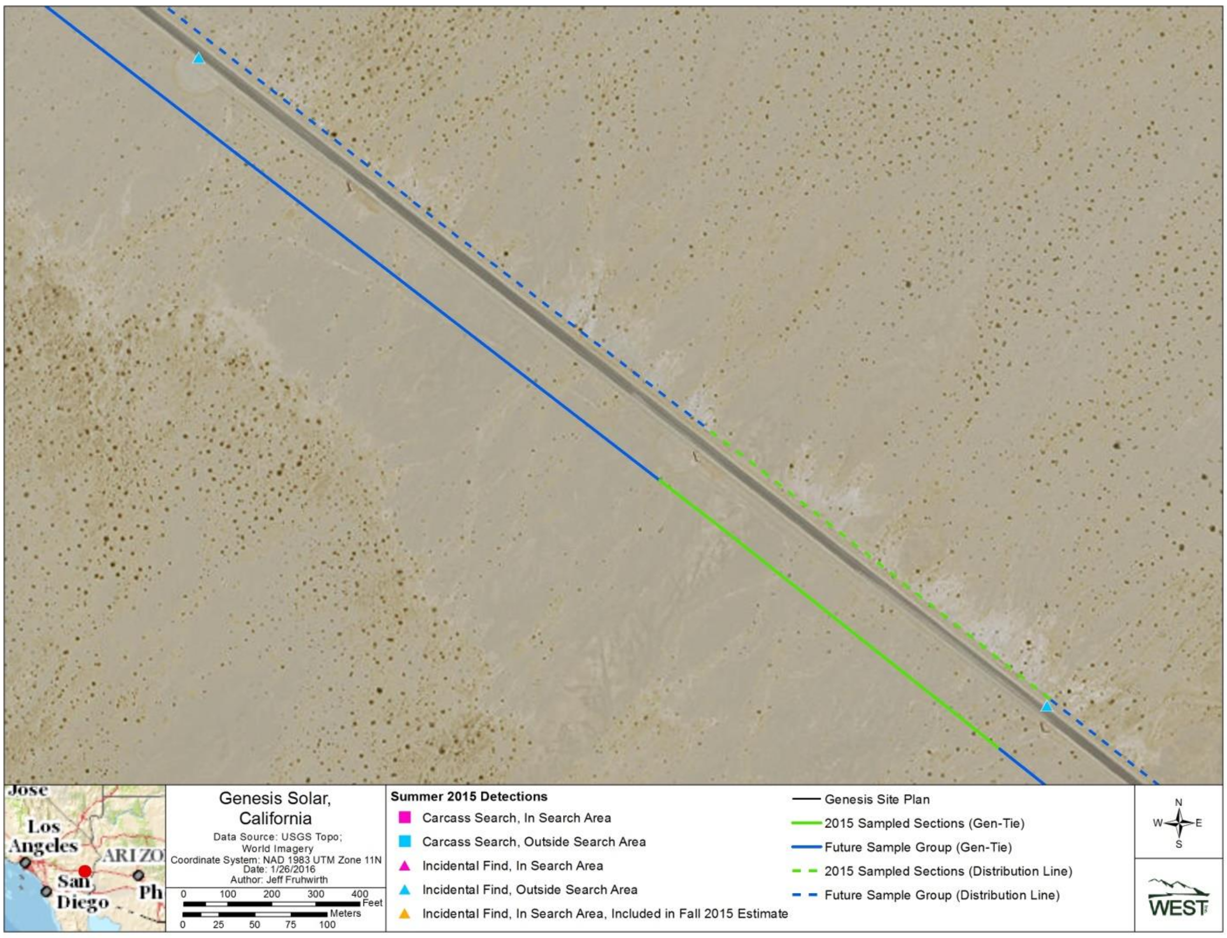


Figure C-1. Detailed map sections of detections along the distribution and generation tie lines of the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

Figure C-2. Detailed map sections of detections along the distribution and generation tie lines of the Genesis Solar Energy Project during summer (June 01 – August 30) 2015.

Appendix D. Individual detections made during standardized carcass searches and incidentally, by species, during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California. SCA = Solar collector trough.

Table D-1. Number of individual detections (those made during standardized carcass searches and incidentally), by species, during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California. SCA = Solar collector trough.

Common Name	Scientific Name	Migration Behavior*	Guild	Count	Project Component
American kestrel	*Falco sparverius*	resident	Falcons	1	Powerblock
bank swallow	*Riparia riparia*	diurnal	Swallows	1	Powerblock
belted kingfisher	*Ceryle alcyon*	nocturnal	Kingfishers	1	Powerblock
black phoebe	*Sayornis nigricans*	variable	Flycatchers	1	Powerblock
brown-headed cowbird	*Molothrus ater*	diurnal	Blackbirds/Orioles	1	Other
				2	Powerblock
				2	SCA
California gull	*Larus californicus*	diurnal	Shorebirds	1	SCA
canyon bat	*Pipistrellus hesperus*	nocturnal	Bats	2	Other
cinnamon teal	*Anas cyanoptera*	nocturnal	Waterbirds/Waterfowl	1	Pond
				1	SCA
cliff swallow	*Petrochelidon pyrrhonota*	diurnal	Swallows	1	Powerblock
common nighthawk	*Chordeiles minor*	variable	Goatsuckers	1	Pond
eared grebe	*Podiceps nigricollis*	nocturnal	Waterbirds/Waterfowl	1	Pond
Eurasian collared-dove	*Streptopelia decaocto*	resident	Doves/Pigeons	1	Other
Gambel's quail	*Callipepla gambelii*	resident	Upland Game Birds	1	Fence
greater roadrunner	*Geococcyx californianus*	resident	Cuckoos	1	Overhead lines
				3	Powerblock
				1	SCA
lesser nighthawk	*Chordeiles acutipennis*	diurnal	Goatsuckers	1	Overhead lines
loggerhead shrike	*Lanius ludovicianus*	diurnal	Shrikes	1	SCA
long-billed curlew	*Numenius americanus*	nocturnal	Shorebirds	1	SCA
Mexican free-tailed bat	*Tadarida brasiliensis*	nocturnal	Bats	1	Powerblock
mourning dove	*Zenaida macroura*	variable	Doves/Pigeons	2	Overhead lines
				1	Powerblock
red-winged blackbird	Agelaius phoeniceus	diurnal	Blackbirds/Orioles	1	Fence
				1	SCA
ruddy duck	*Oxyura jamaicensis*	nocturnal	Waterbirds/Waterfowl	1	Pond

Table D-1. Number of individual detections (those made during standardized carcass searches and incidentally), by species, during summer (June 01 – August 30) 2015 at the Genesis Solar Energy Project, Riverside County, California. SCA = Solar collector trough.

Common Name	Scientific Name	Migration Behavior*	Guild	Count	Project Component
snowy egret	*Egretta thula*	nocturnal	Waterbirds/Waterfowl	1	Powerblock
spotted sandpiper	*Actitis macularia*	both	Shorebirds	1	SCA
Townsend's warbler	*Setophaga townsendi*	unresolved	Warblers	1	Powerblock
tree swallow	*Tachycineta bicolor*	diurnal	Swallows	1	Pond
unidentified bat	-	-	Bats	2	Powerblock
unidentified bird (medium)	-	-	Unidentified Birds	1	Pond
unidentified bird (small)	-	-	Unidentified Birds	1	Fence
				1	Powerblock
				3	SCA
unidentified bird (unknown size)	-	-	Unidentified Birds	1	Fence
				1	Powerblock
				1	SCA
unidentified duck	-	-	Waterbirds/Waterfowl	2	SCA
unidentified sandpiper	-	-	Shorebirds	1	Powerblock
western gull	*Larus occidentalis*	resident	Shorebirds	1	SCA
western kingbird	*Tyrannus verticalis*	diurnal	Flycatchers	1	Other
western sandpiper	*Calidris mauri*	both	Shorebirds	1	Pond
white-winged dove	*Zenaida asiatica*	variable	Doves/Pigeons	2	Powerblock
yellow-billed cuckoo	*Coccyzus americanus*	nocturnal	Cuckoos	1	Powerblock
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	diurnal	Blackbirds/Orioles	1	Pond
yellow warbler	*Setophaga petechia*	nocturnal	Warblers	1	Other
Total				**60**	

* See literature cited for migration behavior references; information for most species was taken from the respective species accounts found in Birds of North America (BNA) Online (http://bna.birds.cornell.edu/bna/); where information on migration behavior was lacking in BNA accounts, Evans and Mellinger (1999), Newton (2008), or Murray (2004) were used.