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IVANPAH SOLAR ELECTRIC GENERATING SYSTEM
AVIAN & BAT MONITORING PLAN

2017 Summer Report

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Executive Summary

Avian and bat monitoring surveys were conducted from 26 May 2017 – 17 August 2017 (the summer 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 potential collision effects with facility structures (towers and heliostats) are evaluated by systematic sampling of 100% of the tower areas (154 acres). The "tower area" consists of the power block and inner high-density (HD) heliostats surrounding each power block on approximately 154 acres. Searches were conducted within the summer season at intervals of approximately 21 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 May 2017 – 17 August 2017, 1 bat detection and 82 avian detections (which included 1 injured bird) were found. Of the 82 avian detections, 78 were discovered in the tower area, and 4 were discovered outside of the tower area.

Per the specifications of the revised Plan, avian detections were 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 tower area.

Using the fatality estimator model, during the period 26 May 2017 – 17 August 2017, there were an estimated 253 fatalities (63%) from known causes and 146 fatalities (37%) from unknown causes in the tower area. Overall, based on the monitoring results and estimates for known causes for the summer season, the effect of the Project in the tower area on birds does 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 (Plan) was prepared by the Project proponent in collaboration with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), California Energy Commission (CEC), and Bureau of Land Management (BLM) to guide comprehensive monitoring of impacts to birds and bats associated with the operation of the Project. Revision 12 of the Plan (2013) was accepted by the agencies in November 2013 and required two years of monitoring, which were completed at the end of October 20, 2015. As part of the Plan, a Technical Advisory Committee (TAC) with representative from the agencies and the project was formed to guide implementation of the Plan. The TAC determined that 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 (i.e., heliostat areas for Units 1 and 3, the Unit 3 collector line, offsite control transects, and fenceline monitoring were removed from the monitoring for the third year) as informed by the first two years of intensive monitoring. Upon reviewing the third year of monitoring, it was determined that surveys in the heliostat area for Unit 2 met the Plan objectives and will be removed after the second quarter (spring) of the fourth year, leaving fatality monitoring in the tower areas for the final two quarters of year four. Thus, the Unit 2 heliostat area was not monitored during the 2017 summer season and will not be monitored in the 2017 fall season.

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 less than 5 detections a season. Additionally, the patterns associated with avian use have been consistent over the seasons and documented in the annual reports. Therefore, as revised, the Plan has the following objectives:

1. Estimate collision-related avian mortality and injury with the following facility structures (Figure 1), using empirical data to calculate facility-wide mortality and injury rates:

   a. Power towers
   b. Heliostats (not required following Spring 2017 survey)

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.

As approved by the TAC, 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 third "quarterly" (i.e., seasonal) report for the fourth year of monitoring (or, the fifteenth quarterly report) summarizing monitoring methods and results for avian and bat fatalities and injuries based on the procedures and requirements specified in the Plan and as required by CEC Condition of Certification BIO-21. This report covers the 2017 summer season, which includes the period from 26 May 2017 – 17 August 2017.

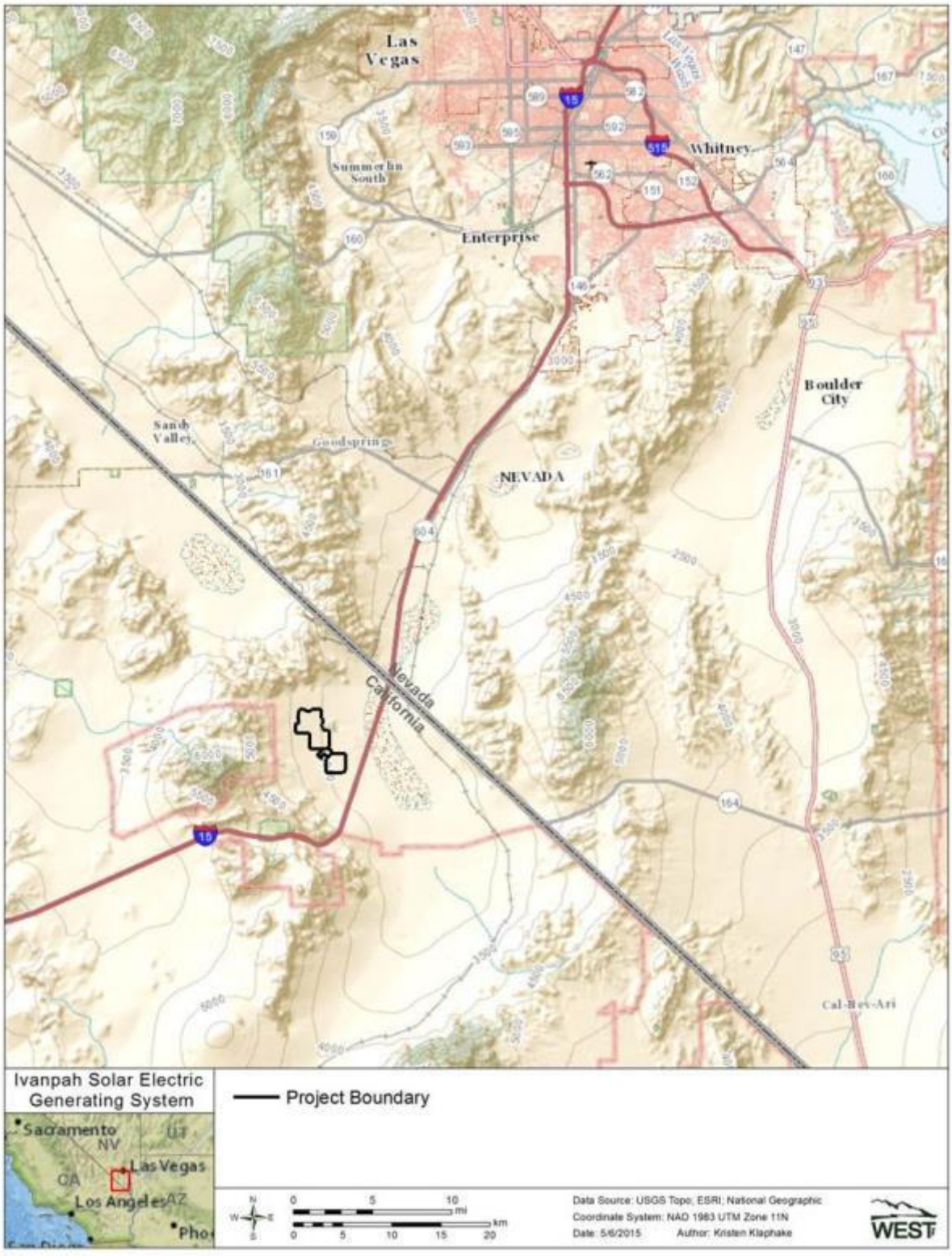

Figure 1. Ivanpah Vicinity Map.

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.

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" of all three units. 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. In year 3, 100% of the tower area at each unit was surveyed and Table 1a provides the acreage searched within the tower area, as well as the percent of the facility represented by the tower area. Overall, approximately 4.8% of the Project was searched (Figure 2).

Table 1a. Monitoring Areas.

Area	Facility Locations Included	Acreage Searched	Percent of Facility
Tower Area	ACC, Power Block, Inner HD	154	4.80%
Total		154	4.80%

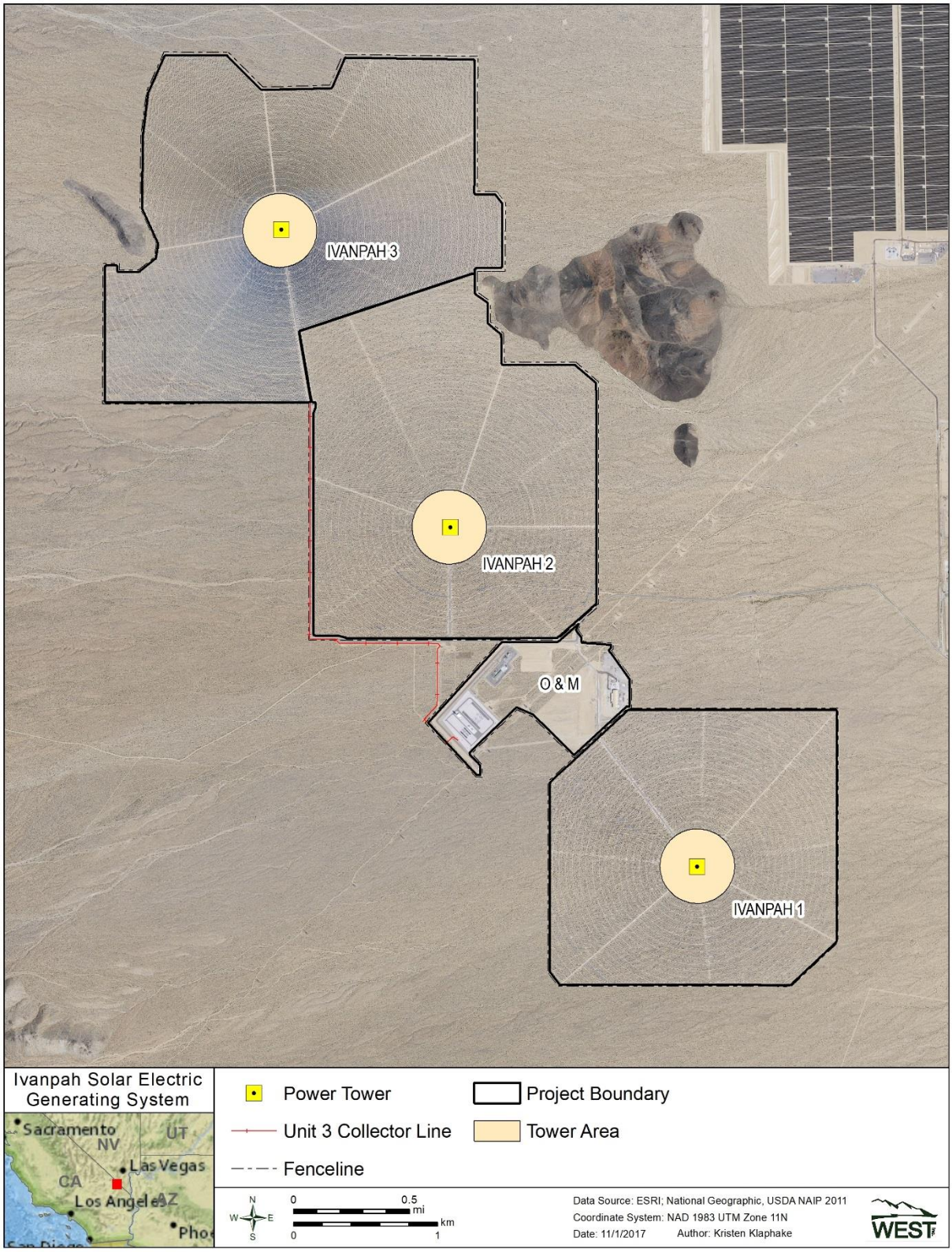

Figure 2. Ivanpah Search Areas.

2.1.1.2 Search Frequency and Timing

Consistent with the first three years of monitoring, standardized searches occurred at each unit on a nominal 21-day interval through the 2017 summer 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 interval between seasons of differing length, as well as the transition to Revision 13 of the Plan (2015), after November 15, 2015. The tower area of Units 1, 2 and 3 were visited a total of four times.

2.1.1.3 Search Methods

Biologists performed surveys in the tower 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). 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.

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-m^2 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 2017 summer monitoring season. A total of 10 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 – 2014 winter monitoring season. Non-native house sparrows (*Passer domesticus*) were used for small carcass trials conducted during the 2017

summer 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 34 searcher efficiency trials (14 small birds, 9 large birds, and 11 feather spots) were conducted during the 2017 summer monitoring season. Trials were placed in the tower areas of all three units; 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 (a biologist responsible for implementing the conditions of certification) 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 see 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.

Of the 34 trial carcasses placed, 26 (8 small carcasses, 7 large carcasses, and 11 feather spots) were available to be found; 8 carcasses (6 small carcasses and 2 large carcass) were removed (scavenged) from the trial location before searchers had an opportunity to find them.

2.1.4 Incidental Reporting

Some detections were discovered 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, Unit 2, 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). 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. For these reasons, it is generally inappropriate to draw conclusions based on the raw number of fatalities alone. The desire to estimate fatalities given these variables has driven the development of several statistical methods for estimating fatalities (e.g., Smallwood 2007, Huso 2010, Korner-Nievergelt 2011). All of these fatality estimation methods share a similar underlying model. Generally, the fatality estimation for a given site may be written as:

$$F=C/rp,$$

where F is the total number of fatalities, C is the number fatalities detected and included in fatality estimation, r is the probability a carcass is unscavenged and available to be found at the end of the search interval, and p is the probability of detecting a carcass (Huso 2010).

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 intervals 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 a range of estimates of r for each carcass.

Estimation and Model Selection for Searcher Efficiency. Searcher efficiency, or the proportion of carcasses detected, *p*, is represented most simply by the following equation:

$$p = \frac{Number\ of\ Trial\ Carcass\ Observed}{Number\ of\ Trial\ Carcasses\ Available}.$$

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 seasons. 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 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 2017 summer season.

Detection Bias Modeling Factors with Historical Data

Consistent with all previous seasonal and annual reports, detection bias modeling was performed using all trial data collected to date in *any* Project area. Using all historical data provides a larger, more robust data set resulting in more precise estimates of avian mortality. Although monitoring was not conducted in the heliostat area during the 2017 summer season, Project area was included as a potential covariate in the model selection process for searcher efficiency and carcass persistence bias. Project area was a potential covariate in models to allow for inclusion (i.e. searcher efficiency and/or carcass persistence differs between vegetated and unvegetated areas) or exclusion of Project area from the chosen models.

The Project area was previously defined using two categories to reflect the suspected, potential differences in searcher efficiency and/or carcass persistence 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; see the Plan (2015), and previous seasonal and annual reports for additional details.

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. 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 power block. All detections within the ACC buildings are considered facility related, whether or not they showed evidence of singeing or collision.

Within the power block, during the 2017 summer season, incidental detections accounted 39.4% 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, consistent with all previous seasonal and annual reports (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 and 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 older than the search interval. Each detection made during the 2017 summer 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. As monitoring has identified patterns of detections, additional measures have been identified, tested and if effective are ultimately deployed as part of the adaptive management program.

Based on the location of greater roadrunner detections along the fenceline, an adaptive management measure was developed in 2016 to allow roadrunners to escape through the unit fence. Hawks were observed to pursue and entrap roadrunners along the fence and depredate them. The measure deployed consisted of installing egress routes through the fence with an elevated platform. The elevated platform allows the egress route to be installed without impacting the desert tortoise fencing. The shade cloth was installed to increase visibility of the egress route. The measure was initially tested at Unit 1 and monitored with a game camera. Evidence of roadrunners use was captured on camera, and this measure is now considered a best management practice and additional egress routes will be installed along fences for the remaining units during 2017.

Several other deterrence measures have been tested and, if effective, implemented for birds at Ivanpah. Specifically, new ground-level LED lighting and spikes were installed at Unit 1 on 5 February 2015. As approved by the TAC, after initial testing, a chemosensory deterrence measure commercially known as BirdBuffer, was deployed on 12 October 2014 at Unit 1, 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.

Enhancements to BirdBuffer were designed in fall 2016 and implemented in early March of 2017. Enhancements included replacing the single output device at each Unit tower with two double output devices at each Unit tower. Enhancements to BirdGard were designed in fall 2016 and implemented in February of 2017. The enhancements included upgrading each speaker device containing 20 speakers to a new speaker device which combines 3 separate speaker towers containing 21 speakers. Each speaker tower has 7 hyper-directional speakers, for a total of 21 directional speakers targeted towards a specific path. The four independent three-speaker-devices will remain positioned on the north, east, south, and west side of each tower area.

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 tested and 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. In November 2015, an ultrasonic testing protocol was implemented to ensure proper function of all deterrence units.

Section 3.0 Monitoring Results

3.1 Summary of Avian Detections

The average search interval in the tower area was 18.5 days (range 7 to 27, median 21.0 days) during the 2017 summer 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 seasons of differing length.

During the 2017 summer season, a total of 82 avian detections (including injured birds and incidentals) of 29 identified species (Table 2) were recorded. Approximately 55% of species detected were songbirds, with 42% being other types of bird; 3% could not be identified to an appropriate level. The most numerous detection of an identified species was black-throated sparrow followed by tree swallow. Most detections occurred in the tower area (Figures 3, 4, 5, and 6), where approximately 154 acres were surveyed, representing 100% of the total tower area.

Table 2. Number of Individual Bird Detections, by Species, 2017 Summer Season.

Species	Scientific Name	Injuries	Fatalities	Songbird?
unidentified swallow	*unidentified*	0	9	Yes
black-throated sparrow	*Amphispiza bilineata*	0	8	Yes
unidentified bird (small)	*unidentified*	0	8	NA
tree swallow	*Tachycineta bicolor*	0	7	Yes
northern mockingbird	*Mimus polyglottos*	0	6	Yes
cliff swallow	*Petrochelidon pyrrhonota*	0	5	Yes
verdin	*Auriparus flaviceps*	0	4	Yes
yellow warbler	*Setophaga petechia*	0	4	Yes
northern rough-winged swallow	*Stelgidopteryx serripennis*	0	4	Yes
lesser nighthawk	*Chordeiles acutipennis*	0	3	No
mourning dove	*Zenaida macroura*	0	2	No
Bullock's oriole	*Icterus bullockii*	0	2	Yes
western tanager	*Piranga ludoviciana*	0	2	Yes
black-tailed gnatcatcher	*Polioptila melanura*	0	2	Yes
Costa's hummingbird	*Calypte costae*	0	2	No
greater roadrunner	*Geococcyx californianus*	0	1	No
unidentified grebe	*unidentified*	0	1	No
Wilson's warbler	*Cardellina pusilla*	0	1	Yes
house finch	*Haemorhous mexicanus*	0	1	Yes
lazuli bunting	*Passerina amoena*	0	1	Yes
violet-green swallow	*Tachycineta thalassina*	0	1	Yes
unidentified warbler	*unidentified*	0	1	Yes
American kestrel	*Falco sparverius*	0	1	No
Anna's hummingbird	*Calypte anna*	0	1	No
calliope hummingbird	*Selasphorus calliope*	0	1	No

Species	Scientific Name	Injuries	Fatalities	Songbird?
rufous hummingbird	*Selasphorus rufus*	0	1	No
unidentified hummingbird	*unidentified*	0	1	No
blue-winged teal	*Anas discors*	0	1	No
red-tailed hawk	*Buteo jamaicensis*	1	0	No
Total		1	81	NA*

*NA – Not Applicable

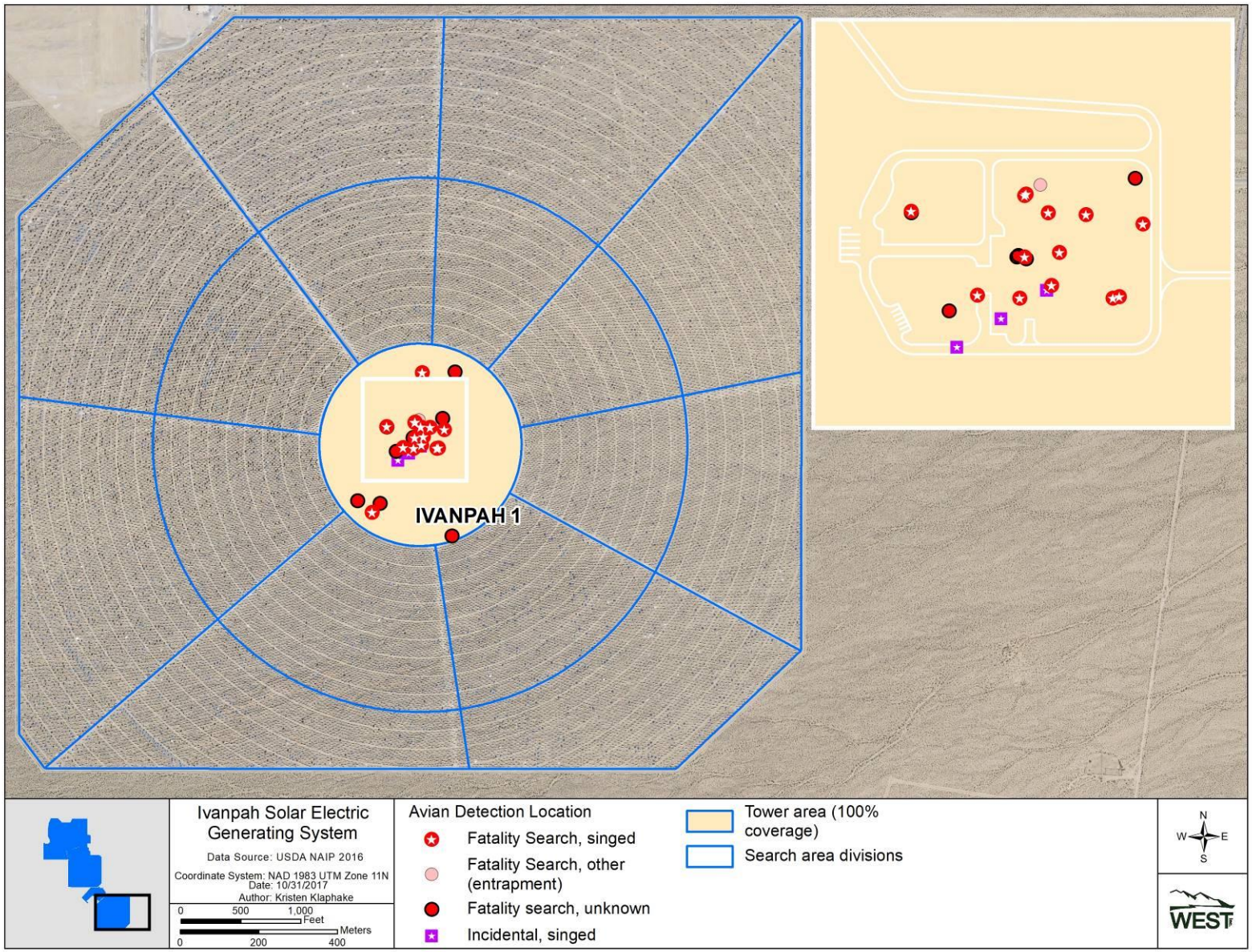

Figure 3. Ivanpah 1 Detections.

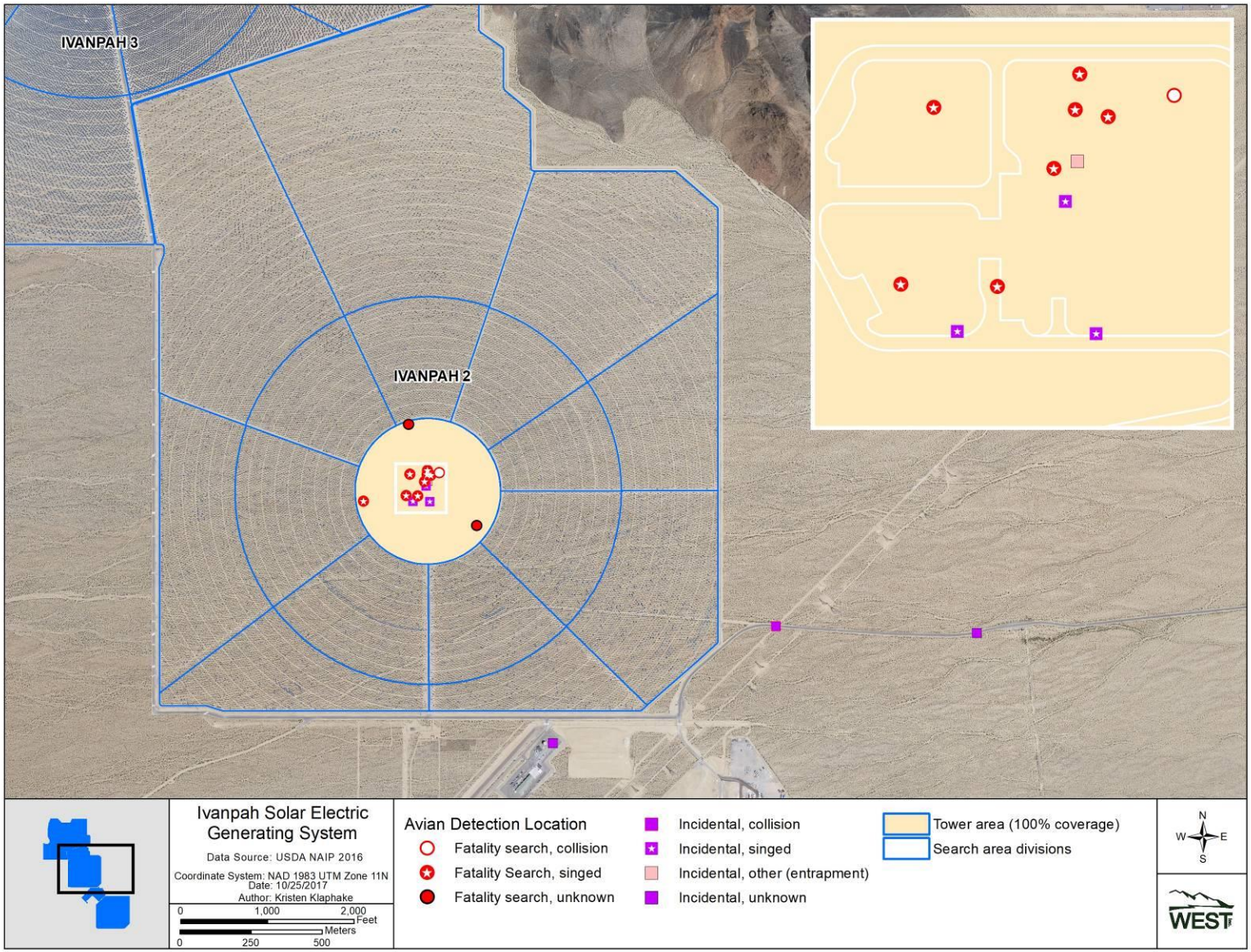

Figure 4. Ivanpah 2 Detections.

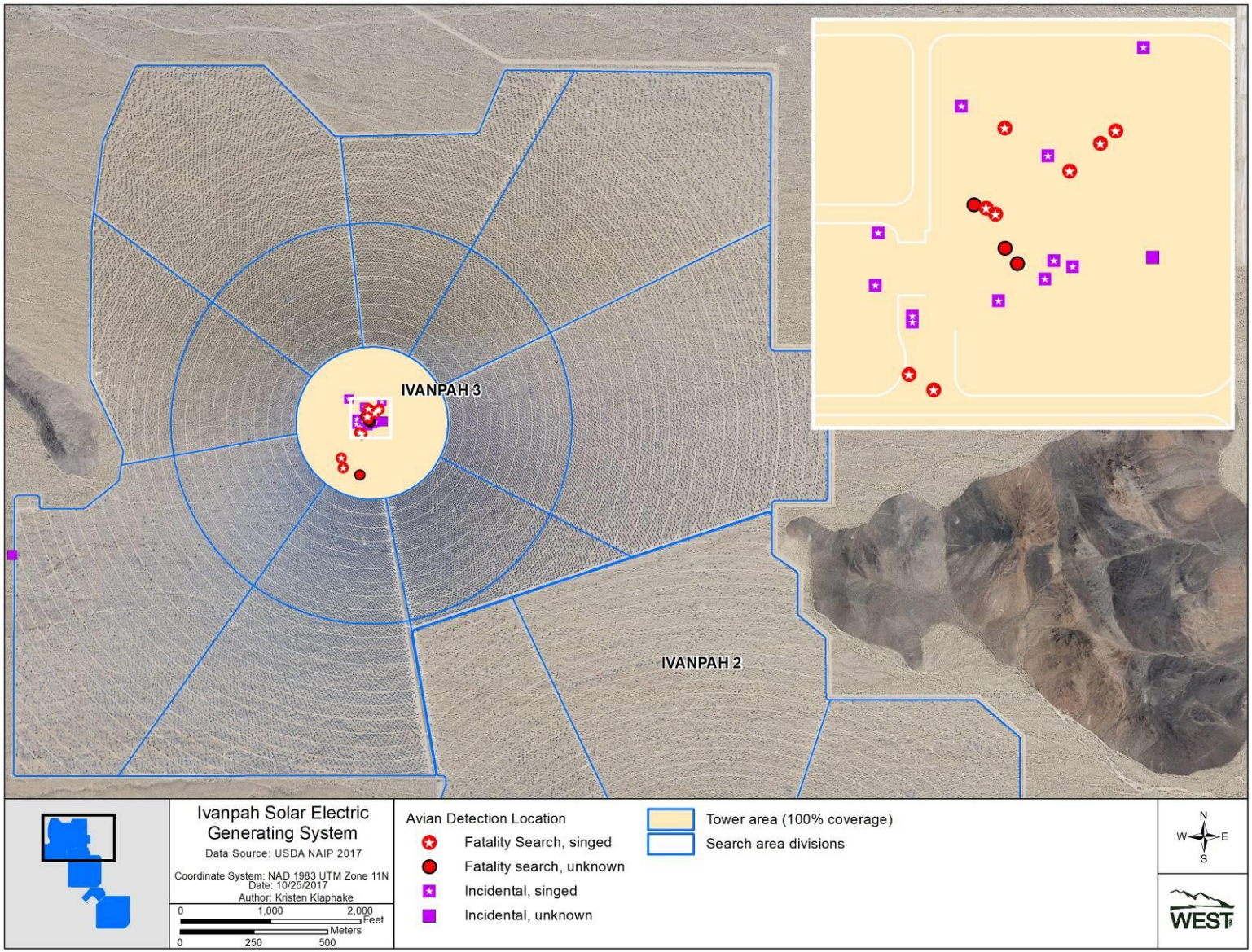

Figure 5. Ivanpah 3 Detections.

3.1.1 Temporal Patterns of Avian Detections

The number of detections reported per day was low throughout the 2017 summer season with the largest peak on July 31 (Figure 6).

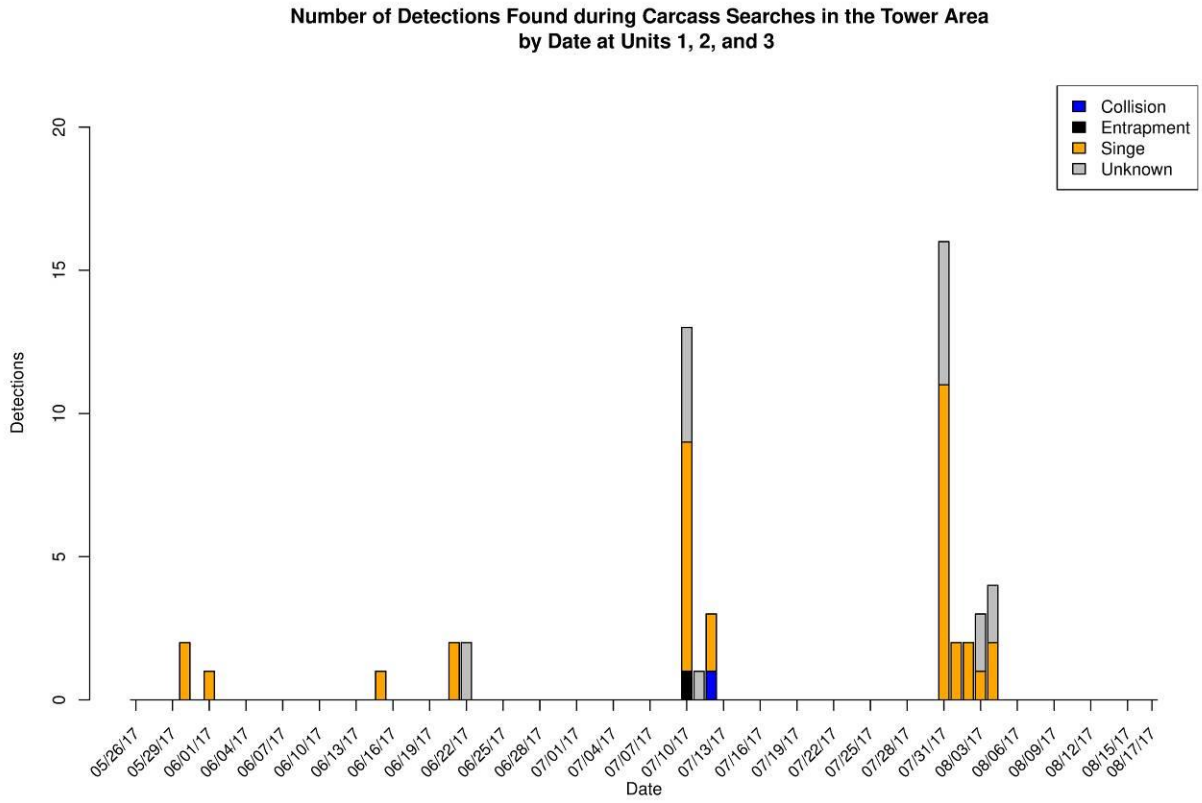

Figure 6. Number of Detections on Each Survey Date, 26 May – 17 August 2017.

One red-tailed hawk with a dislocated foot injury was detected and taken to Animal Kingdom Veterinary Hospital during the 2017 summer season (Table 3).

Table 3. Avian Injuries Detected 26 May – 17 August 2017.

Date	Species	Age	Sex	Cause of Injury	Flux Grade	Fate
6/20/17	red-tailed hawk	Immature	Unknown	Unknown	NA	Transported to rehab and subsequently released

3.1.3 Summary of Bat Detections

One California myotis was found in the ACC of Unit 1. 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 summer 2017, of the 82 total detections, 78 detections (95.1%) were recorded at the tower area and 4 detections (4.9%) were recorded incidentally outside of the tower area (Table 4). Of the 82 avian detections, 35 (42.7%) were detected in Unit 1, 16 (19.5%) in Unit 2, and 29 (35.4%) in Unit 3; 2 detections (2.4%) were found on other project lands.

Table 4. Locations of Avian Detections, 26 May 2017 – 17 August 2017.

Location	Carcasses	Injuries	Percent of Total
Tower Area	77	1	95.1%
Outside of Tower Area	4	0	4.9%
Total	81	1	100%

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 7 shows the distribution of detections by cause.

3.3.1 Singeing Effects

Of the 82 avian detections during the 2017 summer season, 58 detections (70.7%) showed signs of singed feather damage, and all were detected in the tower area (Table 5).

3.3.2 Collisions

Of the 82 avian detections, evidence of collision was observed in two (2.4%) with one collision detection found in the tower area and one outside of the tower area. As described in Section 2.2.1.3, the evidence that was used to classify this 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).

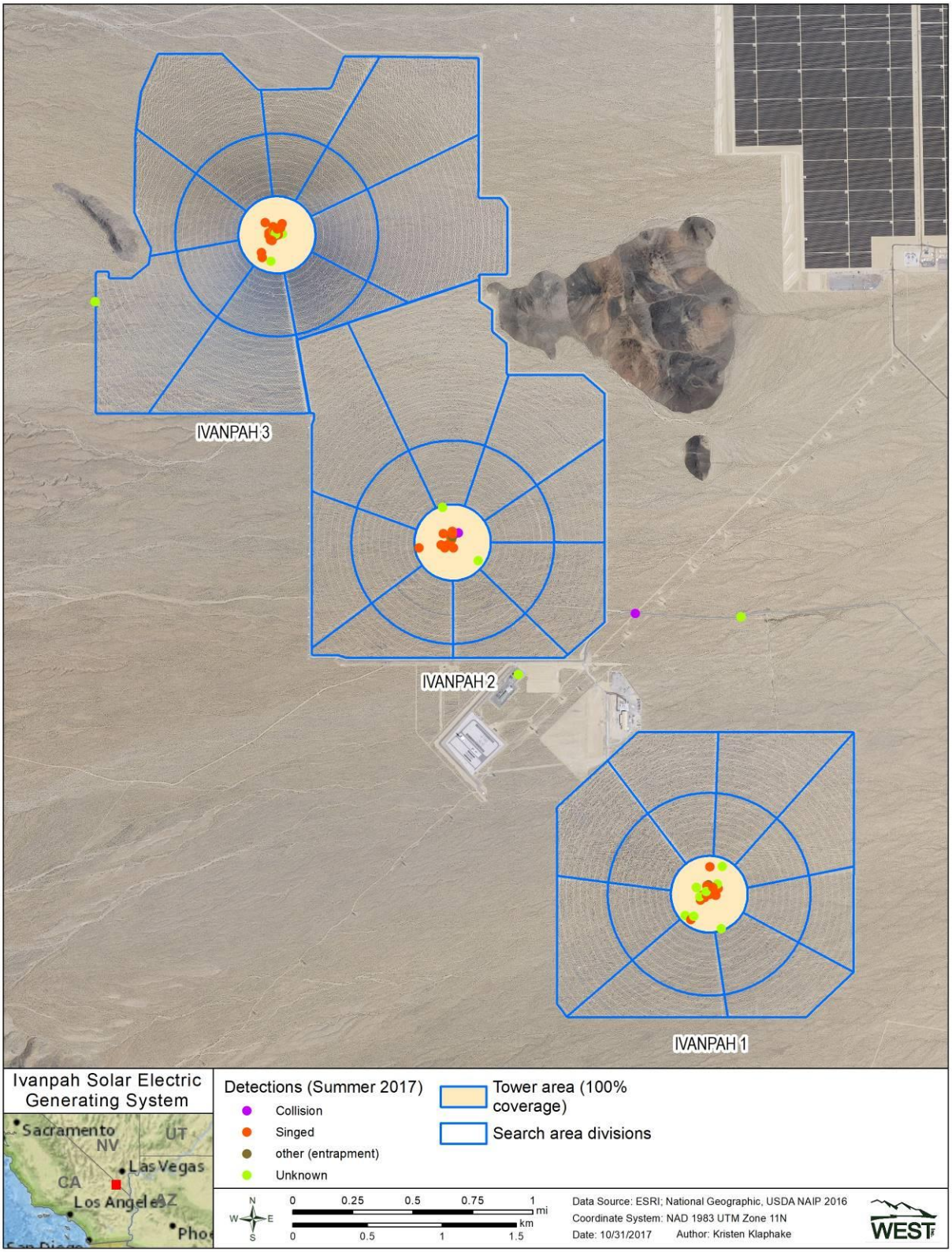

Figure 7. Locations of Singed and Unsinged Detections within Solar Units.

3.3.4 Detections of Unknown Cause

Of the 82 avian detections, evidence of singeing, collision, or other cause could not be assigned for 17 detections within the tower area (21.8%; Table 5). Cause could not be assigned for three of four detections found outside of the tower area. 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. These detections showed no evidence of collision effects, and microscopic analysis did not indicate signs of singeing. Of these 20 unknown detections, 8 (40%) were feather spots, 7 (35%) broken-up carcasses that had been scavenged, and 4 (10%) were whole carcass.

Table 5. Locations of Bird Detections, 26 May 2017 – 17 August 2017.

Location	Singed	Collision	Other*	Unknown	Total
Tower Area	58	1	2	17	78
Outside of Tower Area	0	1	0	3	4
Total	58	2	2	20	82

* Entrapped in ACC

3.4 Types of Detections

Twenty-seven (32.9%) of the 82 detections consisted of feather spots or partial carcasses (Table 6a). Feather spots/partial carcasses accounted for 34.6% of detection in the tower area. Evidence of singeing was noted through direct and microscopic examination on one of these 14 feather spots; evidence of collision (i.e., an impact imprint on a nearby mirror) was noted in the case of zero feather spots. Otherwise, the causes of the feather spots for the other 13 detections are unknown (Table 6b).

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

Location	Carcasses	Feather Spots/Partial Carcasses	Total Detections	Percent Feather Spot*
Tower Area	51	27	78	34.6%
Outside of Tower Area	4	0	4	0
Total	55	27	82	32.9%

*Percent feather spot is total feather spots/partial carcasses divided by total detections.

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

Cause	Carcasses	Feather Spots/Partial Carcasses	Total Detections	Percent Feather Spot*
Singed	44	14	58	24.1%
Collision	2	0	2	0
Other**	2	0	2	0
Unknown	7	13	20	65%
Total	55	27	82	32.9%

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

**Entrapped in ACC.

Section 4.0 Fatality Estimation

This section utilizes the detection data as described in Section 3 to develop fatality estimate in accordance with the Plan (2015) for the tower area.

4.1 Estimating Model Parameters

4.1.1 Carcass persistence Trials

A total of 10 small bird carcass persistence trials were conducted during the 2017 summer monitoring season in the tower area. Consistent with previous seasons, scavengers included common ravens (*Corvus corax*, N=8), and desert kit fox (*Vulpes macrotis*; N=1. In 1 instance no scavenger was recorded on camera. Small bird carcass persistence ranged from less than one day in the case of 6 carcasses, to 3.1 days(Figure 8). 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 9).

In addition to the 2017 summer trials described above, carcass persistence trials from the first three years and the winter and spring seasons of the fourth year of monitoring were also used in the model. Carcass persistence data from 40 small bird carcass persistence trials conducted during the 2016 - 2017 winter and 2017 spring seasons, 92 carcass persistence trials conducted during the 2015 - 2016 monitoring year (92 small birds distributed throughout the facility), carcass persistence data from 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 first year of monitoring (29 October 2013 – 20 October 2014) were used to model carcass persistence time. Details on carcass persistence times can be found in each respective seasonal report.

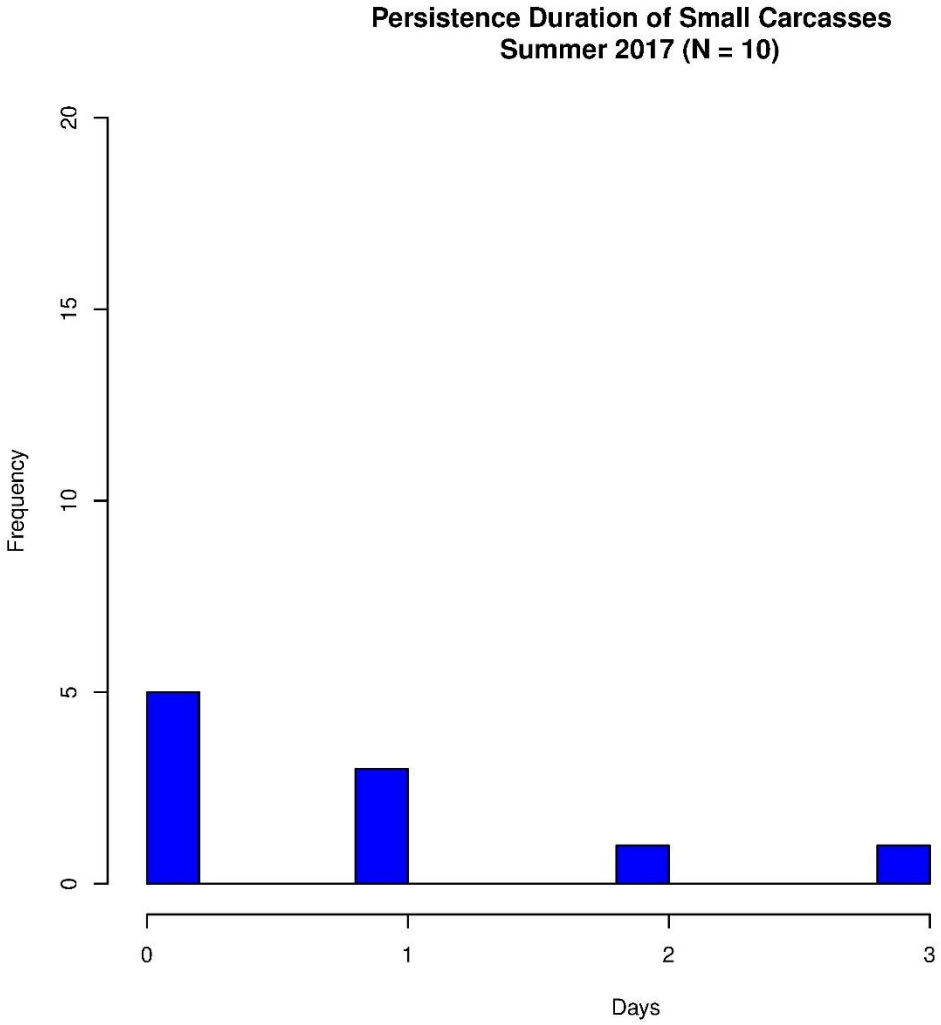

Figure 8. Persistence Durations for Small Carcasses Placed for 2017 Summer Carcass Persistence Trials (N = 10).

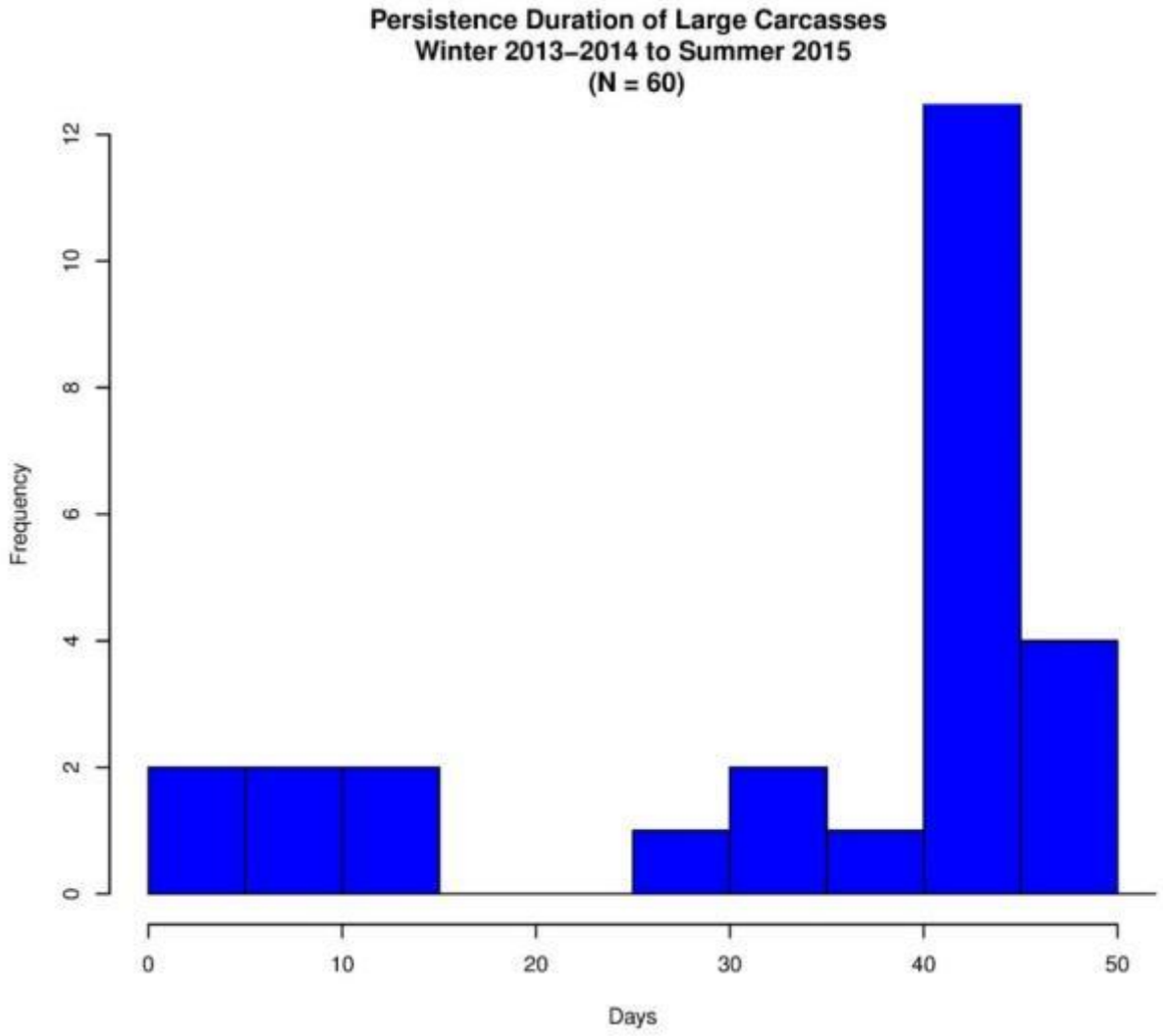

Figure 9. Persistence Durations for Large Carcasses Placed for All Carcass Persistence Trials.

4.1.2 Model Selection for Carcass Persistence Distribution

Consistent with 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, 24 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 covariate to

assess whether respective seasons could be pooled across the first three years (i.e. combine 2014 fall with 2015 fall and 2016 fall persistence trial results). Finally, Project area was also included in all models to evaluate whether or not carcass persistence differed by Project area using the full 15 quarter carcass persistence trial dataset.

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 model that included year+season had ΔAICc values ≤ 2; for large birds, the exponential, Weibull, loglogistic, and lognormal models with intercept only had ΔAICc values ≤ 2 (Tables 7a and 7b). Ultimately, a loglogistic model with year + 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 estimate a different persistence probability for each season and year. For large birds, the top model does not have any temporal or spatial covariates, and thus estimates probability of persistence for large birds based on search interval, only. The chosen models predicted 96.5% of large carcasses persisted for the nominal search interval (21 days), and 10.4% of small bird carcasses persisted for the nominal search interval of during the 2017 summer monitoring season.

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

Small Bird Trials			
Covariates	Distribution	AICc	Δ AICc
Year + Season	loglogistic	1440.44	0
Season + Year + Project Area	loglogistic	1442.28	1.84
Year + Season + Year*Season	loglogistic	1443.6	3.16
Year + Season	lognormal	1443.85	3.41
Season	loglogistic	1445.7	5.26
Season + Year + Project Area	lognormal	1445.74	5.30
Season + Project Area	loglogistic	1446.64	6.20
Season	lognormal	1447.76	7.32
Year + Season + Year*Season	lognormal	1448.64	8.20
Season + Project Area	lognormal	1448.8	8.36
Year + Season	weibull	1450.5	10.06
Season + Year + Project Area	weibull	1451.9	11.46
Year + Season + Year*Season	weibull	1457.74	17.30
Intercept	loglogistic	1460.08	19.64
Intercept	lognormal	1461.42	20.98
Season	weibull	1467.19	26.75

Table 7b. AICc Values for 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
Year + Season	exponential	101.15	4.15
Year + Season	lognormal	101.42	4.42
Season	exponential	101.48	4.48
Year + Season	loglogistic	102.22	5.22
Season	lognormal	102.38	5.38
Year + Season	weibull	102.60	5.60
Season	loglogistic	102.70	5.70
Season	weibull	102.73	5.73
Year + Season + Year*Season	exponential	107.18	10.18
Year + Season + Year*Season	lognormal	108.60	11.60
Year + Season + Year*Season	loglogistic	108.88	11.88
Year + Season + Year*Season	weibull	108.93	11.93

4.1.3 Searcher Efficiency Trials

During the 2017 summer season, a total of 34 searcher efficiency trials (14 small birds, 9 large birds, and 11 feather spots) were placed in the tower areas of Units 1, 2, 3. Eight trials (6 small birds, 2 large birds, and 0 feather spots) were removed (scavenged) prior to a searcher having the opportunity to detect the carcass.

Trial data from the first three years of monitoring, and the winter and spring seasons of year four, were used to fit a searcher efficiency model for the 2017 summer season. Of the 74 (22 small birds, 29 large birds, and 23 feather spots) trials placed in the 2016-2017 winter season, 60 (20 small birds, 20 large birds, 20 feather spots) were available to be found; of the 65 (23 small birds, 22 large birds, 20 feather spots) trials placed during the 2017 spring season, 62 (22 small birds, 20 large birds, and 20 feather spots) were available to be found. Of the 306 human searcher efficiency trials conducted during the 2015-2016 monitoring year (124 small birds, 93 large birds, and 89 feather spots), 263 (95 small carcasses, 83 large carcasses, and 85 feather spots) were available to be found; 43 carcasses (29 small carcasses, 10 large carcasses, and 4 feather spot) were removed from the trial location before searchers had an opportunity to detect the carcass. Of the 320 human searcher efficiency trials conducted in the 2014 – 2015 monitoring year (129 small birds, 96 large birds, and 95 feather spots) 268 (129 small carcasses, 96 large carcasses, and 95 feather spots) were available to be found; 52 carcasses (42 small carcasses, 8 large carcass, and 2 feather spots) were removed from the trial location before searchers had an opportunity to detect the carcass. An additional 154 searcher efficiency trials from the first year of study (2013 – 2014)

were also included in searcher efficiency model building. Of 154 trials from the first year of monitoring, 144 were not removed and thus available to be found by a searcher.

Based on the trials conducted during the 2017 summer season (only) in the unvegetated tower areas, searcher efficiency was 63% for small birds, 100% for large birds, and 82% for feather spots.

Table 8. Covariates, AICc Values, and ΔAICc values for the top ten searcher efficiency models. Data consist of all human searcher efficiency trials for carcasses from the initiation of trials through May 25, 2017.

Covariates	AICc	Δ AICc
Size + Project Area + Year	977.85	0.00
Size + Project Area + Year + Size*Project Area + Size*Year	977.99	0.14
Size + Project Area + Year + Size*Project Area	978.40	0.55
Size + Project Area	978.65	0.80
Size + Project Area + Year + Size*Year	979.44	1.59
Size + Project Area + Size*Project Area	979.46	1.61
Size + Project Area + Season + Year + Size*Project Area + Size*Year	979.98	2.13
Size + Project Area + Year + Project Area*Year	980.89	3.04
Size + Project Area + Season + Year	981.08	3.23
Size + Project Area + Year + Size*Project Area + Size*Year + Project Area*Year	981.40	3.55

The selected model for searcher efficiency included carcass size and project area, with an AICc value 0.80 points higher than the lowest AICc model (Table 8); the model with covariates for size and project area was selected because it was the most parsimonious model within 2 AICc points of the lowest AICc model, and thus considered equally supported by the data. The selected searcher efficiency model produces searcher efficiency estimates based on carcass size and project area (unvegetated versus vegetated rea). 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 to date and the selected model described above.

Table 9. Human Searcher Efficiency Sample Sizes Used for Modeling, and Model Predictions for Size and Project Area Categories Winter 1 – Summer 4.

Size	Location	Found	Available	Placed	Predicted Searcher Efficiency (90% CI)
Feather spot	Tower area (Unvegetated)	106	145	149	0.77 (0.72-0.81)
Small bird	Tower area (Unvegetated)	106	143	188	0.71 (0.65-0.75)
Large bird	Tower area (Unvegetated)	114	130	147	0.88 (0.84-0.91)

4.2 Tower Area Fatality Estimates of Known Causes for 2017 Summer Monitoring

Estimates are not provided for factor combinations with five or fewer detections; thus, marginal totals (e.g. total singed, total known cause, etc.) for the tables below may not reflect the sum of estimates within a given row or column (and are generally higher).

There were 62 bird detections where the cause of death or injury could be determined and were facility related, of which 46 were included in the fatality estimate model (Tables 10a and 10b); of these 46 detections, 16 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). 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. Of the 16 detections excluded from analysis, 15 detections were excluded because they were determined to be older than the search interval, and one detection was discovered outside of standard search areas.

During the period 26 May 2017 – 17 August 2017 (84 days of monitoring), there were an estimated 253 fatalities (90% confidence interval 186-376) based on detections from known causes (i.e., singeing, collision, or entrapment in the ACC; Table 11). Small birds accounted for 99% of the estimated fatalities of known causes (Table 12).

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

	Included			Excluded			
Location	Collision	Singed	Other*	Collision	Singed	Other	Total
Tower Area	1	43	2	0	15	0	61
Outside of Tower Area	0	0	0	1	0	0	1
Total	1	43	2	1	15	0	62

*Entrapped in ACC

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

	Included			Excluded			
Location	Large Birds	Small Birds	Raptors*	Large Birds	Small Birds	Raptors*	Total
Tower Area	2	44	1	0	15	0	61
Outside of Tower Area	0	0	0	0	1	0	1
Total	2	44	1	0	16	0	62

* 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. 2017 Summer Season Avian Fatality Estimates by Cause (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	N ≤ 5	250 (183-373)	N ≤ 5	253 (186-376)

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

**Entrapped in ACC

Table 12. 2017 Summer Season Avian Fatality Estimates by Carcass Size (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	251 (183-373)	N ≤ 5	253 (186-376)

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

4.4 Tower Area 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 20 detections where the cause of death could not be determined, of which 15 were included in the fatality estimator (Tables 13a and 13b). Of the 5 detections of unknown cause excluded from the fatality estimator, two detections were determined to be older than the search interval, and three detections was found outside of standard search areas.

During the period of 26 May 2017 – 17 August 2017, the total estimate of fatalities from unknown cause was 146 (90% confidence interval 104-220; Table 14), and all unknown cause fatalities were estimated for the tower area.

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

Location	Included	Excluded	Total
Tower Area	15	2	17
Outside of Tower Area	0	3	3
Total	15	5	20

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

	Included			Excluded			
Location	Large Birds	Small Birds	Raptors*	Large Birds	Small Birds	Raptors*	Total
Tower Area	4	11	1	0	2	0	17
Outside of Tower Area	0	0	0	1	2	1	3
Total	4	11	1	1	4	1	20

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

Table 14. Site-Wide Fatality Estimates from Unknown Causes by Location, 26 May – 17 August 2017.

Project Area	Estimate (90% CI)
Tower Area	146 (104-220)

Table 15. Site-Wide Fatality Estimates from Unknown Causes by Size and Location, 26 May – 17 August 2017.

Location	Large Birds	Small Birds	Raptors	Total
Tower Area	N ≤ 5	141 (99-214)	N ≤ 5	146 (104-220)

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

4.6 Regional Awareness Monitoring

During the 2017 summer season, one injured bird was taken to rehab. In accordance with the Plan, the rehab centers to which injured birds were transported were asked if they had received any birds with singed feathers or evidence of concentrated-flux effects; no records of singed birds were reported by any rehab center. Furthermore, neither the Ivanpah facility nor its designated biologist was contacted by any veterinarian or rehab center about singed birds brought in by non-project staff.

Section 5.0 Discussion

The 2017 summer season represented the continuation of standardized monitoring of avian and bat detections 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 was low throughout the 2017 summer season with one peak in detections on July 31. The peak occurred prior to fall migration, and primarily consisted of unknown cause detections. Thus, little inference can be drawn about potential temporal correlates of risk during the monitoring period.

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 2017 summer 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. Approximately 55% of the species or species groups 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. A more complete analysis will be conducted for the annual report.

None of the seven identifiable species represented by more than three detections is listed or particularly rare locally, regionally, or nationally. Rather, all seven species are relatively abundant and widespread. Thus, the magnitude of detections of these species at Ivanpah during the 2017 summer season does not rise above the "low" category. Special-status species recorded as detections were four single yellow warblers (California species of special concern), a transient that breeds elsewhere.

Yellow warblers are one of the most abundant warblers in North America and occur as both migrants and summer residents in California (Shuford and Gardali 2008). Yellow warblers occur in the Mojave Desert as common migrants, but they typically do not breed there. An estimated 600,000 yellow warblers occur within California and an estimated 34,000,000 occur in the United States (Partners in Flight Science Committee 2013). The four yellow warbler detected represented a very small proportion of these populations; thus, the estimated yellow warbler fatalities during the 2017 summer season not rise above the "low" category, as loss of this magnitude would have a minimal effect on populations at all geographic scales (local, regional, national or global).

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
2017_076_ISEGS	Lesser Nighthawk	LENI	Incidental	5/26/2017	5/26/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. No evidence of collision or singe.	Unknown		N/A	Administrative Laydown Area	639094, 3934963	NA
2017_077_ISEGS	Calliope Hummingbird	CAHU	Carcass Survey	5/30/2017	5/30/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of singe to bill, back, rear of head, wing coverts, and central rects.	Scorched or singed	3	2	ACC Building	638653, 3935922	NA
2017_078_ISEGS	Wilson's Warbler	WIWA	Carcass Survey	5/30/2017	5/30/2017	Broken up	2 weeks	Carcass without head and left wing. Evidence of singe on edge of primaries and retrices.	Scorched or singed	1	2	Powerblock	638577, 3935833	NA
2017_079_ISEGS	Unidentified Small Bird	UNID	Carcass Survey	6/1/2017	6/1/2017	Feather spot	1 month +	Feather spot size small consisting of 5 secondaries and 4 contour feathers. Evidence of singe on edge of primaries and coverts.	Scorched or singed	3	1	Powerblock	640329, 3933484	NA
2017_080_ISEGS	Lesser Nighthawk	LENI	Incidental	6/7/2017	6/7/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of collision with vehicle with compacted body cavity stemming from tire contact.	Collision (other)		2	Coloseum Road	639878, 3935374	NA
2017_081_ISEGS	Violet-green Swallow	VGSW	Incidental	6/14/2017	6/14/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to all flight feathers and singe to all upperparts.	Scorched or singed	2	2	Powerblock	638660, 3935812	NA
2017_082_ISEGS	Costa's Hummingbird	COHU	Carcass Survey	6/15/2017	6/15/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole carcass. Evidence of singe on left side of head.	Scorched or singed	1	2	Powerblock	638591, 3935908	NA
2017_083_ISEGS	Red-tailed Hawk	RTHA	Incidental	6/20/2017	6/21/2017	Alive, injured	0-8 hours	Injured bird. No evidence of collision or singe.	Unknown		3	Powerblock	637513, 3937917	NA
2017_084_ISEGS	Verdin	VERD	Carcass Survey	6/21/2017	6/21/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole carcass. Evidence of curling to primaries and secondaries in left wing and to all tail feathers, singeing to primaries in right wing.	Scorched or singed	2	1	ACC Building	640398, 3933535	NA
2017_085_ISEGS	Unknown Swallow	UNSW	Carcass Survey	6/21/2017	6/21/2017	Feather spot	3-6 days	Feather spot size small, consisting of 3 primaries, 2 secondaries, and 10 body feathers. Evidence of curling to all flight feathers.	Scorched or singed	Unk	1	Powerblock	640356, 3933482	NA
2017_086_ISEGS	Northern Mockingbird	NOMO	Carcass Survey	6/22/2017	6/22/2017	Feather spot	2 weeks	Feather spot size large consisting of 9 retrices, 2 primaries, 4 secondaries, and 2 body feathers. No evidence of collision or singe.	Unknown		1	Heliostat	640453, 3933259	NA

2017_087_ISEGS	Unknown Small Bird	UNID	Carcass Survey	6/22/2017	6/22/2017	Broken up	3-6 days	Broken up piece of carcass consisting of 30 contour feathers held together by dried flesh. No evidence of collision or singe.	Unknown		1	Heliostat	640461, 3933676	NA
2017_088_ISEGS	Cliff Swallow	CLSW	Incidental	6/24/2017	6/24/2017	Dead, fresh (eyes moist)	8-24 hours	Whole carcass. Evidence of curling to primaries and secondaries in both wings and tail feathers, singeing to left side of face, nape, and upper breast.	Scorched or singed	2	3	Powerblock	637481, 3937916	NA
2017_089_ISEGS	Cliff Swallow	CLSW	Incidental	6/27/2017	6/27/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of singeing to primaries and coverts in left wing, singe to left upper breast, nape, and side of face.	Scorched or singed	1	3	Powerblock	637510, 3937985	NA
2017_090_ISEGS	Northern Mockingbird	NOMO	Incidental	7/4/2017	7/4/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. No evidence of collision or singe.	Unknown		2	ACC Building	638652, 3935885	NA
2017_091_ISEGS	Verdin	VERD	Carcass Survey	7/10/2017	7/10/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of curling to secondaries in left wing and to rectrices, singe to primaries in right wing, top of head, and nape.	Scorched or singed	1	3	ACC Building	637496, 3937954	NA
2017_092_ISEGS	House Finch	HOFI	Carcass Survey	7/10/2017	7/10/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of curling to all flight feathers, singeing to head, nape, and back.	Scorched or singed	2	1	ACC Building	640374, 3933536	NA
2017_093_ISEGS	Anna's Hummingbird	ANHU	Carcass Survey	7/10/2017	7/10/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of curling to rectrices, singeing to primaries and secondaries, head, nape, and back.	Scorched or singed	1	1	ACC Building	640360, 3933548	NA
2017_094_ISEGS	Cliff Swallow	CLSW	Carcass Survey	7/10/2017	7/10/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. No evidence of collision or singe.	Unknown		1	ACC Building	640369, 3933554	NA
2017_095_ISEGS	Yellow Warbler	YWAR	Carcass Survey	7/10/2017	7/10/2017	Feather spot	3-6 days	Feather spot size small consisting of 15 body feathers, 2 rectrices, 1 primary. No evidence of collision or singe.	Unknown		3	Powerblock	637465, 3937920	NA
2017_096_ISEGS	Northern Mockingbird	NOMO	Carcass Survey	7/10/2017	7/10/2017	Feather spot	2 weeks	Feather spot size large consisting of 10 secondaries, 3 tertials, 7 primaries, 9 retrices, and 1 contour feather. Singe found on tip of primary.	Scorched or singed	Unk	1	Powerblock	640359, 3933547	NA
2017_097_ISEGS	Verdin	VERD	Carcass	7/10/2017	7/10/2017	Dead, Semi-	3-6 days	Whole carcass. Evidence of	Scorched or	1	3	Powerblock	637462,	NA

			Survey			fresh (eyes desiccated, rigor mortis)		curling to primaries and secondaries in right wing, secondaries in left wing and coverts in both wings.	singed				3937931	
2017_098_ISEGS	Black-Throated Sparrow	BTSP	Carcass Survey	7/10/2017	7/10/2017	Broken up	3-6 days	Broken up carcass consisting of left leg, partial left and right wing. 12 primaries, 5 retricies and 30+ body feathers. Tips of flight feathers singed.	Scorched or singed	Unk	1	Powerblock	640381, 3933511	NA
2017_099_ISEGS	Northern Mockingbird	NOMO	Carcass Survey	7/10/2017	7/10/2017	Feather spot	3-6 days	Feather spot size large consisting of 12 retrices, 17 primaries, 11 secondaries, and 5 contour feathers. Evidence of singe on tips of primaries.	Scorched or singed	Unk	1	Powerblock	640415, 3933482	NA
2017_100_ISEGS	Black-Throated Sparrow	BTSP	Carcass Survey	7/10/2017	7/10/2017	Broken up	2 weeks	Broken up carcass consisting of partial left wing, 3 retrices, 4 primaries and 4 contour. Evidence of singe on retrices.	Scorched or singed	Unk	1	Powerblock	640376, 3933490	NA
2017_101_ISEGS	Unknown Swallow	UNSW	Carcass Survey	7/10/2017	7/10/2017	Broken up	2 weeks	Broken up carcass consisting of partial right wing of 5 primaries and 2 secondaries held together by dried flesh. No evidence of collision or singe.	Unknown		1	Powerblock	640311, 3933474	NA
2017_102_ISEGS	Unknown Warbler	UNWA	Carcass Survey	7/10/2017	7/10/2017	Broken up	1 month +	Broken up carcass consisting of very old body with missing head and left wing. No evidence of collision or singe.	Unknown		3	Powerblock	637469, 3937915	NA
2017_103_ISEGS	Unknown Small Bird	UNID	Carcass Survey	7/10/2017	7/10/2017	Broken up	1 month +	Broken up carcass consisting of partial right wing. No evidence of collision or singe.	Unknown		3	Powerblock	637455, 3937934	NA
2017_104_ISEGS	Mourning Dove	MODO	Carcass Survey	7/11/2017	7/11/2017	Feather spot	2 weeks	Feather spot size large consisting of 7 retrices, 2 primaries, 4 secondaries, 5 contour feathers, and 1 covert. No evidence of collision or singe.	Unknown		3	Heliostat	637435, 3937736	NA
2017_105_ISEGS	Costa's Hummingbird	COHU	Carcass Survey	7/12/2017	7/12/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 days	Whole carcass. Evidence of singe on the ends of primaries on right wing and on central retrices plus lower right flank.	Scorched or singed	3	2	ACC Building	638642, 3935882	NA
2017_106_ISEGS	Black-Throated Sparrow	BTSP	Carcass Survey	7/12/2017	7/12/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of collision with tip of top mandible broken off and apparent evidence of break to back of skull.	Collision with solar panel/heliostat		2	ACC Building	638693, 3935913	NA
2017_107_ISEGS	Tree Swallow	TRES	Carcass Survey	7/12/2017	7/12/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to primary and	Scorched or singed	1	2	Powerblock	638618, 3935832	NA

								secondary coverts on right wing, singe on nape and rump.						
2017_108_ISEGS	Unknown Swallow	UNSW	Incidental	7/18/2017	7/18/2017	Broken up	3-6 days	Broken up carcass consisting of head,left and right partial wings, torso partial tail and 50+ body feathers. Curling of primary flight feathers.	Scorched or singed	Unk	2	Powerblock	638601, 3935813	NA
2017_109_ISEGS	Bullock's Oriole	BUOR	Incidental	7/28/2017	7/28/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to primaries and secondaries in right wing, singe to top of head, upper breast and throat, and right axillary.	Scorched or singed	1	1	Powerblock	640344, 3933469	NA
2017_110_ISEGS	Tree Swallow	TRES	Incidental	7/28/2017	7/28/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to primaries and secondaries in right wing and in tail, singe to rump, right side of back all the way up to nape, and coverts.	Scorched or singed	2	1	Powerblock	640316, 3933451	NA
2017_111_ISEGS	Tree Swallow	TRES	Carcass Survey	7/31/2017	7/31/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. No evidence of collision or singe.	Unknown		1	ACC Building	640429, 3933558	NA
2017_112_ISEGS	Northern Mockingbird	NOMO	Incidental	7/31/2017	7/31/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of singe to all parts of carcass with majority of flight feathers in both wings and tail being singed off.	Scorched or singed	2	3	Powerblock	637424, 3937925	NA
2017_113_ISEGS	Bullock's Oriole	BUOR	Incidental	7/31/2017	7/31/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of curling to primaries and secondaries in right wing, singeing to right side of nape and auricular.	Scorched or singed	1	3	Powerblock	637463, 3937903	NA
2017_114_ISEGS	Cliff Swallow	CLSW	Carcass Survey	7/31/2017	7/31/2017	Mummified	1 month +	Whole carcass. Evidence of curling to flight feathers in both wings and in tail, singe to coverts and upper breast.	Scorched or singed	2	1	ACC Building	640434, 3933529	NA
2017_115_ISEGS	Verdin	VERD	Carcass Survey	7/31/2017	7/31/2017	Mummified	2 weeks	Whole carcass. Primaries curled with singe present on head and back.	Scorched or singed	1	3	ACC Building	637486, 3937945	NA
2017_116_ISEGS	Unknown Hummingbird	UNHU	Carcass Survey	7/31/2017	7/31/2017	Mummified	2 weeks	Whole carcass. All flight feathers curled or singed off. 90% of body singed.	Scorched or singed	2	3	ACC Building	637501, 3937958	NA
2017_117_ISEGS	Western Tanager	WETA	Carcass Survey	7/31/2017	7/31/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of singe. Primaries curled. Coverts and retricies singed. Singe on face.	Scorched or singed	Unk	3	ACC Building	637465, 3937959	NA
2017_118_ISEGS	Rufous	RUHU	Carcass	7/31/2017	7/31/2017	Dead, fresh	8-24 hours	Whole carcass. Evidence of	Scorched or	1	3	ACC Building	637461,	NA

	Hummingbird		Survey			(eyes moist)		singe on face and tail.	singed				3837958	
2017_119_ISEGS	Unknown Small Bird	UNID	Carcass Survey	7/31/2017	7/31/2017	Feather spot	3-6 days	Feather spot size small consisting of 8 body feathers, 1 secondary, 1 rectrix. Evidence of singe on tip of retrix.	Scorched or singed	1	1	Powerblock	640419, 3933483	NA
2017_120_ISEGS	Yellow Warbler	YWAR	Carcass Survey	7/31/2017	7/31/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of singe in the secondaries and tail feathers	Scorched or singed	1	3	Powerblock	637434, 3937879	NA
2017_121_ISEGS	Unknown Swallow	UNSW	Carcass Survey	7/31/2017	7/31/2017	Feather spot	3-6 days	Featherspot consisting of 2 primaries. No evidence of singe.	Unknown		1	Powerblock	640354, 3933508	NA
2017_122_ISEGS	Yellow Warbler	YWAR	Carcass Survey	7/31/2017	7/31/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Primaries, secondaries, and retricies singed off. Head, nape, back, and rump show heavy singe.	Scorched or singed	Unk	3	Powerblock	637442, 3937874	NA
2017_123_ISEGS	Northern Mockingbird	NOMO	Carcass Survey	7/31/2017	7/31/2017	Feather spot	2 weeks	Feather spot size large consisting of 3 retrices, 1 secondary, and 1 primary. No evidence of collision or singe.	Unknown		1	Powerblock	640355, 3933509	NA
2017_124_ISEGS	Unknown Small Bird	UNID	Carcass Survey	7/31/2017	7/31/2017	Feather spot	1 month +	Feather spot size small consisting of 5 primaries and 5 body feathers. Evidence of singe on primary feathers.	Scorched or singed	Unk	1	Powerblock	640359, 3933508	NA
2017_125_ISEGS	Unknown Swallow	UNSW	Carcass Survey	7/31/2017	7/31/2017	Broken up	3-6 days	Broken up carcass consisting of 2 primaries and coverts connected by sking. Evidence of singe at the base of the primaries.	Scorched or singed	Unk	3	Powerblock	637459, 3937933	NA
2017_126_ISEGS	Unknown Small Bird	UNID	Carcass Survey	7/31/2017	7/31/2017	Feather spot	3-6 days	Feather spot size small consisting of 3 retrices, 1 primary, and 1 secondary. No evidence of collision or singe.	Unknown		1	Powerblock	640360, 3933507	NA
2017_127_ISEGS	American Kestrel	AMKE	Carcass Survey	7/31/2017	7/31/2017	Feather spot	3-6 days	Feather spot small consisting of 10 retrices, 4 primaries, 2 secondaries, 15 coverts, and 40 body feathers. Evidence of singe on several primaries and 1 retrix.	Scorched or singed	1	1	Powerblock	640287, 3933537	NA
2017_128_ISEGS	Unknown Small Bird	UNID	Carcass Survey	7/31/2017	7/31/2017	Feather spot	3-6 days	Feather spot size small consisting of 3 primaries, 1 coverts, and 3 secondaries. No evidence of collision or singe.	Unknown		1	Powerblock	640287, 3933536	NA
2017_129_ISEGS	Northern Rough-winged Swallow	NRWS	Carcass Survey	8/1/2017	8/1/2017	Feather spot	3-6 days	Feather spot size small consisting of 2 primaries and 2 secondaries. Evidence of singe on a secondary.	Scorched or singed	1	3	Heliostat	637379, 3937760	NA
2017_130_ISEGS	Blue-winged Teal	BWTE	Carcass Survey	8/1/2017	8/1/2017	Feather spot	3-6 days	Feather spot size large consisting of 3 primaries, 2	Scorched or singed	Unk	3	Heliostat	637372, 3937793	NA

								secondaries, and 6 contour feathers. Evidence of singe on flight feather.						
2017_131_ISEGS	Tree Swallow	TRES	Carcass Survey	8/2/2017	8/2/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Evidence of curling to all flight feathers with rectrices singed off, singe to back and top of head.	Scorched or singed	2	2	ACC Building	638651, 3935907	NA
2017_132_ISEGS	Black-tailed Gnatcatcher	BTGN	Carcass Survey	8/2/2017	8/2/2017	Mummified	2 weeks	Whole carcass. Evidence of curling to all flight feathers, head, neck, and crown singed.	Scorched or singed	2	2	ACC Building	638665, 3935904	NA
2017_133_ISEGS	Yellow Warbler	YWAR	Incidental	8/2/2017	8/2/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to all flight feathers, singe to nape.	Scorched or singed	2	3	Powerblock	637479, 3937950	NA
2017_134_ISEGS	Black-Throated Sparrow	BTSP	Incidental	8/2/2017	8/2/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to rects and primaries, singe to breast.	Scorched or singed	2	3	Powerblock	637451, 3937966	NA
2017_135_ISEGS	Lazuli Bunting	LAZB	Incidental	8/2/2017	8/2/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of singe to all upperparts with all flight feathers singed off.	Scorched or singed	2	3	Powerblock	637435, 3937896	NA
2017_136_ISEGS	Black-tailed Gnatcatcher	BTGN	Incidental	8/2/2017	8/2/2017	Broken up	2 weeks	Broken up carcass consisting of torso with detached head and missing tail. Evidence of curling to primaries and singe to crown.	Scorched or singed	1	3	Powerblock	637423, 3937908	NA
2017_137_ISEGS	Northern Rough-winged Swallow	NRWS	Incidental	8/2/2017	8/2/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to all flight feathers, singe to head, back, flanks, and rump.	Scorched or singed	2	3	Powerblock	637478, 3937910	NA
2017_138_ISEGS	Northern Rough-winged Swallow	NRWS	Incidental	8/2/2017	8/2/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Evidence of curling to all flight feathers, singeing to breast and upperparts.	Scorched or singed	2	3	Powerblock	637435, 3937898	NA
2017_139_ISEGS	Northern Rough-winged Swallow	NRWS	Carcass Survey	8/3/2017	8/3/2017	Broken up	2 weeks	Broken up carcass consisting of partial right wing, group of secondaries held together by dried flesh, pieces of leg bones and skeleton, 2 primaries, 13 secondaries, 50 body feathers. No evidence of collision or singe.	Unknown		2	Heliostat	638825, 3935728	NA
2017_140_ISEGS	Unknown Grebe	UNGR	Carcass Survey	8/3/2017	8/3/2017	Broken up	2 weeks	Broken up carcass consisting of partial right wing. No evidence of collision or singe.	Unknown		2	Heliostat	638586, 3936084	NA
2017_141_ISEGS	Western Tanager	WETA	Carcass Survey	8/3/2017	8/3/2017	Broken up	2 days	Broken up carcass consisting of partial left and right wing, partial tail, 50 body feathers, 4 primaries, 8 secondaries, and 1 retrix. Evidence of curling to	Scorched or singed	Unk	2	Heliostat	638428, 3935813	NA

								primary flight feathers, singe to retrices and secondaries.						
2017_142_ISEGS	Lesser Nighthawk	LENI	Incidental	8/3/2017	8/3/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	8-24 hours	Whole carcass. No evidence of collision or singe.	Unknown		N/A	Coloseum Road	640586, 3935350	NA
2017_143_ISEGS	Unknown Swallow	UNSW	Carcass Survey	8/4/2017	8/4/2017	Feather spot	3-6 days	Feather spot size large consisting of 2 primaries. Evidence of singe on primary feather.	Scorched or singed	Unk	1	Heliostat	640250, 3933319	NA
2017_144_ISEGS	Mourning Dove	MODO	Carcass Survey	8/4/2017	8/4/2017	Feather spot	2 weeks	Feather spot size large consisting of 4 retrices, 2 primaries, 1 secondary, 1 covert. No evidence of collision or singe.	Unknown		1	Heliostat	640213, 3933348	NA
2017_145_ISEGS	Unknown Swallow	UNSW	Carcass Survey	8/4/2017	8/4/2017	Broken up	2 weeks	Broken up carcass consisting of partial right wing held together by dried flesh, 1 secondary. No evidence of collision or singe.	Unknown		1	Heliostat	640270, 3933342	NA
2017_146_ISEGS	Unknown Swallow	UNSW	Carcass Survey	8/4/2017	8/4/2017	Feather spot	3-6 days	Feather spot size small consisting of 2 primaries, 1 secondary, 2 flight feathers, 40 contour feathers. Evidence of curling to all flight feathers, singe to contour feathers.	Scorched or singed	1	1	Heliostat	640378, 3933674	NA
2017_147_ISEGS	Greater Roadrunner	GRRO	Incidental	8/4/2017	8/4/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass with 150 loose feathers. No evidence of collision or singe.	Unknown		3	Fence	636256, 3937464	NA
2017_148_ISEGS	Cliff Swallow	CLSW	Incidental	8/7/2017	8/7/2017	Mummified	1 month +	Whole carcasss. Singe on edge of primary feathers.	Scorched or singed	1	1	Powerblock	640373, 3933487	NA
2017_149_ISEGS	Black-Throated Sparrow	BTSP	Incidental	8/7/2017	8/7/2017	Mummified	2 weeks	Whole carcass. Singe on primaries, secondaries and tail.	Scorched or singed	1	1	Powerblock	640373, 3933487	NA
2017_150_ISEGS	Black-Throated Sparrow	BTSP	Incidental	8/7/2017	8/7/2017	Dead, fresh (eyes moist)	8-24 hours	Whole carcass. All feathers singed, flight feathers missing from singe damage.	Scorched or singed	2	1	Powerblock	640373, 3933487	NA
2017_151_ISEGS	Unknown Swallow	UNSW	Incidental	8/7/2017	8/7/2017	Mummified	1 month +	Whole carcass. All feathers, excepting neck, with singe.	Scorched or singed	2	1	Powerblock	640373, 3933487	NA
2017_152_ISEGS	Tree Swallow	TRES	Incidental	8/7/2017	8/7/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Whole carcass. Tail feathers curled. Rump singed. Two primaries on right wing curled.	Scorched or singed	1	1	Powerblock	640373, 3933487	NA
2017_153_ISEGS	Tree Swallow	TRES	Incidental	8/7/2017	8/7/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	3-6 days	Singe on rump. Three coverts on left wing curled.	Scorched or singed	1	1	Powerblock	640373, 3933487	NA
2017_154_ISEGS	Black-Throated Sparrow	BTSP	Incidental	8/7/2017	8/7/2017	Dead, Semi-fresh (eyes	2 days	Whole carcass. Tail with singe.	Scorched or singed	1	1	Powerblock	640373, 3933487	NA

						desiccated, rigor mortis)								
2017_155_ISEGS	Tree Swallow	TRES	Incidental	8/7/2017	8/7/2017	Dead, fresh (eyes moist)	0-8 hours	Whole carcass. Primaries and secondaries curled. Head, nape, back and rump singed.	Scorched or singed	2	3	Powerblock	637398, 3937993	NA
2017_156_ISEGS	Black-Throated Sparrow	BTSP	Incidental	8/15/2017	8/15/2017	Dead, Semi-fresh (eyes desiccated, rigor mortis)	2 weeks	Whole carcass. Evidence of singe to crown and upper breast.	Scorched or singed	3	2	Powerblock	638647, 3935868	NA
2017_157_ISEGS	Unknown Small Bird	UNID	Incidental	8/15/2017	8/15/2017	Broken up	2 weeks	Broken up carcass consisting of partial body part with dried skin attached and dried blood present. Evidence of curling to several body/contour feathers on body part.	Scorched or singed	1	3	Powerblock	637487, 3937914	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	Estimator Notes
2017_076_ISEGS	LENI	Outside Search - Admin Laydown area	982	Small	Small Carcass	unknown	Incidental	NA	No					Outside Standard Search Area
2017_077_ISEGS	CAHU	ACC	77	Small	Small Carcass	singed	Fatality Search	7	Yes	X	X			
2017_078_ISEGS	WIWA	Power Block	84	Small	Small Carcass	singed	Fatality Search	7	No	X	X			Older than Search Interval
2017_079_ISEGS	UNID	Power Block	44	Small	Feather Spot	singed	Fatality Search	8	No	X	X			Older than Search Interval
2017_080_ISEGS	LENI	Outside Search - Colosseum Rd.	1321	Small	Small Carcass	collision	Incidental	NA	No					Outside Standard Search Area
2017_081_ISEGS	VGSW	Power Block	37	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X			
2017_082_ISEGS	COHU	Power Block	93	Small	Small Carcass	singed	Fatality Search	16	Yes	X	X			

2017_083_ISEGS	RTHA	Power Block	26	Large	Large Carcass	unknown	Incidental	1(1)	Yes	X	X	
2017_084_ISEGS	VERD	ACC	53	Small	Small Carcass	singed	Fatality Search	20	Yes	X	X	
2017_085_ISEGS	UNSW	Power Block	17	Small	Feather Spot	singed	Fatality Search	20	Yes	X	X	
2017_086_ISEGS	NOMO	Inner HD	313	Small	Feather Spot	unknown	Fatality Search	22	Yes	X		X
2017_087_ISEGS	UNID	Inner HD	206	Small	Feather Spot	unknown	Fatality Search	22	Yes	X		X
2017_088_ISEGS	CLSW	Power Block	6	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X	
2017_089_ISEGS	CLSW	Power Block	74	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X	
2017_090_ISEGS	NOMO	ACC	41	Small	Small Carcass	other (entrapment)	Incidental	1	Yes	X	X	

2017_091_ISEGS	VERD	ACC	41	Small	Small Carcass	singed	Fatality Search	25	Yes	X	X
2017_092_ISEGS	HOFI	ACC	49	Small	Small Carcass	singed	Fatality Search	19	Yes	X	X
2017_093_ISEGS	ANHU	ACC	61	Small	Small Carcass	singed	Fatality Search	19	Yes	X	X
2017_094_ISEGS	CLSW	ACC	65	Small	Small Carcass	other (entrapment)	Fatality Search	19	Yes	X	X
2017_095_ISEGS	YWAR	Power Block	23	Small	Feather Spot	unknown	Fatality Search	25	Yes	X	X
2017_096_ISEGS	NOMO	Power Block	66	Small	Small Carcass	singed	Fatality Search	19	Yes	X	X
2017_097_ISEGS	VERD	Power Block	30	Small	Small Carcass	singed	Fatality Search	25	Yes	X	X
2017_098_ISEGS	BTSP	Power Block	25	Small	Feather Spot	singed	Fatality Search	19	Yes	X	X

2017_099_ISEGS	NOMO	Power Block	42	Small	Feather Spot	singed	Fatality Search	19	Yes	X	X	
2017_100_ISEGS	BTSP	Power Block	4	Small	Feather Spot	singed	Fatality Search	19	Yes	X	X	
2017_101_ISEGS	UNSW	Power Block	64	Small	Feather Spot	unknown	Fatality Search	19	Yes	X	X	
2017_102_ISEGS	UNWA	Power Block	18	Small	Small Carcass	unknown	Fatality Search	25	No	X	X	Older than Search Interval
2017_103_ISEGS	UNID	Power Block	37	Small	Small Carcass	unknown	Fatality Search	25	No	X	X	Older than Search Interval
2017_104_ISEGS	MODO	Inner HD	188	Large	Feather Spot	unknown	Fatality Search	22	Yes	X		X
2017_105_ISEGS	COHU	ACC	41	Small	Small Carcass	singed	Fatality Search	27	Yes	X	X	
2017_106_ISEGS	BTSP	ACC	75	Small	Small Carcass	collision	Fatality Search	27	Yes	X	X	

2017_107_ISEGS	TRES	Power Block	43	Small	Small Carcass	singed	Fatality Search	27	Yes	X	X	
2017_108_ISEGS	UNSW	Power Block	66	Small	Small Carcass	singed	Incidental	1(1)	No	X	X	Older than Search Interval
2017_109_ISEGS	BUOR	Power Block	34	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X	
2017_110_ISEGS	TRES	Power Block	67	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X	
2017_111_ISEGS	TRES	Power Block	90	Small	Small Carcass	unknown	Fatality Search	21	Yes	X	X	
2017_112_ISEGS	NOMO	Power Block	63	Small	Small Carcass	singed	Incidental	1(1)	No	X	X	Older than Search Interval
2017_113_ISEGS	BUOR	Power Block	0	Small	Small Carcass	singed	Incidental	1(1)	No	X	X	Older than Search Interval
2017_114_ISEGS	CLSW	ACC	73	Small	Small Carcass	singed	Fatality Search	21	Yes	X	X	

2017_115_ISEGS	VERD	ACC	30	Small	Small Carcass	singed	Fatality Search	21	Yes	X	X
2017_116_ISEGS	UNHU	ACC	45	Small	Small Carcass	singed	Fatality Search	21	Yes	X	X
2017_117_ISEGS	WETA	ACC	49	Small	Small Carcass	singed	Fatality Search	21	Yes	X	X
2017_118_ISEGS	RUHU	ACC	51	Small	Small Carcass	singed	Fatality Search	21	Yes	X	X
2017_119_ISEGS	UNID	Power Block	46	Small	Feather Spot	singed	Fatality Search	21	Yes	X	X
2017_120_ISEGS	YWAR	Power Block	63	Small	Small Carcass	singed	Fatality Search	21	Yes	X	X
2017_121_ISEGS	UNSW	Power Block	27	Small	Feather Spot	unknown	Fatality Search	21	Yes	X	X
2017_122_ISEGS	YWAR	Power Block	60	Small	Small Carcass	singed	Fatality Search	21	Yes	X	X

2017_123_ISEGS	NOMO	Power Block	27	Small	Feather Spot	unknown	Fatality Search	21	Yes	X	X	
2017_124_ISEGS	UNID	Power Block	24	Small	Feather Spot	singed	Fatality Search	21	No	X	X	Older than Search Interval
2017_125_ISEGS	UNSW	Power Block	33	Small	Feather Spot	singed	Fatality Search	21	Yes	X	X	
2017_126_ISEGS	UNID	Power Block	27	Small	Feather Spot	unknown	Fatality Search	21	Yes	X	X	
2017_127_ISEGS	AMKE	Power Block	98	Large	Feather Spot	singed	Fatality Search	21	Yes	X	X	
2017_128_ISEGS	UNID	Power Block	98	Small	Feather Spot	unknown	Fatality Search	21	Yes	X	X	
2017_129_ISEGS	NRWS	Inner HD	188	Small	Feather Spot	singed	Fatality Search	21	Yes	X		X
2017_130_ISEGS	BWTE	Inner HD	109	Large	Feather Spot	singed	Fatality Search	21	Yes	X		X

2017_131_ISEGS	TRES	ACC	47	Small	Small Carcass	singed	Fatality Search	21	Yes	X	X	
2017_132_ISEGS	BTGN	ACC	56	Small	Small Carcass	singed	Fatality Search	21	Yes	X	X	
2017_133_ISEGS	YWAR	Power Block	36	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X	
2017_134_ISEGS	BTSP	Power Block	61	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X	
2017_135_ISEGS	LAZB	Power Block	44	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X	
2017_136_ISEGS	BTGN	Power Block	57	Small	Small Carcass	singed	Incidental	1(1)	No	X	X	Older than Search Interval
2017_137_ISEGS	NRWS	Power Block	0	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X	
2017_138_ISEGS	NRWS	Power Block	44	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X	

2017_139_ISEGS	NRWS	Inner HD	203	Small	Feather Spot	unknown	Fatality Search	21	Yes	X	X	
2017_140_ISEGS	UNGR	Inner HD	250	Large	Feather Spot	unknown	Fatality Search	21	Yes	X	X	
2017_141_ISEGS	WETA	Inner HD	235	Small	Feather Spot	singed	Fatality Search	21	Yes	X	X	
2017_142_ISEGS	LENI	Outside Search - Colosseum Rd	2015	Small	Small Carcass	unknown	Incidental	NA	No			Outside Standard Search Area
2017_143_ISEGS	UNSW	Inner HD	209	Small	Feather Spot	singed	Fatality Search	21	Yes	X	X	
2017_144_ISEGS	MODO	Inner HD	211	Large	Feather Spot	unknown	Fatality Search	21	Yes	X	X	
2017_145_ISEGS	UNSW	Inner HD	178	Small	Feather Spot	unknown	Fatality Search	21	Yes	X	X	
2017_146_ISEGS	UNSW	Inner HD	185	Small	Feather Spot	singed	Fatality Search	21	Yes	X	X	

2017_147_ISEGS	GRRO	Outside Search - West Fence Line	1314	Large	Large Carcass	unknown	Incidental	NA	No			Outside Standard Search Area
2017_148_ISEGS	CLSW	Power Block	0	Small	Small Carcass	singed	Incidental	1(1)	No	X	X	Older than Search Interval
2017_149_ISEGS	BTSP	Power Block	0	Small	Small Carcass	singed	Incidental	1(1)	No	X	X	Older than Search Interval
2017_150_ISEGS	BTSP	Power Block	0	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X	
2017_151_ISEGS	UNSW	Power Block	0	Small	Small Carcass	singed	Incidental	1(1)	No	X	X	Older than Search Interval
2017_152_ISEGS	TRES	Power Block	0	Small	Small Carcass	singed	Incidental	1(1)	No	X	X	Older than Search Interval
2017_153_ISEGS	TRES	Power Block	0	Small	Small Carcass	singed	Incidental	1(1)	No	X	X	Older than Search Interval
2017_154_ISEGS	BTSP	Power Block	0	Small	Small Carcass	singed	Incidental	1(1)	No	X	X	Older than Search Interval

2017_155_ISEGS	TRES	Power Block	118	Small	Small Carcass	singed	Incidental	1(1)	Yes	X	X	
2017_156_ISEGS	BTSP	Power Block	26	Small	Small Carcass	singed	Incidental	1(1)	No	X	X	Older than Search Interval
2017_157_ISEGS	UNID	Power Block	0	Small	Small Carcass	singed	Incidental	1(1)	No	X	X	Older than Search Interval