

Avian and Bat Fatality Monitoring Manzana Wind Facility Kern County, California Year One Report



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EXECUTIVE SUMMARY

Iberdrola Renewables has developed a wind-energy facility with a capacity of 189 megawatts in Kern County, California, approximately 18 miles northwest of the city of Rosamond. The Manzanita Wind Facility consists of 126 1.5-megawatt wind turbines. This report is intended to satisfy the first year requirements of Mitigation Monitoring Measure 4.4-11/12 (Kern County 2008). This report will be jointly submitted to the US Fish and Wildlife Service, California Department of Fish and Wildlife, Kern County Planning Department and the Audubon Society. The fatality monitoring plan employed employs methods consistent with guidelines from the National Wind Coordinating Collaborative (NWCC, Strickland et al. 2011) and those described in the *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development* (CEC and CDFG 2007) but was designed to meet and exceed those standards. Fatality monitoring was conducted at the Manzanita Wind Facility from March 1, 2013 through February 28, 2014.

The primary objective of the monitoring study was to estimate the number of bird and bat fatalities for the entire facility on an annual basis. The monitoring study consisted of five components: 1) standardized carcass surveys of selected turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and 4) adjusted fatality estimates for bird and bat species calculated using the results from searcher efficiency trials and carcass removal trials to estimate the total number of bird and bat fatalities within the Manzanita Wind Facility.

Standardized surveys were conducted at 38, or 30%, of the turbines throughout the year. All 38 turbines were searched weekly. In addition, 20 turbines were searched daily from September 3 – November 9, 2013. Square plots 120 m on a side were established around each of the selected turbines and systematically searched for carcasses. Surveyors walked parallel transects 6 m apart within the search plots while scanning the ground for fatalities or injured birds or bats.

The objective of the standardized surveys was to systematically search wind turbines for bird and bat fatalities. For the entire monitoring period, 3032 turbine searches were conducted; 493 in spring, 528 in summer, 1563 in fall, and 448 in winter. We found a total of 107 bird fatalities comprising 29 species and 16 bat fatalities comprising four species. No California state species of concern was found. 5 raptors fatalities were observed, 3 red-tailed hawks, 1 barn owl, and 1 American kestrel that was estimated to have died prior to the monitoring period.

Besides unidentified passerines (22 individuals; 20.5% of bird fatalities) and unidentified warblers (10 individuals; 9.3%), the most common bird species found were western meadowlarks (14 individuals; 13.1%), and mourning doves (nine individuals; 8.4%). No other species was represented by more than 4 individuals. The majority (54.2%) of bird fatalities were found during the months of March-May. The greatest number of bird fatalities found at any one turbine was 9 fatalities, found at Turbine R1. Bird fatalities at other turbines ranged from zero to six birds.

The most common bat species found were hoary bats (8 individuals; 50% of bat fatalities), Mexican free-tailed bats (four individuals; 25%), and big brown bats (three individuals; 18.8%). A single western red bat was found. The majority (75.0%) of bat fatalities were found during September and October. Two turbines, E2 and J2, had two bat fatalities; no other turbine had more than one.

All of the bat fatalities, 62.1% of small bird fatalities and 75.9% of medium bird fatalities were found within 60 m of the turbine. Half of the bat fatalities and the majority (62.1%) of small bird fatalities, but only 15.4% of medium bird fatalities, were found in the southeast quadrant of the search plot.

The purpose of the carcass persistence trials was to estimate the proportion of carcasses that would remain for a given interval between surveys. We conducted a total of 238 carcass persistence trials over the course of the first year of monitoring. This included 117 small, bird, 70 medium bird, and 51 bat trials that were conducted in most weeks of the year. We estimated that the proportion of carcasses remaining after a 7 day interval varied by season and ranged from 0.61 -0.81 for small birds, 0.61-0.9 for medium birds and 0.4 – 0.69 for bats.

The objective of the searcher efficiency trials was to estimate the percentage of fatalities found by searchers. We conducted a total of 426 searcher efficiency trials during the first year of monitoring. In total, we conducted 206 small bird trials, 129 medium bird trials, and 91 bat trials. Mean searcher efficiency for small birds varied predictably from 0.70 (95% CI 0.52-0.85) in visibility class 1 to 0.37 (95% CI: 0.24-0.51) in visibility class 4 (Table 12). Mean searcher efficiency for medium birds was 0.82 (95% CI: 0.74-0.89) and for bats was 0.44 (95% CI: 0.33-0.55).

We adjusted fatality estimates based on corrections for carcass persistence, searcher efficiency, and proportion of fatalities within searched areas. Where possible fatalities were adjusted by carcass persistence estimates from the season in which the fatality occurred. However, carcass persistence rates from other seasons were applied when we lacked sufficient data to generate season specific estimates. Small bird fatalities were adjusted by searcher efficiency estimates for the visibility class in which they were observed. All other groups were adjusted by overall searcher efficiency estimates for their size class. Large bird fatality estimates were adjusted using searcher efficiency and carcass persistence of medium birds. We estimated a mean of 4.64 small bird fatalities per turbine per year (95% confidence interval: 3.21- 6.60); a mean of 0.81 medium bird fatalities per turbine per year (95% CI: 0.56–1.11); a mean of 0.23 large bird fatalities per turbine per year (95% CI: 0.06–0.50); and a mean of 1.25 bat fatalities per turbine per year (95% CI: 0.90–1.83).

Adjusted estimates of small bird fatality rates were similar to those from other wind energy facilities in California. Fatality rates of medium birds, large birds, and bats were all lower than other reported adjusted estimates from wind facilities in California.

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INTRODUCTION

Iberdrola Renewables (Iberdrola) has developed a wind-energy facility with a capacity of 189 megawatts (MW) in Kern County, California, approximately 18 miles northwest of the city of Rosamond. The Manzana Wind Facility consists of 126 GE SLE 1.5-MW wind turbines. Iberdrola partnered with the USDA Forest Service's Pacific Southwest Research Station and Bat Conservation International on a research project entitled: *Improving the Accuracy and Cost-effectiveness of Pre-Construction and Operations Monitoring Efforts for Bats and Birds at Wind Energy Facilities in California* that was funded primarily via a grant from the California Energy Commission's Public Interest Energy Research program as well as support from Iberdrola. The research project had multiple objectives centered around exploring the relationship between pre-construction monitoring techniques and fatality rates of bats and birds in the Southern California area. A critical component of that project, and the subject of this report is the completion of a one-year post-construction fatality monitoring study at the Manzana to quantify impacts to birds and bats from operation of the facility. This report is intended to satisfy the year one requirements of Mitigation Monitoring Measure 4.4-11/12 (Kern County 2008). This report will be jointly submitted to the US Fish and Wildlife Service, California Department of Fish and Wildlife, Kern County Planning Department and the Audubon Society. The fatality monitoring plan employed follows the recommendations for robust fatality estimation described in the *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development* (CEC and CDFG 2007) but was designed to meet and exceed those standards.

The primary objective of this report is to provide bias-corrected estimates of bird and bat fatality during the first two years of operations at the Manzana Wind Project. Our estimates correct for two primary sources of bias: searcher efficiency and carcass persistence. Searcher efficiency refers to an estimate of the proportion of carcasses in known locations that are found by searchers. Carcass persistence refers to estimates of the length of time that carcasses remain on the ground and available for detection. We evaluated both of these phenomena using a series of "constant effort" field trials throughout the year. We present annual estimates for the number of bats and small and medium-sized birds killed at the facility.

This report presents the results of the one-year avian and bat fatality monitoring study conducted at Manzana from March 1, 2013 through February 28, 2014.

STUDY AREA

The Manzana Wind Project, located in southern Kern County, California, began commercial operations on December 1, 2012. The facility is adjacent to the southern foothills of the Tehachapi Mountains in the western portion of the Mojave Desert. The 6441 acre site comprises 12 vegetation communities with Mojavean juniper woodland and scrub, Mojave creosote bush scrub, non-native grassland, desert native grassland, and Great Basin mixed scrub accounting for 88% of the habitat types. The 189 MW facility consists of 126 GE SLE 1.5 MW turbines with hub heights of 65 m and maximum blade-tip heights of 103.5 m. Turbines are

located at elevations from 977 – 1320m and arranged in multiple strings oriented roughly southwest to northeast (Figure 1).

METHODS

The primary objective of the monitoring program was to estimate the number of bird and bat fatalities at the entire facility on an annual basis. The first year monitoring period began after the wind-energy facility began commercial operations on December 1, 2012 and were conducted for one full year; March 1, 2013 through February 28, 2014. The methods for the fatality study are broken into four primary components: 1) standardized carcass surveys of selected turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remains in the field for possible detection; and 4) adjusted fatality estimates for birds and bats calculated using the results from searcher efficiency trials and carcass removal trials to estimate the total number of bird and bat fatalities at Manzana. The surveys were conducted using methods consistent with guidelines from the National Wind Coordinating Collaborative (NWCC, Strickland et al. 2011) and were designed to meet or exceed standards of the California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development (CEC and CDFG 2007).

We report every bat and bird fatality observed at Manzana during the monitoring period. The vast majority of fatalities were discovered using standardized searches around wind turbines. Incidental discoveries of fatalities occurred outside of survey plots and at times other than during standardized searches. These fatalities are reported but not included in facility-wide annual estimates. We are aware of a single bird fatality that was observed and reported by facility personnel not involved in fatality monitoring. This fatality was later found, without past knowledge of its existence, during a standardized survey.

We did not attempt to assign cause of death to any casualty found at Manzana. Fatalities found during standardized searches around turbines were simply included in site-wide fatality estimates. If some fatalities were not caused by turbines this may result in an overestimate of the number of fatalities associated with wind energy infrastructure.

Selection of Search Turbines

We selected a spatially-distributed random sample of 38 turbines (30% following California Guidelines (CEC and CDFG 2007)) to be searched for fatalities. The project area was divided into 8 sectors each with 15-16 turbines. The sectors were designated to achieve spatial balance across the site in terms of the turbines selected for fatality searches. Within each sector, 4 or 5 turbines were randomly selected to be searched for fatalities, until a total of 38 turbines were selected.

Sector I: D1-D8, E1-E7

Sector II: E8-E11, F8-F9, K1-K9, L6

Sector III: L1-L5, M1-M3, P1-P5, R1-R3

Sector IV: F1-F7, G1-G4, H1-H2, J1-J2

Sector V: N1-N9, Q1-Q2, T9-T13

Sector VI: S1-S5, T1-T8, V1-V3

Sector VII: V4-V13, W1-W6

Sector VIII: U1-U7, V14-V17, W7-W11

Search Plots and Habitat Mapping

We delineated a square plot, centered on the turbine, that was 120 m east-west by 120 m north-south (i.e., 60 m from the turbine at transect center points, Figure 2). The 120 m sides of our plots are longer than the California Guidelines' recommendation of 103.5 m for the type of turbines used at Manzanita (CEC and CDFG 2007; Table 1). Transects were set 6 m apart within each plot and observers searched 3 m on each side of the transect line. Endpoints of transects were marked by stakes or flags in alternating colors (e.g., odd numbered transects orange, even numbers green). When dictated by terrain, ≥ 1 center point was demarcated along transects to facilitate navigation along transects. These latter steps were taken to keep searchers' focus on fatality detection as opposed to transect navigation.

Table 1. Comparison between California Guidelines (CEC and CDFG 2007) recommendations

Criterion	CA Guidelines	Manzanita Wind	and
Turbines searched	Approx. 30%	30%	fata
Search frequency	Approx. every 2 weeks	Weekly	lity
Search Plot Width	103.5 m	120 m	sear
Search Area	2.65 acres	3.56 acres	ch
Transect Width	6m	6m	met

hods used at Manzanita Wind Project, Kern County, California.

We categorized carcass visibility at each plot by mapping the habitat according to 4 habitat classes (Table 2). In mapping carcass-visibility classes we considered percent ground cover, height of ground cover, type of habitat (vegetation, shrubs, rocks, etc.), as well as presence of extreme slope, and combined this suite of habitat characteristics into visibility classes that reflect their combined influence on carcass detectability (Figures 3 and 4).

Table 2. Habitat visibility classification scheme used at Manzanita Wind Project, Kern County, California.

Visibility Class	Description
Class 1 (Road/Pad)	Turbine pad and access roads

Class 2 (Easy)	Compacted or largely unvegetated areas
Class 3 (Moderate)	Largely covered in herbaceous vegetation > 10 cm in height, <25% shrubs
Class 4 (Difficult)	≥25% shrubs

Search Schedules

Turbines were searched at least once per week during the first year of operations. We scheduled surveys to begin on March 1 to coincide with the beginning of a season. We defined seasons as follows:

Spring: March 1 – May 31
Summer: June 1 – August 31
Fall: September 1 – November 30
Winter: December 1 – February 28

In this manner, surveys for a particular season were conducted consecutively as opposed to beginning midway through a season in year 1 and resuming surveys for that season 10 months later.

We conducted daily searches on a subset of 20 turbines during a 10-week period from September 3 – November 9, 2013 to inform some of our research objectives. The first 20 turbines selected via the spatially-balanced random selection procedure were designated for daily searches during these periods. The remaining 18 turbines were searched on their regular weekly interval.

Standardized Fatality Searches

Personnel trained in proper search techniques conducted carcass searches. Searchers walked at a rate of approximately 25–45 m/min along each transect searching out to 3 m on each side for carcasses. Search speed was adjusted by visibility class such that easy classes were searched at a faster rate than more difficult classes. Plots were usually searched by two people and typically required 50–100 person-minutes to complete depending on topography and vegetative conditions. Searchers started on opposite corners of the search plot from each other (e.g. northeast and southwest) and worked toward the turbine. On the following week, the searchers switched sides and the direction of search was reversed (i.e., start points at southeast and northwest). Scheduled searches were occasionally abandoned due to unsafe weather conditions (e.g., very high winds or lightning). However, the requisite number of searches was conducted each week, with rare exceptions. Searches commenced approximately 30 minutes after sunrise and were generally completed within 8 hours after sunrise. During weekly searches, we generally searched at least one turbine from each of the 8 sectors on site; this was to ensure that search effort was distributed throughout the site each day. The order in which turbines were searched was changed weekly so that individual turbines were searched at different times of day.

Prior to initiation of the annual fatality monitoring, all 38 turbines were searched to identify any existing carcasses or remains of carcasses on the search plots. These searches, commonly referred to as "clean sweep surveys", were conducted during the week prior to initiation of the fatality monitoring program. Search methods followed the same protocol as the standardized carcass surveys. Carcasses discovered during clean sweep surveys are reported here, but were not included in bias-corrected fatality estimates.

Field Data Recording

Data recorded for each turbine searched included date, start time, end time, observer, and weather data.

When a fatality was found, the searcher recorded date, time, transect, estimated distance along transect, and azimuth from turbine and photographed the fatality. A flag was placed near the fatality, crew leader notified, and the search continued. A crew leader later returned to each fatality to record information on a data sheet, including date, time found, species, sex and age (where possible), observer name, identification number of carcass, turbine number, perpendicular distance from the transect line to the carcass, distance from turbine, azimuth from turbine, habitat surrounding fatality, condition of fatality (entire, partial, or feather spot), and estimated time of death (e.g., <1 day, 2-3 days). Photographs of the fatality including a photo 1 m directly above the carcass and close-ups to help confirm species identification were taken. Rubber gloves or an inverted plastic bag were used to handle all carcasses to reduce possible human scent bias for carcasses later used in carcass persistence trials. Carcasses were placed in a plastic bag and labeled. Most fresh carcasses were redistributed on the same day for field bias trials (see below). Fatalities found at times other than during formal plot surveys, and those found outside the search plot (even within 3m of its outside edge), were recorded but not included in bias-corrected fatality estimates.

Bird fatalities were frequently detected in the form of feather spots. Feather spots are aggregations of feathers where it is suspected that a scavenger removed the feathers and consumed, or at least moved, the bird. We defined a feather spot as follows:

- 1) 3 or more flight feathers
- 2) 10 or more down feathers
- 3) 2 flight feathers and at least 4 down feathers
- 4) 1 flight feather and at least 7 down feathers

Generally, we presumed that a feather spot observed within the search plot was a fatality caused by the wind turbine. Occasionally, searchers suspected that there may have been other causes of death (e.g., a roadrunner was killed by a predator in the search plot) or that the feather loss was natural (e.g., preened by the bird under a shrub). We categorized cause of death for these occurrences as 'unknown', but include all fatalities found during standardized searches in fatality estimates.

Field Bias Trials

Credible estimates of fatality rates at wind energy facilities must account for two primary sources of bias: searcher efficiency and carcass persistence. Searcher efficiency refers to differential ability to detect carcasses based on differences among observers or field conditions (e.g., weather, vegetation density). Carcass persistence refers to the duration of time before carcasses are removed by scavengers (e.g. birds, mammals, or insects) or disappear via other means (e.g., strong winds). For example if carcasses persist, on average, for 3 days but searches are conducted weekly, the estimated number of fatalities will be higher than what was observed in the field. We accounted for these biases via standardized trials wherein a crew leader placed carcasses at known locations and recorded a) whether they were detected by searchers and b) the duration until they were removed by scavengers.

We employed a 'constant effort' program of bias trials wherein searcher efficiency and carcass persistence were measured during every week and most days and at all turbines. This contrasts with other studies where bias trials are consolidated into a few weeks or at a few turbines. We reckoned that constant searcher efficiency trials are preferable because searchers expect to be evaluated every day rather than on a few specific weeks. In other words, they would not be tempted to search more carefully on days when they suspected they were being evaluated for searcher efficiency. In addition, this procedure allowed us to evaluate searcher efficiency and carcass persistence across a wide variety of turbines and all of the weather conditions encountered during regular searches.

The California Guidelines recommend classifying carcasses as small (< 10 inches in length) versus large (> 10 inches in length) (CEC and CDFG 2007), but we categorized carcasses as small (≤ 23 cm length), medium ($23 \text{ cm} < x \leq 40 \text{ cm}$ length) or large birds (> 40 cm length) for greater resolution and consistency with other studies in California (Kerlinger et al. 2009). Carcasses used in bias trials include native birds that were found dead on-site. We used these carcasses following approval of a Special Purpose Utility (SPUT) permit from US Fish and Wildlife Service. Native and non-native birds were also legally obtained from valid salvage-permitted entities under the SPUT permit. We were not able to obtain any large birds (e.g., ravens, hawks, gulls) to use as bias carcasses so we corrected estimates of large bird fatalities via use of medium bird bias trials. The result will be somewhat of an overestimate for large birds due to corrections for both searcher efficiency (medium birds are more difficult to detect than large birds) and carcass persistence (medium birds may not last as long on the landscape). Bat fatalities were considered separately.

Data recorded for each trial carcass prior to placement included identification number, species, size class, date and time of placement, turbine number, distance and direction from turbine, and habitat visibility class in which it was placed. No more than 2 carcasses were placed at any one time at a given turbine. During subsequent visits to each trial carcass, the field crew leader noted presence/absence of carcass, degree of scavenging (none, light, medium, heavy), location of scavenging on the body, probable scavenger, and any additional observations on its condition.

We expected lower searcher efficiency and higher variability in results of searcher efficiency trials in more difficult visibility classes. Accordingly, we targeted 40% of carcasses to be placed in visibility class 4, 25% in visibility class 3, 20% in visibility class 2, and 15% in visibility class 1. We used the *Sampling Design Tool for ArcGIS* (<http://www.arcgis.com/home/item.html?id=ecbe1fc44f35465f9dea42ef9b63e785>), to provide UTM coordinates for randomly selected points within search plots that met our visibility class proportion targets. We created separate lists of coordinates for 3 carcass classes (small bird, medium bird, and bat). We subsequently converted UTM coordinates into specified distances and azimuths from turbines for easier use in the field. Carcasses were placed by navigating to the specified location and dropping the carcass from waist height. If the specified coordinates were directly above a shrub, the carcass was dropped there.

The majority of bias trials (68% of carcass persistence and 82% of searcher efficiency trials) were conducted using frozen carcasses obtained off site. Our general protocol was to remove a carcass from the freezer and place it at a turbine, prior to the time it was to be searched, for use as a searcher efficiency trial. If the carcass was present and intact it was moved to a turbine that would be searched the following day. This allowed us to use a single carcass for searcher efficiency trials at two separate turbines. Carcass persistence time was assessed from the time the carcass was placed at the second turbine. If the carcass was removed prior to its discovery at the first turbine, the time between placement and the time it was first observed missing was considered its persistence time. We did not include in the carcass persistence analysis the many trials in which the carcass was not removed from the first turbine. If the carcass became a feather spot at the first turbine, it was counted as a searcher efficiency trial and its carcass persistence trial began at the time it was originally placed.

We also used fatalities found on site for bias trials. Carcasses found on-site that were deemed to have been killed within the previous 24 hours were re-located to a different location on the date of discovery. This was necessary to maintain targeted percentages among visibility classes. Searchers attempted to locate the carcass on the following day as a searcher efficiency trial. The carcass was then left in place in order to determine its carcass persistence time. When a bird fatality was found as a feather spot, its time of death was categorized as follows: $\leq$ 1 day, 2-3 days, 4-7 days, 7-14 days. The feather spot was left in place to monitor its carcass persistence time and for use as a searcher efficiency trial if a new searcher was assigned to its location on a subsequent survey. The total persistence time for feather spots was calculated as the time it was observed to persist plus the midpoint of its estimated age at discovery i.e., 2.5, 5.5 or 10.5 days. Fatalities found as carcasses that were estimated to be > 1 day old were used as searcher efficiency trial carcasses only. Such carcasses could be moved multiple times so long as they remained an intact carcass representative of their size class.

During daily searches in fall 2013, 1-13 bird or bat carcasses per day were available across the site for detection by searchers and/or removal by scavengers. The field crew leader placed a carcass at a randomly selected turbine and location and it was monitored daily as to whether

the carcass was observed by the searcher or removed by scavengers. We rotated searchers among turbines such that the same carcass, in the same location, was used to evaluate searcher efficiency up to 6 times. This same carcass/feather spot was then left in place to provide information on carcass persistence times. Our protocol called for carcasses and feather spots to be monitored daily for up to 20 days (or until removed) to elucidate the timing of removal and change in condition over time. Carcasses/feather spots that persisted 20 days were removed. Occasionally carcasses/feather spots were monitored for >20 days as dictated by site logistics/priorities.

Statistical Methods

We estimated annual, facility-wide fatalities of bats and birds using the methods described in Huso (2011).

Carcass persistence

Estimates of the probability that a bat or bird carcass was not removed in the interval between searches were used to adjust carcass counts for removal bias. Removal included scavenging, wind, or decomposition beyond recognition. The length of time a carcass remained on the study area before it was removed was modeled as a Weibull-distributed random variable. We fit carcass persistence data to an interval-censored parametric failure time model, with carcass persistence time modeled as a function season. We used AIC to determine the best model. When a more parsimonious model was within 2 AIC units of the best, it was chosen over the more complicated model.

The probability that a carcass is not removed during an interval of length I can be approximated as the average probability of persisting given its death might have occurred at any time during the interval:

$$\hat{r}_{jk} = \int_0^{I_{ij}} \exp(-I / \lambda_k)^{1/\sigma} / I_{ij}$$

where:

$\hat{r}_{jk}$ is the estimated probability that a carcass in the k^{th} visibility class that died during the interval preceding the j^{th} search will not be removed;

λ_k is the scale parameter of the Weibull distribution for the k^{th} visibility class;

σ is the shape parameter of the Weibull distribution for the k^{th} visibility class;

I_{ij} is the length of the effective interval preceding the j^{th} search at the i^{th} turbine;

Searcher efficiency

Estimates of the probability that a carcass will be seen by an observer during a search were used to adjust observed fatalities for observer bias. The failure of an observer to detect a fatality on the search plot may be due to its size, color, or time since death, as well as conditions in its immediate vicinity (e.g., vegetation density, shade). In most fatality monitoring efforts, because we cannot measure time since death, it is assumed that a carcass's

observability is constant over the period of the search interval, which it likely is not. For each size group, a binary response (found/not found) was fit to a logistic regression model, with odds of observing a carcass given that it persisted, modeled as a function of visibility class. We used AIC to determine the best model.

Density Weighting

The plot size surrounding each searched turbine was 120 m by 120 m (Figure 2). We considered all areas of our search plots to be 'searchable', so there was no need to correct for unsearched areas (Huso and Dalthorp 2014). However some proportion of fatalities were expected to be found outside the searched plot, with the proportion depending on size of carcass. Because there were very few carcasses found at the site, the density weighted proportion of area searched could not be modeled from observed data, so it was calculated following methods described in Huso and Dalthorp (2014) assuming a linear model of the presence of bird carcasses as a function of distance. The maximum fall distance (d_{max}) was set at 61, 77, 94, and 115 m for bats, small birds, medium birds, and large birds, respectively. These distances were based on estimates from Hull and Muir (2010; Table 9). The density weight was calculated by standardizing the following relationship to integrate to 1 around the turbine:

$$f(d) = (1 - (1/d_{max}) * d) / d_{max}$$

where d = distance and d_{max} is defined above.

Fatality Estimates

We generated fatality estimates using USGS DS 729 software. To meet assumptions of the estimator, we only included fatalities found within plot boundaries during standardized searches and those judged to have been killed in the interval immediately preceding the search on which they were found. In other words if a fatality was judged to have occurred 7-10 days prior to the search and the search interval was weekly, the fatality was not included in estimates.

We adjusted the number of fatalities found by searchers by estimates of searcher efficiency and by the proportion of carcasses expected to persist unscavenged during each interval using the following equation:

$$\hat{f}_{ijk} = \frac{c_{ijk}}{\hat{a}_i \hat{p}_{jk} \hat{r}_{jk} \hat{e}_{jk}}$$

where:

$\hat{f}_{ijk}$ is the estimated fatality in the k^{th} visibility class that occurred at the i^{th} turbine during the j^{th} search;

c_{ijk} is the observed number of carcasses in the k^{th} visibility class at the i^{th} turbine during the j^{th} search;

$\hat{a}_i$ is the density-weighted proportion of the area of the i^{th} turbine that was searched;

$\hat{p}_{jk}$ is the estimated probability that a carcass in the k^{th} visibility class that is on the ground during the j^{th} search will actually be seen by the observer;
 $\hat{r}_{jk}$ is the probability that an individual bird or bat that died in the k^{th} visibility class during the interval preceding the j^{th} search will not be removed; and
 $\hat{e}_{jk}$ is the effective interval adjustment (i.e., the ratio of the length of time before 99% of carcasses can be expected to be removed to the search interval) associated with a carcass in the k^{th} visibility class that died during the interval preceding the j^{th} search.

The value for $\hat{p}_{jk}$ was estimated through searcher efficiency trials with estimates given above; $\hat{r}_{jk}$ is a function of the average carcass persistence rate and the length of the interval preceding the j^{th} search; and $\hat{r}_{jk}$, $\hat{e}_{jk}$ and $\hat{p}_{jk}$ are assumed not to differ among turbines, but differ with search interval (j) and visibility class (k).

The estimated annual per turbine fatality for bats and birds was calculated using a newly derived estimator (Huso 2011) and the equation is:

$$\hat{f} = \frac{\sum_{i=1}^{38} \sum_{j=1}^{n_i} \sum_{k=1}^3 \hat{f}_{ijk}}{38}$$

where n_i is the number of searches carried out at turbine i , $i = 1, \dots, 38$, and $\hat{f}_{ijk}$ is defined above. The per turbine estimate and confidence limits were multiplied by 126, the total number of turbines, and divided by the density-weighted area searched for small birds, medium birds, large birds and bats, respectively, to give total annual fatality estimates (Cochran 1977). No closed form solution is yet available for the variance of this estimator, so 95% confidence intervals of this estimate were calculated by bootstrapping (Manly 1997). Searcher efficiency was estimated from a bootstrap sample (with replacement) of searcher efficiency data, carcass persistence estimated from a bootstrap sample of carcass persistence data, and these values were applied to the carcass data from a bootstrap sample of turbines to estimate average fatality per turbine. This process was repeated 1000 times. The 2.5th and 97.5th quantiles from the 1,000 bootstrapped estimates formed the 95% confidence limits of the estimated fatality (Huso 2011).

RESULTS

Standardized Carcass Surveys

We searched a total of 38 wind turbines at the Manzana Wind Facility during the first year of monitoring, for a total of 3032 turbine searches (493 in spring, 528 in summer, 1563 in fall, and 448 in winter; Table 3).

Across all seasons we found a total of 107 bird fatalities (58 in spring, 13 in summer, 24 in autumn and 13 in winter; Figure 5). Five of the fatalities were found either during clean sweep surveys or during the first week of surveys in March 2013 but deemed to have been killed prior to March 1, 2013. The most common bird species found were unidentified passerines ($n=22$), western meadowlarks ($n=14$), unidentified warblers ($n=10$), and mourning doves ($n=9$; Tables 4 and 5). The high proportion of unidentified birds reflects the fact that a large proportion of fatalities detected were in the form of feather spots, often just a collection of down feathers.

We observed 5 raptor casualties. An American kestrel feather spot was detected on 4 March 2013, but we determined that it had likely been killed prior to the official start of carcass surveys. A fresh red-tailed hawk carcass was found incidental to formal turbine surveys on 29 May 2013 and a red-tailed hawk feather spot was found during a turbine survey on 3 December 2013. A red-tailed hawk was found injured incidental to turbine surveys on 13 December 2013. This animal was transported to Tehachapi Wildlife Rehab and Education for treatment. A barn owl feather spot was found incidental to turbine surveys on 26 October 2013. A full accounting of each bird fatality found, its condition and its disposition can be found in Appendix 1.

We found a total of 16 bat fatalities (1 during spring, 3 during summer, and 12 during autumn; Figure 5). Hoary bats (*Lasiurus cinereus*) were the most frequently detected species (1 during spring and 7 during autumn). We found 4 Mexican free-tailed bats (*Tadarida brasiliensis*) during autumn, 3 big brown bats (*Eptesicus fuscus*) during summer and 1 western red bat (*Lasiurus blossevillii*) during autumn.

Fatalities were distributed throughout the year with peaks of fatalities in the spring for small birds and autumn for bats (Figures 5 and 6). No large fatality events were observed. The largest number of observed fatalities on a single day was 4 birds, and this occurred twice. Four small birds (2 sparrows, a warbler, and a finch) were found on 10 April 2013 and 2 small (both sparrows) and 2 medium birds (mourning dove and western meadowlark) were found on 24 April 2013. Three bat fatalities (2 hoary bats and a Mexican free-tailed bat) were found on 4 September 2013. Five bat fatalities were found over a 6 day period from September 11-16, 2013. The middle of summer was particularly devoid of fatalities of any taxon. From June 21-August 13, 2013 a single fatality (big brown bat) was found.

Fatalities were well-distributed throughout the facility (Figure 7). We observed fatalities at all but one turbine (T13) over the course of the year. The largest number of fatalities observed at an individual turbine was 9 at Turbine R1. Hot spots of fatalities at individual turbines or in particular regions of the facility were not apparent.

The distance from turbines at which we found fatalities varied with size class (Table 6, Figure 8). The majority of bat fatalities (81%) were found within 40 m of turbines whereas the majority of small bird fatalities (83.7%) were found more than 40m from turbines. Only one large bird was found within 50m of a turbine.

The direction relative to the turbine in which fatalities were found appeared to depend on the season and the size of the animal (Figures 9-13). Two thirds of small birds were found in the southeast quadrant of search plots (Table 6) and this proportion remained relatively constant among seasons (Figure 9). By contrast, 69% of the medium birds were found in the northeast or northwest quadrants (Table 6), including 80% in both spring and summer (Figures 9-11). Overall 50% of bat fatalities were found in the SE quadrant, but during fall 10 of 12 (83.3%) fatalities were found in either the SE or SW quadrant of search plots (Figures 9 and 12).

Carcass Persistence

We conducted a total of 238 carcass persistence trials over the course of the first year of monitoring (Tables 7-10, Figure 14). This included 117 small bird, 70 medium bird, and 51 bat trials. Carcass trials were distributed among visibility classes as follows: Class 1: 10.9%, Class 2: 26.9%, Class 3: 33.6%, and Class 4: 28.6% (Figure 14). Placement among visibility classes approximated our target of 15/20/25/40% on visibility classes 1-4, but differed because we could not control visibility classes where fatalities were initially encountered.

Carcass persistence rates depended on size class and condition of fatalities. Bats were the removed the fastest. Ten bat carcasses were confirmed removed within 1 day. The fastest removal of a bat carcass was 5 hours and 52 minutes on October 8, 2013 although this carcass was seen at 12:38 pm and missing at 1:29 pm. An additional 9 bat carcasses were confirmed removed with 2 days and a further 7 were removed within 3 days. Four bat carcasses persisted at least 20 days.

For birds, carcass persistence time was highly dependent on whether the trial was or became a feather spot. Ten small bird carcasses were confirmed removed within 1 day, 16 were removed within 2 days and 5 within 3 days. A single small bird carcass persisted at least 20 days. However, if the small bird became a feather spot, persistence was much longer. A total of 3 small bird feather spots disappeared within 3 days while 37 persisted longer than 20 days. The situation was similar for medium birds. Twelve medium bird carcasses were removed on the first day, 10 more on the 2nd day and 1 within 3 days of placement. Only 2 medium bird carcasses persisted longer than 20 days. A single medium bird feather spot was removed within 3 days while 16 medium bird feather spots persisted at least 20 days.

We used an information-theoretic model selection process to assess whether carcass persistence varied according to season. For small birds, the model for carcass persistence as a function of season was more likely (AICc= 433.50) than the null model which assumed no seasonal differences (AICc= 436.67), so we evaluated carcass persistence separately for each season. For medium birds the carcass persistence model that accounted for season was also more likely (AICc= 276.79) than the null model (AICc= 283.28). We did not conduct a valid carcass persistence trial for medium birds during summer, so we corrected our single medium bird fatality from summer (Mourning Dove found June 10, 2013) using the carcass persistence value from spring. For bats, the carcass persistence model that accounted for season was also more likely (AICc= 225.07) than the null model (AICc= 232.40). However, we were only able to calculate carcass persistence of bats during fall and winter. During spring, we only conducted a

single valid carcass persistence trial (bat was found absent 2 days after placement) and during summer we conducted 4 valid trials (1 persisted a day and was moved by crew lead, 1 was first absent after 2 days, 1 was first absent after 5 days, and 1 bat was removed between day 16 and 18). We corrected spring bat fatalities using carcass persistence estimates from fall and summer fatality using carcass persistence estimates from winter. Although this is somewhat counterintuitive, we based this on patterns we observed for small bird carcasses (not feather spots). Small bird average carcass persistence times were moderate and similar during winter and summer and short and similar during fall and spring, so we assumed a similar pattern applied to bats.

Rather than report a point estimate of mean carcass persistence time, we report the estimated proportion of fatalities that remain available for searcher detection (r) after a standard interval of 7 days, which is based on a modeled distribution (Figures 16 and 17). Proportion of fatalities remaining after 7 days varied according to size and season (Table 11). Surprisingly, the highest proportion of fatalities persisting 7 days was in the spring and lowest in winter for both small and medium birds. The proportion of bats remaining 7 days was markedly lower than small or medium birds during fall but slightly higher than birds during winter.

Searcher Efficiency Trials

We conducted a total of 426 searcher efficiency trials during the first year of monitoring (Tables 7-10, Figure 15). In total, we conducted 206 small bird trials, 129 medium bird trials, and 91 bat trials (Figure 15). Searcher efficiency trials were conducted on a "continuous" basis throughout the year and were conducted at every one of the search turbines (Tables 7-10). We conducted 247 searcher efficiency trials during fall when we conducted daily surveys and 9 people were conducting surveys. We conducted 105 searcher efficiency trials during winter, 41 during summer and 33 in spring when we conducted weekly fatality surveys and generally had 3 people conducting surveys.

The best model for searcher efficiency depended on size class of the carcass. For small birds, the model for searcher efficiency as a function of visibility class was more likely (AICc= 278.44) than the null model (AICc= 287.6), so we evaluated searcher efficiency separately for each visibility class. For medium birds and bats, the null models (AICc= 101.33 and 117.3 respectively) were more likely than models of searcher efficiency as a function of visibility class where carcasses were placed (AICc= 107.38 and 123.07 respectively).

Mean searcher efficiency for small birds varied predictably from 0.70 (95% CI 0.52-0.85) in visibility class 1 to 0.37 (95% CI: 0.24-0.51) in visibility class 4 (Table 12). Mean searcher efficiency for medium birds was 0.82 (95% CI: 0.74-0.89) and for bats was 0.44 (95% CI: 0.33-0.55). These results conformed to our expectations in that bats were most difficult to detect followed by small birds and medium birds and that small birds were easiest to detect in the easiest visibility classes and more difficult under more challenging visibility classes. It was somewhat surprising that visibility class did not help predict searcher efficiency in bats.

Adjusted Fatality Estimates

Fatality estimates, standard errors, and confidence intervals were calculated for birds and bats (Table 13). We adjusted fatality estimates based on corrections for carcass persistence (Table 11), searcher efficiency (Table 12), and proportion of fatalities within searched areas. We estimated the proportion of carcasses expected to land within the searched area to be 1.00, 0.938, 0.796, 0.625 for bats, small birds, medium birds and large birds, respectively (Figure 19).

Small Birds

We estimated a mean of 4.64 small bird fatalities per turbine per year with a 95% confidence interval of 3.21–6.60 small birds per turbine per year. This results in an estimate of 585 (95% CI: 404–832) small bird fatalities over an entire year at Manzana Wind Facility for the period of March 1, 2013 – February 28, 2014.

Medium Birds

We estimated a mean of 0.81 medium bird fatalities per turbine per year with a 95% confidence interval of 0.56–1.11 medium birds per turbine per year. This results in a mean estimate of 103 (95% CI: 70–140) medium bird fatalities over an entire year at Manzana Wind Facility for the period of March 1, 2013 – February 28, 2014.

Large Birds

We estimated a mean of 0.23 large bird fatalities per turbine per year with a 95% confidence interval of 0.06–0.50 large birds per turbine per year. This results in an estimate of 29 (95% CI: 7–63) large bird fatalities over an entire year at Manzana Wind Facility for the period of March 1, 2013 – February 28, 2014.

Bats

We estimated a mean of 1.25 bat fatalities per turbine per year with a 95% confidence interval of 0.90–1.83 bats per turbine per year. This results in an estimate of 158 (95% CI: 113–231) bat fatalities over an entire year at Manzana Wind Facility for the period of March 1, 2013 – February 28, 2014.

DISCUSSION

Overall our fatality monitoring at Manzana produced few surprises. Fatalities of small birds were moderate and concentrated during spring. Fatality rates of medium and large birds were somewhat lower than from other sites in the state. The species composition of bird fatalities was similar to those found at other nearby wind facilities. Fatality rates of bats were somewhat lower than other wind facilities in the state but species composition was predictable.

Fatality Estimation

Despite the large number of carcass persistence and searcher efficiency trials we conducted over the course of the year, we were still not able to generate specific estimates for all of the variables we considered. We endeavored to estimate carcass persistence and searcher efficiency for 4 habitat visibility classes in 4 seasons for 3 groups of fatalities (small birds, medium birds, bats). We were only completely successful for small birds, and this was likely

because they were the most frequently observed class of fatality, thereby supplementing our sample size of bias carcasses on a regular basis.

Our biggest challenge was determining how to account for carcass persistence of birds, given that many of them were either found as or became feather spots. We observed this directly in among our carcass persistence trials as about one third of the carcasses became a feather spot at some point during the trial. Carcasses that did not turn into feather spots were generally removed within a week or so. However feather spots generally persisted much longer, many of them until the end of the 20 day period. We monitored the persistence of each carcass whether it was a carcass or feather spot and included persistence times in our models. We acknowledge that this does not precisely reflect the process of carcass removal at Manzana. Accurately modeling the process would require a multi-state approach wherein the probability of carcasses becoming a feather spot would be estimated and then combined with separate estimates of carcass persistence for carcasses and feather spots. We did not have a large enough sample size to employ such an approach during this first year but hope to do so following the second year of monitoring.

Our estimates of large bird fatality were corrected by estimates of searcher efficiency and carcass persistence for medium birds because we were not able to obtain a large enough sample size of large bird carcasses for use in trials. We expect that search efficiency rates would be higher and carcass persistence longer for large birds resulting in overestimates for the number of large bird fatalities on site.

We found a total of 5 raptor casualties over the course of the study. The American kestrel was judged to have died prior to the monitoring period. Two red-tailed hawks and the barn owl were found incidental to standardized fatality surveys. So only a single red-tailed hawk was able to enter into the fatality estimation procedure. As a result, we are not able to generate a bias-adjusted raptor fatality estimate. Only 3 large birds were found during standardized turbine surveys.

We included all bat and bird fatalities found in survey plots during standardized searches in our fatality estimates. We did not attempt to determine cause of death for fatalities we observed and this would have been impossible for the 68% of birds that were originally found as feather spots. Fatality estimates at wind energy facilities are commonly interpreted as fatalities caused by wind energy infrastructure. It is possible that some of the carcasses and feather spots we observed were caused by predators or natural mortality. It is also possible that some of the feather spots we observed were not the result of a fatality at all, but instead a location where a bird naturally lost feathers in a concentrated location (e.g., from preening). We state this not to de-emphasize the fact that birds are killed by wind turbines and other energy infrastructure but instead because it corroborates the observations and suspicions of our search crews who are on the ground every day at Manzana. The level of background mortality can be determined by searching areas away from energy infrastructure for the presence of carcasses and, especially feather spots. Generally such efforts are considered too costly to pursue, but it may

be a direction worth considering in future wind energy fatality monitoring programs in the vicinity of Manzana.

We found that carcass persistence differed among seasons for all three size groups (small birds, medium birds, and bats) but we were not able to estimate persistence for all groups in all seasons due to low number of trials in some seasons. Further, it is possible that carcass persistence could also vary with respect to visibility class, but we did not have enough trial data to evaluate both parameters. We chose to model carcass persistence as a function of season, because it seemed to be a more influential factor than visibility class based on field observations. Potential scavenger sightings (e.g. ravens, coyotes) were low in winter and, especially, summer and higher during spring and fall. On the other hand, we expected visibility class to be more important than season in influencing searcher efficiency so we modeled its impact rather than season given a limited number of searcher efficiency trials particularly in some seasons.

We took steps to avoid potential biases raised during previous studies of carcass persistence. In other studies, carcass persistence trials are conducted by placing a large number of carcasses at one or more turbines and monitoring their persistence over time (Smallwood et al. 2010). However concerns have been raised that 'overseeding' of carcasses may lead to overestimates of carcass persistence if the number of carcasses is much greater than normal levels of fatality and exceeds scavengers' ability to remove carcasses (Smallwood et al. 2010). We avoided this concern by placing single carcasses at turbines on a daily basis. In addition to keeping densities of carcasses low it also allowed us to estimate carcass persistence across the full suite of weather conditions that occurred at the site. Similarly, our estimates of searcher efficiency were distributed across all turbines during every week of the year. In addition to the benefits noted above for carcass persistence, we believe that constant evaluation of searcher efficiency improved searchers' chances of finding carcasses as they expected to encounter a bias carcass each day they searched.

We corrected fatality estimates for the proportion of fatalities expected to be found outside our survey plots (Huso and Dalthorp 2014, Hull and Muir 2010). For bats, we estimated the maximum distance bats would be found from the turbine to be 61m and the greatest distance we found a bat from a turbine in the field was 57 m. Therefore our estimates assume 100% of bat fatalities occurred within search plots and we have no empirical data to contradict our estimate. If undetected bat fatalities did occur outside our search plots, our fatality estimates would be slight underestimates. For small birds, we estimated that the maximum distance from a turbine to be 77m. However, we found 3 small birds at 78-80 m from a turbine in the corner of our search plots and another bird (not included in estimates) was found just outside a search plot at 83 m from a turbine. Hence it is likely that even our density-weighted corrected fatality estimates are slight underestimates for small birds. We expect that the magnitude of this adjustment will be quite small, but it points to the need for additional field research to calibrate analytical methods used to correct fatality estimates. For small and medium birds we estimated maximum distance of fatalities from turbines to be 94 and 115m respectively. We were not

able to validate these estimates in the field because our search plots did not approach these distances from the turbine, but no have no reason to expect them to be grossly inaccurate.

Comparison to Other Studies

Comparison of fatality rates and species composition among studies are challenging for a number of reasons. Studies use different search survey methods, different search schedules, different estimation procedures and, importantly different numbers and methods of bias correction trials to correct estimates (Huso 2001, Huso and Dalthorp 2014). Encouragingly, most current fatality studies at wind energy facilities attempt to correct estimates for biases associated with searcher efficiency and carcass persistence and are employing an improving set of equations and statistical measures to adjust estimates. Nevertheless, some differences in fatality estimates may simply be due to varying methodologies.

We compare our adjusted estimates of bird and bat fatality to those conducted at other wind energy facilities in California within the last ten years when modern analytical procedures have been employed. We specifically exclude comparison the Altamont Pass Wind Resource Area due to difference in turbine technology. We compare adjusted estimates from other studies at "face-value" and do not attempt to evaluate or criticize methods used in other studies. While acknowledging that differing field and analytical methods could result in substantial differences in fatality rates among studies, we make comparisons to look for striking differences between our results and those found elsewhere in the state and to satisfy Mitigation Monitoring Measure 4.4-11 (Kern County 2008) which requires such comparisons.

Bird Fatalities

The estimated small bird fatality rate of 3.09 fatalities/MW/year at Manzanita is comparable to other estimates of bird fatalities from wind energy facilities in California (Table 14). Adjusted fatality estimates for medium and large birds at Manzanita are lower than those reported from other wind energy facilities in California. There are no obvious ecological reasons why medium and large bird fatality rates would be lower at Manzanita. We speculate that differences in field and analytical techniques may explain this, particularly in the manner in which feather spots were accounted.

We compared species composition of fatalities to the two available studies in closest geographic proximity to Manzanita: Pine Tree Wind Farm in Kern County and Dillon Wind-Energy Facility in Riverside County (Chatfield et al. 2009, BioResource Consultants Inc. 2010). In all three studies passerines comprised the majority of observed fatalities. However, at the species-level there was little apparent pattern among the studies. Western meadowlarks and mourning doves were among the most common fatalities at Manzanita and Pine Tree (BioResource Consultants Inc. 2010). However, the most common fatalities at Pine Tree, western scrub-jays, chukar, mountain quail, and California quail were not found as fatalities at Manzanita. This could reflect differences in habitat between the two facilities. Interestingly, greater roadrunners were reported as fatalities at both Manzanita and Pine Tree. Only 5 species of bird fatalities were common among all 3 sites: loggerhead shrike, mourning dove, yellow-

rumped warbler, western tanager, and Wilson's warbler, which was the most frequently found species at Dillon Wind-Energy Facility (Chatfield et al. 2009).

The majority of small bird fatalities were found during the spring migration period. This is similar to studies in other habitats throughout California (Chatfield et al. 2009, Tetra Tech 2013) but contrasts with another study in Kern County (BioResource Consultants Inc. 2010) that found the highest fatality rates of small birds during the fall migration period.

All 3 studies found low numbers of fatalities during summer. At Pine Tree only 2 bird fatalities (mourning dove and mountain quail) were found during the month of July; at Dillon a rock pigeon and a mourning dove were the only fatalities found; and at Manzana no bird fatalities were found during July.

Bat Fatalities

Bat fatality rates from wind facilities in California are generally lower than those reported from most other areas of North America (Arnett et al. 2008). The estimated bat fatality rate of 0.83 fatalities/MW/year is lower than other estimates of bat fatalities from wind energy facilities in California (Table 14). Bias-adjusted estimates of bat fatalities at other wind facilities in California range from 2.1–5.2 bats/MW/yr (Table 11). It is unclear why the adjusted bat fatality rate we estimated for Manzana was lower than other studies though carcass persistence rates may have played a role. Similar to other studies, the majority of bat fatalities were removed from study plots within a few days. However, there were 8 bat carcasses that persisted longer than 2 weeks which may have lengthened the tail of the distribution for proportion of carcasses persisting, thereby lower estimates of bat fatality relative to other sites in California. This is the third published study of bat and bird fatalities (Chatfield et al. 2009, BioResource Consultants Inc. 2010) from desert regions of California. To date, none of the studies have reported bat fatality rates comparable to other areas of North America where bat fatalities are a concern.

Species composition of bat fatalities at Manzana is similar to a growing body of knowledge from other wind facilities in California. Either hoary bats or Mexican free-tailed bats have been the most common bat species found as fatalities at every wind energy facility in California for which we have data (Kerlinger et al. 2006, 2009, 2010, Chatfield et al. 2009, WEST Inc. 2006, Tetra Tech 2013). Western red bats are also represented by a few individuals at many wind energy facilities in California (Kerlinger et al. 2006, 2009). Similar to other studies in California and throughout North America (Arnett et al. 2008) most bat fatalities at Manzana occurred during the fall migration season. Hoary bats and red bats are considered migratory tree bats and southern California has been proposed as a migration destination for these species (Cryan 2003). Mexican free-tailed bats are presumed to undertake only local, seasonal movements within California (Russell et al. 2005). However their occurrence as fatalities during the fall migration period raises questions about their migratory ecology. The occurrence of big brown bats as fatalities during summer may indicate that these were summer resident individuals. However with a sample size of three, conclusions about seasonality or ecology are premature.

Results of this study continue to contribute to our understanding of wind energy impacts to birds and bats in California. In addition, we believe they will help to improve the accuracy and efficiency of field and analytical methods for estimating fatalities of bats and birds at wind energy facilities.

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Table 3. Summary of bird and bat fatalities at the Manzana Wind Facility

Season	Dates	Weekly surveys	Daily Surveys	# Bird Species	# Bird fatalities	# Bat Species	# Bat fatalities
Spring	3/4 to 5/31	493	0	24	58	1	1
Summer	6/3 to 8/30	494	44	6	13	1	3
Fall	9/3 to 11/27	494	1069	9	23	3	12
Winter	12/2 to 2/28	450	0	5	13	0	0
Overall		1931	1113	29	107	4	16

Table 4. Raw number of fatalities of bats and birds found during fatality monitoring at Manzanita Wind Project, Kern County California 1 March- 31 December 2013 sorted by number of observations.

Species Common Name	Number of Fatalities	Seasons of Fatalities
BIRDS		
UNIDENTIFIED PASSERINE	22	Spring, Summer, Fall, Winter
WESTERN MEADOWLARK	14	Spring, Fall
UNIDENTIFIED WARBLER	10	Spring, Summer, Fall
MOURNING DOVE	9	Spring, Summer, Fall, Winter
HOUSE FINCH	4	Spring, Winter
UNIDENTIFIED SPARROW	4	Spring
HORNED LARK	3	Summer
LARK SPARROW	3	Spring, Summer, Fall
GREATER ROADRUNNER	3	Spring, Fall
LOGGERHEADED SHRIKE	3	Spring, Summer
ORANGE-CROWNED WARBLER	3	Spring
RED-TAILED HAWK	3	Spring, Winter
YELLOW-RUMPED WARBLER	3	Spring
FOX SPARROW	2	Spring, Fall
RUBY-CROWNED KINGLET	2	Spring, Fall
UNIDENTIFIED COLUMBIDAE (DOVE)	2	Spring
AMERICAN KESTREL	1	Spring
AMERICAN ROBIN	1	Spring
BARN OWL	1	Fall
BLACK-THROATED GRAY WARBLER	1	Spring
BULLOCK'S ORIOLE	1	Spring
EUROPEAN STARLING	1	Fall
HAMMOND'S FLYCATCHER	1	Spring
HERMIT WARBLER	1	Spring
MACGILLVRAI'S WARBLER	1	Spring
NORTHERN FLICKER	1	Fall
PACIFIC SLOPE FLYCATCHER	1	Fall
SWAINSON'S THRUSH	1	Spring
TOWNSEND'S WARBLER	1	Spring
UNIDENTIFIED CARPODACEUS FINCH	1	Spring
UNIDENTIFIED KINGLET (REGULUS SPP.)	1	Fall
WESTERN BLUEBIRD	1	Spring
WESTERN TANAGER	1	Spring
WHITE-CROWNED SPARROW	1	Spring
WILSON'S WARBLER	1	Spring
BATS		
HOARY BAT	8	Spring, Fall
MEXICAN FREE-TAILED BAT	4	Fall
BIG BROWN BAT	3	Summer
WESTERN RED BAT	1	Fall

Table 5. Raw number of bird and bat fatalities found during fatality monitoring at Manzanita Wind Project, Kern County California March 1, 2013 – February 28, 2014 summarized by species and month.

Order and Species	2013										2014		Total
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
Accipitriformes (Hawks and Eagles)													
Red-tailed Hawk			1							2			3
American Kestrel	1												1
Stringiformes (Owls)													
Barn Owl								1					1
Columbiformes (Doves and Pigeons)													
Mourning Dove	2	1	2	1		1	1			1			9
Cuculiformes (Cuckoos, Roadrunners)													
Greater Roadrunner	2								1				1
Piciformes (Woodpeckers)													
Northern Flicker								1					1
Passeriformes (Songbirds)													
American Robin		1											1
Black-throated Gray Warbler		1											1
Bullock's Oriole		1											1
European Starling						1							1
Fox Sparrow		1						1					2
Hammond's Flycatcher			1										1
Hermit Warbler			1										1
Horned Lark						2						1	3
House Finch	2									1	1		4
Lark Sparrow		1		1				1					3
Loggerheaded Shrike	2			1									3
MacGillivray's Warbler			1										1
Orange-crowned Warbler		3											3
Pacific-slope Flycatcher								1					1
Ruby-crowned Kinglet	1								1				2
Swainson's Thrush			1										1
Townsend's Warbler		1											1
Unidentified Carpodacus Finch		1											1
Unidentified Kinglet								1					1
Unidentified Passerine	1	2	3	3		1	5	2	1	2	1	2	23
Unidentified Sparrow		3	1										4
Unidentified Warbler		1	5	3			1						10
Western Bluebird		1											1
Western Meadowlark	5	2						3	2		2		14
Western Tanager			1										1
White-crowned Sparrow		1											1
Wilson's Warbler			1										1
Yellow-rumped Warbler	1	2											3
Bats (Chiroptera)													
Big Brown Bat				1	1	1							3
Western Red Bat							1						1
Hoary Bat		1					6	1					8
Mexican Free-tailed Bat							3	1					4
Month Total	17	24	18	10	1	6	17	13	5	6	4	3	124

Table 6. Distribution of distances of bird and bat fatalities from turbines at the Manzanita Wind Facility, Kern County, California.

Quadrant	% Bat (n=16)	% Small Bird (n=74)	% Medium Bird (n=26)
NE	12.5	10.8	34.6
SE	50.0	66.2	15.4
SW	31.3	6.8	15.4
NW	6.3	16.2	34.6
Distance to Turbine (m)			
0 – 20	25.0	2.7	0
21 – 40	56.3	13.5	26.9
41 – 60	18.8	45.9	50
61 – 80	0	36.5	19.2
>80	0	1.3	3.8

[illegible]

Table 8. Turbines surveyed and bias trials conducted, by date, at Manzanita Wind Facility, Kern County, California June 3, 2013-August 31, 2013. Calendar weeks are separated by gray shading and the number 1 indicates a survey was conducted. Purple highlighting indicates a carcass persistence (CP) trial, orange indicates two CP trials at the same turbine, light green indicates a searcher efficiency (SE) trial and light blue indicates both SE and CP trials at same turbine on the same date.

	D4	D8	E2	E6	E7	F5	F8	F9	G2	H1	H2	J2	K6	K8	L6	N4	N8	P1	P2	P4	Q1	R1	S2	S4	T3	T4	T7	T13	U1	U2	V5	V8	V9	V11	V14	V15	V16	W3		
6/1/2013																																								
6/2/2013																																								
6/3/2013	1																																							
6/4/2013		1																																						
6/5/2013			1																																					
6/6/2013				1																																				
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6/8/2013																																								
6/9/2013																																								
6/10/2013	1																																							
6/11/2013		1																																						
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6/27/2013				1																																				
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6/30/2013																																								
7/1/2013	1	1																																						
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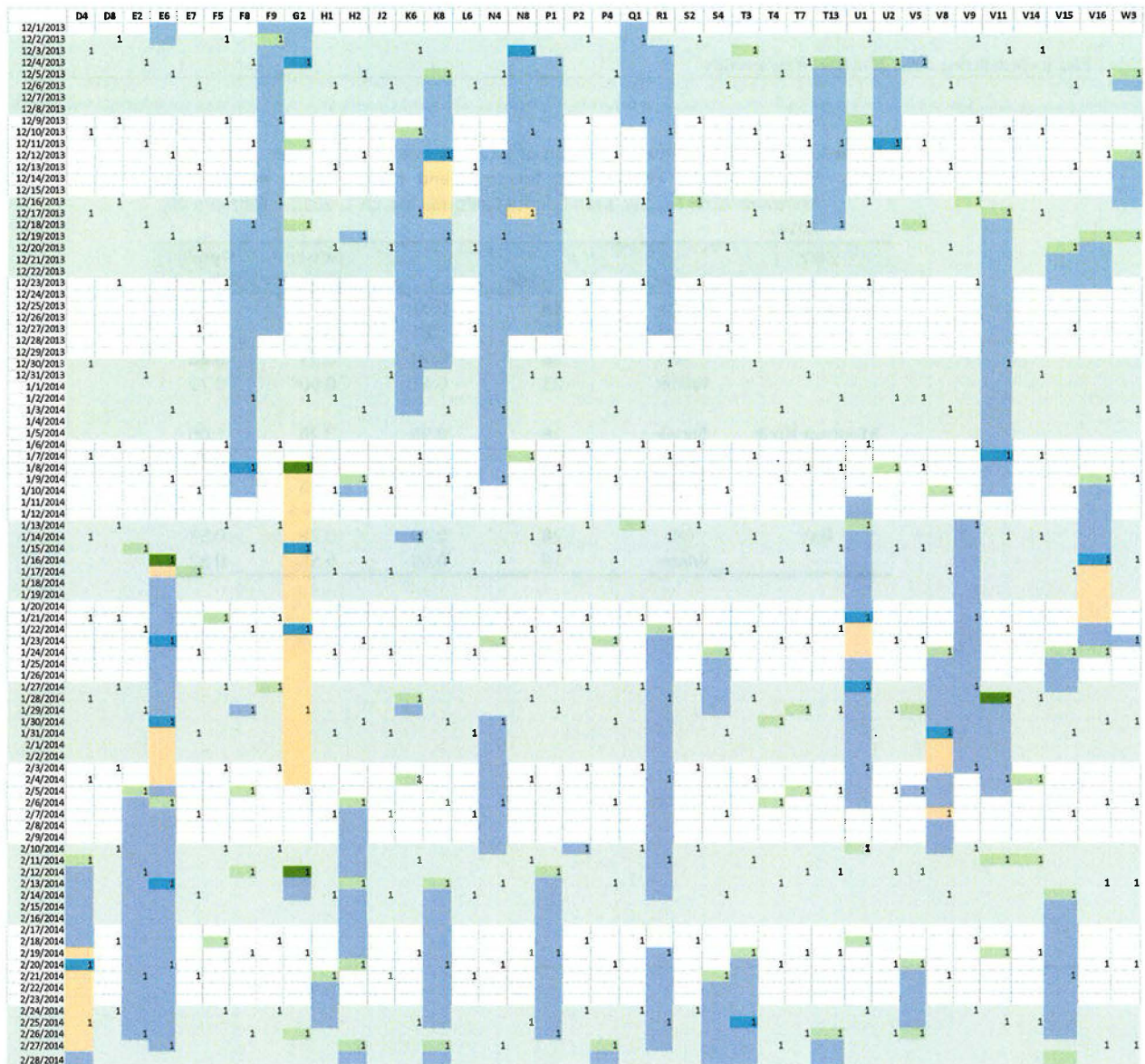


Table 11. Estimates of the proportion of fatalities remaining (*r*) after 7 days with 95% confidence intervals (CI) for small and medium birds and bats at Manzana Wind Facility, Kern County California March 1, 2013 – February 28, 2014.

Size	Season	# of Trials	r	Lower 95% CI	Upper 95% CI
Small Bird	Spring	39	0.81	0.70	0.90
	Summer	17	0.81	0.67	0.92
	Fall	36	0.70	0.59	0.80
	Winter	25	0.61	0.50	0.71
Medium Bird	Spring	16	0.90	0.76	1.00
	Fall	31	0.61	0.48	0.72
	Winter	23	0.61	0.45	0.75
Bat	Fall	28	0.40	0.26	0.53
	Winter	18	0.69	0.55	0.82

Table 12. Searcher efficiency (SE) estimates with 95% confidence intervals (CI) as a function of visibility class at the Manzanita Wind Facility, Kern County California March 1, 2013 – February 28, 2014

Size	Visibility Class	# Found	# Placed	SE	Lower 95% CI	Upper 95% CI
Small Bird	1	19	27	0.7	0.52	0.85
	2	36	56	0.64	0.52	0.77
	3	29	72	0.4	0.29	0.51
	4	19	51	0.37	0.24	0.51
Medium Bird	All	86	105	0.82	0.74	0.89
Bat	All	37	84	0.44	0.33	0.55

Table 13. Estimated fatality rates (mean and 95% confidence intervals [CI]) for small, medium, and large birds, and bats at the Manzanita Wind Facility, Kern County California March 1, 2013 – February 28, 2014. Estimates are adjusted for searcher efficiency, carcass persistence, and proportion of carcasses expected within search plots.

		Fatalities per Turbine			Total Annual Fatalities		
Size	# found	Estimate	Lower 95% CI	Upper 95% CI	Estimate	Lower 95% CI	Upper 95% CI
Small Bird	58	4.64	3.21	6.60	585	404	832
Medium Bird	15	0.81	0.56	1.11	103	70	140
Large Bird	3	0.23	0.06	0.50	29	7	63
Bat	14	1.25	0.9	1.83	158	113	231

Table 14. Comparison of adjusted fatality levels of small, medium, and large birds, and bats from the Manzana Wind Facility to other wind facilities in California

Site	County	Years	Small birds per MW/yr	Medium birds per MW/yr	Large birds per MW/yr	All Birds per MW/yr	Bats Per MW/yr	Citation
Manzana (this study)	Kern	2013-2014	3.09	0.54	0.15		0.83	
High Winds	Solano	2003-2005				2.65	3.91	1
Diablo Winds	Alameda	2005-2006	1.08		0.72			2
Shiloh I	Solano	2006-2009	4.86	1.89	0.21	6.96	3.92	3
Dillon	Riverside	2008-2009	4.26		0.46	4.71	2.17	4
Pine Tree	Kern	2009-2010	1.7	1.8	0.2	11.8		5
Shiloh II	Solano	2009-2010	0.81	0.7 ^a		1.51	2.72	6
Hatchet Ridge	Shasta	2011	2.03		0.47		2.23	7
Hatchet Ridge	Shasta	2012	0.31		0.52		5.22	7

Citations

1) Kerlinger et al. 2006; 2) WEST Inc. 2006; 3) Kerlinger et al. 2009; 4) Chatfield et al. 2009; 5) BioResource Consultants, Inc. 2010; 6) Kerlinger et al. 2010; 7) Tetra Tech 2013

^a Reported as medium/large birds



Figure 1. Manzanita Wind Project, Kern County, California, depicting locations of turbines, roads, and meteorological towers.

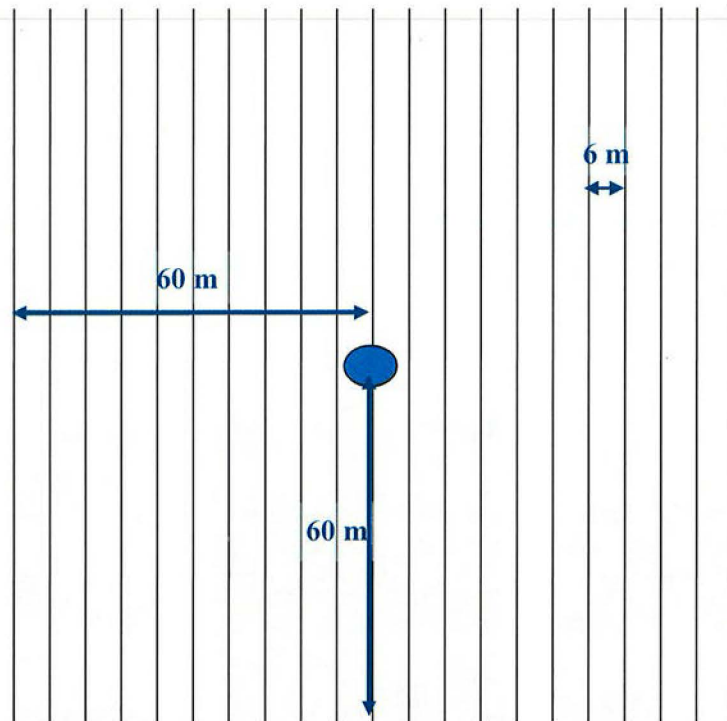


Figure 2. Illustration of a plot centered on a wind turbine and transects (vertical lines) searched for bird and bat fatalities at Manzana Wind Energy Project, Kern County, California.

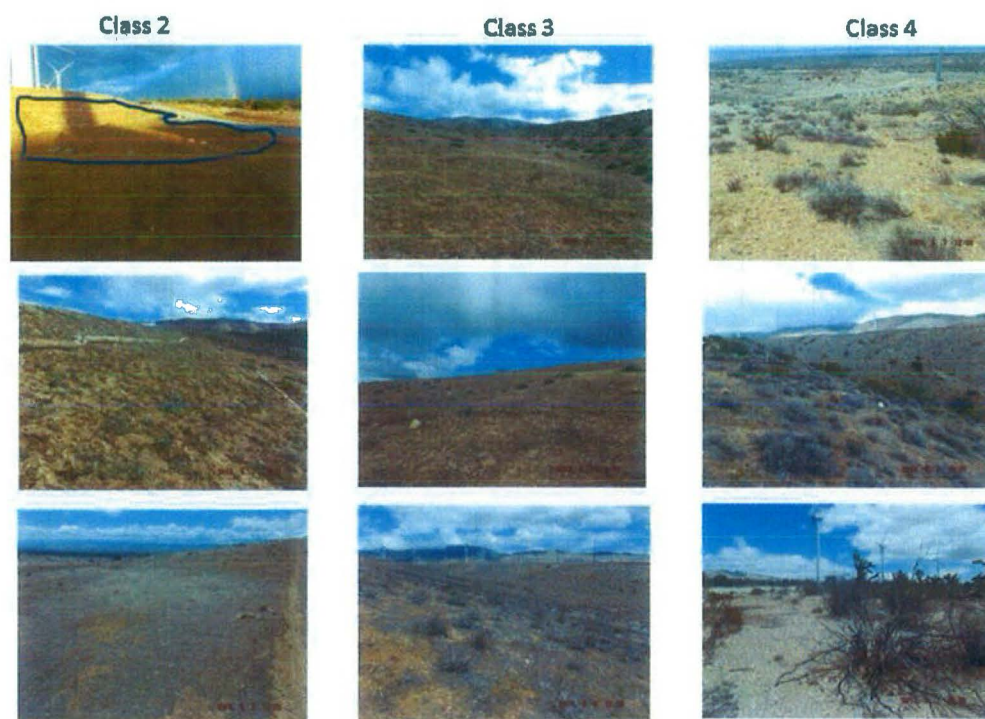


Figure 3. Examples of visibility classes used in turbine search plots at Manzana Wind Facility, Kern County, California. Visibility Class 1 was comprised by roads and turbine pads.

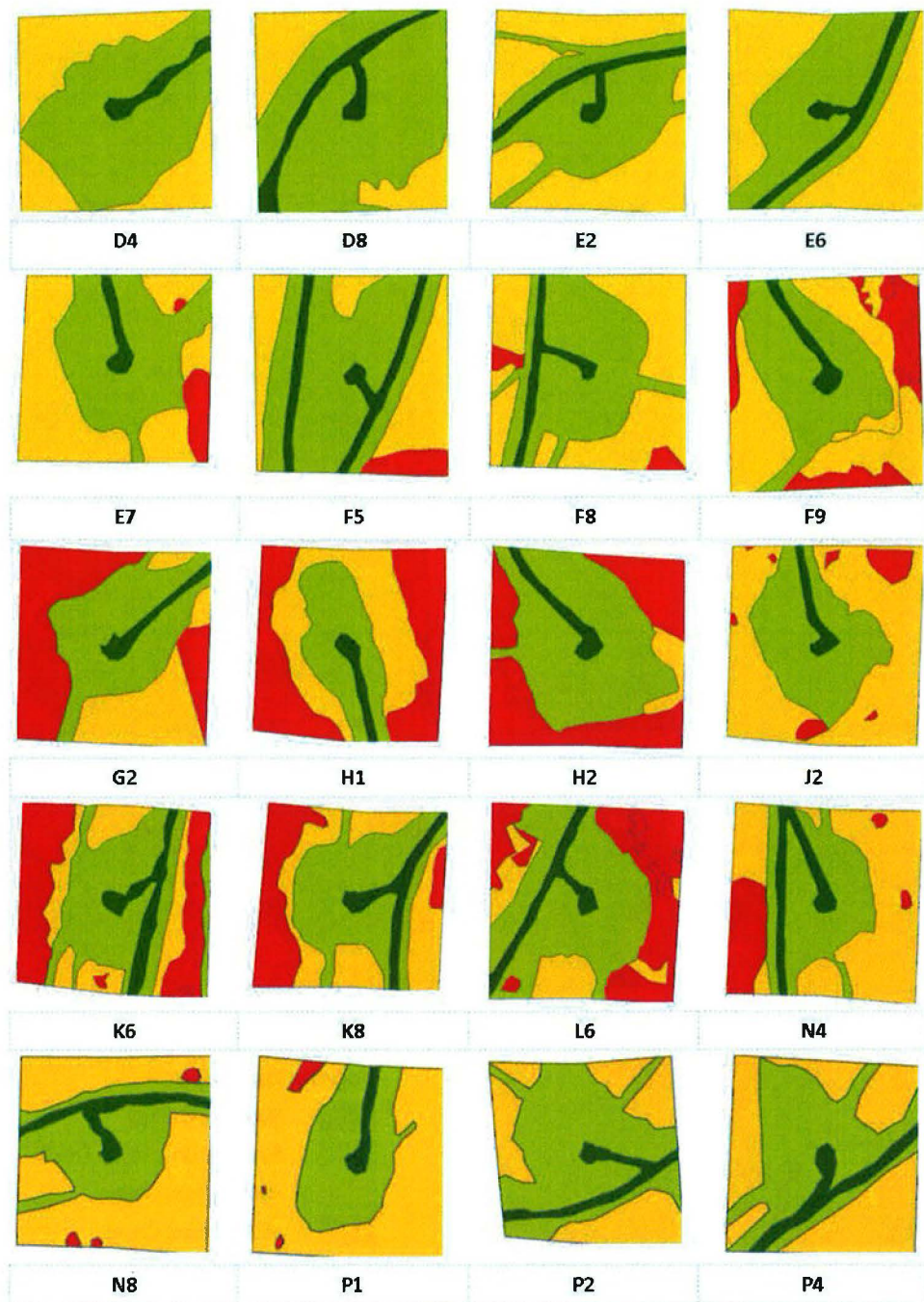


Figure 4. Mapped visibility classes for wind turbines searched for fatalities at Manzanita Wind Facility, Kern County, California. Class 1: dark green, Class 2: light green, Class 3: Red Class 4: yellow.

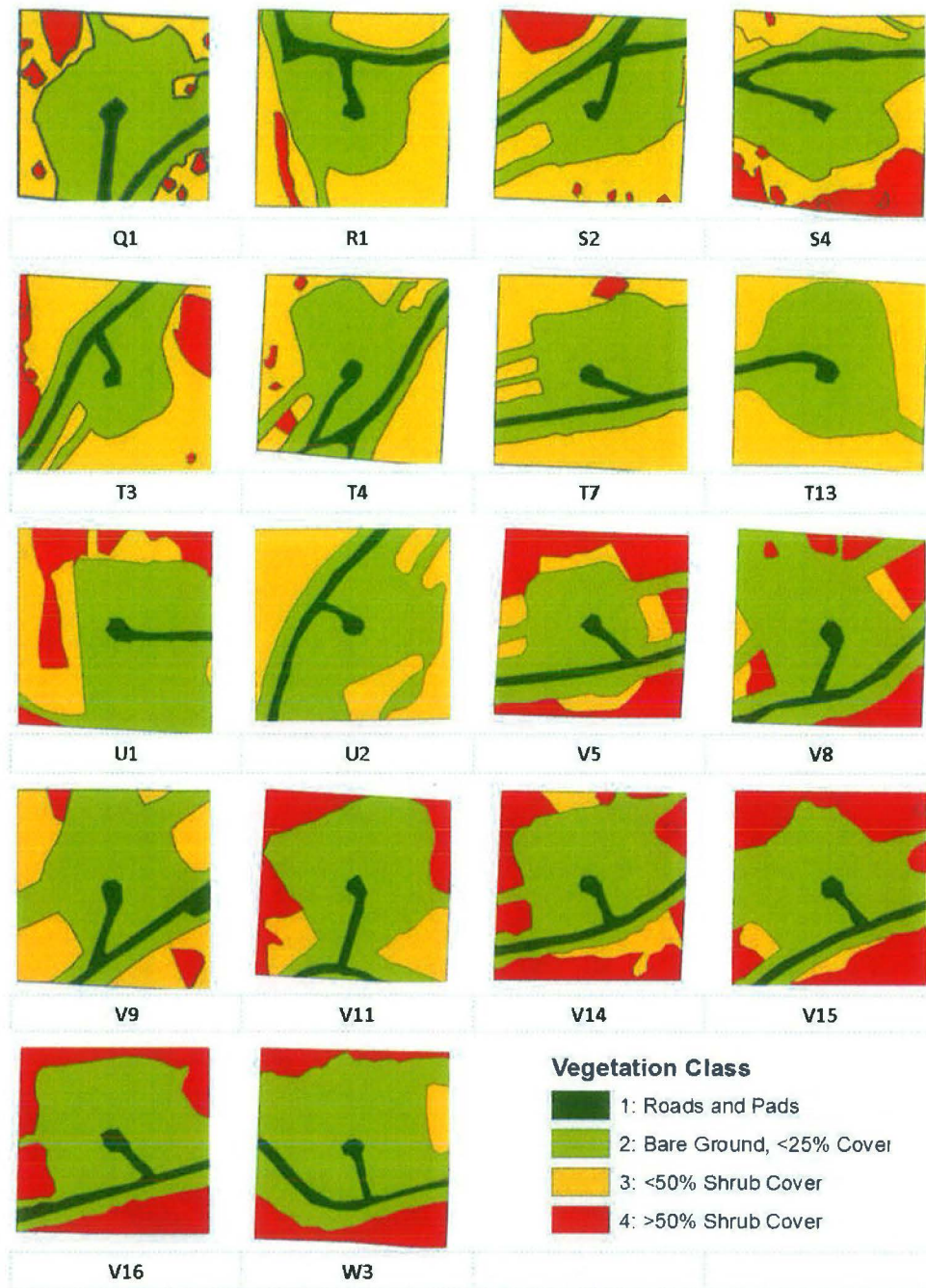


Figure 4 continued.

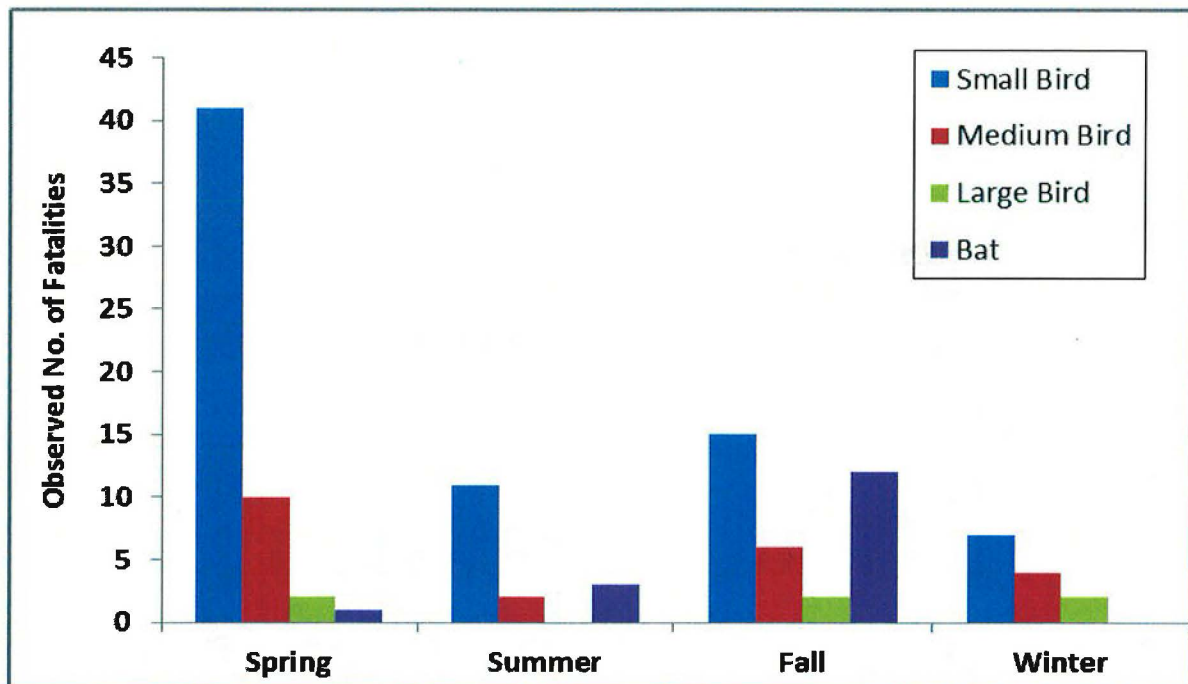


Figure 5. Number of observed fatalities by season at Manzanita Wind Facility, Kern County, California during standardized turbine searches March 1, 2013 – February, 28, 2014. Note that turbine surveys were conducted daily between September 3 – November 9, 2013 but weekly during all other periods.

Fatality Monitoring at the Manzana Wind Facility

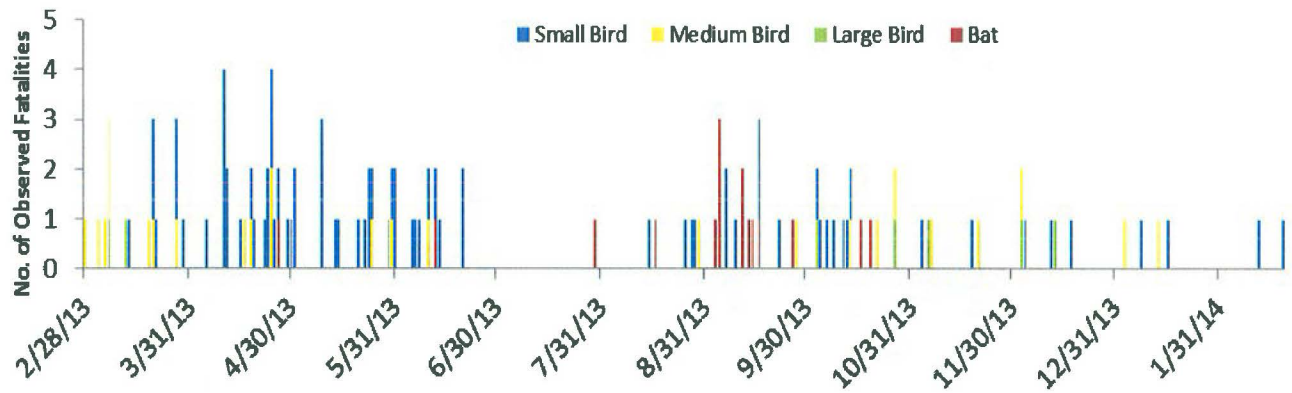


Figure 6. Temporal distribution of bat, and small, medium and large bird fatalities found at Manzana Wind Project, Kern County, California March 1, 2013 – February 28, 2014. Note that turbine surveys were conducted daily between September 3 – November 9, 2013 but weekly during all other periods.

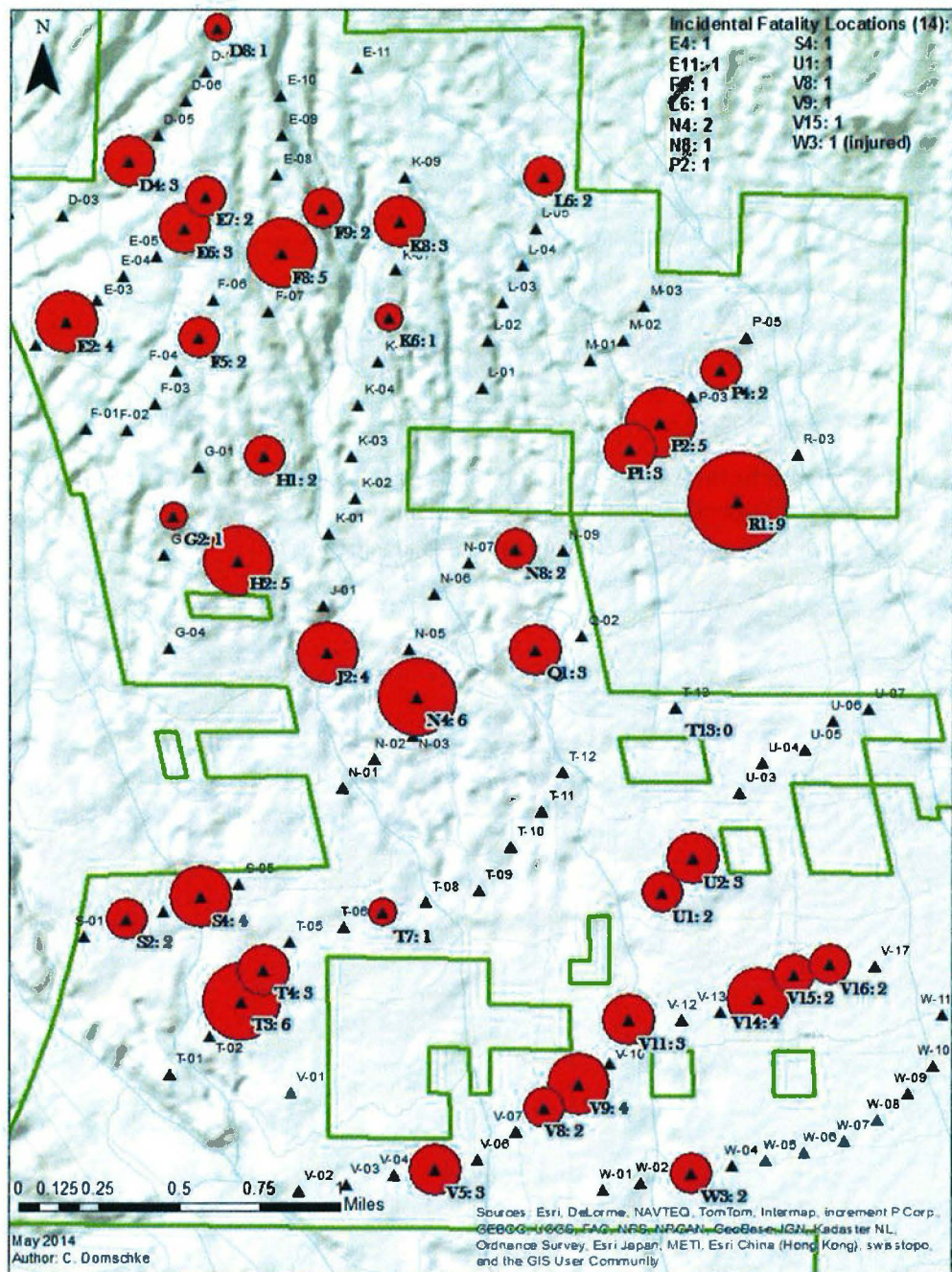


Figure 7. Spatial distribution of bat and bird fatalities found at Manzanita Wind Project, Kern County, California March 1, 2013 – February 28, 2014. Triangles without labels are unsearched turbines, those with labels present turbine number followed, after colon, by total number of fatalities observed.

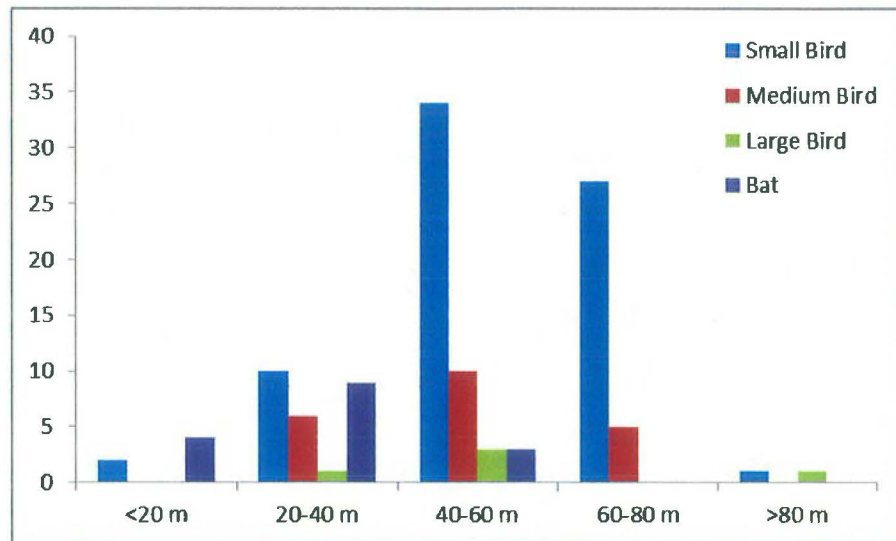


Figure 8. Distance from turbine where bat and bird fatalities were observed at Manzana Wind Facility, Kern County, California March 1, 2013 – February 28, 2014. Fatalities observed outside search plots but during standardized fatality searches are included

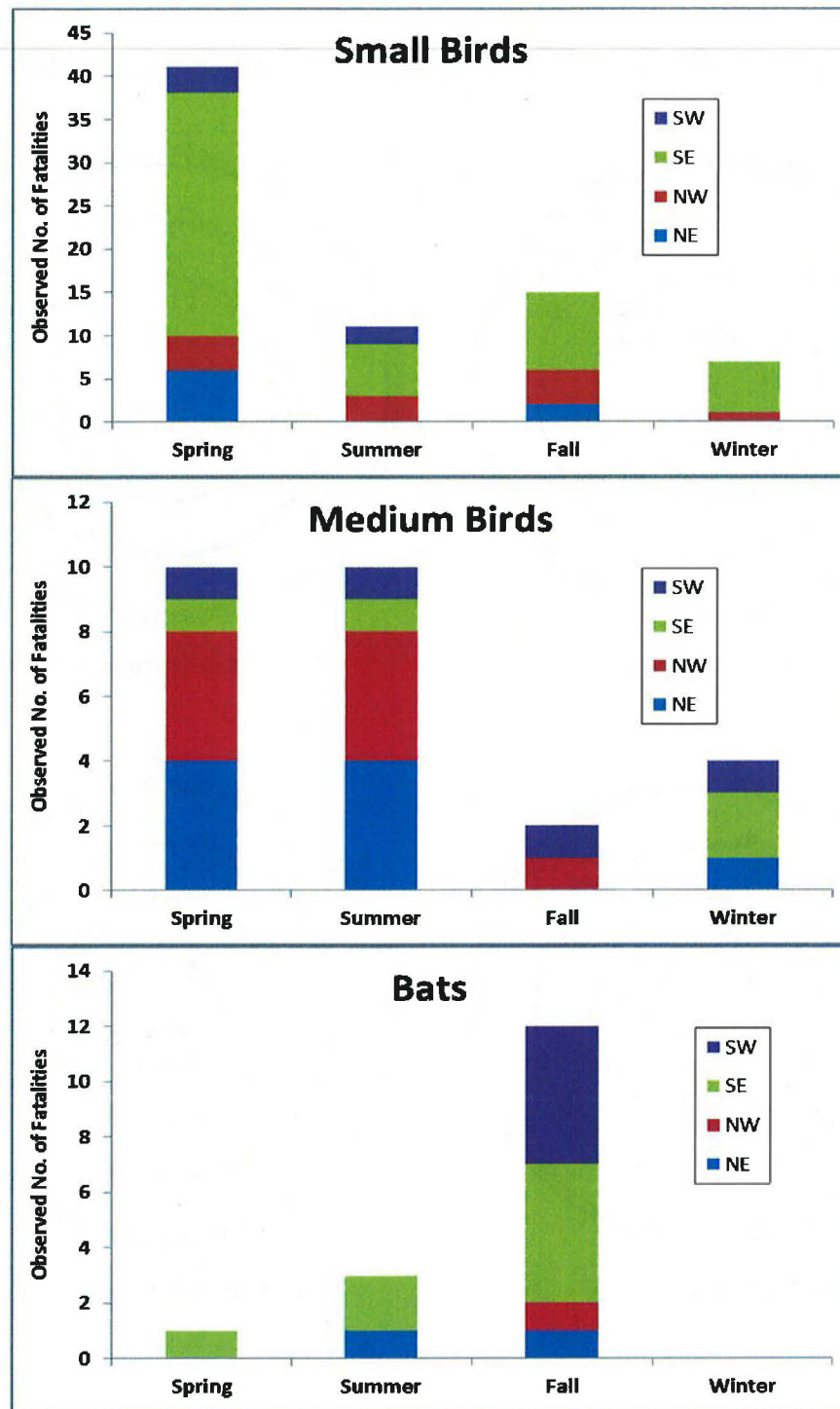


Figure 9. Number of observed fatalities by season and turbine search quadrant at the Manzanita Wind Facility, Kern County, California March 1, 2013 – February 28, 2014.

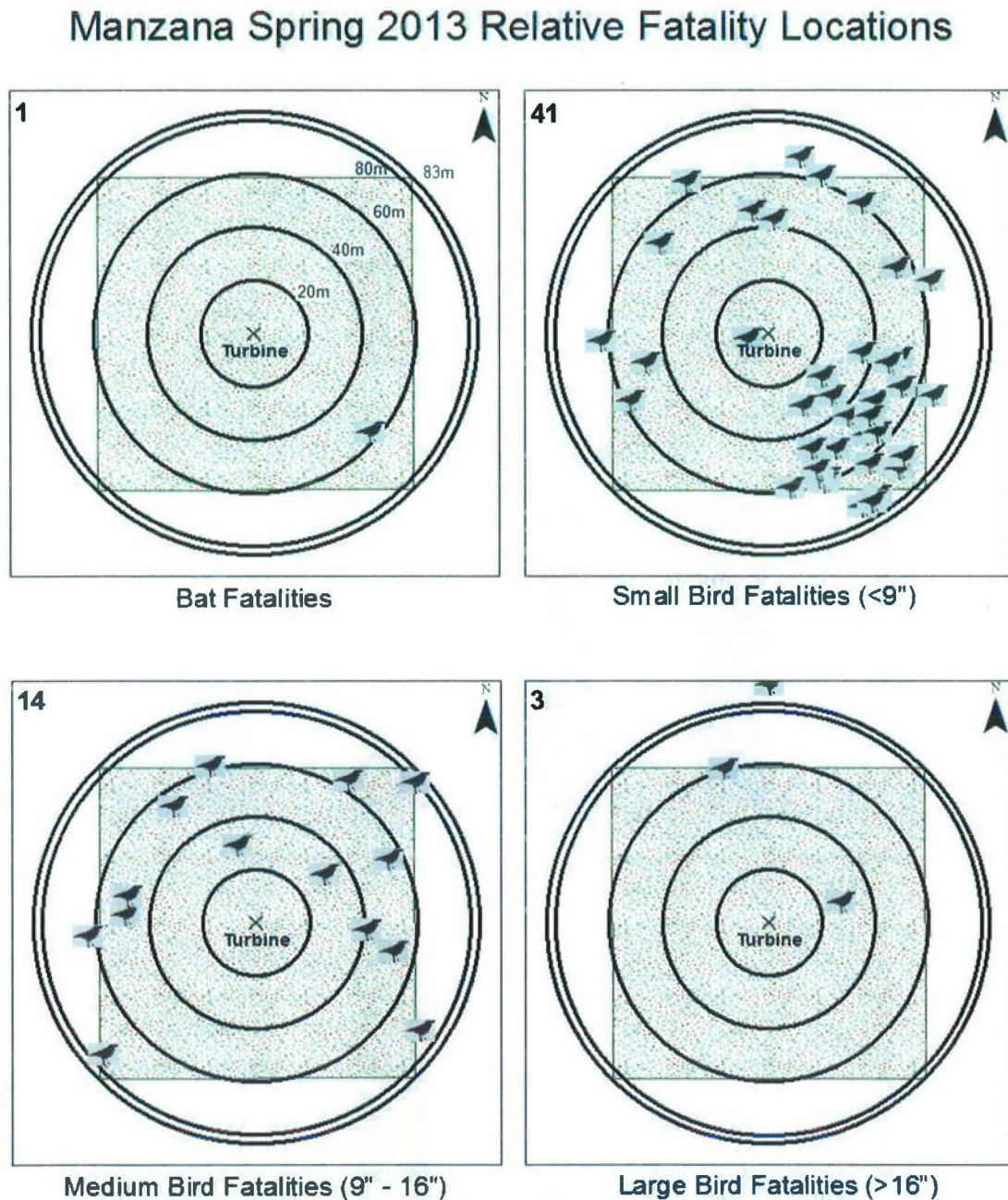


Figure 10. Location of fatalities, by size class, on search plots observed March 1 – May 31, 2013 at Manzanita Wind Facility, Kern County, California.

Manzanita Summer 2013 Relative Fatality Locations

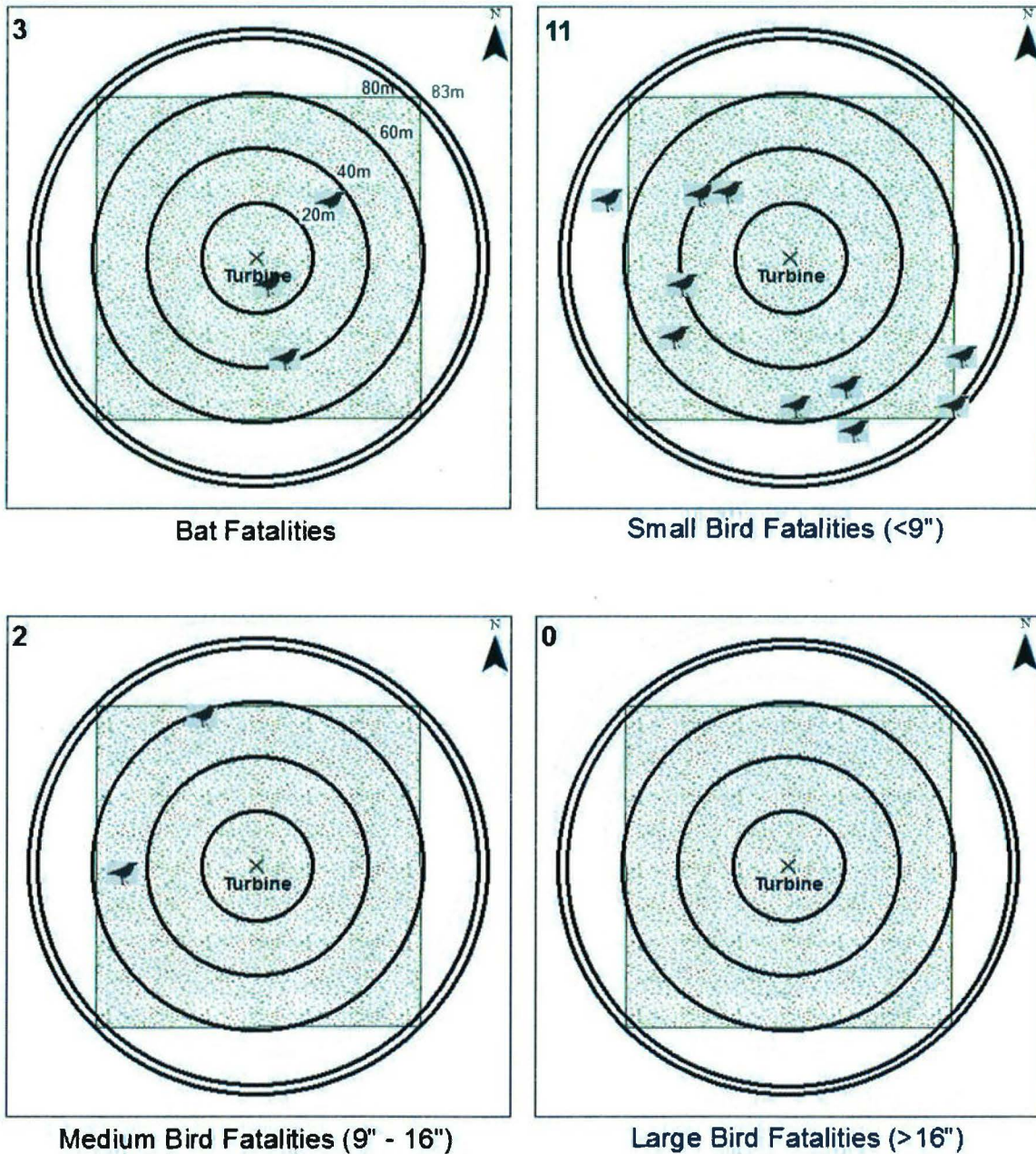


Figure 11. Location of fatalities, by size class, on search plots observed June 1 – Aug 31, 2013 at Manzanita Wind Facility, Kern County, California.

Manzanita Fall 2013 Relative Fatality Locations

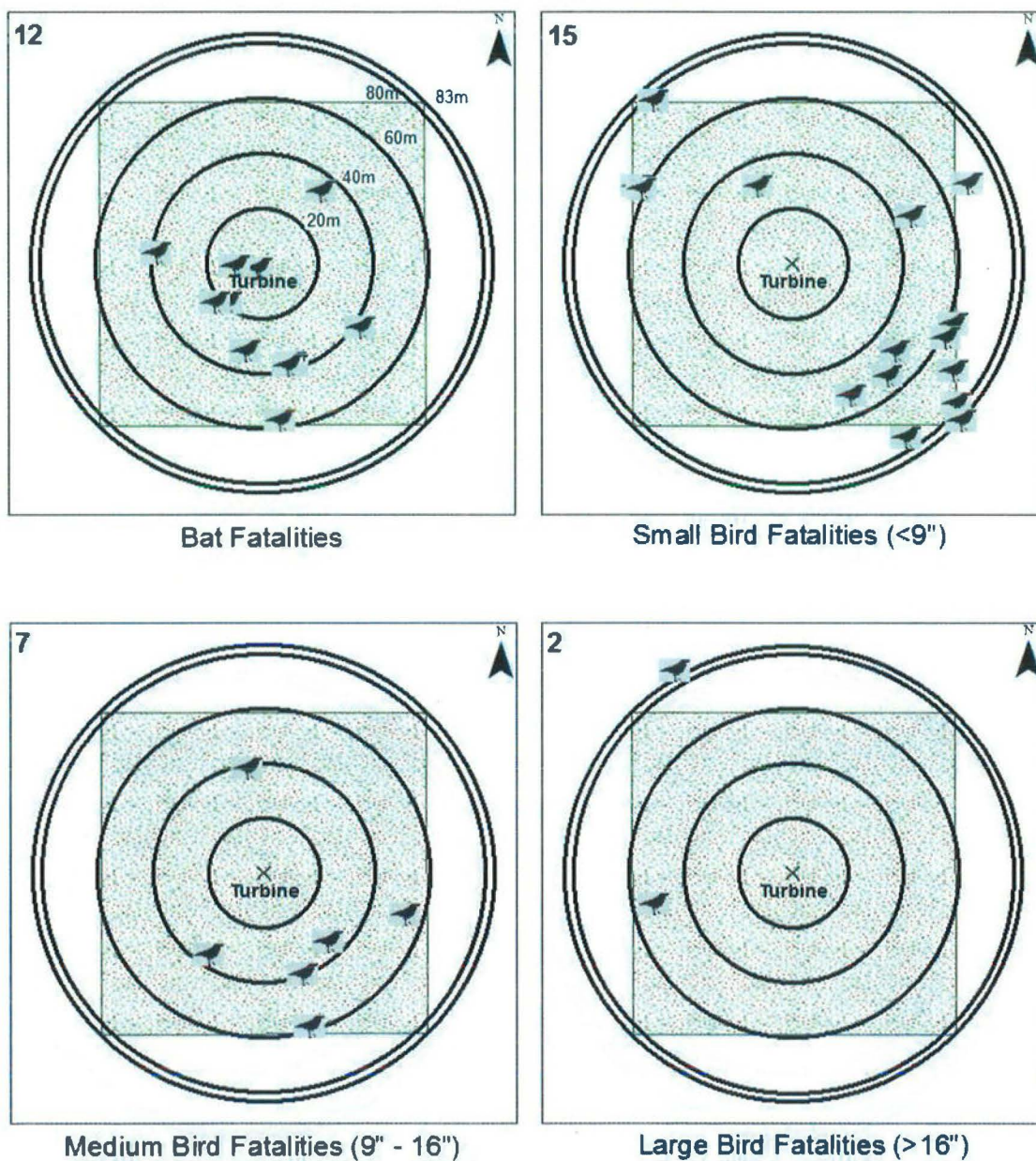


Figure 12. Location of fatalities, by size class, on search plots observed September 1 – November 30, 2013 at Manzanita Wind Facility, Kern County, California.

Manzanita Winter 2013/2014 Relative Fatality Locations

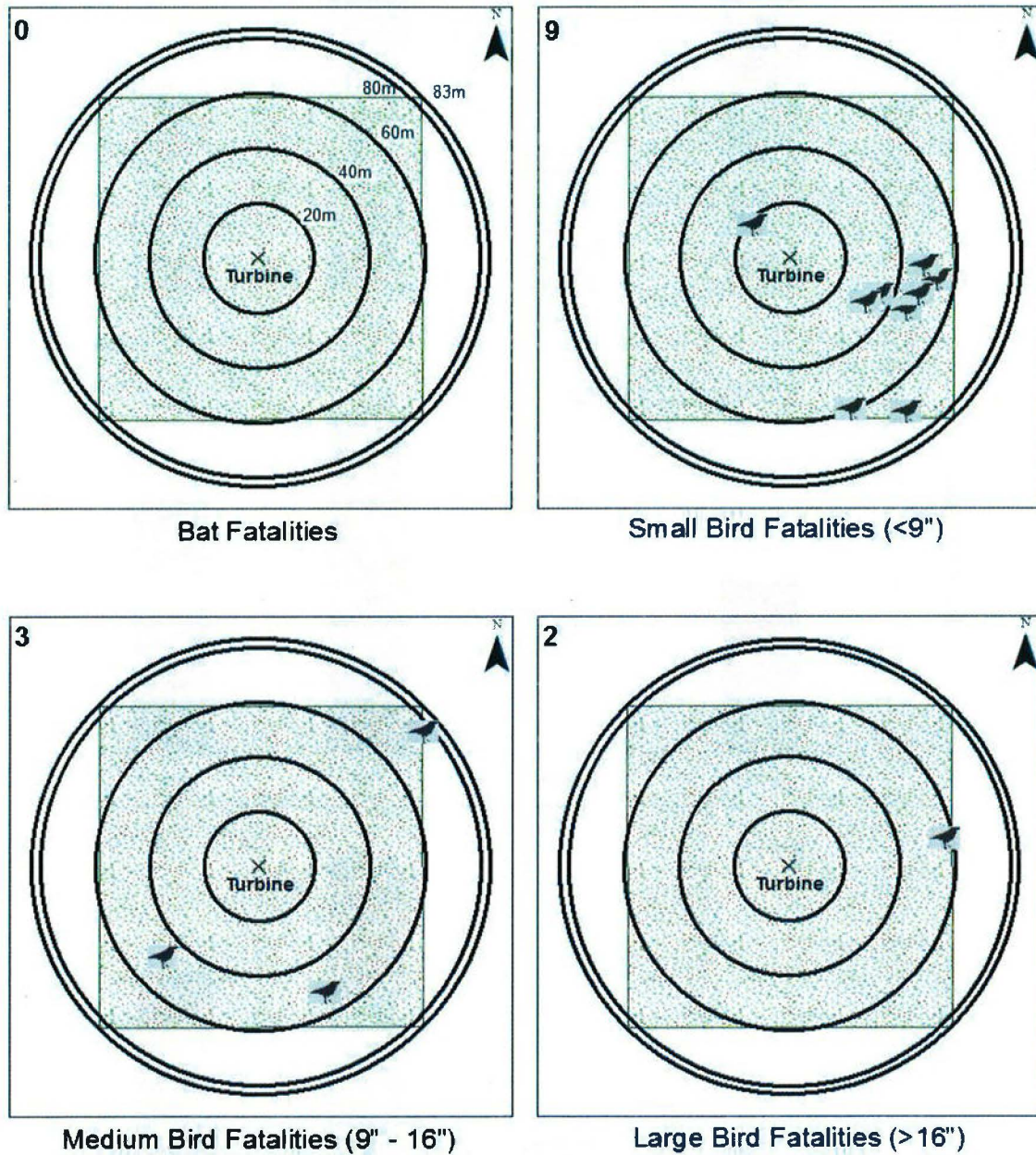


Figure 13. Location of fatalities, by size class, on search plots observed December 1, 2013 – February 28, 2014 at Manzanita Wind Facility, Kern County, California.

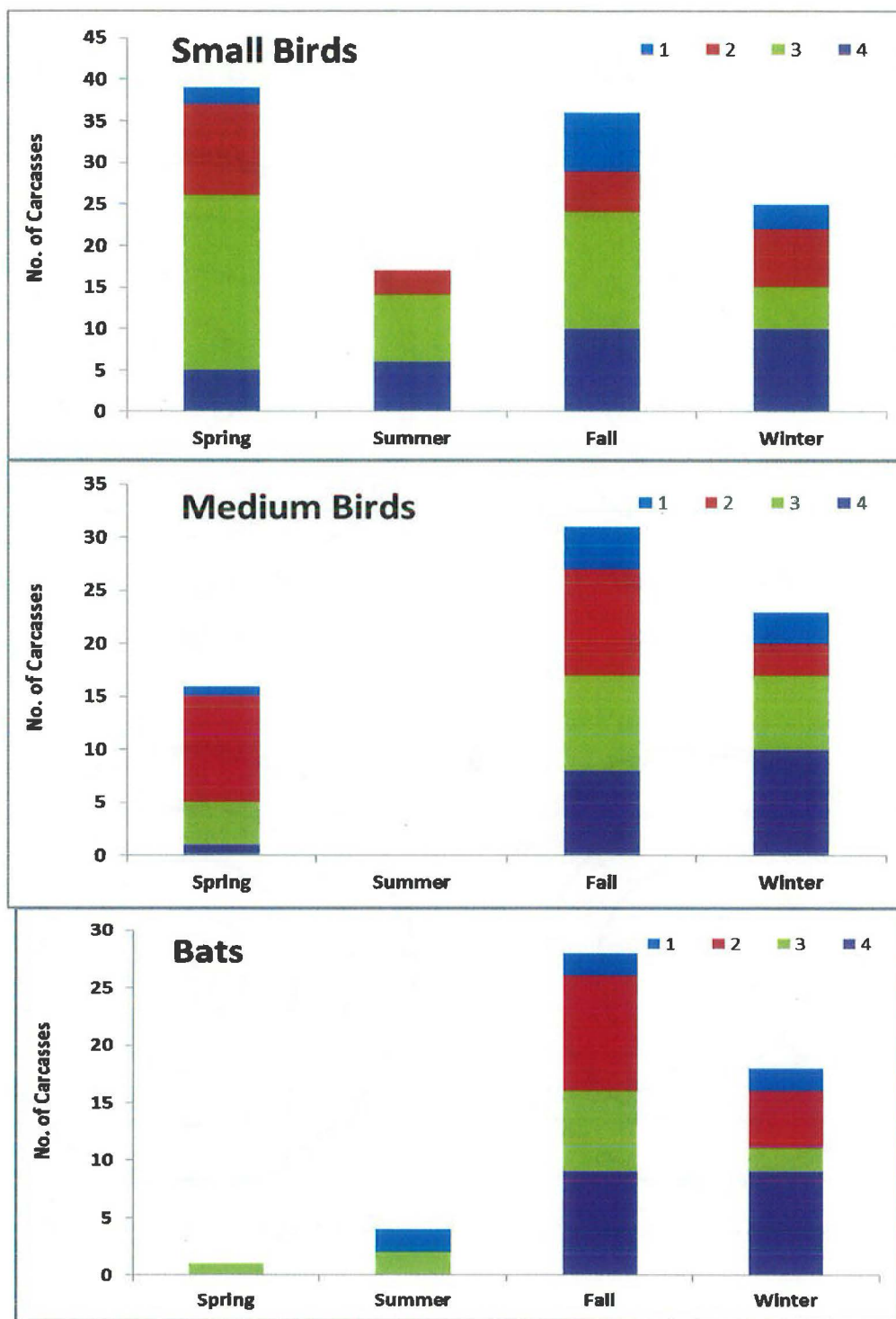


Figure 14. Number of carcasses placed, by season and visibility class, to inform estimation of carcass persistence at the Manzanita Wind Facility, Kern County, California March 1, 2013 – February 28, 2014.

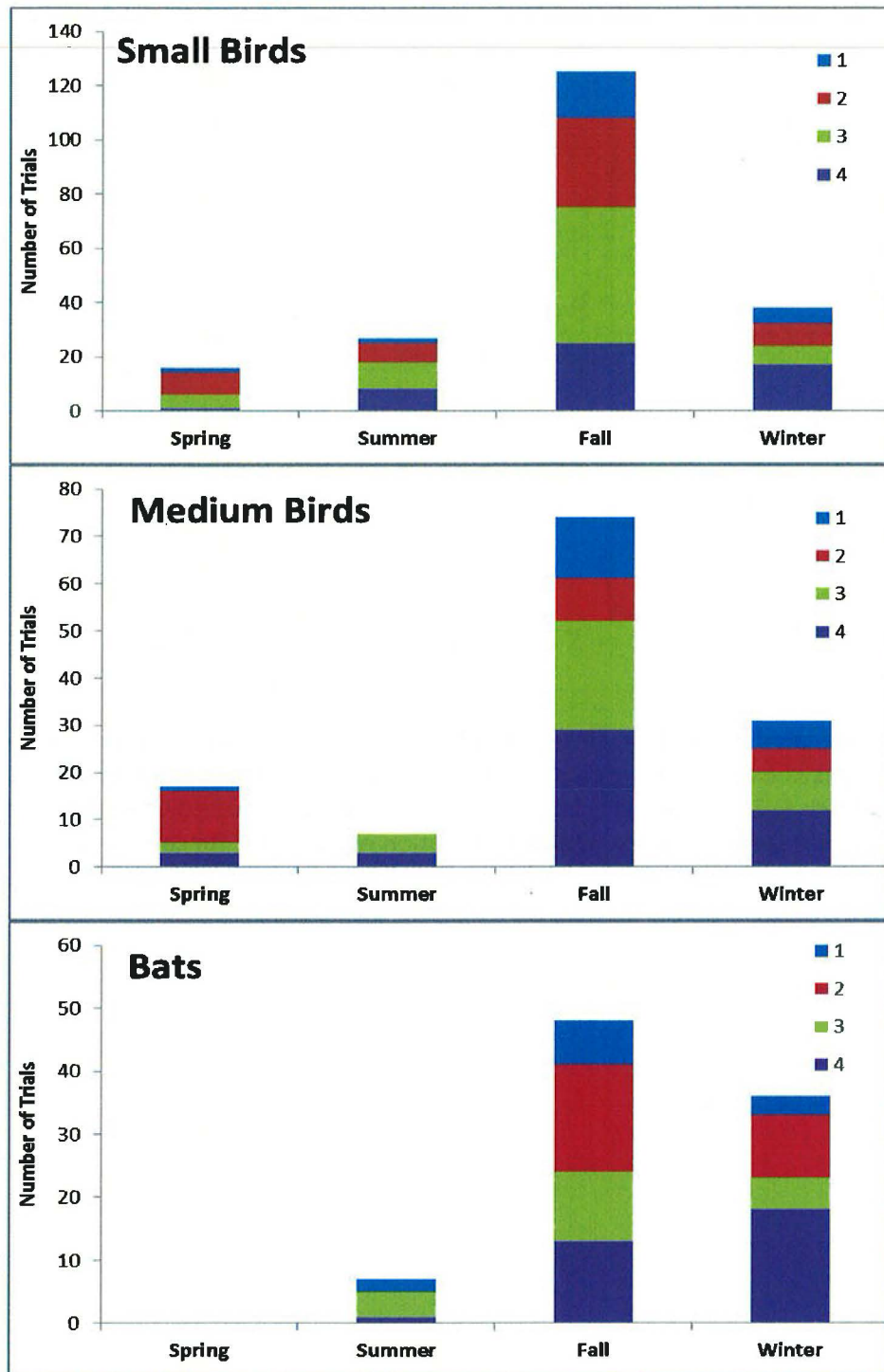


Figure 15. Number of searcher efficiency trials conducted by season and visibility-class at Manzanita Wind Energy Facility, Kern County, California March 1, 2013- February 28, 2014.

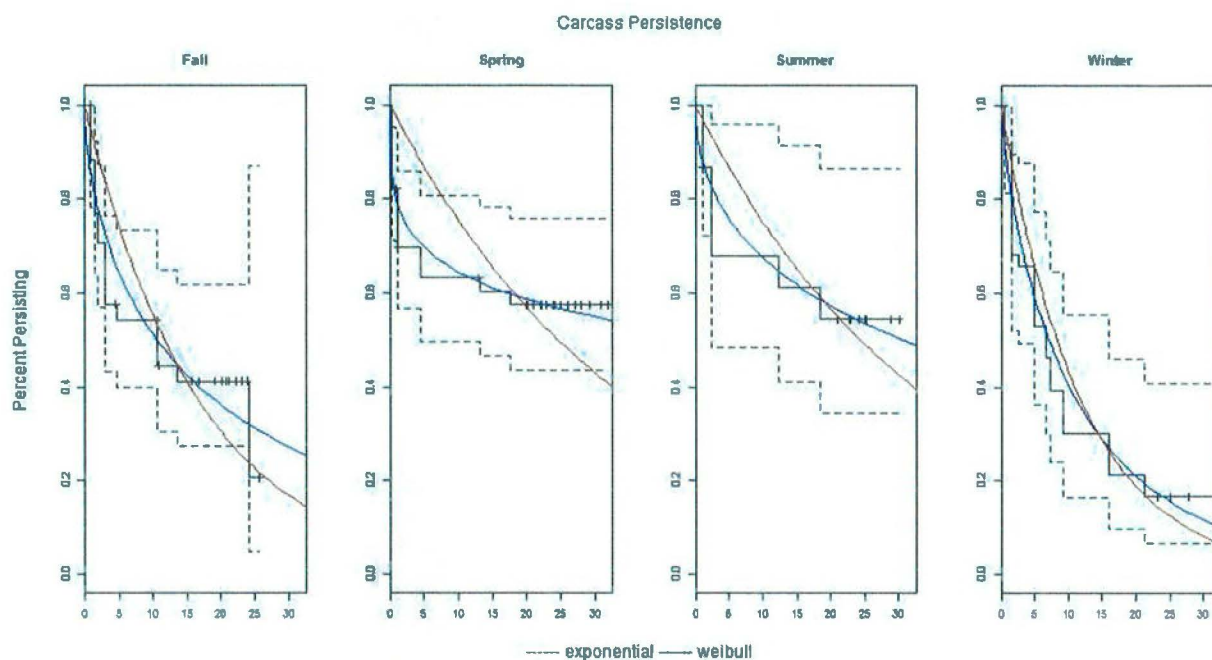


Figure 16. Estimated proportion, by season, of small bird carcasses persisting for a given number of days (x-axis) following placement at Manzanita Wind Energy Facility, Kern County, California March 1, 2013- February 28, 2014. Persistence was modeled using the Weibull distribution (blue curve). The exponential distribution is presented for comparison purposes only.

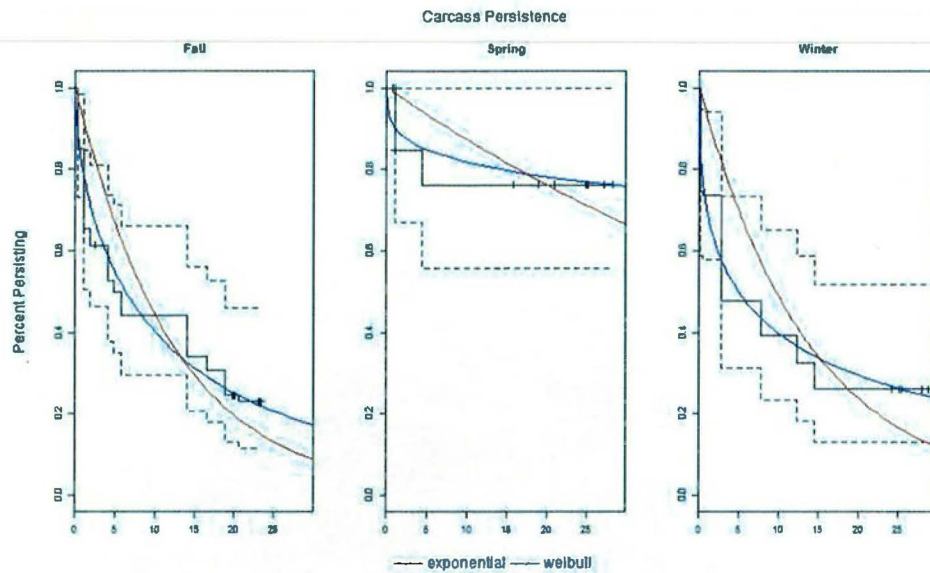


Figure 17. Estimated proportion, by season, of medium bird carcasses persisting for a given number of days (x-axis) following placement at Manzanita Wind Energy Facility, Kern County, California March 1, 2013- February 28, 2014. Persistence was modeled using the Weibull distribution (blue curve). The exponential distribution is presented for comparison purposes only.

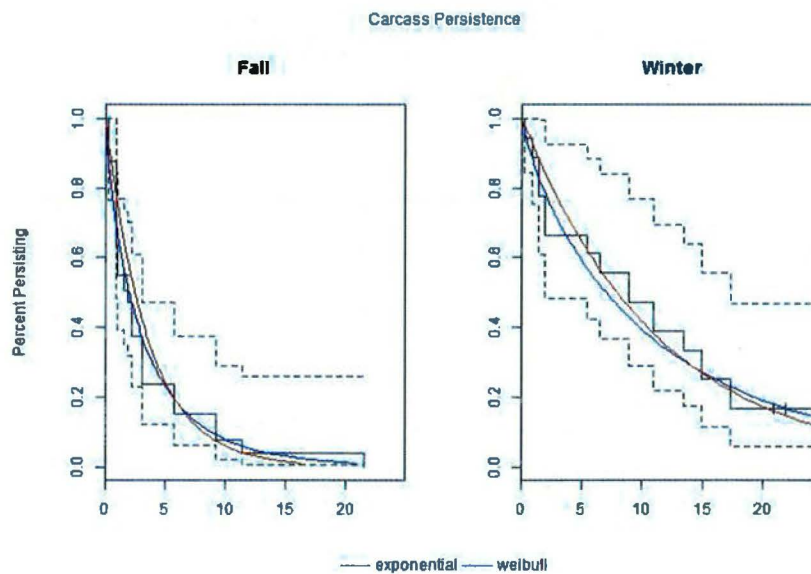


Figure 18. Estimated proportion, by season, of bat bird carcasses persisting for a given number of days (x-axis) following placement Manzanita Wind Energy Facility, Kern County, California September 1, 2013- February 28, 2014. Persistence was modeled using the Weibull distribution (blue curve). The exponential distribution is presented for comparison purposes only.

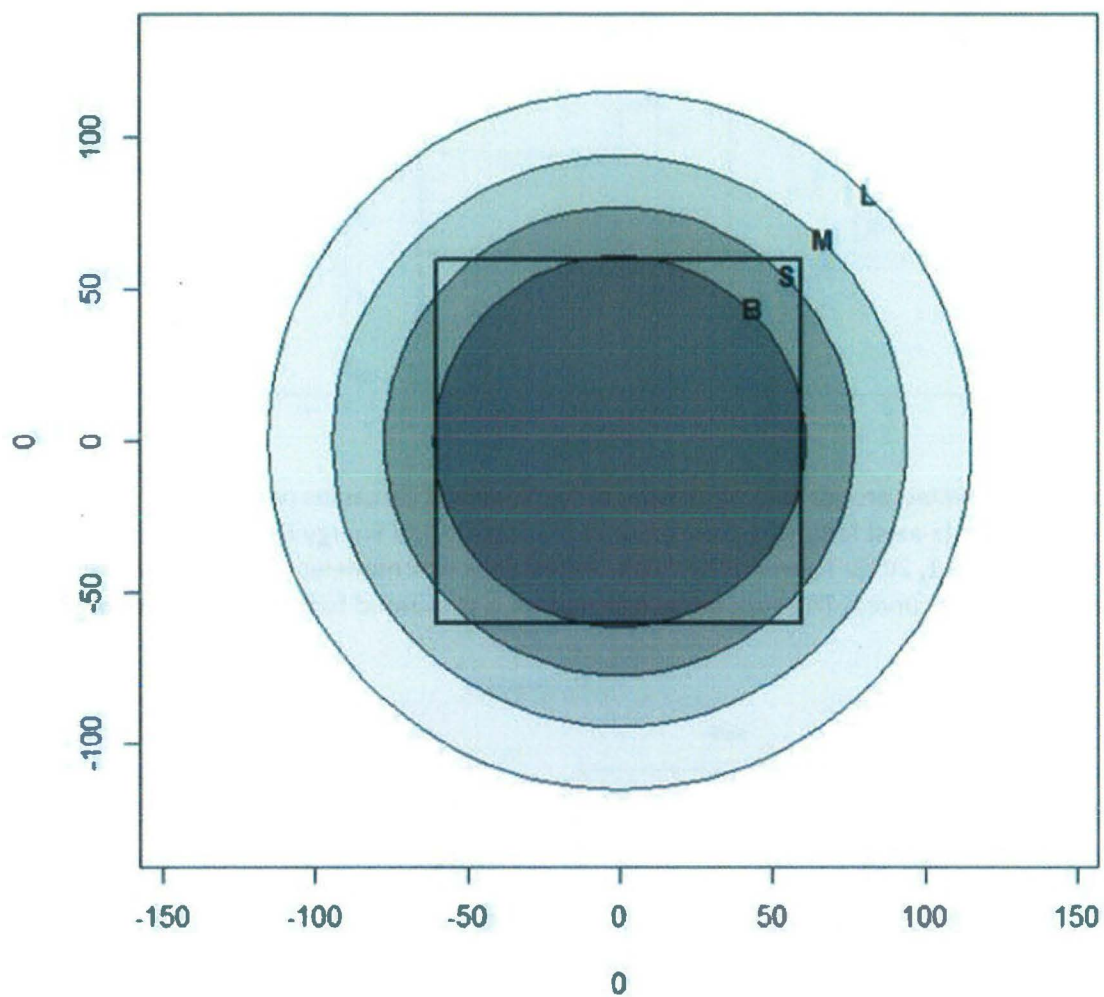


Figure 19. Search plot area (square box) relative to estimated maximum distance from turbine (0, 0 in figure) for bats (B), small birds (S), medium birds (M) and large birds (L) at Manzanita Wind Energy Facility, Kern County, California. Units of both axes are meters.

**Appendix A: Bird and Bat Fatalities Found During Year One of Fatality Monitoring Study
at the Manzana, Wind Facility, Kern County California**

Appendix 1: Complete list of fatalities from Manzanita Wind Energy Facility, Kern County, California 1 March – 31 December 2013.

#	Carcass ID	Species Name	Date Found	Carcass Condition	Disposition
1	20130228-WEME-U1-01	WESTERN MEADOWLARK	28-Feb-13	Feather spot	Left in place
2	20130304-AMKE-E6-01	AMERICAN KESTREL	04-Mar-13	Feather spot	Left in place
3	20130306-WEME-INCI-01	WESTERN MEADOWLARK	06-Mar-13	Feather spot	Left in place
4	20130307-GRRR-INCI-01	GREATER ROADRUNNER	07-Mar-13	Feather spot	Left in place
5	20130307-WEME-S4-01	WESTERN MEADOWLARK	07-Mar-13	Feather spot	Left in place
6	20130307-WEME-U1-01	WESTERN MEADOWLARK	07-Mar-13	Feather spot	Left in place
7	20130312-GRRR-G2-01	GREATER ROADRUNNER	12-Mar-13	Feather spot	Left in place
8	20130313-HOFI-R1-01	HOUSE FINCH	13-Mar-13	Dead, fresh (eyes moist)	Used in Research Trials
9	20130319-MODO-H2-01	MOURNING DOVE	19-Mar-13	Feather spot	Left in place
10	20130320-RCKI-P2-01	RUBY-CROWNED KINGLET	20-Mar-13	Dead, semi-fresh (eyes desiccated, rigor mortis)	Used in Research Trials
11	20130320-WEME-P2-02	WESTERN MEADOWLARK	20-Mar-13	Feather spot	Left in place
12	20130320-YRWA-R1-01	YELLOW-RUMPED WARBLER	20-Mar-13	Dead, semi-fresh (eyes desiccated, rigor mortis)	Left in place
13	20130322-LOSH-V14-01	LOGGERHEADED SHRIKE	22-Mar-13	Feather spot	Left in place
14	20130327-HOFI-R1-02	HOUSE FINCH	27-Mar-13	Feather spot	Left in place
15	20130327-MODO-P2-01	MOURNING DOVE	27-Mar-13	Feather spot	Left in place
16	20130327-UNPA-R1-01	UNIDENTIFIED PASSERINE	27-Mar-13	Feather spot	Left in place
17	20130329-LOSH-V14-01	LOGGERHEADED SHRIKE	29-Mar-13	Feather spot	Left in place
18	20130405-OCWA-R1-01	ORANGE-CROWNED WARBLER	05-Apr-13	Dead, fresh (eyes moist)	Left in place
19	20130410-LASP-S4-01	LARK SPARROW	10-Apr-13	Feather spot	Left in place
20	20130410-UCFI-V8-01	UNIDENTIFIED CARPODACEUS FINCH	10-Apr-12	Feather spot	Left in place
21	20130410-WCSP-INCI-01	WHITE-CROWNED SPARROW	10-Apr-13	Feather spot	Left in place
22	20130410-YRWA-U2-01	YELLOW-RUMPED WARBLER	10-Apr-13	Mummified	Left in place
23	20130411-BTYW-P4-01	BLACK-THROATED GRAY WARBLER	11-Apr-13	Dead, semi-fresh (eyes desiccated, rigor mortis)	Left in place
24	20130411-YRWA-Q1-01	YELLOW-RUMPED WARBLER	11-Apr-13	Dead, fresh (eyes moist)	Left in place
25	20130415-FOSP-F8-01	FOX SPARROW	15-Apr-13	Dead, semi-fresh (eyes desiccated, rigor mortis)	Left in place
26	20130416-WEME-D8-01	WESTERN MEADOWLARK	16-Apr-13	Feather spot	Left in place
27	20130418-AMRO-E6-01	AMERICAN ROBIN	18-Apr-13	Feather spot	Left in place
28	20130418-UNSP-P4-01	UNIDENTIFIED SPARROW	18-Apr-13	Feather spot	Left in place
29	20130419-UNPA-R1-01	UNIDENTIFIED PASSERINE	19-Apr-13	Feather spot	Left in place
30	20130422-WEBL-V5-01	WESTERN BLUEBIRD	22-Apr-13	Feather spot	Left in place

31	20130423-UNPA-F9-01	UNIDENTIFIED PASSERINE	23-Apr-13	Feather spot	Left in place
32	20130423-UNWA-U2-01	UNIDENTIFIED WARBLER	23-Apr-13	Feather spot	Left in place
33	20130424-MODO-T3-01	MOURNING DOVE	24-Apr-13	Feather spot	Left in place
34	20130424-UNSP-INCI-01	UNIDENTIFIED SPARROW	24-Apr-13	Feather spot	Left in place
35	20130424-UNSP-K6-01	UNIDENTIFIED SPARROW	24-Apr-13	Feather spot	Left in place
36	20130424-WEME-P2-01	WESTERN MEADOWLARK	24-Apr-13	Feather spot	Left in place
37	20130425-BUOR-V15-01	BULLOCK'S ORIOLE	25-Apr-13	Feather spot	Left in place
38	20130426-LACI-T7-01	LASIURUS CINEREUS	26-Apr-13	Dead, fresh (eyes moist)	Left in place
39	20130426-OCWA-V16-01	ORANGE-CROWNED WARBLER	26-Apr-13	Mummified	Left in place
40	20130429-TOWA-N4-01	TOWNSEND'S WARBLER	29-Apr-13	Dead, fresh (eyes moist)	Left in place
41	20130430-OCWA-S4-01	ORANGE-CROWNED WARBLER	30-Apr-13	Feather spot	Left in place
42	20130501-UNPA-V14-01	UNIDENTIFIED PASSERINE	01-May-13	Feather spot	Left in place
43	20130501-WETA-F9-01	WESTERN TANAGER	01-May-13	Feather spot	Left in place
44	20130509-HAFL-K8-01	HAMMOND'S FLYCATCHER	09-May-13	Dead, semi-fresh (eyes desiccated, rigor mortis)	Left in place
45	20130509-UNSP-T4-01	UNIDENTIFIED SPARROW	09-May-13	Feather spot	Left in place
46	20130509-UNWA-H2-01	UNIDENTIFIED WARBLER	09-May-13	Feather spot	Left in place
47	20130513-UNWA-INCI-01	UNIDENTIFIED WARBLER	13-May-13	Mummified	Left in place
48	20130514-UNWA-U2-01	UNIDENTIFIED WARBLER	14-May-13	Feather spot	Left in place
49	20130520-SWTH-N4-01	SWAINSON'S THRUSH	20-May-13	Feather spot	Left in place
50	20130522-MGWA-V14-01	MACGILLVRAI'S WARBLER	22-May-13	Dead, fresh (eyes moist)	Left in place
51	20130523-HEWA-E6-01	HERMIT WARBLER	23-May-13	Dead, semi-fresh (eyes desiccated, rigor mortis)	Left in place
52	20130523-UNWA-H2-01	UNIDENTIFIED WARBLER	23-May-13	Feather spot	Left in place
53	20130524-MODO-E7-01	MOURNING DOVE	24-May-13	Feather spot	Left in place
54	20130524-WIWA-W3-01	WILSON'S WARBLER	24-May-13	Dead, fresh (eyes moist)	Left in place
55	20130529-RTHA-INCI-01	RED-TAILED HAWK	29-May-13	Dead, fresh (eyes moist)	Left in place
56	20130530-MODO-T3-01	MOURNING DOVE	30-May-13	Feather spot	Left in place
57	20130530-UNPA-K8-01	UNIDENTIFIED PASSERINE	30-May-13	Feather spot	Left in place
58	20130531-UNPA-E7-01	UNIDENTIFIED PASSERINE	31-May-13	Feather spot	Left in place
59	20130531-UNWA-J2-01	UNIDENTIFIED WARBLER	31-May-13	Feather spot	Left in place
60	20130605-UNWA-P2-01	UNIDENTIFIED WARBLER	05-Jun-13	Feather spot	Left in place
61	20130606-UNPA-T4-01	UNIDENTIFIED PASSERINE	06-Jun-13	Feather spot	Left in place
62	20130607-UNPA-R1-01	UNIDENTIFIED PASSERINE	07-Jun-13	Feather spot	Left in place

63	20130610-MODO-D4-01	MOURNING DOVE	10-Jun-13	Feather spot	Left in place
64	20130610-UNWA-F8-01	UNIDENTIFIED WARBLER	10-Jun-13	Feather spot	Left in place
65	20130612-EPFU-V9-01	EPTESICUS FUSCUS	12-Jun-13	Articulated skeletal	Left in place
66	20130612-UNPA-H1-01	UNIDENTIFIED PASSERINE	12-Jun-13	Feather spot	Left in place
67	20130613-UNWA-H2-01	UNIDENTIFIED WARBLER	13-Jun-13	Feather spot	Left in place
68	20130620-LASP-H2-01	LARK SPARROW	20-Jun-13	Dead, semi-fresh (eyes desiccated, rigor mortis)	Left in place
69	20130620-LOSH-V11-01	LOGGERHEADED SHRIKE	20-Jun-13	Feather spot	Left in place
70	20130729-EPFU-D4-01	EPTESICUS FUSCUS	29-Jul-13	Dead, semi-fresh (eyes desiccated, rigor mortis)	Left in place
71	20130814-UNPA-INCI-01	UNIDENTIFIED PASSERINE	14-Aug-13	Feather spot	Left in place
72	20130816-EPFU-INCI-01	EPTESICUS FUSCUS	16-Aug-13	Dead, fresh (eyes moist)	Used in Research Trials
73	20130827-HOLA-E2-01	HORNED LARK	27-Aug-13	Feather spot	Left in place
74	20130828-HOLA-S4-01	HORNED LARK	28-Aug-13	Feather spot	Left in place
75	20130829-MODO-K8-01	MOURNING DOVE	29-Aug-13	Feather spot	Left in place
76	20130903-LABL-F5-01	LASIURUS BLOSSEVILLII	03-Sep-13	Mummified	Used in Research Trials
77	20130904-LACI-L6-01	LASIURUS CINEREUS	04-Sep-13	Dead, fresh (eyes moist)	Used in Research Trials
78	20130904-LACI-Q1-01	LASIURUS CINEREUS	04-Sep-13	Dead, fresh (eyes moist)	Used in Research Trials
79	20130904-TABR-V16-01	TADARIDA BRASILIENSIS	04-Sep-13	Dead, fresh (eyes moist)	Used in Research Trials
80	20130906-UNPA-INCI-01	UNIDENTIFIED PASSERINE	06-Sep-13	Feather spot	Left in place
81	20130906-UNPA-V11-01	UNIDENTIFIED PASSERINE	06-Sep-13	Feather spot	Freezer on site
82	20130909-UNPA-P1-01	UNIDENTIFIED PASSERINE	09-Sep-13	Feather spot	Freezer on site
83	20130911-LACI-E2-01	LASIURUS CINEREUS	11-Sep-13	Dead, fresh (eyes moist)	Used in Research Trials
84	20130911-LACI-V11-01	LASIURUS CINEREUS	11-Sep-13	Dead, fresh (eyes moist)	Used in Research Trials
85	20130913-LACI-INCI-01	LASIURUS CINEREUS	13-Sep-13	Dead, fresh (eyes moist)	Used in Research Trials
86	20130914-LACI-J2-01	LASIURUS CINEREUS	14-Sep-13	Mummified	Used in Research Trials
87	20130916-TABR-H1-01	TADARIDA BRASILIENSIS	16-Sep-13	Dead, fresh (eyes moist)	Used in Research Trials
88	20130916-UNPA-F5-01	UNIDENTIFIED PASSERINE	16-Sep-13	Feather spot	Left in place
89	20130916-UNWA-T3-01	UNIDENTIFIED WARBLER	17-Sep-13	Feather spot	Freezer on site
90	20130922-UNPA-D4-01	UNIDENTIFIED PASSERINE	22-Sep-13	Feather spot	Freezer on site

91	20130926-TABR-J2-01	TADARIDA BRASILIENSIS	26-Sep-13	Dead, fresh (eyes moist)	Used in Research Trials
92	20130927-MODO-S2-01	MOURNING DOVE	27-Sep-13	Broken up	Used in Research Trials
93	20131003-FOSP-INCI-02	FOX SPARROW	03-Oct-13	Dead, semi-fresh (eyes desiccated, rigor mortis)	Used in Research Trials
94	20131003-NOFL-INCI-01	NORTHERN FLICKER	03-Oct-13	Broken up	Used in Research Trials
95	20131004-UNPA-J2-01	UNIDENTIFIED PASSERINE	04-Oct-13	Feather spot	Left in place
96	20131006-LASP-S2-01	LARK SPARROW	06-Oct-13	Feather spot	Freezer on site
97	20131008-PSFL-N8-01	PACIFIC SLOPE FLYCATCHER	08-Oct-13	Dead, fresh (eyes moist)	Used in Research Trials
98	20131011-EUST-E2-01	EUROPEAN STARLING	11-Oct-13	Feather spot	Freezer on site
99	20131012-UNPA-INCI-01	UNIDENTIFIED PASSERINE	12-Oct-13	Feather spot	Freezer on site
100	20131013-UNKI-T4-01	UNIDENTIFIED KINGLET (REGULUS SPP.)	13-Oct-13	Broken up	Used in Research Trials
101	20131013-WEME-V9-01	WESTERN MEADOWLARK	13-Oct-13	Feather spot	Used in Research Trials
102	20131016-TABR-F8-01	TADARIDA BRASILIENSIS	16-Oct-13	Dead, semi-fresh (eyes desiccated, rigor mortis)	Left in place
103	20131019-LACI-E2-01	LASIURUS CINEREUS	19-Oct-13	Dead, fresh (eyes moist)	Used in Research Trials
104	20131021-WEME-V9-01	WESTERN MEADOWLARK	21-Oct-13	Broken up	Freezer on site
105	20131026-BANO-INCI-01	BARN OWL	26-Oct-13	Feather spot	Freezer on site
106	20131026-WEME-W3-01	WESTERN MEADOWLARK	26-Oct-13	Feather spot	Left in place
107	20131103-RCKI-N4-01	RUBY-CROWNED KINGLET	03-Nov-13	Dead, semi-fresh (eyes desiccated, rigor mortis)	Used in Research Trials
108	20131105-GRRR-T3-01	GREATER ROADRUNNER	05-Nov-13	Feather spot	Freezer on site
109	20131106-WEME-V5-01	WESTERN MEADOWLARK	06-Nov-13	Feather spot	Left in place
110	20131118-UNPA-Q1-01	UNIDENTIFIED PASSERINE	18-Nov-13	Feather spot	Left in place
111	20131120-WEME-P1-01	WESTERN MEADOWLARK	20-Nov-13	Feather spot	Left in place
112	20131203-MODO-N8-01	MOURNING DOVE	03-Dec-13	Feather spot	Left in place
113	20131203-RTHA-R1-01	RED-TAILED HAWK	03-Dec-13	Feather spot	Left in place
114	20131204-HOFI-P1-01	HOUSE FINCH	04-Dec-13	Feather spot	Left in place
115	20131212-UNPA-N4-01	UNIDENTIFIED PASSERINE	12-Dec-13	Feather spot	Freezer on site
116	20131213-RTHA-INCI-01	RED-TAILED HAWK	13-Dec-13	Alive, injured	Other
117	20131218-UNPA-F8-01	UNIDENTIFIED PASSERINE	18-Dec-13	Feather spot	Freezer on site
118	20140108-UNPA-V5-01	UNIDENTIFIED PASSERINE	1-Jan-14	Just tail and rump	Collected
119	20140113-WEME-V9-01	WESTERN MEADOWLARK	13-Jan-14	Feather spot	Left in place
120	20140116-HOFI-N4-01	HOUSE FINCH	16-Jan-14	Carcass with missing head	Used in Research Trials

121	20140130-WEME-N4-01	WESTERN MEADOWLARK	30-Jan-14	Feather spot	Left in place
122	20140212-UNPA-F8-01	UNKNOWN PASSERINE	12-Feb-14	Feather spot	Collected
123	20140219-HOLA-R1-01	HORNED LARK	19-Feb-14	Feather spot	Left in place