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**IVANPAH SOLAR ELECTRIC GENERATING SYSTEM
AVIAN & BAT MONITORING PLAN**

2016 SPRING REPORT



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Executive Summary

Avian and bat monitoring surveys were conducted from 26 March, 2016 to 24 May, 2016 (the spring season) at the Ivanpah Solar Electric Generating System facility (referred to in this report as "Ivanpah" or "Project") in accordance with the Project's Avian & Bat Monitoring and Management Plan (Plan) as revised November 2015.

Per the revised Plan, potential flux effects are investigated by surveying 100 percent of the tower area in all three units, and collisions with facility structures (towers and heliostats) are evaluated by systematic sampling of 100% of the tower areas (154 acres) in each of the three units, and 20% of Unit 2 heliostat field (240 acres) as representative of the facility. The "tower area" consists of the power block and inner high-density (HD) heliostats surrounding each power block on approximately 154 acres; and 2) the "heliostat area" consists of the inner and outer heliostat segments outside of the inner HD heliostats on approximately 2,991 acres. Searches were conducted within the spring season at intervals of approximately 7 days.

All bird and bat fatalities and injuries, referred to as "detections" in this report, including those found incidentally and during standardized facility searches, were documented and categorized as singed, collision, other project causes or unknown based on examination with a binocular microscope and evidence collected from the location of the detection. During the period 26 March, 2016 to 24 May, 2016, a total of 4 bat detections, and 132 avian detections (including 12 injured birds), were found.

According to the specifications of the revised Plan, the number of avian detections was categorized by facility structure and cause. These avian fatality search results, along with searcher efficiency and carcass removal rates from trials conducted onsite, were input into a fatality estimator model (Huso 2010) to provide an estimate of the fatalities for the facility.

Using the fatality estimator model, during the period 26 March, 2016 to 24 May, 2016, there were an estimated 591 fatalities (70.7%) from known causes and 246 fatalities (29.3%) from unknown causes. Of the known causes, 141 fatalities (23.9%) were estimated for the 154-acre tower area, and 450 fatalities (76.1%) were estimated for the 2,991 acre heliostat area. Of the unknown causes, 46 fatalities (18.4%) were estimated for the tower area, 5 or fewer detections occurred in the heliostat area; thus, an estimate is not provided. Overall, based on the monitoring results and estimates for known causes for the 2016 spring season, the effect of the Project on birds will not rise above the "low" category.

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Section 1.0 Introduction

1.1 Project Background

The Ivanpah Solar Electric Generating System (referred to in this report as "Ivanpah" or "Project") consists of three solar power electrical generating facilities (Units 1, 2, and 3) with a combined net capacity of 377 megawatts. Each unit includes a central power tower with an air cooled condenser (ACC) and associated electrical generating equipment, surrounded by a heliostat array that reflects sunlight to a boiler at the top of the power tower. Ivanpah is located on approximately 1,457 hectares (3,600 acres) of Bureau of Land Management (BLM) land west of Interstate 15 near the town of Nipton in San Bernardino County, California (Figure 1). Construction was initiated in 2010 and completed in late 2013.

1.2 Monitoring Plan Overview and Goals

An Avian & Bat Monitoring and Management Plan was prepared by the Project proponent in collaboration with the Technical Advisory Committee (TAC) made up of 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 the operation of the Project. Revision 12 of the Plan (2013) was accepted by the TAC in November 2013 and required two years of monitoring, which were completed at the end of October 20, 2015. As determined by the TAC, the goals of the Plan (2013) were met, and in November 2015, the TAC-approved Revision 13 to the Plan (2015) to require a third year of monitoring to provide collision and flux mortality estimates. Revision 13 of the Plan (2015) reflects reduced monitoring requirements as informed by the first two years of intensive monitoring. Specifically, the Plan (2015) details the onsite and offsite surveys to be conducted and the data analysis and reporting processes that will be implemented by Ivanpah in collaboration with the USFWS, CDFW, CEC, and BLM and provides the following goals and objectives as excerpted from the Plan (2015):

Plan Goals

1. Provide Collision Mortality Estimates: Estimates of avian mortality from collision will be calculated from data obtained by monitoring and identifying avian mortality and injury associated with facility structure collisions.
2. Provide Solar Flux Mortality Estimates: Estimates of avian mortality from flux effects will be calculated from data obtained by monitoring and identifying avian mortality and injury associated with solar flux generated by the facility.
3. Provide a Framework for Management and Response to Risks: The designation and description of the functioning of the TAC provides a management and decision framework for the identification and implementation of potential adaptive management measures.

Plan Objectives

The first two years of monitoring documented that the mortality associated with the perimeter fences, transmission lines, and offsite transects was generally less than 5 detections per season. Additionally, the patterns associated with avian use have been consistent over the seasons and documented in the annual reports. Therefore, as revised, this plan has the following goals:

1. Estimate collision-related avian mortality and injury with the following facility structures (Figure 2), using empirical data to calculate facility-wide mortality and injury rates:
 - a. Power towers
 - b. Heliostats
2. Estimate flux-related avian mortality and injury using empirical data to calculate facility-wide mortality and injury rates.
3. Document patterns of collision or flux-related mortality and injury associated with species, age/sex, season, weather, and visibility.
4. Document spatial patterns associated with collision- or flux-related mortality and injury.
5. Provide quantitative information for developing and implementing adaptive management responses commensurate with identified impacts.

The revised Plan (2015) continues to: 1) satisfy the BLM Right-of-Way (ROW) Permit requirement that the proponent develop an avian plan as well as a Migratory Bird Treaty Act (MBTA) Conservation Agreement; 2) satisfy the requirements for the Avian & Bat Monitoring and Management Plan approved by the CEC for Ivanpah per CEC Condition of Certification BIO-21; and 3) achieve the avian and bat protection objectives of the USFWS in relation to the MBTA, Bald and Golden Eagle Protection Act (Eagle Act), and Federal Endangered Species Act (FESA), including preparing written records of the actions that have been taken to avoid, minimize, and compensate for potential adverse impacts to avian and bat species. By developing a proactive management plan in close consultation with the USFWS and other relevant state and federal agencies, Project proponents can effectively comply with the intent of the federal MBTA, Eagle Act, FESA, and relevant state regulations (USFWS 2012).

1.3 Purpose of This Report

This report represents the second “quarterly” (i.e., seasonal) report for the third year of monitoring (or, the tenth quarterly report) summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the USFWS-accepted Plan and as required by CEC Condition of Certification BIO-21. This report covers the spring 2016 season, which includes the period from 26 March 2016 to 24 May 2016.

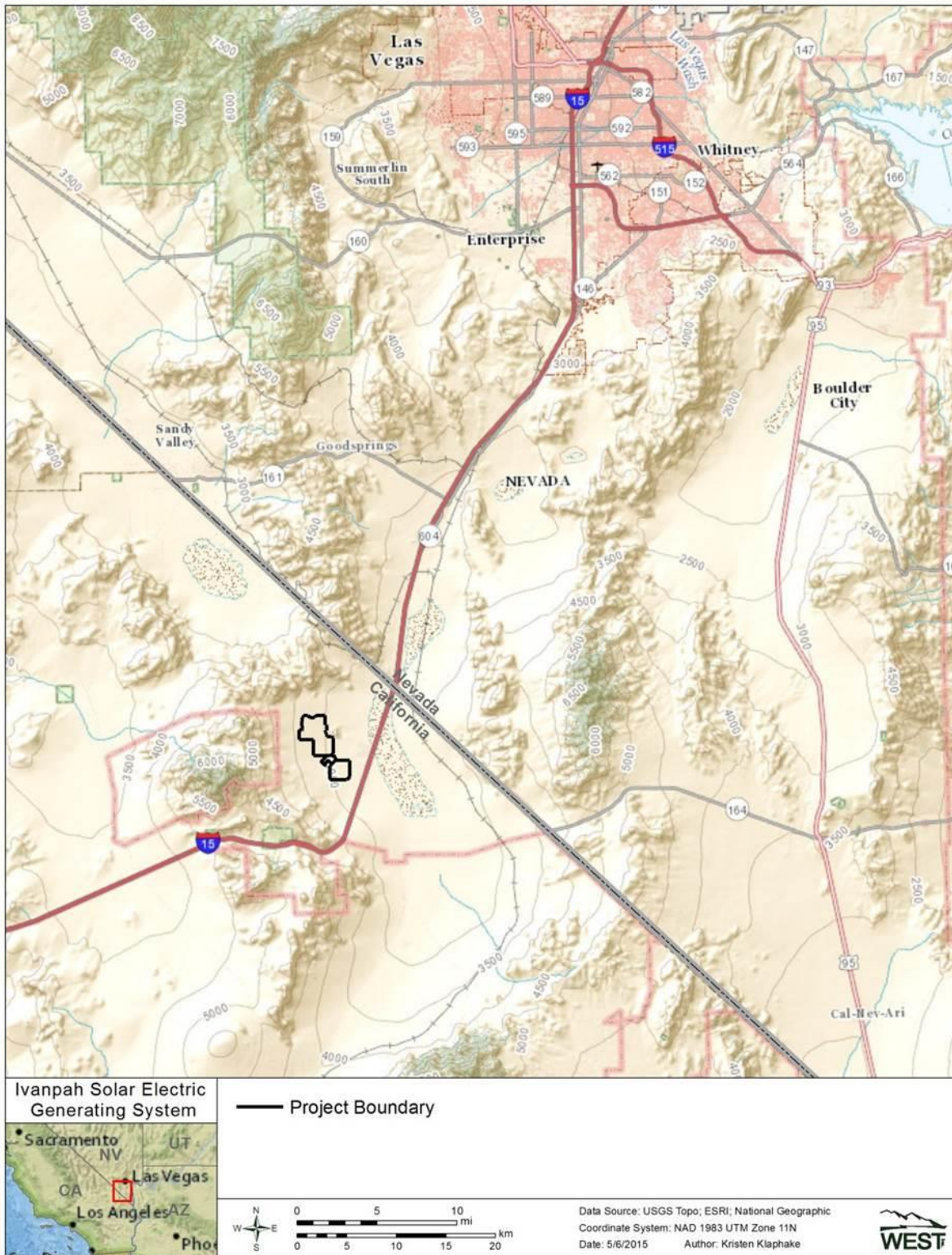


Figure 1. Ivanpah Vicinity Map.

Section 2.0 Methods

The Plan (2015) describes the methods by which monitoring and certain analyses, including compilation of the overall fatality estimate, will occur. Below is an abridged description (see Plan (2015) for detailed methods), with greater detail provided when methods differ from original Plan (2013).

2.1 Facility Monitoring

This section describes areas surveyed, the timing and frequency of the searches, and the methods by which standardized searches were conducted to identify dead/injured birds and bats (hereafter detections) at the Project. This section also describes the methods for conducting carcass removal and searcher efficiency trials; how data were reported and analyzed for incidental detections; and the methods for producing fatality estimates for the Project.

2.1.1 Standardized Searches

2.1.1.1 Areas Surveyed

Per the Plan (2015), monitoring was conducted in the “tower area” and a sample of the “heliostat area”. The tower area is defined as the power block (the area consisting of the tower, the ACC unit, the associated control building, and immediately adjacent areas defined by the ring road and berm/slopes surrounding these facilities) and inner high-density (HD) heliostats surrounding each power block. . The heliostat area is defined as the inner and outer heliostat segments outside of the inner HD heliostats. For year 3, 100% of the tower area at each unit was surveyed and 20% of the Unit 2 heliostat area (8% of the total heliostat area) was surveyed. Table 1a provides the acreage searched within each of the survey areas, as well as the percent of the facility comprised by these search areas. Overall, approximately 12.9% of the Project was searched (Figure 2).

To ensure a balanced distribution of heliostat field survey plots, Unit 2 was divided into inner and outer heliostat fields, and approximately 20% of each sub-area was randomly selected for monitoring. Arc plots used for monitoring in Unit 2 were the same as previous years. This stratified random sampling design ensures that survey plots will not be clustered or biased in any distance or direction from the tower.

Table 1a. Monitoring Areas, 2016 Spring Season.

Area	Facility Locations Included	Acreage Searched	Percent of Facility
Tower Area	ACC, Power Block, Inner HD	154	4.80%
Heliostat Area	Unit 2 Inner and Outer Heliostat Segments	240	8.09%
Total		394	12.89%

*NA = Not applicable as offsite survey areas are located outside of the facility

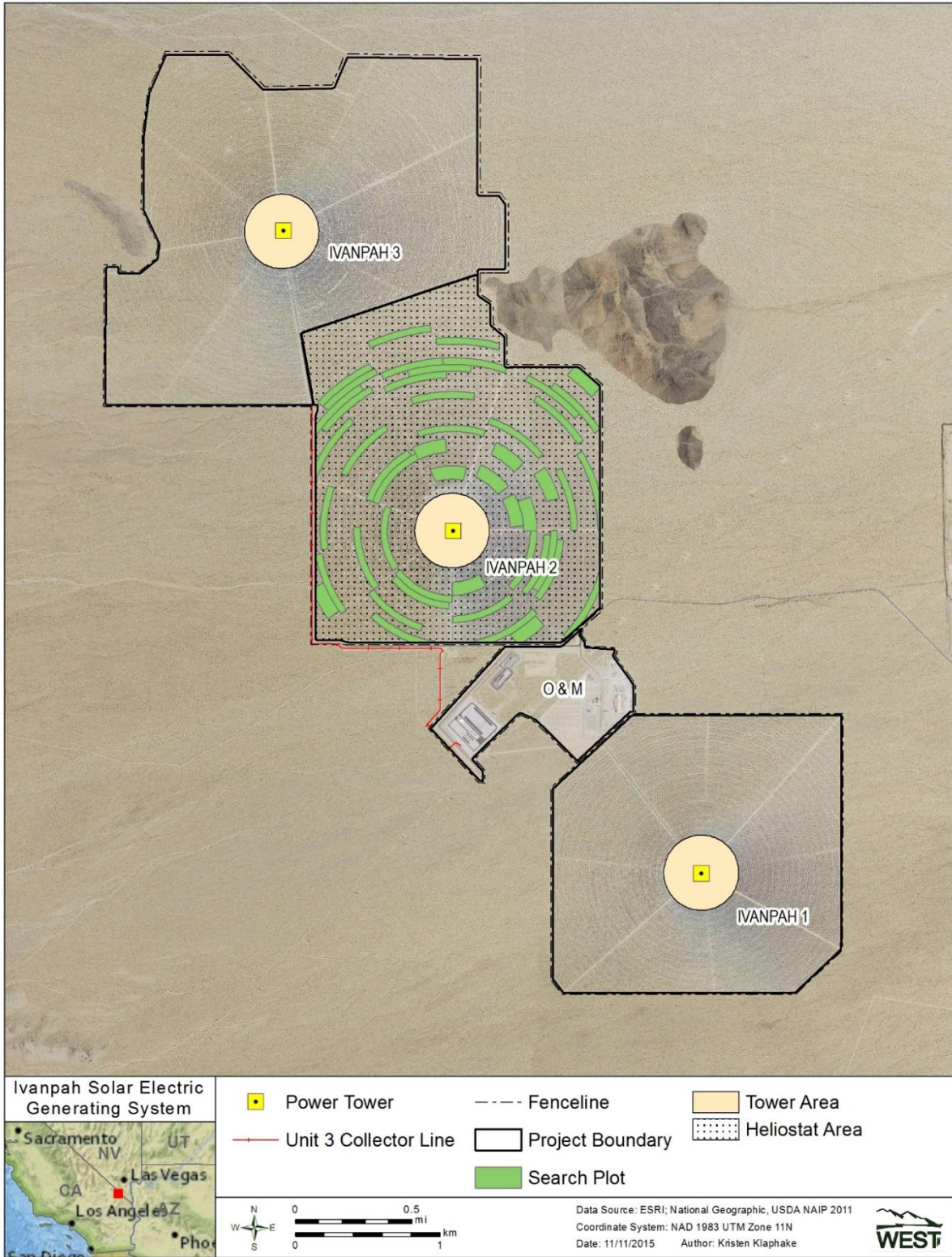


Figure 2. Ivanpah Search Areas.

2.1.1.2 Search Frequency and Timing

Consistent with the first two years of monitoring, standardized searches occurred at each unit on a nominal 7-day interval through the 2016 spring season. Variation in search interval and number of visits to each unit was anticipated to occur due to the transition between 21-day search and 7-day search intervals between seasons of differing length. The tower areas of Units 1, 2 and 3 were visited a total of eight times, and the inner and outer heliostat segments of Unit 2 was visited 8 times.

2.1.1.3 Search Methods

Biologists performed surveys in the tower area, and plots in the heliostat area. Standardized walking surveys for fatalities were performed by biologists approved by CEC and BLM, in accordance with the methods outlined in the Plan (2015). In the heliostat area, a pair of biologists walked a total of four transects oriented longitudinally along the complete length of each arc-plot, with the ring roads serving as the outer boundaries of each arc plot (Figure 3). While walking each transect, biologists walked a narrow search section approximately 10 meters (m) wide. Within the power block, biologists walked through and around the power tower and ACC unit looking for dead and injured birds and bats, and walked transects through the gravel surrounding the structures to achieve 100% coverage within physically accessible areas. Within the inner HD heliostats surrounding each power block, biologists walked transects to ensure 100% coverage. Thus, the tower area, comprising the area within 260 m of each tower, was completely covered during each survey, excepting any areas that were physically inaccessible or unsafe to survey. Inaccessible areas were, to the extent possible, scanned using binoculars.



Figure 3. Monitoring Search Pattern for Arc Plots.

Carcass and Feather Spot Examination. Every carcass and feather spot was examined visually by a biologist approved by the CEC and BLM for evidence of singeing or collision. Singeing to feathers can occur when a bird enters the flux around the power tower. When no obvious evidence of singeing or collision were evident to the naked eye, the carcass or feather spot was then examined using an AmScope SE306R-AZ-E2 20X-40X-80X Digital Binocular Stereo Microscope. When singed detections involving carcasses (as opposed to only feather spots) were found, the singeing was assigned a grade based on Kagan et al. (2014), as follows.

- Grade 1 – curling of less than 50% of the flight feathers
- Grade 2 – curling of 50% or more of the flight feathers
- Grade 3 – curling and visible charring of contour feathers

Kagan et al. (2014) originally found no singeing of contour feathers in the absence of curling of 50% or more of the flight feathers. In contrast, we have found singeing of contour feathers with curling of less than 50% of flight feathers, and in the absence of curling or singeing of any flight feathers. We therefore assigned grade 3 independent of grades 1 and 2.

When a carcass was detected, biologists looked for evidence of collision, including obvious physical trauma or detection adjacent to a heliostat with a bird-strike imprint, smudge mark, and/or feathers on or near the surface of the mirror. If there was no evidence of collision or singeing (e.g., charring, curling, or melting of feathers), as confirmed through microscopic examination, the cause of injury or fatality was listed as “unknown”.

For the purpose of these surveys, feather spots were considered detections when they met the following definition:

At least two or more primary flight feathers, 5 or more tail feathers, or 10 or more feathers of any type concentrated together in an area 1-m² or smaller (Smallwood 2007), without any bone, beak, or significant amounts of flesh or skin.

In some cases, an individual detection was broken up into aggregations of feathers that would meet the criteria for a feather spot, but with pieces of the carcass that contained bone or significant amounts of flesh or skin also present. In these cases, the detection was categorized as a partial carcass (rather than a feather spot), per the “feather spot” definition above.

2.1.2 Carcass Persistence Trials

Carcass persistence trials were performed throughout the 2016 spring monitoring season. A total of 21 small bird carcass trials were conducted. The TAC approved discontinuing large bird carcass trials at the conclusion of the 2015 summer season due to the consistency of large bird persistence times collected over the previous seasons. In response to the previous TAC request of increased sample size, the number of small bird trials was increased relative to the 2013 spring monitoring season.

The facility contains vegetated and unvegetated areas that could affect the ability to detect a carcass or the amount of time a carcass persists until it is scavenged. The tower area (power block and inner high density (HD) heliostat area, where most singed detections occur, is unvegetated; all other areas are considered vegetated. In order to examine carcass persistence times for vegetated and unvegetated areas, carcasses were also distributed through the facility, with 11 carcasses placed in the unvegetated tower area, and 10 carcasses placed in the vegetated heliostat arrays. Non-native house sparrows (*Passer domesticus*) were used for small carcass trials conducted during the 2016 spring monitoring season. A camera was placed at each carcass to record the time of scavenging and the scavenging species.

2.1.3 Searcher Efficiency Trials

A total of 69 searcher efficiency trials (26 small birds, 21 large birds, and 22 feather spots) were conducted during the 2016 spring monitoring season. Carcasses and feather spots 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. Trials were placed in the tower areas of all three units and in the heliostat area of Unit 2; however, no trials were placed in the ACC building since detection probability is assumed to be 100% in this area of the power block. Each trial carcass was placed by a designated biologist prior to a scheduled search without knowledge of the searchers. For trial carcasses that were not detected by searchers, the designated biologist returned to the trial location to determine if the trial carcass was still available to be found. If the trial carcass was absent, it was assumed to have been removed prior to the search, and thus not available to be detected.

Overall, 37 trial carcasses/feather spots were placed in the tower area and 32 trial carcasses were placed in vegetated areas in the inner/outer segments of the heliostat area. Of the 69 trial carcasses placed, 66 (23 small carcasses, 21 large carcasses, and 23 feather spots) were available to be found; 3 carcasses (3 small carcasses,) were removed (scavenged) from the trial location before searchers had an opportunity to find them.

2.1.4 Incidental Reporting

Some detections were made outside standardized search areas, or were within search areas but not during standardized searches. Detections at locations not searched under the Plan (2015) such as the fenceline and heliostat areas of Unit 1 and Unit 3, are considered incidental detections for this report. These detections were reported in accordance with the facility's Wildlife Incident Reporting System (described in Section 3.4 of the Plan) and were considered “incidental” detections. Data on these incidental detections were reported in the SPUT permit database. As described in Section 2.2.5, incidental data could be included in the fatality estimates when they were found in areas covered during standardized surveys (e.g., tower area or heliostat area of Unit 2). Incidental detections from outside the survey areas were not included in the fatality estimates as discussed in Section 2.2.5; however, all detections regardless of the method or source of detection are reported in the SPUT permit database.

2.1.5 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 heliostats versus cleared areas around towers). 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 available to be found at the end of the search interval, and p is the probability of detecting a carcass (Huso 2010).

The bias correction factors r and p are estimated by covariates that may influence the detectability and persistence of each carcass, such as carcass size, presence of vegetation, and stage of decay or scavenging (i.e., feather spot versus carcass). For this study, the Huso estimator was used to correct for detection and scavenging bias; the estimator was demonstrated to perform well under a variety of conditions (Huso 2010). The Huso model was developed in the context of estimating fatalities for post-construction fatality studies at wind energy facilities; however, the Huso estimator is suitable for other sources of anthropogenic avian mortality, including power lines and utility scale solar facilities (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.

Estimating Carcass Persistence Times. Measurement of carcass persistence time is often subject to censoring. In this context, censoring refers to the fact that a value (e.g., days a carcass is present before being removed) may not be known exactly, but 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 six-week trial period, that carcass is “right censored”—we know the carcass lasted at least six weeks, but it could have persisted longer. Due to the fact that camera traps (e.g., cameras that automatically document activity at the trial carcass) were used for carcass removal trials, the majority of scavenging times can be known precisely, and data are not censored. However, when cameras fail to record the moment of scavenging, trials are treated as interval censored between the last time the carcass was visible on the camera, and the earliest time at which it was known to be removed.

Survival regressions models are well-suited to accommodate censored carcass persistence data and are typically used to generate the average probability of persistence for fatality estimation (Huso et. al 2012). There are four commonly used distributions implemented in the survival models used to estimate the value of r : exponential, Weibull, loglogistic, and lognormal. These four distributions exhibit varying

degrees of flexibility in order to model a wide variety of removal time distributions. Akaike's Information Criterion adjusted for sample size (AICc; Akaike 1973) was used to rank the fit of each survival model fit to carcass removal data. The exact time of death for detected fatalities is usually unknown, so the probability of persistence cannot be calculated exactly for each carcass; however, it can be estimated from the selected survival model and bootstrapped to obtain the variation of r for the observed detection data.

Estimating Searcher Efficiency. Searcher efficiency, or the proportion of carcasses detected, p , is represented most simply by the following equation:

$$p = \frac{\text{Number of Carcass Observed}}{\text{Number of Carcasses available}}$$

Model Selection for Searcher Efficiency Trials. The Plan states that searcher efficiency trials will be conducted during each season in which vegetation differs from the prior season, because changes in vegetative cover may affect carcass detectability. *A priori* decisions were not made regarding whether vegetative cover would differ between seasons, but rather, searcher efficiency trials were conducted in all season. Following the completion of fall searcher efficiency trials, there was sufficient cumulative data for the year to assess whether searcher efficiency differed significantly by Project area (e.g., unvegetated tower area versus vegetated heliostat fields), season, and/or carcass size. The nearly complete lack of vegetation cover in the tower area suggested that searcher efficiency may be higher in the tower area than in other Project areas. If this hypothesis were true, accounting for this difference in searcher efficiency across Project areas would be important for producing accurate fatality estimates.

To evaluate various hypotheses regarding differences in carcass detectability among Project areas, seasons, and/or carcass size, logistic regression models were fit to searcher efficiency data and corrected Akaike's Information Criteria (AICc) was used to compare models. The Project area was defined using two categories to reflect the suspected differences in searcher efficiency due to differences in vegetation cover: the tower area, which consists of the power block and the inner HD heliostats, and other areas, which consists of all other Project areas not included in the tower area. Models were constructed for all combinations of year, season, carcass size, Project area, and compared to the null model (Table 8). The data for this analysis included all human searcher efficiency trials of carcasses from the beginning of trials in the winter 2013 – 2014 season through the 2016 spring season.

Fatality Estimates. Estimates for the number of detections in the tower area components (i.e., the power block and inner HD heliostats) are reported combined, because 100% of these areas were searched. A separate estimate was produced for the heliostat area of all three Units (the inner and outer heliostat segments combined), in which 8% of the total area was searched. Fatality estimates reported in the inner/outer heliostat areas were adjusted to account for the unsearched area in the inner/outer heliostat areas (i.e., divided by 0.08).

The ACC buildings are only marginally accessible to scavengers from the outside; therefore, they act primarily as a closed system with a scavenging rate that approaches zero. Furthermore, carcasses are, generally, visible against the industrial backgrounds. Thus, the fatalities found in the ACC were not adjusted using the Huso estimator; rather, raw counts of ACC detections were added to fatality estimates for the tower area. All detections within the ACC buildings are considered facility related, whether or not

they showed evidence of singeing or collision; if there was no evidence of singeing or collision on a detection found in the ACC, the cause was assumed to be entrapment in some portion of the ACC unit.

Within the power block, during the 2016 spring season, incidental detections accounted for 30.4% of the detections recorded. Thus, as previously modeled, incidentals found within the power block were included in estimates, but treated differently from other fatalities. To reflect the high human activity in the power block—and frequent observation of the areas within the power block—the search interval for these detections was set to one day (Table 1b).

In previous seasons, incidental detections found outside of the power block but within standardized search areas were partially processed in the field and left in place to give searchers the opportunity to discover the carcass on the next scheduled search. As approved by the TAC, this method was discontinued in the 2015 fall season to prevent the scenario where an incidental detection is recorded, left in place, but scavenged before the next standard search and no carcass is associated with the data. In the 2015 fall season, incidental detections found outside of the power block, but within standardized search areas, were removed from field and included in fatality estimates under the conservative assumption that the search interval was the time between the last search of the area and the time of incidental discovery (Table 1b).

Table 1b. Treatment of Incidental Detections by Location

Location	Search Interval	Included in Analysis?
Power Block	1 Day	Yes, if carcass age is less than 24 hours
All Other Standardized Search Areas	Calculated days between date of detection and date of previous standard search in that location	Yes, if carcass age is less than calculated search interval

All fatality estimators have limitations, particularly when fatality counts are low. In particular, when detections are fewer than five, regardless of survey effort, estimates and confidence intervals can be unstable and must be interpreted with caution (Korner-Nievergelt et. al 2011). Rather than report estimates with little inferential value, no estimates were provided for combinations of covariates (e.g. size, location, cause) resulting in five or fewer detections.

The fatality estimator accounts for imperfect detection probability by using bias trials to estimate searcher efficiency. The Huso estimator is constructed under the assumption that searchers have a single opportunity to discover a carcass. Therefore, if a carcass is missed on the first search it was available, then found on the next search, it will effectively be over-counted. The method typically used to overcome multiple-detection-bias is to exclude any detection determined to be significantly older than the search interval (Huso et. al 2016). Each detection made during the 2016 spring season was evaluated for exclusion from the estimator based on the observed time since death (i.e., the length of time between an animal’s death and when the detection was discovered), and the search interval associated with that detection. For example, if a detection determined to have been on the ground for > 1 month was made in the inner HD of Unit 2, which had been searched seven days earlier, that carcass would be excluded from analysis.

Determining the age of a carcass was based on detailed qualitative analysis of every detection (carcasses and feather spots) recovered onsite. Qualitative analysis began with in situ aging analysis in the field by biologists approved by the CEC and BLM, followed by a more detailed analysis in the lab. In the field, biologists noted the presence of rigor mortis, condition of eyes and feathers, and condition of blood or viscera (if present). In the lab, each carcass was further examined and compared to photographs of decomposed test carcasses. The test carcasses were used to document decomposition over time at Ivanpah to better inform biologist of site-specific characteristics of avian decomposition that could be expected at the Project.

Decomposition test carcasses were placed in tamper-proof containers, exposed to onsite environmental conditions, and allowed to decompose. Carcasses used in decomposition tests were placed to account for variation in space (e.g. underneath fans in the ACC unit versus shaded under a heliostat) and time (e.g. ephemeral weather patterns). As the test carcasses aged, the biologists photographed and recorded the condition of body tissue and fluids, eyes, feathers, and indications of rigor mortis. All decomposition specimens were placed during the 2015 spring monitoring season.

To correctly account for searcher efficiency in the fatality estimate model, when partial carcasses are initially identified as feather spots by the observer in the field, they are modeled (in the fatality estimates) as a feather spot. In other words, the primary means of identification of the detection (feather spot, small carcass, or large carcass) is the appropriate classification to utilize in the modeled estimates. The primary identification approach is appropriate since different searcher efficiency rates are estimated for feather spots as opposed to carcasses. Because searcher efficiency is an important component of the fatality estimator, what the surveyors detect first (i.e., feather spot versus a complete or partial carcass) influences how that detection should be included in the model. Such detections are noted in Appendix A as “partial carcass + feather spot” in the “Description of Carcass/Injury” column.

2.2 Deterrence Measures

2.2.1 Avian Measures

Ivanpah commenced an investigation of the use of various deterrence measures to reduce avian mortality at the facility in 2013. These initial investigations combined with the results of the monitoring conducted during 2014 resulted in a list of potential deterrence measures for adaptive management. The list of deterrence measures has been updated, and progress reports towards deterrence implementation have been provided to the TAC on a periodic basis.

Several deterrence measures have been implemented at Unit 1 for birds at Ivanpah. Specifically, new ground-level LED lighting and spikes were installed 5 February 2015. As approved by the TAC, a chemosensory deterrence measure commercially known as BirdBuffer, was deployed on 12 October 2014, and a sonic deterrence measure commercially known as BirdGard, was deployed on 13 March 2015 at Unit 1. Bird Buffer was installed at Unit 2 and Unit 3 on 29 September 2015; BirdGard was installed at Unit 2 on 25 August 2015 and Unit 3 on 31 August 2015. The chemosensory deterrence measure is hypothesized to deter resident species, since the deterrent induces a conditioned response over time, and the sonic deterrence measure is hypothesized to deter transient and migrant species, as the sounds produced by the system are thought to startle and deter subjects. Together, the combination of

BirdBuffer and BirdGard systems are intended to deter avian species from entering this area associated with elevated flux mortality.

2.2.2 Bat Measures

Bat fatalities were detected primarily in the ACC, and as the ACC provides a roosting location, a Binary Acoustic Technology Ultrasonic Bat Deterrence was tested at Unit 3. The bat deterrence measure is not designed to elicit a fear response in bats, but is designed to interfere with the echolocation capabilities of bats. As bats navigate utilizing sonar, the method deployed “jams” the sonar signals and bats species avoid the area as a result of the inherent difficulties to navigate under these conditions. Although bats can adjust echolocation under jamming conditions, the use of broadband ultrasound requires bats to shift frequencies to avoid overlap that interferes with echolocation and therefore deters within the area subject to broadband ultrasound (Arnett, et al, 2013). As a result of the broadband ultrasonic signal and the inherent “jamming” effect, adaptation to the deterrence measure is minimal. The deterrence measure has been installed at all Units, and the installation dates are as follows: 10 September 2014 at Unit 1, 23 April 2015 at Unit 2, and 23 April 2015 at Unit 3. After Unit 3 bat deterrence was found to be nonfunctional in November 2015, an ultrasonic testing protocol has been implemented to ensure proper function of all deterrence units.

Section 3.0 Monitoring Results

3.1 Summary of Avian Detections

The average search interval was 7.5 days (range 3 to 20, median 7 days) during the 2016 spring season for the three solar units. Variation in search interval was anticipated to occur due to the transition between 7-day and 21-day search intervals associated with switching seasons, and several holidays during the spring season.

During the 2016 spring season, a total of 132 avian detections (including injured birds and incidentals) of 43 identified species (Table 2) were recorded. Approximately 65% of detections were songbirds, with 28% being other types of bird; 7% could not be identified to at least a species group. The most numerous detection of an identified species was Costa's hummingbird followed by Wilson's warbler and orange-crowned warbler. Most detections occurred in the tower area (Figures 4, 5, 6, and 7), where approximately 154 acres were surveyed, representing 100% of the total tower area.

Table 2. Number of Individual Bird Detections, by Species, 2016 Spring Season.

Species	Scientific Name	Injuries	Fatalities	Songbird?
Costa's hummingbird	<i>Calypte costae</i>	0	11	No
Wilson's warbler	<i>Cardellina pusilla</i>	1	10	Yes
unidentified bird (small)		0	9	No
yellow-rumped warbler	<i>Setophaga coronata</i>	0	8	Yes
orange-crowned warbler	<i>Oreothlypis celata</i>	0	7	Yes
tree swallow	<i>Tachycineta bicolor</i>	1	4	Yes
violet-green swallow	<i>Tachycineta thalassina</i>	0	4	Yes
unidentified hummingbird		0	4	No
mourning dove	<i>Zenaida macroura</i>	0	3	No
eared grebe	<i>Podiceps nigricollis</i>	0	3	No
unidentified warbler		0	3	Yes
American pipit	<i>Anthus rubescens</i>	1	3	Yes
white-crowned sparrow	<i>Zonotrichia leucophrys</i>	0	3	Yes
black-chinned hummingbird	<i>Archilochus alexandri</i>	0	3	No
calliope hummingbird	<i>Selasphorus calliope</i>	0	3	No
ruby-crowned kinglet	<i>Regulus calendula</i>	0	3	Yes
common raven	<i>Corvus corax</i>	0	2	No
unidentified grebe		0	2	No
unidentified sparrow		0	2	Yes
horned lark	<i>Eremophila alpestris</i>	0	2	Yes
house finch	<i>Haemorhous mexicanus</i>	0	2	Yes
Lincoln's sparrow	<i>Melospiza lincolnii</i>	1	2	Yes
savannah sparrow	<i>Passerculus sandwichensis</i>	0	2	Yes
lazuli bunting	<i>Passerina amoena</i>	0	2	Yes

rufous hummingbird	<i>Selasphorus rufus</i>	0	2	No
lesser nighthawk	<i>Chordeiles acutipennis</i>	0	1	No
northern saw-whet owl	<i>Aegolius acadicus</i>	0	1	No
unidentified swallow		0	1	Yes
black-throated sparrow	<i>Amphispiza bilineata</i>	0	1	Yes
hermit thrush	<i>Catharus guttatus</i>	0	1	Yes
lark sparrow	<i>Chondestes grammacus</i>	0	1	Yes
barn swallow	<i>Hirundo rustica</i>	3	1	Yes
dark-eyed junco	<i>Junco hyemalis</i>	0	1	Yes
northern mockingbird	<i>Mimus polyglottos</i>	0	1	Yes
spotted towhee	<i>Pipilo maculatus</i>	0	1	Yes
summer tanager	<i>Piranga rubra</i>	0	1	Yes
blue-gray gnatcatcher	<i>Polioptila caerulea</i>	0	1	Yes
unidentified kinglet	<i>Regulus spp</i>	0	1	Yes
black phoebe	<i>Sayornis nigricans</i>	0	1	Yes
Townsend's warbler	<i>Setophaga townsendi</i>	1	1	Yes
lesser goldfinch	<i>Spinus psaltria</i>	0	1	Yes
northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>	0	1	Yes
western meadowlark	<i>Sturnella neglecta</i>	0	1	Yes
crissal thrasher	<i>Toxostoma crissale</i>	0	1	Yes
American coot	<i>Fulica americana</i>	0	1	No
American avocet	<i>Recurvirostra americana</i>	0	1	No
Lucy's warbler	<i>Oreothlypis luciae</i>	1	0	Yes
western tanager	<i>Piranga ludoviciana</i>	1	0	Yes
yellow warbler	<i>Setophaga petechia</i>	1	0	Yes
	<i>Xanthocephalus</i>			
yellow-headed blackbird	<i>xanthocephalus</i>	1	0	Yes
Total		12	117	NA

*NA – Not Applicable

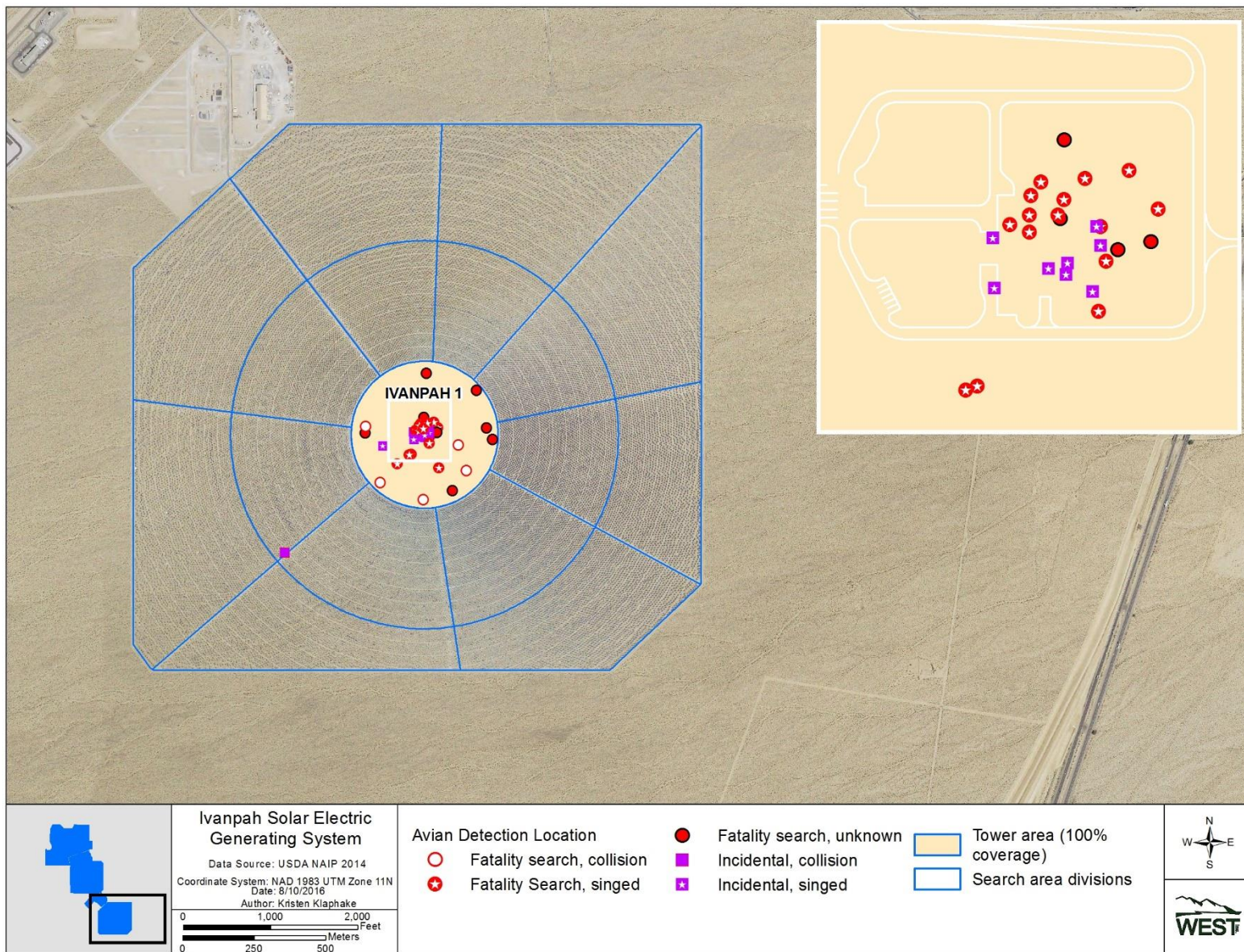


Figure 4. Ivanpah 1 Detections.

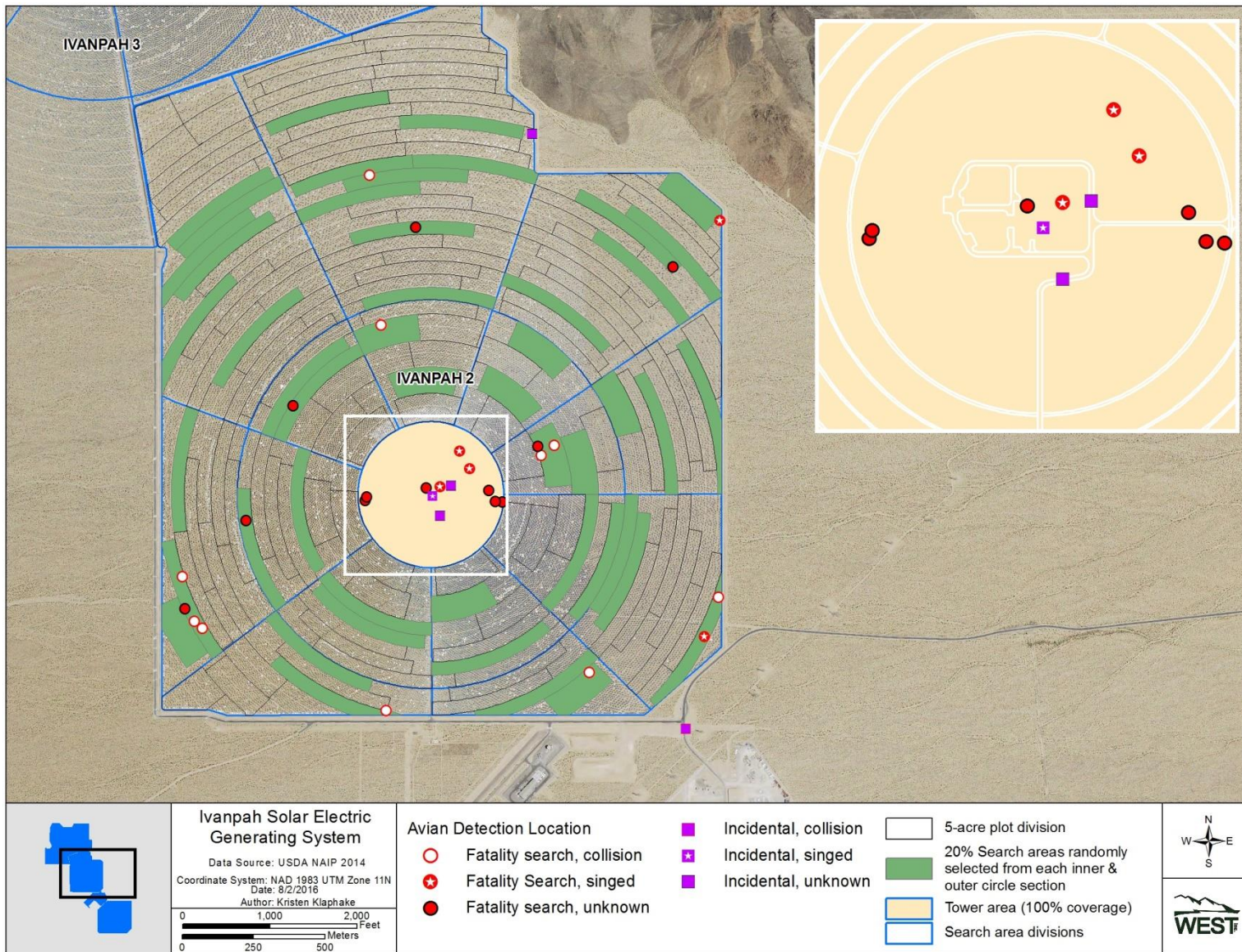


Figure 5. Ivanpah 2 Detections.

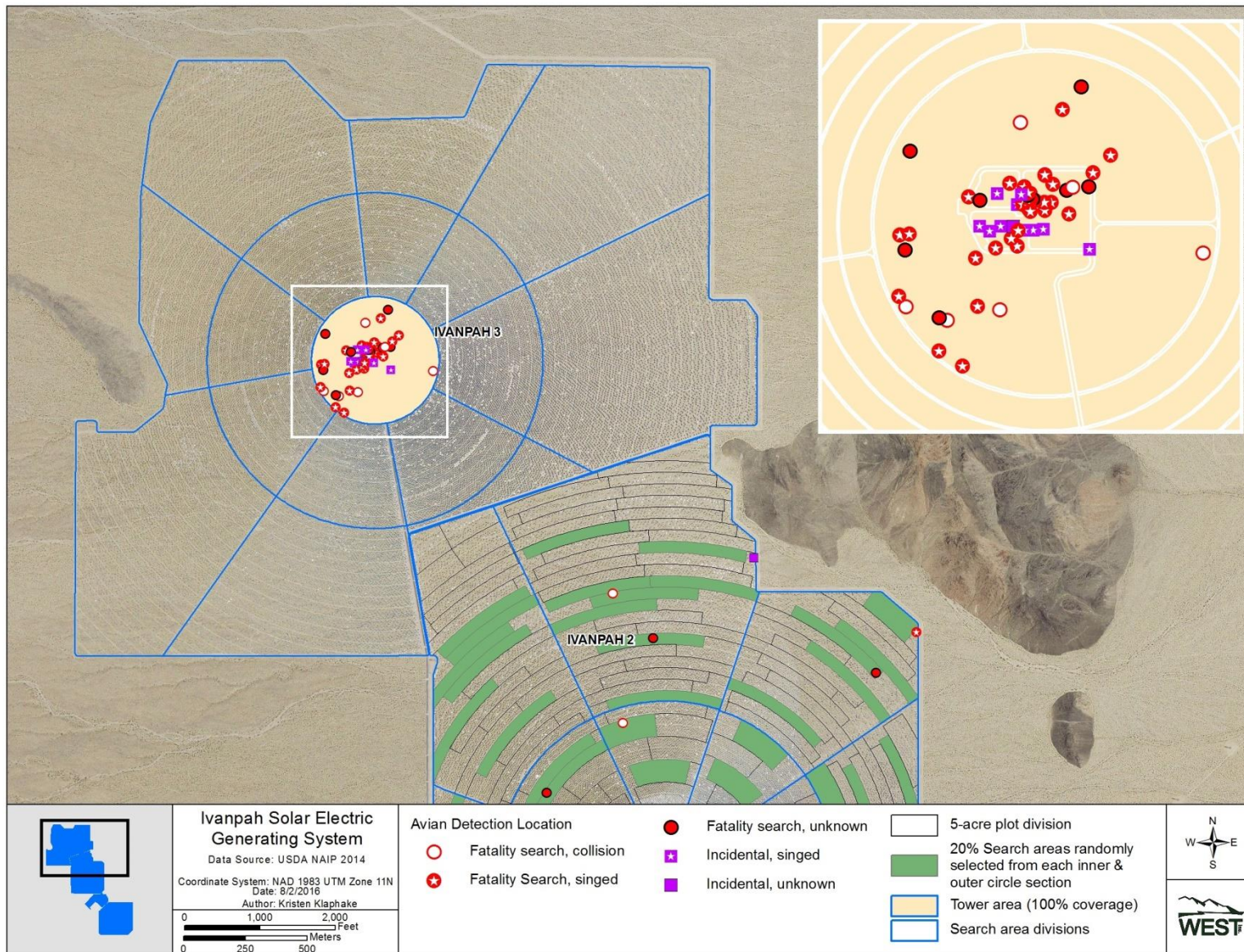


Figure 6. Ivanpah 3 Detections.

3.1.1 Temporal Patterns of Avian Detections

The number of detections reported per day was moderate throughout the 2016 spring season with consistent peaks beginning in April through May (Figure 7). The pattern of detections was influenced by unplanned forced outages spring the 2016 spring season. Unit 1 was offline and not producing flux from 19 April – 3 May, Unit 2 was offline from 6 April – 19 June, and Unit 3 was offline from 19 May – 24 June 2016. The unplanned forced outages are reflected in the pattern of signed detections per day where the higher number of signed detections from April 16 through the end of the season occurred at Unit 3, which had the fewest days of unplanned forced outages.

Data from BirdCast suggests that the 2015 spring season captured the spring migration. The BirdCast West regional migration summaries were available from 26 March – 24 May 2015. During the 2016 spring season, movements were described as light to moderate in California and Desert Southwest each week with ‘more intense’ movements the week of 18 April and locally heavy movements noted the week of 23 April.

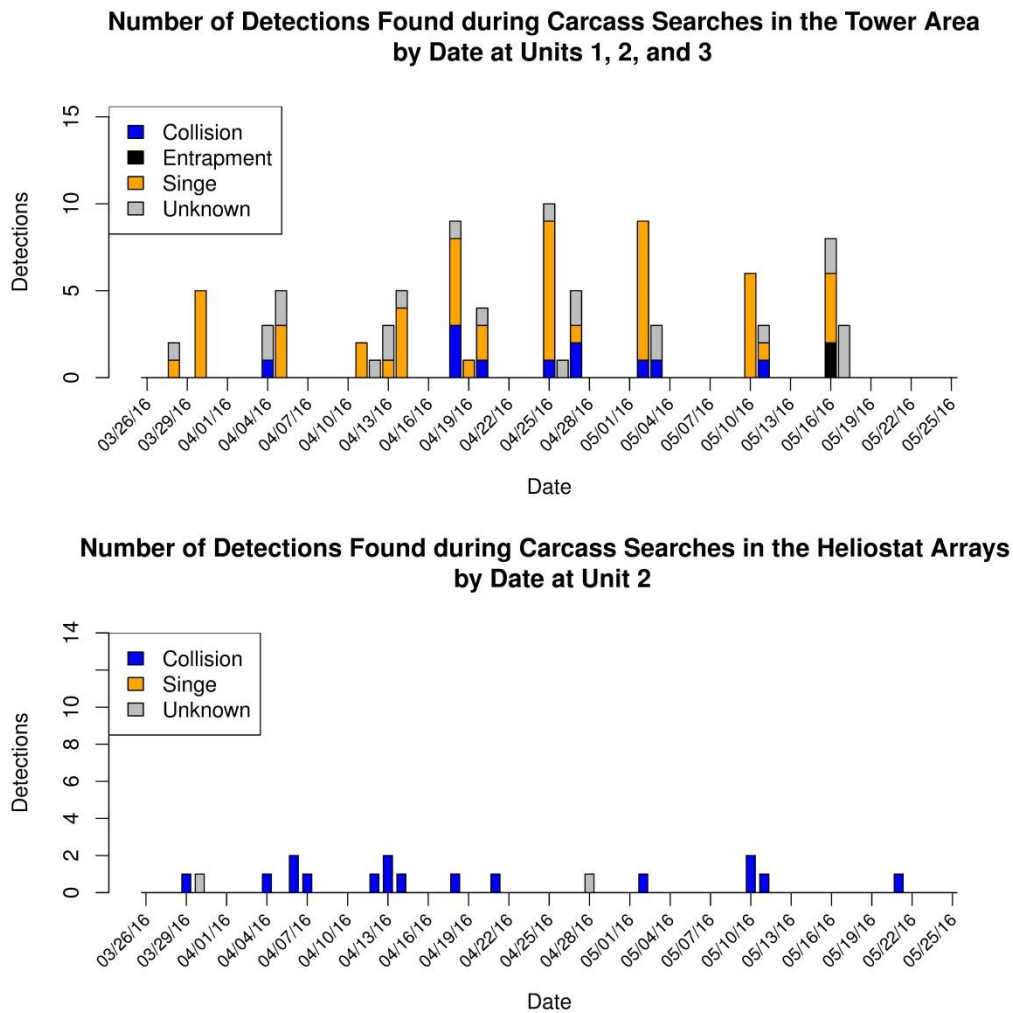


Figure 7. Number of Detections on Each Survey Date, 26 March – 24 May 2016.

Twelve injured birds were detected during the 2016 spring season (Table 3) and three were released alive off-site. One injured bird (tree swallow) was successfully released by the Animal Kingdom Veterinary Hospital. Two injured birds were not captured as the bird was mobile enough to escape easy capture and the decision was made to not further stress the bird by pursuing.

Table 3. Avian Injuries Detected 26 March – 24 May 2016.

Date	Species	Age	Sex	Cause of Injury	Flux Grade	Status
4/4/2016	Lincoln's sparrow	Adult	Unknown	collision	NA	Released off-site
4/13/2016	tree swallow	Adult	Male	singed	1;3	Released by rehab
4/18/2016	American pipit	Unknown	Unknown	collision	NA	Released off-site
4/18/2016	barn swallow	Adult	Male	singed	2;3	Died at rehab
4/18/2016	barn swallow	Adult	Male	singed	2;3	Died at rehab
4/19/2016	Lucy's warbler	Unknown	Unknown	singed	2;3	Died at rehab
5/2/2016	barn swallow	Unknown	Unknown	singed	2;3	Died on-site
5/2/2016	yellow-headed blackbird	Adult	Female	unknown	NA	Not captured
5/8/2016	western tanager	Unknown	Male	singed	2;3	Died at rehab
5/10/2016	Wilson's warbler	Unknown	Unknown	singed	2;3	Not captured
5/10/2016	yellow warbler	Adult	Male	collision	NA	Released off-site
5/11/2016	Townsend's warbler	Adult	Unknown	singed	2;3	Died on-site

3.1.3 Summary of Bat Detections

Four bats representing three species and one unidentified species were detected during the 2016 spring season. A Mexican free-tailed bat and canyon bat were located in the Unit 1 power block, a California myotis was detected incidentally, adjacent to a project building, and an unidentified bat was located in the Unit 2 ACC. Given the few detections of bats, they are not discussed further.

3.2 Locations of Avian Detections

3.2.1 Detections by Project Area

During spring 2016, of the 132 total detections, 111 detections (84.1%) were recorded at the tower area, 19 detections (14.4%) were recorded over the heliostat area, 2 (1.5%) of the detections were located at other project lands (Table 4). Of the 132 avian detections, 41 (31.1%) were detected in Unit 1, 34 (25.8%) in Unit 2, and 57 (43.2%) in Unit 3.

Table 4. Locations of Avian Detections, 26 March – 24 May 2016.

Location	Carcasses	Injuries	Percent of Total
Tower Area	101	10	84.1%
Heliostat Array	17	2	14.4%
Other Project Lands	2	0	1.5%
Total	120	12	100.0%

3.3 Cause of Injury or Fatality

The following section describes the number of detections with evidence of singeing or collision; the number from other known causes; the number for which cause of injury or fatality is unknown; and the spatial distributions of detections with these causes. Figure 8 shows the distribution of detections by cause.

3.3.1 Singeing Effects

Of the 132 avian detections during the 2016 spring season, 74 detections (56.1%) showed signs of singed feather damage, and 72 (97.3%) of singed detections were recorded in the tower area (Table 5). Two detections with evidence of singeing were recorded in the heliostat area of Unit 2, including a whole common raven carcass with evidence of singe effects, and an American coot feather spot with evidence of singeing on a single feather.

3.3.2 Collisions

Of the 132 avian detections, evidence of collision was observed in the case of 23 (17.4%). Eleven detections (47.8%) with evidence of collision were located in the tower area, 10 detections (43.5%) were located in the heliostat area, and 2 detections (8.7%) were located outside of the standard search areas. As described in Section 2.2.1.3, the evidence that was used to classify these detections as collisions was obvious physical trauma, proximity to heliostats that had smudge marks, body imprints, and/or feathers on or near the surface of the mirror (although birds that collide with structures do not always leave visible evidence).

3.3.2 Other Cause

Of the 132 avian detections, two (1.5%) were found within the ACC with no evidence of singeing or collision. Thus, consistent with previous cause assignments, these birds were determined to have been entrapped in the ACC, which resulted in fatality.

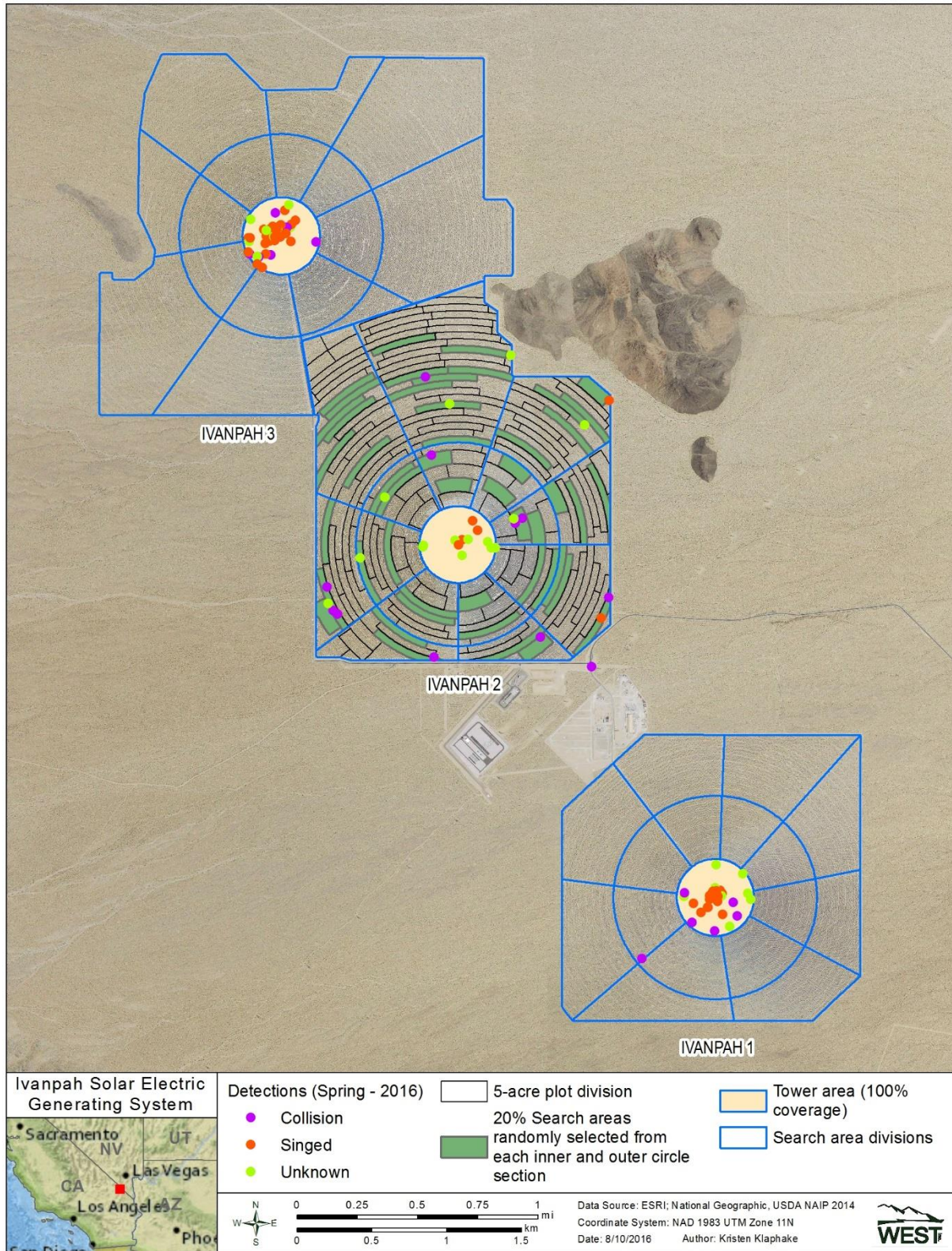


Figure 8. Locations of Singed and Unsinged Detections within Solar Units.

3.3.4 Detections of Unknown Cause

Of the 132 avian detections, evidence of singing, collision, or other cause could not be assigned for 33 detections (25.0%; Table 5). Per the Plan section 2.1, these detections cannot be presumed with or presumed without a reasonable doubt to be caused by the facility; see Section 6.2 of this report for further discussion. Of the unknown cause detections, 7 (21.2%) were recorded in the heliostat area, and 26 (78.8%) were recorded in the tower area.

Table 5. Locations of Bird Detections, 26 March – 24 May 2016.

Location	Singing	Collision	Other	Unknown	Total
Tower Area	72	11	2*	26	111
Heliostat Area	2	10	0	7	19
Other Project Lands	0	2	0	0	2
Total	74	23	2	33	132

*These carcasses were found in the ACC unit with no sign of collision or singe and are attributed to entrapment.

3.4 Types of Detections

Thirty-eight (28.8%) of the 132 detections consisted only of feather spots (Table 6a). Feather spots accounted for over 42% of detections in the heliostats area, and 27.0% of detection in the tower area. Percent of the detections that were feather spots was lower in the power block (19.4%), and no detections in the ACC were feather spots. Evidence of singeing was noted through direct and microscopic examination on 12 of these 38 feather spots; evidence of collision (i.e., an impact imprint on a nearby mirror) was noted in the case of two feather spots. Otherwise, the causes of the feather spots for the other 49 detections are unknown (Table 6b).

Table 6a. Percent Composition Feather Spots to Carcasses Relative to Site Locations.

Location	Carcasses	Feather Spot	Total	Percent Feather Spot*
Tower Area	81	30	111	27.0%
Heliostat Area	11	8	19	42.1%
Other Project Lands	2	0	2	0%
Total	94	38	132	28.8%

*NA = Not applicable

Table 6b. Percent Composition Feather Spots to Carcasses Relative to Cause.

Cause	Carcasses	Feather Spots	Total	Percent Feather Spot*
Singed	62	12	74	16.2%
Collision	21	2	23	8.7%
Other	2**	0	2	0%
Unknown	9	24	33	72.7%
Total	94	38	132	28.8%

*Total percent feather spot is total feather spots divided by total detections.

**These carcasses were found in the ACC unit with no sign of collision or singe and are attributed to entrapment.

Section 4.0 Fatality Estimation

This section utilizes the detection data as described in Section 3 to develop an overall fatality estimate in accordance with the Plan (2015). The total estimate for the entire facility is presented separately for fatalities with evidence of singeing or collision effects, or for detections in the ACC buildings, and fatalities of unknown cause. Following presentation of the total fatality estimates, estimates are provided separately for the tower area, and heliostat area.

4.1 Estimating Model Parameters

4.1.1 Carcass persistence Trials

A total of 21 small bird carcass persistence trials were conducted during the 2016 spring monitoring season. Trials were distributed throughout the facility. Consistent with previous seasons, scavengers included common ravens (*Corvus corax*, N=9), desert kit fox (*Vulpes macrotis*, N=7), white-tailed antelope squirrels (*Ammospermophilus leucurus*, N=2), desert woodrat (*Neotoma lepida*, N=2), and ants (N=2). In two instances no scavenger was captured on film. Small bird carcass persistence ranged from less than one day in the case of 1 carcass to over 42 days; one carcass lasted the full six-week trial period (Figure 9). Large bird carcass persistence trials were discontinued beginning fall 2015 per TAC approval because no seasonal effects were found in previous large bird models and most trial carcasses persisted at least 42 days (Figure 10).

In addition to the 2016 spring trials described above, carcass persistence trials from the first two years of monitoring, and prior season (winter) of year 3 were also used in the model. Carcass persistence data from 30 small bird trials conducted during the 2015-2016 winter season, 127 carcass persistence trials conducted during the 2014 - 2015 monitoring year (97 small birds and 30 large birds distributed throughout the facility) and data from 87 trials (57 small birds and 30 large birds distributed throughout the facility) performed during the 2013-2014 monitoring year were used to model carcass persistence time. Details on carcass persistence times can be found in each respective seasonal report.

**Persistence Duration of Small Carcasses
Winter 2015–2016 (N = 21)**

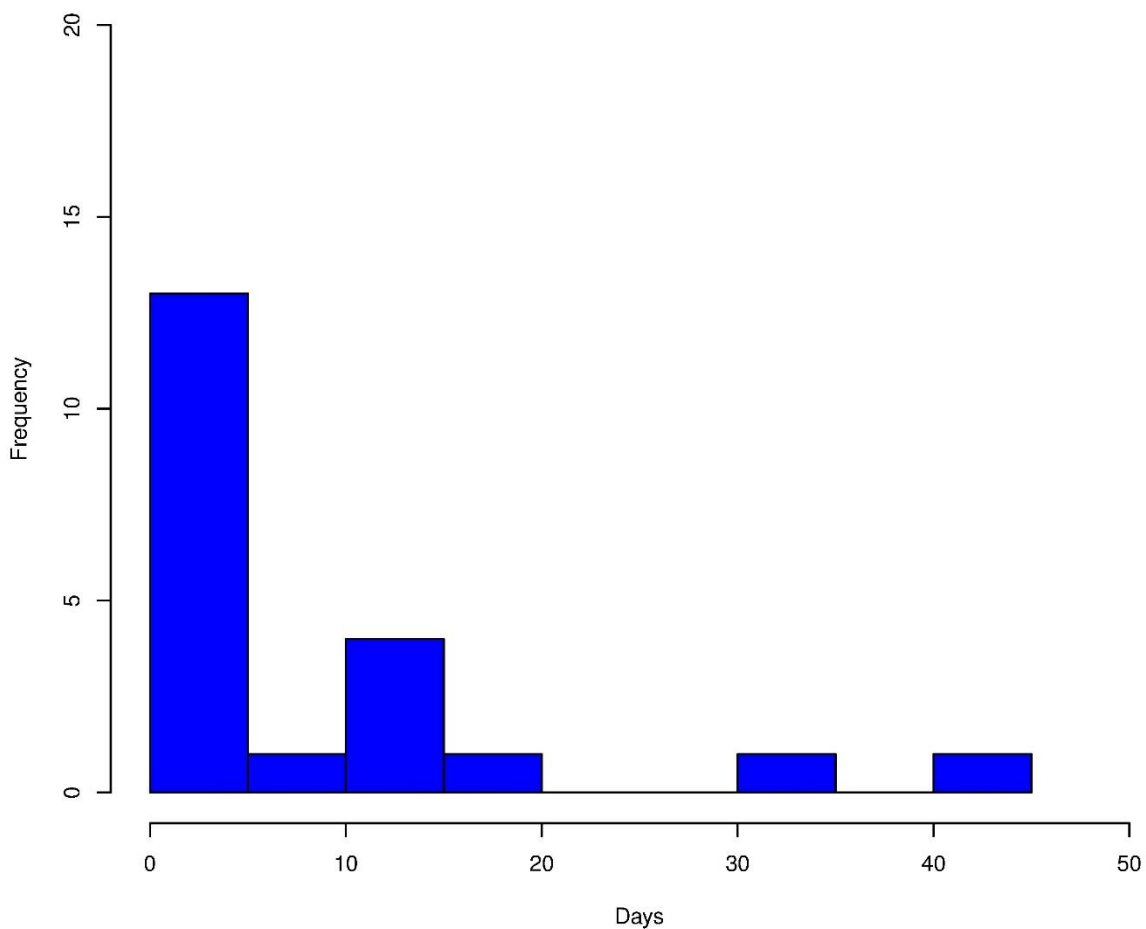


Figure 9. Persistence Durations for Small Carcasses Placed for 2016 Spring Carcass Persistence Trials (N = 30).

**Persistence Duration of Large Carcasses
Winter 2013–2014 to Summer 2015
(N = 60)**

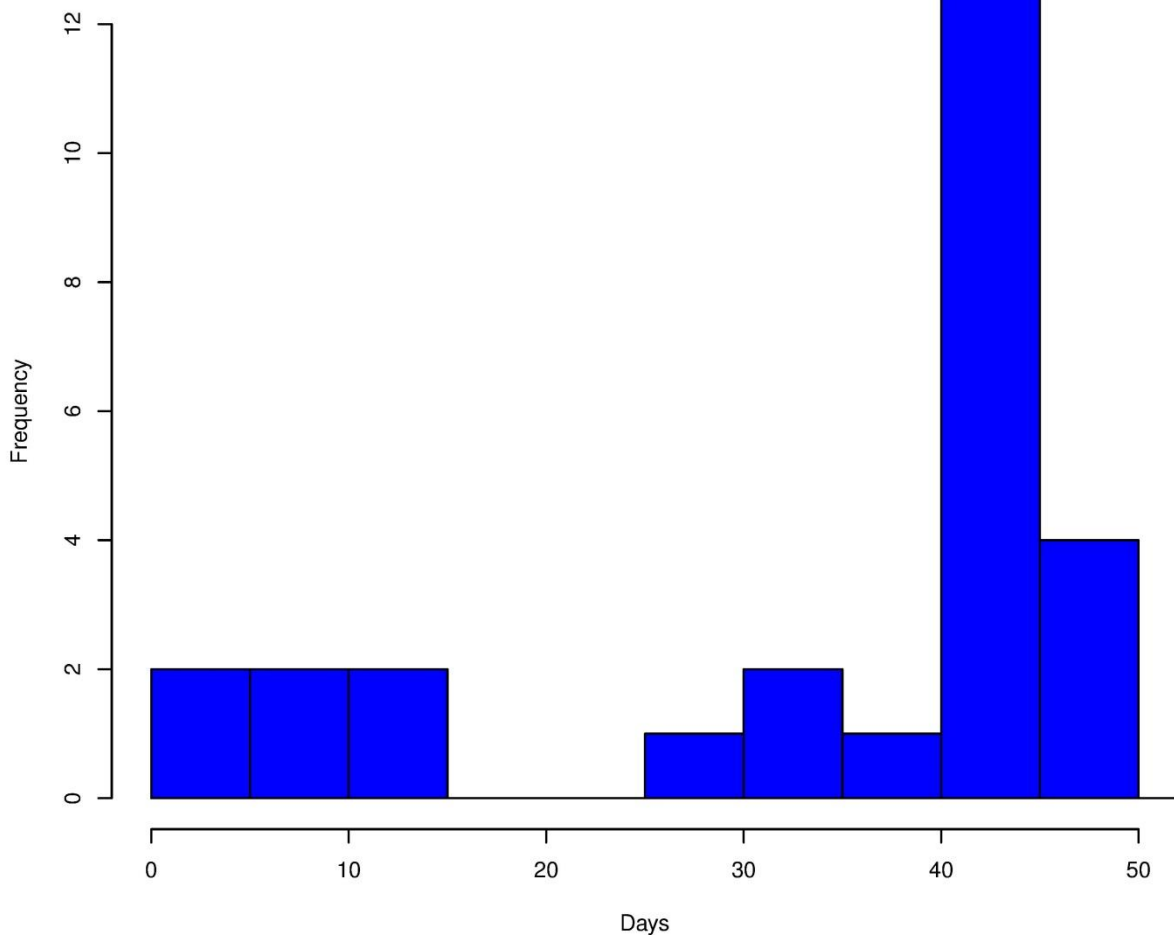


Figure 10. Persistence Durations for Large Carcasses Placed for All Carcass Persistence Trials.

4.1.2 Model Selection for Carcass Persistence Distribution

Consistent with the second year of monitoring and the findings that the removal process for small birds and large birds has been markedly different, two separate carcass persistence models were fit to this dataset: one for small birds and one for large birds. Specifically, large birds consistently persist for long periods of time (typically greater than six weeks), while small birds tend to be removed with days or hours, and exhibit seasonal variability. Fitting separate models by size allows for more flexibility, enabling different distributions with different shapes to be fit to the small bird and large bird data, respectively.

Based on the carcass persistence data from the cumulative trials, 16 survival models were compared for the small bird and large bird datasets, respectively. Models were compared for relative explanatory power using the corrected Akaike information criterion (AICc) score (Akaike 1973), as suggested in Huso (2010). AICc provides a relative measure of model fit and parsimony among a selection of candidate models. Season was considered as a possible covariate due to cyclical variation in scavenging pressure

and environmental conditions associated with seasons. Year was also incorporated as a potential covariate to assess whether respective seasons could be pooled across the first two years (i.e. combine 2014 fall with 2015 fall persistence trial results). Finally, location (unvegetated tower area or the vegetated heliostat area) was considered a potential covariate to understand if carcass persistence in the tower area and heliostat area was different.

The model with lowest AICc is typically chosen as the “best-fit” model relative to other models tested; however, any model within two AICc point of the best model is considered strongly supported (Burnham and Anderson 2004). For small birds the loglogistic and lognormal models that included season had $\Delta AICc$ values ≤ 2 ; for large birds, the exponential, Weibull, loglogistic, and lognormal models with intercept only had $\Delta AICc$ values ≤ 2 (Tables 7a and 7b). Ultimately, a loglogistic model with season covariate was chosen for small birds, and an exponential model with no covariates was chosen for large birds. Thus, the selected model for small birds can be interpreted to treat as separate the persistence probability for each season, with seasons pooled across years. For large birds, the top model does not have any temporal covariates, and thus uses all large bird data collected to date to estimate persistence probability. The chosen models predicted 98.8% of large carcasses persisted for the nominal search interval (7 days), and 56.8% of small bird carcasses persisted for the nominal search interval of during the 2016 spring monitoring season.

Table 7a. AICc Values for the Top 10 Small Bird Carcass Persistence Models

Small Bird Trials			
Covariates	Distribution	AICc	$\Delta AICc$
Season	loglogistic	1079.53	0
Season	lognormal	1080.01	0.48
Year + Season	loglogistic	1080.81	1.28
Year + Season	lognormal	1081.51	1.98
Season + Location	loglogistic	1081.65	2.12
Season + Location	lognormal	1082.13	2.60
Season + Year + Location	loglogistic	1082.77	3.24
Season + Year + Location	lognormal	1083.41	3.88
Season + Year + Location	weibull	1084.12	4.59
Intercept	loglogistic	1085.62	6.09

Table 7b. AICc Values for All Large Bird Carcass Persistence Models

Large Bird Trials			
Covariates	Distribution	AICc	Δ AICc
Intercept	exponential	97.00	0
Intercept	weibull	97.96	0.96
Intercept	loglogistic	98.03	1.03
Intercept	lognormal	98.15	1.15
Season	exponential	98.34	1.34
Season	weibull	99.62	2.62
Year + Season	exponential	99.64	2.64
Season	loglogistic	99.75	2.75
Season	lognormal	99.87	2.87
Year + Season	lognormal	100.68	3.68
Year + Season	loglogistic	100.98	3.98
Year + Season	weibull	101.08	4.08
Year + Season + Year*Season	exponential	107.36	10.36
Year + Season + Year*Season	lognormal	108.69	11.69
Year + Season + Year*Season	loglogistic	109.00	12.00
Year + Season + Year*Season	weibull	109.09	12.09

4.1.3 Searcher Efficiency Trials

During the 2016 spring season, a total of 69 searcher efficiency trials (26 small birds, 21 large birds, and 21 feather spots) were placed. Trials were placed in locations with various vegetation heights and with a range of contrast between the soil and vegetation to represent the various conditions under which searches occur. Carcasses were placed in most areas where searches occurred (tower area and heliostat area). Three small bird trials were removed (scavenged) prior to a searcher having the opportunity to detect the carcass.

A total of 83 searcher efficiency trials (33 small birds, 24 large birds, 26 feather spots) from the 2015-2016 winter monitoring seasons were included in the dataset used to fit a searcher efficiency model for the 2016 spring season. An additional 320 human searcher efficiency trials (129 small birds, 96 large birds, and 95 feather spots) from the 2014 - 2015 monitoring year used to fit a searcher efficiency model for the 2016 spring season. Of the 320 trial carcasses placed, 268 (129 small birds, 96 large birds, and 95 feather spots) were available to be found; 52 carcasses (42 small birds, 8 large birds, and 2 feather spots) were removed from the trial location before searchers had an opportunity to detect the carcass. Finally, 154 searcher efficiency trials (52 small birds, 44 large birds, 57 feather spots) from the first year of study were also included in searcher efficiency model building. Of 154 trials from the first year of monitoring, 144 (48 small birds, 39 large birds, and 57 feather spots) were not removed and thus available to be found by a searcher. Details about searcher efficiency trials performed prior to the 2016 spring season can be found in the respective quarterly reports.

Searcher efficiency rates were generally higher on in the unvegetated areas in the tower area. During the 2016 spring season, in unvegetated areas, human searcher efficiency was 80% for small birds, 92% for large birds, and 80% for feather spots. In the vegetated areas in the heliostat arrays, searcher efficiency was 53% for small birds, 76% for large birds, and 53% for feather spots.

Table 8. Covariates, AICc Values, and Δ AICc values for the top ten searcher efficiency models. Data consist of all human searcher efficiency trials for carcasses from the initiation of trials through March 25, 2016.

Covariates	AICc	Δ AICc
Size + Project Area + Season + Year	663.40	0.00
Season + Size*Project Area + Year	665.97	2.57
Size + Season + Size*Project Area + Year	665.97	2.57
Project Area + Season + Size*Project Area + Year	665.97	2.57
Size + Project Area + Season + Size*Project Area + Year	665.97	2.57
Size + Project Area + Year	666.49	3.09
Project Area + Season + Size*Year	667.17	3.77
Size + Project Area + Season + Size*Year	667.17	3.77
Project Area + Season + Year + Size*Year	667.17	3.77
Size + Project Area + Season + Year + Size*Year	667.17	3.77

The best model for searcher efficiency included carcass size, project area, season, and year with an AICc value 2.57 points lower than the second best model that included season, year, and an interaction term for size and project area (Table 8). Thus, the most supported searcher efficiency model produces searcher efficiency estimates based on carcass size, project area (unvegetated tower area and vegetated heliostat area), season, and year. Searcher efficiency values used to adjust detections to calculate a fatality estimate are provided in Table 9 and are based on all searcher efficiency data collected.

Table 9. Human Searcher Efficiency Sample Sizes Used for Modeling, and Model Predictions for Size and Project Area Categories Spring 1 – Spring 3.

Size	Location	Found	Available	Placed	Predicted Searcher Efficiency (90% CI)
Feather spot	Tower area (Unvegetated)	67	95	99	0.80 (0.71-0.87)
Large bird	Tower area (Unvegetated)	71	84	91	0.92 (0.87-0.95)
Small bird	Tower area (Unvegetated)	69	93	125	0.80 (0.71-0.87)
Feather spot	Heliostat area (Vegetated)	43	100	101	0.53 (0.41-0.65)
Large bird	Heliostat area (Vegetated)	57	86	94	0.76 (0.66-0.84)
Small bird	Heliostat area (Vegetated)	34	89	116	0.53 (0.42-0.66)

4.2 Fatality Estimates of Known Causes for 2016 Spring Monitoring

Fatality estimates were calculated separately for the tower area (power block and inner HD heliostats) and heliostat area. Note that estimates are not provided for factor combinations with five or fewer detections; thus, marginal totals (e.g. total singed, total known cause in the heliostat area, etc.) for the tables below may not reflect the sum of estimates within a given row or column (and are generally higher).

4.3.1 Total Fatality Estimates for Known Causes

There were 99 bird detections where the cause of death or injury could be determined and were facility related, of which 88 were included in the fatality estimate model (Tables 10a and 10b); of these 88 detections, 13 were from the ACC that were added unadjusted to the estimator output, to produce the total fatality estimate of known cause (Tables 11 and 12). There were 11 detections showing evidence of singeing or collision outside the ACC buildings that were not included in the fatality estimates; two were excluded because they were outside the standardized survey area and 9 were excluded because they were determined to be older than the search interval.

Table 10a. Number of Bird Detections Based on Known Causes in Each Project Element Included or Excluded from Fatality Estimates, by Cause.

Location	Included			Excluded			Total
	Collision	Singed	Other	Collision	Flux	Other	
Tower Area	11	63	2*	0	9	0	85
Heliostat Area	10	2	0	2	0	0	14
Total	21	65	2	2	9	0	99

*These carcasses were found in the ACC unit with no sign of collision or singe and are attributed to entrapment.

Table 10b. Number of Bird Detections Based on Known Causes in Each Project Element Included or Excluded from Fatality Estimates, by Carcass Size.

Location	Included			Excluded			Total
	Large Birds	Small Birds	Raptors*	Large Birds	Small Birds	Raptors*	
Tower Area	1	75	0	0	9	0	85
Heliostat Area	2	10	0	2	0	0	14
Total	3	85	0	2	9	0	99

* All raptors are considered "Large Birds", therefore the number of raptor detections in a row or column is not added to the total.

Table 11. 2016 Spring Season Avian Fatality Estimates by Cause and Project Element (with Lower and Upper 90% Confidence Intervals) Based on Detections of Known Causes Included in the Model.

Location	Collision	Singed	Other*	Total Known Cause
Tower Area	24 (20-28)	115 (100-134)	N ≤ 5**	141 (121-163)
Heliostat Area	410 (172-744)	N ≤ 5	N ≤ 5	450 (210-795)
Total	434 (196-771)	155 (11-214)	N ≤ 5	591 (340-952)

*These carcasses were found in the ACC unit with no sign of collision or singe and are attributed to entrapment.

** N ≤ 5 indicates 5 or fewer detections and no fatality estimate is provided

Table 12. 2016 Spring Season Avian Fatality Estimates by Carcass Size and Project Element (with Lower and Upper 90% Confidence Intervals) Based on Detections of Known Causes Included in the Model.

Location	Large Birds	Small Birds	Raptors	Total
Tower Area	N ≤ 5*	139 (120-162)	0	141 (121-163)
Heliostat Area	N ≤ 5	410 (172-744)	0	450 (210-795)
Total	N ≤ 5	549 (308-895)	0	591 (340-952)

* N ≤ 5 indicates 5 or fewer detections and no fatality estimate is provided

4.3.2 Fatality Estimate for Tower Area and Heliostat Area

Tables 11 and 12 present the fatality estimates for known causes within the tower area, broken down by cause or carcass size, respectively. A subset of the incidental detections in the power block were included within the tower area total estimate, due to the assumption of a daily search interval; those incidental detections in the power block which were determined to be older than 24 hours were not included in the fatality estimator. Estimates from the tower area should be interpreted with caution due to the inclusion of numerous incidental discoveries in the power block.

During the period 26 March, 2016 to 24 May, 2016 (60 days of monitoring), there were an estimated 591 fatalities (90% confidence interval 340-952) based on detections from known causes (i.e., singeing, collision, entrapment in the ACC; Table 11). Of these, 141 fatalities (23.9%) were estimated for the 154 acre tower area, and 450 (76.1%) were estimated for the 2,991 acre heliostat area. There were 549 estimated small bird fatalities (Table 12).

4.4 Fatality Estimates from Unknown Causes

Per Section 3.1 of the Plan, fatality estimates are also to be provided based on detections of birds that were injured or that died of unknown causes. Because no observable evidence of known causes (i.e., singeing, collision, entrapment, or predation) was noted in the case of these unknown detections, they cannot be clearly included in an estimate attributed to a specific cause. The methods for determining

fatality estimates for these unknown detections are the same as those described in Section 5.2 for detections with direct evidence of the cause of the fatality (i.e., singeing, collision, or other).

There were 33 detections where the cause of death could not be determined, of which 29 were included in the fatality estimator (Tables 13a and 13b). Of the 4 detections of unknown cause excluded from the fatality estimator, all detections were determined to be older than the search interval.

Table 13a Number of Detections from Unknown Causes in Each Project Element, and Number Included in Fatality Estimates, by Cause.

Location	Included	Excluded	Total
Tower Area	24	2	26
Heliostat Area	5	2	7
Other Project Lands	0	0	0
Total	29	4	33

Table 13b. Number of Detections from Unknown Causes in Each Project Element, and Number Included in Fatality Estimates, by Carcass Size.

Location	Included			Excluded			Total
	Large Birds	Small Birds	Raptors*	Large Birds	Small Birds	Raptors*	
Tower Area	7	17	0	0	2	0	26
Heliostat Area	0	5	0	0	2	0	7
Other Project Lands	0	0	0	0	0	0	0
Total	7	22	0	0	4	0	33

* All raptors are considered “Large Birds”, therefore the number of raptor detections in a row or column is not added to the total.

4.4.1 Total Fatality Estimates from Unknown Causes

During the period of 26 March, 2016 to 24 May, 2016, the total estimate of fatalities from unknown cause was 246 (90% confidence interval 113-423; Table 14). A total of 46 (18.7%) were in the tower area. No estimate is provided for the heliostat area since five or fewer detections were attributed to that survey area; however, the estimate from unknown cause detections found in the heliostat area are included in the total estimate for unknown cause fatalities. Of the estimated unknown cause fatalities, small birds accounted for 96% of the estimated fatalities (Table 15).

Table 14. Site-Wide Fatality Estimates from Unknown Causes by Location, 26 March – 24 May.

Project Area	Estimate (90% CI)
Tower Area	46 (39-53)
Heliostat Area	N ≤ 5
Total	246 (113-423)

Table 15. Site-Wide Fatality Estimates from Unknown Causes by Size and Location, 26 March – 24 May 2016.

Location	Large Birds	Small Birds	Raptors	Total
Tower Area	9(8-9)	37 (31-44)	0	46 (39-53)
Heliostat Area	0	N ≤ 5	0	N ≤ 5
Total	9(8-9)	237 (104-414)	0	246 (113-423)

* N ≤ 5 indicates 5 or fewer detections and no fatality estimate is provided

4.6 Regional Awareness Monitoring

During the 2015 spring season, five injured birds were taken to Animal Kingdom Veterinary Hospital, a wildlife rehabilitation facility located approximately 35 miles northeast of Las Vegas. Biologist delivering injured birds or requesting follow-up information on project birds were not informed of other injured birds brought in for rehab from outside the Project. In addition, Dr. Craig Himmelwright, who performs periodic raven surveys across the Ivanpah Valley has not report signed detections occurring outside of the Project.

Section 5.0 Discussion

The 2016 spring season represented the continuation of standardized monitoring of avian and bat detections and avian use of the Ivanpah site as revised per the Avian & Bat Monitoring and Management Plan (2015).

5.1 Temporal Patterns in Detections

The number of detections reported at the tower area increased after 13 April 2015 coinciding with an increase in small passerine migration activity. A tower area search during the 2015 spring season is a look back over approximately 7 days, so it would be expected that short search interval at the tower areas would reflect pulses in small passerine migration. BirdCast analysis reported light to moderate migration movements in California and the Desert Southwest throughout the 2016 spring season. ‘More intense’ migration and moderate movements were noted the week ending 23 April through May 6. Although the BirdCast migration analysis is coarse compared to the location-specific fatality monitoring at the Project, the number of detections recorded during the 2016 spring season can be considered representative of generally light to moderate movements of migrants in the Desert Southwest region.

5.2 Spatial Patterns in Detections and Fatality Estimates

The distribution of known cause detections varied by facility area. Of collision detections, 43.5% were located in the heliostat area consistent with the risk of the heliostats to birds. Of singed detections, 98.5% occurred in the tower area indicating that singed birds rarely transition outside of the tower area. A feather spot and a common raven detection were found with evidence of singeing outside the tower area. Discoveries of singed birds outside the tower are uncommon; however, based on carcass persistence trial data, scavengers often remove whole carcasses from the original location and singed injured birds have been discovered that are ambulatory. The pattern of singed detections per unit aligned with the pattern of unplanned forced outages – the longest unplanned forced outage was at Unit 2, which had the fewest detections, followed by Unit 1 and then Unit 3.

Unknown cause detections accounted for approximately 28.8% of all detections during the 2016 spring season. Of the unknown cause detections, 72.7% were feather spots or partial carcasses that showed signs of scavenging. Determining a cause of mortality from a feather spot or partial carcass is challenging because sources of mortality such as collision or predation would rarely leave visible evidence on the feathers as would flux effects. Thus, feather spots with an unknown cause of mortality could be encountered anywhere birds occur, and an unknown cause of mortality is not unique to the Project. Further, the large proportion of feather spots 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.

Section 6.0 Framework for Management and Risk Response

According to Section 5.3 of the Plan, migratory bird mortality at Ivanpah is categorized as high, medium, or low to provide an appropriate biological basis for TAC review and decision making, based on the following definitions:

1. “High: Estimated avian mortality or injury levels are facility-caused and likely to seriously and negatively affect local, regional, or national avian populations within a particular species or group of species.”
2. “Medium: Estimated avian mortality or injury levels are facility-caused and have the potential to negatively affect local, regional, or national populations within a particular avian species or group of species.”
3. “Low: Estimated avian mortality or injury levels that have minimal or no potential to negatively affect local, regional, or national populations within a particular species or group of species.”

Only limited conclusions can be drawn from the 2016 spring season fatality data owing to the low numbers of detections within “a particular species or group of species”; however, the results indicate that the potential migratory bird mortality by species or groups of species from this project would be categorized as low. A more complete analysis will be conducted for the annual report. Approximately 64% of the detections were songbirds, and in general songbirds are short-lived, have high reproductive output, and their population growth rates are less sensitive to changes in survival rates than to changes in reproductive rates (Stahl and Oli 2006). Therefore, mortality of most songbird species is expected to have negligible effects on population dynamics.

None of the 15 species represented by more than three detections is particularly rare locally, regionally, or nationally. Rather, all 15 species are relatively abundant and widespread. Thus, the magnitude of detections of these species at Ivanpah during the 2016 fall season does not rise above the “low” category. Special-status species recorded as detections were one yellow warbler (California species of special concern), one crissal thrasher (California species of special concern), and one yellow-headed blackbird (California species of special concern). The one detection of each of the three California species of special concern will not have local or regional population level impacts.

Section 7.0 Literature Cited

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Appendix A. Individual Avian Detections.

USFWS #	Common Name	Species Code	How Found	Detection Date	Collection Date	Condition	Time Since Death/Injury	Description of Carcass/Injury	Cause of Death/Injury	Burn Grade	Unit	Nearest Project Feature	UTM Coordinates	SPUT Revisions
2016_057_ISEGS	Violet-green Swallow	VGSW	Carcass Survey	3/28/2016	3/28/2016	Broken up	3-6 days	Broken up carcass consisting of part of lower torso including part of pelvis, connective tissue, and body feathers. Evidence of singeing on several body feathers.	Scorched or singed	3	3	Heliostat	637255, 3937802	NA
2016_058_ISEGS	Unknown Small Bird	UNID	Carcass Survey	3/28/2016	3/28/2016	Broken up	3-6 days	Broken up carcass consisting of clump of 15 body feathers held together by connective tissue. No evidence of collision or singe.	Unknown	NA	3	Heliostat	637527, 3938114	NA
2016_059_ISEGS	Northern Saw-whet Owl	NSWO	Carcass Survey	3/29/2016	3/29/2016	Broken up	3-6 days	Broken up carcass, consisting of 8 primaries, 12 secondaries, 5 rectrices, and 16 body; 6 of the primaries and 3 of the rectrs were held together by connective tissue. No evidence of collision or singe.	Unknown	NA	2	Heliostat	637790, 3935450	NA
2016_060_ISEGS	Violet-green Swallow	VGSW	Carcass Survey	3/30/2016	3/30/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole carcass, curling to rectrices and back, singeing on primaries, secondaries, cheek, and crown.	Scorched or singed	2/3	3	Powerblock	637442, 3937965	NA
2016_061_ISEGS	Rufous Hummingbird	RUHU	Carcass Survey	3/30/2016	3/30/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling and singeing on left cheek, throat, chest, and belly of bird, singe present on both alulas.	Scorched or singed	1/3	1	Powerblock	640354, 3933511	NA
2016_062_ISEGS	American Coot	AMCO	Carcass Survey	3/30/2016	3/30/2016	Feather spot	2 days	Feather spot size large, consisting of 500+ body feathers, three rectrices, 3 undertail coverts. Evidence of curling on tip of tail feather.	Scorched or singed	Unk	2	Heliostat	639613, 3935353	NA
2016_063_ISEGS	Dark-eyed Junco	DEJU	Carcass Survey	3/30/2016	3/30/2016	Feather spot	3-6 days	Feather spot carcass consisting of 3 primaries, 3 secondaries, 1 rectrice, 3 body feathers. Evidence of singe on 2 primaries.	Scorched or singed	Unk	1	Powerblock	640421, 3933514	NA
2016_064_ISEGS	Unknown Warbler	UNWA	Carcass Survey	3/30/2016	3/30/2016	Broken up	3-6 days	Broken up carcass consisting of partial outer wing, 5 primaries, and 3 body feathers. Evidence of singe on tips of primaries.	Scorched or singed	Unk	1	Powerblock	640354, 3933502	NA
2016_065_ISEGS	Unknown Small Bird	UNID	Carcass Survey	3/30/2016	3/30/2016	Broken up	1 month +	Broken up carcass consisting of 9 primaries, 3 secondaries connected together by bone. Evidence of curling and singe present on primaries.	Scorched or singed	Unk	1	Powerblock	640344, 3933506	NA
2016_066_ISEGS	Lincoln's Sparrow	LISP	Carcass Survey	4/4/2016	4/4/2016	Alive, injured	0-8 hours	Alive, injured. Evidence of collision by body feathers on heliostat mirror and close proximity to heliostat.	Collision with solar panel/heliostat	NA	3	Heliostat	637327, 3937766	NA
2016_067_ISEGS	Unknown Small Bird	UNID	Carcass Survey	4/4/2016	4/4/2016	Broken up	8-24 hours	Broken up carcass consisting of 11 body feathers attached by small section of flesh. No evidence of singe or collision.	Unknown	NA	3	Powerblock	637454, 3937946	NA

2016_068_ISEGS	White-Crowned Sparrow	WCSP	Carcass Survey	4/4/2016	4/4/2016	Feather spot	3-6 days	Feather spot size small, consisting of 1 trailing secondary, 12 body feathers. No evidence of collision or singe.	Unknown	Unk	2	Powerblock	638637, 3935873	NA
2016_069_ISEGS	Black-Throated Sparrow	BTSP	Carcass Survey	4/4/2016	4/4/2016	Feather spot	2 days	Feather spot size large, consisting of 10 primaries, 17 secondaries, 10 rectrices, and 50 body feathers. No evidence of singe or collision.	Unknown	NA	2	Heliostat	638600, 3936786	NA
2016_070_ISEGS	Unknown Small Bird	UNID	Carcass Survey	4/5/2016	4/5/2016	Feather spot	3-6 days	Feather spot size small, consisting of 12 body feathers. No evidence of collision or singe.	Unknown	NA	2	Heliostat	638423, 3935829	NA
2016_071_ISEGS	Western Meadowlark	WEME	Carcass Survey	4/5/2016	4/5/2016	Feather spot	3-6 days	Feather spot size large, consisting of 12 body feathers, 2 rectrices. No evidence of collision or singe.	Unknown	NA	2	Heliostat	638427, 3935840	NA
2016_072_ISEGS	Costa's Hummingbird	COHU	Carcass Survey	4/5/2016	4/5/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of curling on tail feathers, singeing on right nape and rump.	Scorched or singed	1/3	2	Heliostat	638754, 3936003	NA
2016_073_ISEGS	Tree Swallow	TRES	Carcass Survey	4/5/2016	4/5/2016	Feather spot	2 days	Feather spot size large, consisting of 52 body, 5 primaries, 6 secondaries, and 4 coverts. Evidence of curling on 3 primaries and 4 secondaries.	Scorched or singed	Unk	1	Powerblock	640321, 3933420	NA
2016_074_ISEGS	Costa's Hummingbird	COHU	Carcass Survey	4/5/2016	4/5/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evience of singeing on breast and belly, tail feathers, and rump.	Scorched or singed	1/3	2	Heliostat	638789, 3935941	NA
2016_075_ISEGS	House Finch	HOFI	Incidental	4/5/2016	4/5/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to rectrices, singeing on rump and left cheek extending to nape.	Scorched or singed	1/3	3	Powerblock	637443, 3937901	NA
2016_076_ISEGS	Spotted Towhee	SPTO	Carcass Survey	4/6/2016	4/6/2016	Feather spot	3-6 days	Feather spot size large, consisting of 5 retricies. No evidence of collision or singe.	Unknown	Unk	2	Heliostat	638004, 3935758	NA
2016_077_ISEGS	Crissal Thrasher	CRTH	Carcass Survey	4/6/2016	4/6/2016	Feather spot	2 weeks	Large featherspot consisting of 6 retricies and 1 body feather. No evidence of singe or collision.	Unknown	NA	2	Heliostat	638169, 3936161	NA
2016_078_ISEGS	White-Crowned Sparrow	WCSP	Carcass Survey	4/7/2016	4/7/2016	Feather spot	3-6 days	Large featherspot consisting of 3 primary, 6 secondary, 2 retricies and 50+ body. Evidence of collision by imprint on heliostat and feather still attached to mirror.	Collision with solar panel/heliostat	NA	2	Heliostat	639086, 3936022	NA
2016_079_ISEGS	Wilson's Warbler	WIWA	Incidental	4/10/2016	4/10/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass with evidence of singeing to primary feathers and tail (singed off), back and head.	Scorched or singed	2/3	2	Powerblock	638659, 3935844	NA
2016_080_ISEGS	Hermit Thrush	HETH	Carcass Survey	4/11/2016	4/11/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass with evidence of curling to some barbs of the left outer primaries.	Scorched or singed	1	3	Powerblock	637451, 3937955	NA
2016_081_ISEGS	Yellow-rumped Warbler	YRWA	Carcass Survey	4/11/2016	4/11/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass with evidence of singeing to tips of primaries and secondaries.	Scorched or singed	1	3	Powerblock	637433, 3937900	NA
2016_082_ISEGS	Eared Grebe	EAGR	Incidental	4/11/2016	4/11/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass with upper mandible of bill broken at tip to show evidence of collision.	Collision (other)	NA	2	Project Structure	639548, 3935028	NA

2016_083_ISEGS	Horned Lark	HOLA	Carcass Survey	4/12/2016	4/12/2016	Feather spot	3-6 days	Feather spot size small, consisting of 7 rectrices. No evidence of collision or singe.	Unknown	NA	3	Heliostat	637272, 3938018	NA
2016_084_ISEGS	Unknown Small Bird	UNID	Carcass Survey	4/12/2016	4/12/2016	Feather spot	8-24 hours	Feather spot size small, consisting of 25 body feathers. Evidence of collision by heliostat imprint.	Collision with solar panel/heliostat	NA	2	Heliostat	639208, 3935226	NA
2016_085_ISEGS	Unknown Grebe	UNGR	Carcass Survey	4/13/2016	4/13/2016	Broken up	8-24 hours	Broken up carcass consisting of 37 body feathers and 3 pieces of connective tissue. No evidence of collision or singe.	Unknown	NA	1	Heliostat	640380, 3933704	
2016_086_ISEGS	Unknown Grebe	UNGR	Carcass Survey	4/13/2016	4/13/2016	Feather spot	3-6 days	Feather spots size large, consisting of 500 body feathers. No evidence of singe or collision.	Unknown	NA	1	Heliostat	640590, 3933513	NA
2016_087_ISEGS	Costa's Hummingbird	COHU	Carcass Survey	4/13/2016	4/13/2016	Dead, fresh (eyes moist)	8-24 hours	Whole carcass. No evidence of singe but placement under mirror suggests probable collision.	Collision with solar panel/heliostat	NA	2	Heliostat	637852, 3935381	
2016_088_ISEGS	Costa's Hummingbird	COHU	Carcass Survey	4/13/2016	4/13/2016	Dead, fresh (eyes moist)	8-24 hours	Whole carcass. Evidence of collision by broken upper section of bill.	Collision with solar panel/heliostat	NA	2	Heliostat	637823, 3935406	NA
2016_089_ISEGS	Tree Swallow	TRES	Carcass Survey	4/13/2016	4/13/2016	Alive, injured	0-8 hours	Injured bird captured. Evidence of heavy singeing on primaries, greater coverts, and secondaries, singeing on side of face, nape, and rump feathers.	Scorched or singed	1/3	1	Heliostat	640278, 3933388	NA
2016_090_ISEGS	Ruby-crowned Kinglet	RCKI	Carcass Survey	4/14/2016	4/14/2016	Dead, fresh (eyes moist)	8-24 hours	Singe on head, neck, back, rump, and undertail. Curling on primaries, secondaries, rectrices.	Scorched or singed	2/3	1	Powerblock	640369, 3933511	NA
2016_091_ISEGS	Ruby-crowned Kinglet	RCKI	Carcass Survey	4/14/2016	4/14/2016	Dead, fresh (eyes moist)	8-24 hours	Whole carcass. Singe on cheek, crown, nape, neck and lower back. Primary and secondary flight feathers curled and singed. Tail absent due to singe damage.	Scorched or singed	2/3	1	ACC Building	640355, 3933521	NA
2016_092_ISEGS	Unknown Hummingbird	UNHU	Carcass Survey	4/14/2016	4/14/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole Carcass. Curling of rectrices and primaries. Singeing present on throat, belly and breast.	Scorched or singed	2/3	1	Project Structure	640227, 3933449	NA
2016_093_ISEGS	Costa's Hummingbird	COHU	Carcass Survey	4/14/2016	4/14/2016	Dead, fresh (eyes moist)	8-24 hours	Whole carcass. No singe. Found directly below heliostat.	Collision with solar panel/heliostat	NA	2	Heliostat	639040, 3935987	NA
2016_094_ISEGS	White-Crowned Sparrow	WCSP	Carcass Survey	4/14/2016	4/14/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole Carcass. No sign of singe or collision damage.	Unknown	NA	1	Powerblock	640417, 3933497	NA
2016_095_ISEGS	Unknown Hummingbird	UNHU	Carcass Survey	4/14/2016	4/14/2016	Dead, fresh (eyes moist)	8-24 hours	Whole Carcass. Evidence of singe. Culring in primaries, secondaires and rectrices. Most tail feathers singed off. Singeing on head, nape, back, breast and flanks.	Scorched or singed	2/3	1	Powerblock	640394, 3933487	NA
2016_096_ISEGS	Yellow-rumped Warbler	YRWA	Carcass Survey	4/14/2016	4/14/2016	Dead, fresh (eyes moist)	8-24 hours	Singe apparent on crown and nape, and one tail feather. Singe on crown and nape heavy.	Scorched or singed	1/3	1	Powerblock	640390, 3933461	NA
2016_097_ISEGS	Mourning Dove	MODO	Incidental	4/15/2016	4/15/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Bill damaged and opened to extreme angle.	Collision with solar	Unk	1	Heliostat	639883, 3933078	NA

								Found near heliostat with matching imprint.	panel/heliostat					
2016_098_ISEGS	Tree Swallow	TRES	Carcass Survey	4/18/2016	4/18/2016	Broken up	3-6 days	Two wings found. Singe on flight feathers of both wings.	Scorched or singed	2/UNK	3	Heliostat	637350, 3937698	NA
2016_099_ISEGS	American Pipit	AMPI	Carcass Survey	4/18/2016	4/18/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass in addition to 4 body feathers. Evidence of collision by location of carcass at base of heliostat with matching imprint of size and shape of species and feathers on face of mirror.	Collision with solar panel/heliostat	NA	3	Heliostat	637266, 3937786	NA
2016_100_ISEGS	Lincoln's Sparrow	LISP	Carcass Survey	4/18/2016	4/18/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Upper mandible chipped, lower mandible with broken tip. No singe.	Collision with solar panel/heliostat	NA	2	Heliostat	638438, 3936967	NA
2016_101_ISEGS	American Pipit	AMPI	Carcass Survey	4/18/2016	4/18/2016	Alive, injured	0-8 hours	Injured, alive. Imprint on nearby heliostat with matching size and attached body feathers.	Collision with solar panel/heliostat	NA	3	Heliostat	637406, 3937782	NA
2016_102_ISEGS	Barn Swallow	BARS	Carcass Survey	4/18/2016	4/18/2016	Alive, injured	0-8 hours	Alive, injured. Curling on all major flight feathers in wings/tail. Singe on top of head, nape, right side face.	Scorched or singed	2/3	3	Heliostat	637373, 3937787	NA
2016_103_ISEGS	Unknown Sparrow	UNSP	Incidental	4/18/2016	4/18/2016	Broken up	2 days	Broken up carcass consisting of piece of wing held together by connective tissue in addition to 4 retrices held together by tissue, 6 primaries, 50 body feathers, 6 coverts, 5 rects. No evidence of collision or singe.	Unknown	NA	2	Heliostat	639009, 3937111	NA
2016_104_ISEGS	Barn Swallow	BARS	Carcass Survey	4/18/2016	4/18/2016	Alive, injured	0-8 hours	Alive, injured. Singe and curl on majority of flight feathers in both wing/tail.	Scorched or singed	2/3	3	Heliostat	637257, 3937893	NA
2016_105_ISEGS	House Finch	HOFI	Carcass Survey	4/18/2016	4/18/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Singe on nape.	Scorched or singed	1/3	3	Powerblock	637421, 3937970	NA
2016_106_ISEGS	Rufous Hummingbird	RUHU	Carcass Survey	4/18/2016	4/18/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of singeing on right side of face, nape, back, rump, and right lower flank.	Scorched or singed	3	3	Powerblock	637458, 3937945	NA
2016_107_ISEGS	Black Phoebe	BLPH	Carcass Survey	4/18/2016	4/18/2016	Broken up	3-6 days	Torso, 2 legs, partial shoulder. No singe or evidence of collision.	Unknown	NA	3	Powerblock	637538, 3937965	NA
2016_108_ISEGS	American Pipit	AMPI	Carcass Survey	4/18/2016	4/18/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Collision imprint on heliostat with six adhered body feathers. No singe.	Collision with solar panel/heliostat	NA	3	Heliostat	637709, 3937866	NA
2016_109_ISEGS	Yellow-rumped Warbler	YRWA	Incidental	4/19/2016	4/19/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to all major flight feathers in wings and tail, singeing to head, nape, axillaries, breast, back, and rump.	Scorched or singed	2/3	3	Powerblock	637438, 3937954	NA
2016_110_ISEGS	Unknown Hummingbird	UNHU	Incidental	4/19/2016	4/19/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Curling of all remaining flight feathers, most no longer present. Singeing of almost all other body feathers.	Scorched or singed	2/3	1	Powerblock	640389, 3933505	NA

2016_111_ISEGS	Violet-green Swallow	VGSW	Incidental	4/19/2016	4/19/2016	Dead, fresh (eyes moist)	0-8 hours	Whole Carcass. Curling to all flight feathers. Singe present on head, nape, back, rump and flanks.	Scorched or singed	2/3	3	Powerblock	637376, 3937907	NA
2016_112_ISEGS	Lucy's Warbler	LUWA	Incidental	4/19/2016	4/19/2016	Alive, injured	0-8 hours	Alive, injured. Curling on all major flight feathers in wings/tail. Singe on top of head.	Scorched or singed	2/3	3	Powerblock	637391, 3937899	NA
2016_113_ISEGS	Costa's Hummingbird	COHU	Carcass Survey	4/19/2016	4/16/2016	Mummified	2 weeks	Whole carcass. Curling of all flight feathers. Singe on head, nape, back and rump.	Scorched or singed	2/3	2	Powerblock	638685, 3935878	NA
2016_114_ISEGS	Yellow-rumped Warbler	YRWA	Carcass Survey	4/20/2016	4/20/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole carcass. Evidence of curling to primaries, secondaries, coverts, and retrices, singeing to sides of head, top of head, axillaries, breast, back, and rump.	Scorched or singed	2/3	1	ACC Building	640360, 3933528	NA
2016_115_ISEGS	Northern Rough-winged Swallow	NRWS	Carcass Survey	4/20/2016	4/20/2016	Dead, fresh (eyes moist)	8-24 hours	Whole carcass. Evidence of curling to all major flight feathers in wings and tail, singeing to breast, chin, sides of face, and rump.	Scorched or singed	2/3	1	Powerblock	640391, 3933505	NA
2016_116_ISEGS	Savannah Sparrow	SAVS	Carcass Survey	4/20/2016	4/20/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Probable evidence of collision by placement of carcass under heliostat mirror.	Collision with solar panel/heliostat	NA	1	Heliostat	640520, 3933363	NA
2016_117_ISEGS	Unknown Small Bird	UNID	Carcass Survey	4/20/2016	4/20/2016	Broken up	3-6 days	Broken up carcass consisting of 4 primaries and 2 secondaries held together by a piece of dried flesh. No evidence of collision or singe.	Unknown	NA	1	Powerblock	640370, 3933509	NA
2016_118_ISEGS	Lesser Nighthawk	LENI	Incidental	4/20/2016	4/20/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. No evidence of collision or singe.	Unknown	NA	2	Powerblock	638724, 3935880	NA
2016_119_ISEGS	Unknown Kinglet	UNKL	Incidental	4/20/2016	4/20/2016	Feather spot	3-6 days	Feather spot size large consisting of 5 primaries, 8 secondaries and tertials. Evidence of singe to tertials and primary tips.	Scorched or singed	Unk	3	Powerblock	637402, 3937955	NA
2016_120_ISEGS	Yellow-rumped Warbler	YRWA	Incidental	4/20/2016	4/20/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of singeing on all retrices and flight feathers, head, nape, and breast.	Scorched or singed	2/3	3	Powerblock	640374, 3933486	NA
2016_121_ISEGS	Yellow-rumped Warbler	YRWA	Incidental	4/20/2016	4/20/2016	Feather spot	3-6 days	Feather spot size small consisting of 1 body feather, 3 primaries, and 3 retrices. Evidence of curling and singeing on all feathers collected.	Scorched or singed	3/UNK	3	Powerblock	637471, 3937902	NA
2016_122_ISEGS	Tree Swallow	TRES	Carcass Survey	4/21/2016	4/21/2016	Broken up	3-6 days	Broken Up. Right Wing & Part of upper thoracic. Not evidence of collision or singe.	Unknown	NA	2	Heliostat	639502, 3936646	NA
2016_123_ISEGS	Calliope Hummingbird	CAHU	Carcass Survey	4/25/2016	4/25/2016	Dead, fresh (eyes moist)	8-24 hr	Whole carcass. Evidence of singeing on two retrices.	Scorched or singed	1	3	Heliostat	637499, 3938080	NA
2016_124_ISEGS	Costa's Hummingbird	COHU	Carcass Survey	4/25/2016	4/25/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Probable evidence of collision by placement of carcass under heliostat mirror.	Collision with solar panel/heliostat	NA	3	Heliostat	637436, 3938061	NA
2016_125_ISEGS	Blue-Gray Gnatcatcher	BGGN	Carcass Survey	4/25/2016	4/25/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of singe on dorsal plumage.	Scorched or singed	2/3	3	Powerblock	637473, 3937930	NA

2016_126_ISEGS	Violet-green Swallow	VGSW	Carcass Survey	4/25/2016	4/25/2016	Dead, fresh (eyes moist)	8-24 hours	Whole carcass. Singe on majority of dorsal, ventral, and flight feathers, and crown. Tail destroyed from singe, absent.	Scorched or singed	2/3	3	Powerblock	637451, 3937928	NA
2016_127_ISEGS	Lesser Goldfinch	LEGO	Carcass Survey	4/25/2016	4/25/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of singeing to nape, back, secondaries, primaires, and tail feathers.	Scorched or singed	2	3	ACC Building	637473, 3937982	NA
2016_128_ISEGS	Black-chinned Hummingbird	BCHU	Carcass Survey	4/25/2016	4/25/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of curling on primaries and secondaries, singeing to back, head, nape, and throat.	Scorched or singed	1/3	3	ACC Building	637485, 3937969	NA
2016_129_ISEGS	Orange-crowned Warbler	OCWA	Carcass Survey	4/25/2016	4/25/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole carcass. Evidence of singeing to all flight feathers, back, and head.	Scorched or singed	2/3	3	ACC Building	637472, 3937942	NA
2016_130_ISEGS	Costa's Hummingbird	COHU	Carcass Survey	4/25/2016	4/25/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to central retrices, singeing to right rump and lower flank and present on right tail feathers.	Scorched or singed	1/3	3	ACC Building	637483, 3937942	NA
2016_131_ISEGS	Yellow-rumped Warbler	YRWA	Carcass Survey	4/25/2016	4/25/2016	Broken up	3-6 days	Broken up carcass consisting of whole right wing. No evidence of singe or collision.	Unknown	NA	3	Powerblock	637376, 3937945	NA
2016_132_ISEGS	Costa's Hummingbird	COHU	Carcass Survey	4/25/2016	4/25/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole carcass. Evidence of singeing on right side of face and body, right side of breast, and to tips of flight feathers.	Scorched or singed	1/3	3	Powerblock	637370, 3937859	NA
2016_133_ISEGS	American Pipit	AMPI	Carcass Survey	4/26/2016	4/26/2016	Broken up	3-6 days	Broken up carcass, consisting of clumps of body feathers held together by connective tissue, 2 rectrices, 2 tertials, and 37 loose body feathers. No evidence of singe or collision.	Unknown	NA	2	Heliostat	638855, 3935864	NA
2016_134_ISEGS	Eared Grebe	EAGR	Carcass Survey	4/27/2016	4/27/2016	Broken up	3-6 days	Broken up carcass consisting of 9 tertials and 4 secondaries held together by connective tissue, 3 primaries, 6 body feathers. No evidence of singe or collision.	Unknown	NA	1	Heliostat	640611, 3933473	NA
2016_135_ISEGS	Costa's Hummingbird	COHU	Carcass Survey	4/27/2016	4/27/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 weeks	Whole carcass. Evidence of singe on right auricular, belly, and right side of rump.	Scorched or singed	2/3	1	Heliostat	640424, 3933374	NA
2016_136_ISEGS	Horned Lark	HOLA	Carcass Survey	4/27/2016	4/27/2016	Mummified	3-6 days	Whole carcass. Evidence of collision with structural damage to bill and proximity to heliostat mirror.	Collision with solar panel/heliostat	NA	1	Heliostat	640218, 3933321	NA
2016_137_ISEGS	Orange-crowned Warbler	OCWA	Carcass Survey	4/27/2016	4/27/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Possible evidence of collision with heliostat based on whole carcass and proximity to heliostat mirror.	Collision with solar panel/heliostat	NA	1	Heliostat	640369, 3933262	NA
2016_138_ISEGS	Lincoln's Sparrow	LISP	Carcass Survey	4/27/2016	4/27/2016	Broken up	3-6 days	Broken up carcass consisting of partial right wing, 25 body feathers held together by connective tissue, 8 primaries, 4 secondaries. No evidence of collision or singe.	Unknown	NA	1	Heliostat	640166, 3933496	NA
2016_139_ISEGS	Barn Swallow	BARS	Incidental	4/27/2016	4/27/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to majority of all flight feathers, singeing to crown, nape, throat, back, and rump.	Scorched or singed	2/3	3	Powerblock	637540, 3937872	NA

2016_140_ISEGS	Common Raven	CORA	Carcass Survey	4/28/2016	4/28/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole carcass. Evidence of singeing to flight feathers, back, and nape.	Scorched or singed	2/3	2	Project Structure	639666, 3936810	NA
2016_141_ISEGS	Summer Tanager	SUTA	Carcass Survey	5/2/2016	5/2/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Broken neck with fresh wound. No singe.	Collision (other)	Unk	3	Powerblock	637514, 3937964	NA
2016_142_ISEGS	Costa's Hummingbird	COHU	Carcass Survey	5/2/2016	5/2/2016	Dead, fresh (eyes moist)	8-24 hours	Whole carcass. Evidence of curling to retrices, singeing to back of crown, nape, back, and rump.	Scorched or singed	1/3	3	Heliostat	637571, 3938012	NA
2016_143_ISEGS	Orange-crowned Warbler	OCWA	Carcass Survey	5/2/2016	5/2/2016	Dead, fresh (eyes moist)	8-24 hours	Whole carcass. Primaries, secondaries, retrices curled. Most of head and upperparts singed.	Scorched or singed	2/3	3	Powerblock	637400, 3937874	NA
2016_144_ISEGS	Unknown Small Bird	UNID	Carcass Survey	5/2/2016	5/2/2016	Broken up	2 weeks	Broken up feather spot consisting of 7 flight feathers held together by dried connective tissue, 2 separate flight and body feathers . Evidence of curling to all flight feathers.	Scorched or singed	NA	3	Powerblock	637423, 3937888	NA
2016_145_ISEGS	Tree Swallow	TRES	Carcass Survey	5/2/2016	5/2/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of singeing to primaries, secondaries, retrices, and back of crown on head.	Scorched or singed	2/3	3	Powerblock	637449, 3937932	NA
2016_146_ISEGS	Calliope Hummingbird	CAHU	Carcass Survey	5/2/2016	5/2/2016	Mummified	3-6 days	Whole carcass. Evidence of curling to remaining primaries and secondaries, singeing to rear of head, nape, back, and rump with retrices being singed off.	Scorched or singed	2/3	3	Powerblock	637449, 3937931	NA
2016_147_ISEGS	Yellow-rumped Warbler	YRWA	Carcass Survey	5/2/2016	5/2/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to both wing coverts and tertials and in retrices, singeing to tips of primaries, right axillary, left lower flank, top of head, nape, back, and rump.	Scorched or singed	1/3	3	Heliostat	637271, 3937895	NA
2016_148_ISEGS	Ruby-crowned Kinglet	RCKI	Carcass Survey	5/2/2016	5/2/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. All primaries, secondaries, retrices singed to point of absence. Singe on over 80% of body.	Scorched or singed	2/3	3	Powerblock	637432, 3937877	NA
2016_149_ISEGS	Common Raven	CORA	Carcass Survey	5/2/2016	5/2/2016	Feather spot	3-6 days	Feather spot consisting of 2 primaries. Evidence of singeing on outer barbs of 1 primary.	Scorched or singed	Unk	3	Powerblock	637545, 3937986	NA
2016_150_ISEGS	Barn Swallow	BARS	Incidental	5/2/2016	5/2/2016	Alive, injured	0-8 hours	Alive bird. Later perished in office. Evidence of curling to all flight feathers, singeing to entirety of dorsal and flanks.	Scorched or singed	2/3	3	Powerblock	637456, 3937901	NA
2016_151_ISEGS	Yellow-headed Blackbird	YHBL	Carcass Survey	5/2/2016	5/2/2016	Alive, injured	0-8 hours	Alive. Disoriented and unable to maintain strong flight, however bird was healthy enough to avoid capture. Capture not possible without severely stressing the bird, so it was left in place. No singe.	Unknown	NA	2	Heliostat	639028, 3936018	NA
2016_152_ISEGS	American Avocet	AMAV	Carcass Survey	5/3/2016	5/3/2016	Dead, fresh (eyes moist)	8-24 hours	Broken up. Lower part of carcass intact includes legs, wings and lower thoracic cavity. Missing head, neck and most internal organs. Evidence	Unknown	NA	1	Heliostat	640471, 3933293	NA

									of scavenging. No evidence of singe or collision.					
2016_153_ISEGS	Lark Sparrow	LASP	Carcass Survey	5/3/2016	5/3/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Probable collision due to the location of the whole carcass found at base of heliostat intact and without external injuries	Collision with solar panel/heliostat	NA	1	Heliostat	640493, 3933454	NA
2016_154_ISEGS	Unknown Small Bird	UNID	Carcass Survey	5/3/2016	5/3/2016	Feather spot	3-6 days	Featherspot size small consisting of 7 primaries, 1 retrix, 3 secondaries, 2 body and 3 wing coverts. No evidence of singe or collision.	Unknown	NA	1	Heliostat	640556, 3933644	NA
2016_155_ISEGS	Western Tanager	WETA	Incidental	5/8/2016	5/8/2016	Alive, injured	0-8 hours	Alive bird. Evidence of curling to flight feathers in right wing and in tail.	Scorched or singed	2/3	1	Powerblock	640373, 3933480	NA
2016_156_ISEGS	Yellow Warbler	YWAR	Carcass Survey	5/10/2016	5/10/2016	Alive, injured	0-8 hours	Alive, injured bird found under heliostat. No evidence of singe. Placement under heliostat and drooping of right wing suggests collision.	Collision with solar panel/heliostat	NA	2	Heliostat	638495, 3935093	NA
2016_157_ISEGS	Wilson's Warbler	WIWA	Carcass Survey	5/10/2016	5/10/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole carcass. All retrices, back and head with severe singe. Curling of 90% of primary and secondary feathers.	Scorched or singed	2	3	ACC Building	637448, 3937956	NA
2016_158_ISEGS	Wilson's Warbler	WIWA	Carcass Survey	5/10/2016	5/10/2016	Alive, injured	0-8 hours	Alive and injured bird could not be captured. Evidence of singeing to flight feathers in both wings and in tail.	Scorched or singed	2/3	3	Powerblock	637509, 3937925	NA
2016_159_ISEGS	Black-chinned Hummingbird	BCHU	Carcass Survey	5/10/2016	5/10/2016	Dead, fresh (eyes moist)	8-24 hours	Whole carcass. Placement under heliostat indicates probable collision. No evidence of singe.	Collision with solar panel/heliostat	NA	2	Heliostat	639661, 3935490	NA
2016_160_ISEGS	Unknown Swallow	UNSW	Carcass Survey	5/10/2016	5/10/2016	Mummified	3-6 days	Whole skeleton consisting of 31 flight feathers, 30 body feathers attached and unattached to skeletal frame. Evidence of curling to all flight feathers and some body feathers.	Scorched or singed	2/3	3	Powerblock	637450, 3937936	NA
2016_161_ISEGS	Unknown Small Bird	UNID	Carcass Survey	5/10/2016	5/10/2016	Feather spot	3-6 days	Feather spot size small consisting of 28 body feathers. Evidence of singeing and curling to 24 of the feathers.	Scorched or singed	3	3	Powerblock	637440, 3937939	NA
2016_162_ISEGS	Calliope Hummingbird	CAHU	Carcass Survey	5/10/2016	5/10/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of singeing to right rump and several right retrices.	Scorched or singed	1/3	3	Powerblock	637359, 3937950	NA
2016_163_ISEGS	Orange-crowned Warbler	OCWA	Carcass Survey	5/10/2016	5/10/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole carcass. Evidence of singeing on primaries and to right nape.	Scorched or singed	1/3	1	ACC Building	640406, 3933534	NA
2016_164_ISEGS	Wilson's Warbler	WIWA	Carcass Survey	5/10/2016	5/10/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to primaries, secondaries, and retrices, singeing to nape, back, and rump.	Scorched or singed	2/3	1	Powerblock	640387, 3933471	NA
2016_165_ISEGS	Wilson's Warbler	WIWA	Carcass Survey	5/10/2016	5/10/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole carcass. Singe on crown, nape, back, coverts, retrices, remiges and underside of left wing. Majority of flight feathers curled from singe.	Scorched or singed	2/3	1	Powerblock	640391, 3933495	NA

2016_166_ISEGS	Townsend's Warbler	TOWA	Incidental	5/11/2016	5/11/2016	Alive, injured	0-8 hours	Injured bird. Evidence of curling to flight feathers in both wings and tail.	Scorched or singed	2/3	1	Powerblock	640335, 3933499	NA
2016_167_ISEGS	Orange-crowned Warbler	OCWA	Incidental	5/11/2016	5/11/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	8-24 hours	Whole bird. Evidence of curling to flight feathers, with tail singed off, singeing to body feathers.	Scorched or singed	2/3	1	Powerblock	640364, 3933483	NA
2016_168_ISEGS	Unknown Warbler	UNWA	Carcass Survey	5/11/2016	5/11/2016	Broken up	3-6 days	Broken up carcass consisting of partial tail and rump connected to one full leg. No evidence of collision or singe.	Unknown	NA	1	Powerblock	640372, 3933550	NA
2016_169_ISEGS	Townsend's Warbler	TOWA	Carcass Survey	5/11/2016	5/11/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of singeing in head, face, throat, nape, belly, rump, legs and back, both wings singed off to coverts as well as tail .	Scorched or singed	2/3	1	Powerblock	640327, 3933422	NA
2016_170_ISEGS	Orange-crowned Warbler	OCWA	Carcass Survey	5/11/2016	5/11/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole carcass. Evidence of collision by ant scavenged carcass in close proximity to heliostat.	Collision with solar panel/heliostat	NA	2	Heliostat	637782, 3935561	NA
2016_171_ISEGS	Wilson's Warbler	WIWA	Carcass Survey	5/11/2016	5/11/2016	Dead, fresh (eyes moist)	8-24 hours	Whole carcass. Evidence of collision with close proximity and abrasion to head.	Collision with solar panel/heliostat	NA	1	Heliostat	640168, 3933518	NA
2016_172_ISEGS	Wilson's Warbler	WIWA	Incidental	5/13/2016	5/13/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to rump and head, singeing to crown.	Scorched or singed	1/3	1	Powerblock	640336, 3933473	NA
2016_173_ISEGS	Lazuli Bunting	LAZB	Incidental	5/13/2016	5/13/2016	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling on all flight feathers in wings, singeing to head, face, nape, back, rump, throat, and tail.	Scorched or singed	2/3	3	Powerblock	637432, 3937939	NA
2016_174_ISEGS	Unknown Hummingbird	UNHU	Carcass Survey	5/16/2016	5/16/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of curling to all major flight feathers in wings with tail singed off, singeing to all major parts of body.	Scorched or singed	2/3	3	ACC Building	637473, 3937983	NA
2016_175_ISEGS	Lazuli Bunting	LAZB	Carcass Survey	5/16/2016	5/25/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 weeks	Whole carcass. No evidence of singe or collision.	Unknown	Unk	3	ACC Building	637505, 3937960	NA
2016_176_ISEGS	Northern Mockingbird	NOMO	Carcass Survey	5/16/2016	5/16/2016	Broken up	2 days	Broken up carcass consisting of partial right and left wing, clumps of body feathers attached by skin, 100 body feathers and 1 rectrice. No evidence of singe or collision.	Unknown	NA	3	Heliostat	637315, 3937770	NA
2016_177_ISEGS	Unknown Warbler	UNWA	Carcass Survey	5/16/2016	5/16/2016	Broken up	3-6 days	Broken up carcass consisting of partial left wing, 8 body feathers, 14 secondaries, 1 primary, 1 rect. Singeing present on all flight feathers.	Scorched or singed	Unk	3	Heliostat	637315, 3937720	NA
2016_178_ISEGS	Wilson's Warbler	WIWA	Carcass Survey	5/16/2016	5/16/2016	Dead, fresh (eyes moist)	8-24 hours	Whole carcass. No evidence of singe or collision.	Unknown	Unk	3	ACC Building	637447, 3937952	NA
2016_179_ISEGS	Mourning Dove	MODO	Carcass Survey	5/16/2016	5/16/2016	Feather spot	2 days	Feather spot size large consisting of 7 retricies, 8 primaries, 3 secondaries, and 40 body feathers. No evidence of singe or collision.	Unknown	Unk	3	Heliostat	637264, 3937871	NA
2016_180_ISEGS	Eared Grebe	EAGR	Incidental	5/16/2016	5/16/2016	Broken up	0-8 hours	Broken up carcass consisting of head and part of neck. No evidence of singe or collision.	Unknown	Unk	2	Powerblock	638685, 3935774	NA

2016_181_ISEGS	Wilson's Warbler	WIWA	Carcass Survey	5/16/2016	5/16/2016	Dead, fresh (eyes moist)	8-24 hours	Whole carcass. Evidence of singeing on head, face, nape, back, rump, tail, both wings, and flanks.	Scorched or singed	2/3	1	ACC Building	640383, 3933530	NA
2016_182_ISEGS	Wilson's Warbler	WIWA	Carcass Survey	5/16/2016	5/16/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole carcass. Evidence of curling to retrices, singeing to flight feathers in wings, and top of head.	Scorched or singed	NA	1	ACC Building	640372, 3933519	NA
2016_183_ISEGS	Mourning Dove	MODO	Carcass Survey	5/17/2016	5/17/2016	Broken up	3-6 days	Feather spot size = large. 13 primaries, 4 seconds, mixed body and covert feathers. Wing contains bits of attached flesh. No singe.	Unknown	NA	2	Heliostat	638904, 3935823	NA
2016_184_ISEGS	Orange-crowned Warbler	OCWA	Carcass Survey	5/17/2016	5/17/2016	Feather spot	0-8 hours	Feather spot size = small. 15 mixed flight feathers (including 6 primary, 3 tail) and 2 uppertail coverts. No singe.	Unknown	NA	1	Powerblock	640400, 3933493	NA
2016_185_ISEGS	Savannah Sparrow	SAVS	Carcass Survey	5/17/2016	5/17/2016	Broken up	2 weeks	Feathers spot size = large. 12 retrices, 4 secondaries, 7 body feathers with attached flesh. No singe.	Unknown	NA	2	Heliostat	638879, 3935825	NA
2016_186_ISEGS	Unknown Sparrow	UNSP	Incidental	5/18/2016	5/18/2016	Mummified	1 month +	Whole carcass. Evidence of singeing to all major body parts including all major flight feathers singed off.	Scorched or singed	2/3	2	Powerblock	637407, 3937907	NA
2016_187_ISEGS	Wilson's Warbler	WIWA	Incidental	5/18/2016	5/18/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole carcass. Left in place due to placement on beam of solar concentrating tower.	Unknown	NA	2	Powerblock	637426, 3937906	NA
2016_188_ISEGS	Black-chinned Hummingbird	BCHU	Carcass Survey	5/21/2016	5/21/2016	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole Carcass. Left wing broken at scapular, right wing with 1 broken primary. No singe.	Collision with solar panel/heliostat	NA	2	Heliostat	638478, 3936443	NA

Appendix B. Additional Detection Data for Fatality Estimates and Documentation of Fatality Estimates in Which Each Detection Was Included.

USFWS #	Species Code	Location	Distance from Tower (m)	Bird Size	Model Size	Cause of Death	How Found	Time Since Last Survey (days)	Used in Estimator	Tower Area	Power Block	Inner HD	Heliostat Area	Unit Fence	Collector Line	Estimator Notes
2016_057_ISEGS	VGSW	Inner HD	245	Small	Small Carcass	singed	Fatality Search	7	Yes	X		X				
2016_058_ISEGS	UNID	Inner HD	219	Small	Feather Spot	unknown	Fatality Search	7	Yes	X		X				
2016_059_ISEGS	NSWO	Outer Segment	950	Small	Feather Spot	unknown	Fatality Search	5	Yes				X			
2016_060_ISEGS	VGSW	Power Block	65	Small	Small Carcass	singed	Fatality Search	8	Yes	X	X					
2016_061_ISEGS	RUHU	Power Block	30	Small	Small Carcass	singed	Fatality Search	6	Yes	X	X					
2016_062_ISEGS	AMCO	Outer Segment	1075	Large	Feather Spot	singed	Fatality Search	9	Yes				X			
2016_063_ISEGS	DEJU	Power Block	55	Small	Feather Spot	singed	Fatality Search	6	Yes	X	X					
2016_064_ISEGS	UNWA	Power Block	23	Small	Feather Spot	singed	Fatality Search	6	Yes	X	X					
2016_065_ISEGS	UNID	Power Block	33	Small	Feather Spot	singed	Fatality Search	6	No	X	X					Older than Search Interval
2016_066_ISEGS	LISP	Inner HD	197	Small	Small Carcass	collision	Fatality Search	5	Yes	X		X				
2016_067_ISEGS	UNID	Power Block	42	Small	Feather Spot	unknown	Fatality Search	5	Yes	X	X					
2016_068_ISEGS	WCSP	Power Block	36	Small	Feather Spot	unknown	Fatality Search	6	Yes	X	X					
2016_069_ISEGS	BTSP	Outer Segment	941	Small	Feather Spot	unknown	Fatality Search	7	Yes				X			
2016_070_ISEGS	UNID	Inner HD	236	Small	Feather Spot	unknown	Fatality Search	7	Yes	X		X				
2016_071_ISEGS	WEME	Inner HD	231	Small	Feather Spot	unknown	Fatality Search	7	Yes	X		X				
2016_072_ISEGS	COHU	Inner HD	184	Small	Small Carcass	singed	Fatality Search	7	Yes	X		X				
2016_073_ISEGS	TRES	Power Block	80	Small	Feather Spot	singed	Fatality Search	6	Yes	X	X					
2016_074_ISEGS	COHU	Inner HD	162	Small	Small Carcass	singed	Fatality Search	7	Yes	X		X				
2016_075_ISEGS	HOFI	Power Block	5	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X					

2016_076_ISEGS	SPTO	Inner Segment	660	Small	Feather Spot	unknown	Fatality Search	8	Yes					X			
2016_077_ISEGS	CRTH	Inner Segment	582	Small	Feather Spot	unknown	Fatality Search	8	No					X			Older than Search Interval
2016_078_ISEGS	WCSP	Inner Segment	462	Small	Feather Spot	collision	Fatality Search	7	Yes					X			
2016_079_ISEGS	WIWA	Outside Search - TOWER, TURBINE DECK	0	Small	Small Carcass	singed	Incidental	NA	No								Outside Standard Search Area
2016_080_ISEGS	HETH	Power Block	52	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X						
2016_081_ISEGS	YRWA	Power Block	38	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X						
2016_082_ISEGS	EAGR	Outside Search - DRAINAGE WASH	1202	Large	Large Carcass	collision	Incidental	NA	No								Outside Standard Search Area
2016_083_ISEGS	HOLA	Inner HD	229	Small	Feather Spot	unknown	Fatality Search	8	Yes	X		X					
2016_084_ISEGS	UNID	Outer Segment	819	Small	Feather Spot	collision	Fatality Search	7	Yes					X			
2016_085_ISEGS	UNGR	Inner HD	198	Large	Feather Spot	unknown	Fatality Search	7	Yes	X		X					
2016_086_ISEGS	UNGR	Inner HD	221	Large	Feather Spot	unknown	Fatality Search	7	Yes	X		X					
2016_087_ISEGS	COHU	Outer Segment	931	Small	Small Carcass	collision	Fatality Search	7	Yes					X			
2016_088_ISEGS	COHU	Outer Segment	946	Small	Small Carcass	collision	Fatality Search	7	Yes					X			
2016_089_ISEGS	TRES	Inner HD	122	Small	Small Carcass	singed	Fatality Search	7	Yes	X		X					
2016_090_ISEGS	RCKI	Power Block	23	Small	Small Carcass	singed	Fatality Search	9	Yes	X	X						
2016_091_ISEGS	RCKI	ACC	37	Small	Small Carcass	singed	Fatality Search	9	Yes	X	X						
2016_092_ISEGS	UNHU	Inner HD	148	Small	Small Carcass	singed	Incidental	8	Yes	X		X					
2016_093_ISEGS	COHU	Inner Segment	404	Small	Small Carcass	collision	Fatality Search	7	Yes					X			
2016_094_ISEGS	WCSP	Power Block	45	Small	Small Carcass	unknown	Fatality Search	9	Yes	X	X						
2016_095_ISEGS	UNHU	Power Block	20	Small	Small Carcass	singed	Fatality Search	9	Yes	X	X						

2016_096_ISEGS	YRWA	Power Block	31	Small	Small Carcass	singed	Fatality Search	9	Yes	X	X					
2016_097_ISEGS	MODO	Outer Segment	640	Large	Large Carcass	collision	Incidental	NA	No				X			Older than Search Interval
2016_098_ISEGS	TRES	Inner HD	242	Small	Feather Spot	singed	Fatality Search	6	Yes	X		X				
2016_099_ISEGS	AMPI	Inner HD	238	Small	Small Carcass	collision	Fatality Search	6	Yes	X		X				
2016_100_ISEGS	LISP	Outer Segment	1107	Small	Small Carcass	collision	Fatality Search	7	Yes				X			
2016_101_ISEGS	AMPI	Inner HD	135	Small	Small Carcass	collision	Fatality Search	6	Yes	X		X				
2016_102_ISEGS	BARS	Inner HD	155	Small	Small Carcass	singed	Fatality Search	6	Yes	X		X				
2016_103_ISEGS	UNSP	Outer Segment	1320	Small	Feather Spot	unknown	Incidental	NA	No				X			Older than Search Interval
2016_104_ISEGS	BARS	Inner HD	212	Small	Small Carcass	singed	Fatality Search	6	Yes	X		X				
2016_105_ISEGS	HOFI	Power Block	79	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X					
2016_106_ISEGS	RUHU	Power Block	39	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X					
2016_107_ISEGS	BLPH	Power Block	87	Small	Small Carcass	unknown	Fatality Search	7	Yes	X	X					
2016_108_ISEGS	AMPI	Inner HD	243	Small	Small Carcass	collision	Fatality Search	6	Yes	X		X				
2016_109_ISEGS	YRWA	Power Block	56	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X					
2016_110_ISEGS	UNHU	Power Block	25	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X					
2016_111_ISEGS	VGSW	Power Block	94	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X					
2016_112_ISEGS	LUWA	Power Block	80	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X					
2016_113_ISEGS	COHU	Power Block	42	Small	Small Carcass	singed	Fatality Search	7	No	X	X					Older than Search Interval
2016_114_ISEGS	YRWA	ACC	42	Small	Small Carcass	singed	Fatality Search	6	Yes	X	X					
2016_115_ISEGS	NRWS	Power Block	25	Small	Small Carcass	singed	Fatality Search	6	Yes	X	X					
2016_116_ISEGS	SAVS	Inner HD	190	Small	Small Carcass	collision	Fatality Search	7	Yes	X		X				
2016_117_ISEGS	UNID	Power Block	21	Small	Feather Spot	unknown	Fatality Search	6	Yes	X	X					

2016_118_ISEGS	LENI	Power Block	73	Small	Small Carcass	unknown	Incidental	1(1)	Yes	X	X						
2016_119_ISEGS	UNKL	Power Block	84	Small	Feather Spot	singed	Incidental	1(1)	No	X	X						Older than Search Interval
2016_120_ISEGS	YRWA	Power Block	5	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X						
2016_121_ISEGS	YRWA	Power Block	6	Small	Feather Spot	singed	Incidental	1(1)	No	X	X						Older than Search Interval
2016_122_ISEGS	TRES	Outer Segment	1165	Small	Small Carcass	unknown	Fatality Search	7	Yes				X				
2016_123_ISEGS	CAHU	Inner HD	181	Small	Small Carcass	singed	Fatality Search	7	Yes	X			X				
2016_124_ISEGS	COHU	Inner HD	160	Small	Small Carcass	collision	Fatality Search	7	Yes	X			X				
2016_125_ISEGS	BGGN	Power Block	21	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X						
2016_126_ISEGS	VGSW	Power Block	28	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X						
2016_127_ISEGS	LEGO	ACC	75	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X						
2016_128_ISEGS	BCHU	ACC	63	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X						
2016_129_ISEGS	OCWA	ACC	35	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X						
2016_130_ISEGS	COHU	ACC	35	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X						
2016_131_ISEGS	YRWA	Power Block	102	Small	Feather Spot	unknown	Fatality Search	7	Yes	X	X						
2016_132_ISEGS	COHU	Power Block	112	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X						
2016_133_ISEGS	AMPI	Inner HD	196	Small	Feather Spot	unknown	Fatality Search	7	Yes	X			X				
2016_134_ISEGS	EAGR	Inner HD	239	Large	Feather Spot	unknown	Fatality Search	7	Yes	X			X				
2016_135_ISEGS	COHU	Inner HD	121	Small	Small Carcass	singed	Fatality Search	7	No	X			X				Older than Search Interval
2016_136_ISEGS	HOLA	Inner HD	224	Small	Small Carcass	collision	Fatality Search	7	Yes	X			X				
2016_137_ISEGS	OCWA	Inner HD	221	Small	Small Carcass	collision	Fatality Search	7	Yes	X			X				
2016_138_ISEGS	LISP	Inner HD	206	Small	Feather Spot	unknown	Fatality Search	7	Yes	X			X				
2016_139_ISEGS	BARS	Power Block	78	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X						

2016_140_ISEGS	CORA	Outer Segment	1434	Large	Large Carcass	singed	Fatality Search	7	Yes					X			
2016_141_ISEGS	SUTA	Power Block	75	Small	Small Carcass	collision	Fatality Search	7	Yes	X	X						
2016_142_ISEGS	COHU	Inner HD	144	Small	Small Carcass	singed	Fatality Search	7	Yes	X		X					
2016_143_ISEGS	OCWA	Power Block	79	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X						
2016_144_ISEGS	UNID	Power Block	51	Small	Feather Spot	singed	Fatality Search	7	No	X	X						Older than Search Interval
2016_145_ISEGS	TRES	Power Block	32	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X						
2016_146_ISEGS	CAHU	Power Block	31	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X						
2016_147_ISEGS	YRWA	Inner HD	200	Small	Small Carcass	singed	Fatality Search	7	Yes	X		X					
2016_148_ISEGS	RCKI	Power Block	49	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X						
2016_149_ISEGS	CORA	Power Block	107	Large	Feather Spot	singed	Fatality Search	7	Yes	X	X						
2016_150_ISEGS	BARS	Power Block	15	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X						
2016_151_ISEGS	YHBL	Inner Segment	246	Small	Small Carcass	unknown	Fatality Search	6	Yes				X				
2016_152_ISEGS	AMAV	Inner HD	219	Large	Large Carcass	unknown	Fatality Search	6	Yes	X		X					
2016_153_ISEGS	LASP	Inner HD	121	Small	Small Carcass	collision	Fatality Search	6	Yes	X		X					
2016_154_ISEGS	UNID	Inner HD	248	Small	Feather Spot	unknown	Fatality Search	6	Yes	X		X					
2016_155_ISEGS	WETA	Power Block	5	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X						
2016_156_ISEGS	YWAR	Outer Segment	757	Small	Small Carcass	collision	Fatality Search	6	Yes				X				
2016_157_ISEGS	WIWA	ACC	53	Small	Small Carcass	singed	Fatality Search	8	Yes	X	X						
2016_158_ISEGS	WIWA	Power Block	43	Small	Small Carcass	singed	Fatality Search	8	Yes	X	X						
2016_159_ISEGS	BCHU	Outer Segment	1061	Small	Small Carcass	collision	Fatality Search	6	Yes				X				
2016_160_ISEGS	UNSW	Power Block	35	Small	Small Carcass	singed	Fatality Search	8	Yes	X	X						
2016_161_ISEGS	UNID	Power Block	45	Small	Feather Spot	singed	Fatality Search	8	Yes	X	X						

2016_162_ISEGS	CAHU	Power Block	119	Small	Small Carcass	singed	Fatality Search	8	Yes	X	X					
2016_163_ISEGS	OCWA	ACC	56	Small	Small Carcass	singed	Fatality Search	8	Yes	X	X					
2016_164_ISEGS	WIWA	Power Block	20	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X					
2016_165_ISEGS	WIWA	Power Block	19	Small	Small Carcass	singed	Incidental	1(1)	No	X	X					Older than Search Interval
2016_166_ISEGS	TOWA	Power Block	28	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X					
2016_167_ISEGS	OCWA	Power Block	0	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X					
2016_168_ISEGS	UNWA	Power Block	60	Small	Small Carcass	unknown	Fatality Search	9	Yes	X	X					
2016_169_ISEGS	TOWA	Power Block	69	Small	Small Carcass	singed	Fatality Search	9	Yes	X	X					
2016_170_ISEGS	OCWA	Outer Segment	921	Small	Small Carcass	collision	Fatality Search	7	Yes				X			
2016_171_ISEGS	WIWA	Inner HD	200	Small	Small Carcass	collision	Fatality Search	8	Yes	X			X			
2016_172_ISEGS	WIWA	Power Block	40	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X					
2016_173_ISEGS	LAZB	Power Block	50	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X					
2016_174_ISEGS	UNHU	ACC	75	Small	Small Carcass	singed	Fatality Search	14	Yes	X	X					
2016_175_ISEGS	LAZB	ACC	62	Small	Small Carcass	other (entrapment)	Fatality Search	14	Yes	X	X					
2016_176_ISEGS	NOMO	Inner HD	208	Small	Feather Spot	unknown	Fatality Search	7	Yes	X			X			
2016_177_ISEGS	UNWA	Inner HD	208	Small	Feather Spot	singed	Fatality Search	7	Yes	X			X			
2016_178_ISEGS	WIWA	ACC	50	Small	Small Carcass	other (entrapment)	Fatality Search	14	Yes	X	X					
2016_179_ISEGS	MODO	Inner HD	211	Large	Feather Spot	unknown	Fatality Search	7	Yes	X			X			
2016_180_ISEGS	EAGR	Power Block	74	Large	Large Carcass	unknown	Incidental	1(1)	Yes	X	X					
2016_181_ISEGS	WIWA	ACC	45	Small	Small Carcass	singed	Fatality Search	5	Yes	X	X					
2016_182_ISEGS	WIWA	ACC	32	Small	Small Carcass	singed	Fatality Search	5	Yes	X	X					
2016_183_ISEGS	MODO	Inner HD	246	Large	Feather Spot	unknown	Fatality Search	7	Yes	X			X			

2016_184_ISEGS	OCWA	Power Block	28	Small	Feather Spot	unknown	Fatality Search	6	Yes	X	X					
2016_185_ISEGS	SAVS	Inner HD	220	Small	Feather Spot	unknown	Fatality Search	7	No	X		X				Older than Search Interval
2016_186_ISEGS	UNSP	Power Block	0	Small	Small Carcass	singed	Incidental	1(1)	No	X	X					Older than Search Interval
2016_187_ISEGS	WIWA	Power Block	0	Small	Small Carcass	unknown	Incidental	1(1)	No	X	X					Older than Search Interval
2016_188_ISEGS	BCHU	Inner Segment	621	Small	Small Carcass	collision	Fatality Search	10	Yes				X			