Bird and Bat Mortality Monitoring at the Alta Wind Energy Center, Phases I - V Kern County, California

Final Report for the Third Year of Monitoring

March 10, 2015 – March 4, 2016

Prepared for:

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June 9, 2016

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EXECUTIVE SUMMARY

Alta Windpower Development, LLC (Alta Windpower) constructed and operates a wind energy facility in Kern County, California, referred to as the Alta Wind Energy Center. Following the start of operation of Phases I-V of the Alta Wind Energy Center (Alta I-V or "Project"), Western EcoSystems Technology, Inc. (WEST) was contracted by Alta Windpower to develop and implement study protocols for a 3-year post-construction bird and bat mortality monitoring study at Alta I-V consistent with Mitigation Measure 4.4-13 under the *Alta-Oak Creek Mojave Draft Environmental Impact Report*. The primary objective of the mortality monitoring study was to determine the level of bird and bat mortality attributable to collisions with wind turbines for the entire Project on an annual basis. The monitoring study consisted of four components: 1) standardized casualty surveys of selected turbines; 2) searcher efficiency trials to estimate the percentage of casualties found by searchers; 3) carcass removal trials to estimate the length of time that a casualty remained in the field for possible detection; and 4) calculation of adjusted mortality estimates for bird and bat species using the results of searcher efficiency and carcass removal trials.

The third year of mortality monitoring was completed at Alta I-V from March 10, 2015 through March 4, 2016, with mortality surveys conducted at the same sample of 55 turbine search plots surveyed during the initial year of monitoring. The 55 selected turbines consisted of 25 GE1.5sle (1.5-MW) turbines located within Alta I and 30 Vestas V90 (3.0-MW) turbines within Alta II-V. Each of these 55 turbines was searched approximately every two weeks during the yearlong study, resulting in a total of 1,094 turbine searches. Search plots consisted of 120-meter (m; 394-foot [ft]) radius circular plots centered on selected search turbines. Surveyors walked parallel transects spaced six to 10 m (20 to 33 ft) apart within the search plots while scanning the ground for carcasses or injured birds or bats.

During the third year of the study, 52 birds, representing 17 identifiable species, and three bats, representing one identifiable species, were found within search plots. An additional 13 bird and two bat causalities were found incidentally within the facility but outside of the standardized search plots. The bird species most commonly identified among the casualties was California quail. The most commonly identified raptor species was red-tailed hawk (five casualties), while other raptor fatalities consisted of one American kestrel, one golden eagle, and one unidentified owl. The five bat casualties found during the study consisted of three Mexican free-tailed bats and two hoary bats. Bird casualties were distributed throughout the year, with a slight increase in the spring and early summer, while the bat casualties were found from late spring through early fall.

A total of 251 trial carcasses were used to estimate searcher efficiency. Overall searcher efficiency rates were 94.0% for large birds, 82.1% for small birds, and 68.4% for bats. Because bats were not available for use in searcher efficiency trials, dark-colored mice were used as surrogates for bats. Three-hundred-nineteen carcasses were used to estimate carcass removal times, including 110 large birds, 157 small birds, and 52 bats/mice. Due to the limited number of

bat carcasses available, a mix of mice and bat carcasses were used in carcass removal trials. The mean carcass removal time was 23.89 days for large birds, 3.18 days for small birds, and 1.95 days for bats/mice.

Based on the mean search interval, estimated searcher efficiency, and carcass removal rates, the probability that a carcass would both remain in a search plot and be found by a searcher was 0.14 for small birds, 0.68 for large birds, and 0.07 bats. Overall mortality estimates were calculated for six categories: 1) small birds, 2) large birds, 3) diurnal raptors, 4) all birds, 5) all birds excluding upland game birds and domestic fowl, and 6) bats. Because Alta I and Alta II-V were comprised of different turbine types and also had differing landscape characteristics (e.g., topography and vegetation), mortality estimates were calculated for the Project as a whole and for Alta I and Alta II-V separately. To calculate the annual Project-wide mortality rate for each category, the seasonal average, weighted by the number of turbines in each turbine group (Alta I and Alta II-V), was calculated and summed across seasons. The estimated Project-wide mortality rate for all bird species was 1.45 birds per megawatt (MW) per year, with an estimated mortality estimate for diurnal raptors of 0.07 raptors per MW per year. The estimated Project-wide mortality estimate for bats was 0.32 bats per MW per year.

All categories of bird mortality were lower in Year 3 studies (2015/2016) relative to Years 1 and 2, while the estimated bat mortality in Year 3 was intermediate relative to Years 1 and 2. Compared to other regional projects, Year 3 bird and bat mortality estimates at the Project were relatively low. The three years of mortality monitoring at Alta I-V indicate that bird and bat mortality varies annually and will likely due so over the life of the Project. However, given the relatively low mortality observed over the three years of study on average, it does not appear that continued Project operations will result in unanticipated impacts to bird or bat populations.

STUDY PARTICIPANTS

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REPORT REFERENCE

Thompson, J., J. Lombardi, and C. Boyd. 2016. Bird and Bat Mortality Monitoring at the Alta Wind Energy Center, Phases I-V, Kern County, California. Final Report for the Third Year of Monitoring: March 10, 2015 – March 4, 2016. Prepared for Alta Windpower Development, LLC, Mojave, California. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming.

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INTRODUCTION

Alta Windpower Development, LLC (Alta Windpower) constructed and operates a wind energy facility in Kern County, California, referred to as the Alta Wind Energy Center (Figure 1). As described in Mitigation Measure 4.4-13 of the *Alta-Oak Creek Mojave Project Draft Environmental Impact Report* (Kern County Planning Department 2009), Alta Windpower is committed to conducting post-construction bird and bat mortality monitoring during the first, third, and fifth years of operation. Following the start of operations of Phases I - V of the Alta Wind Energy Center (Alta I-V or "Project"), Alta Windpower contracted Western EcoSystems Technology, Inc. (WEST) to develop and implement a standardized protocol for the mortality monitoring study with the purpose of estimating the impacts of the Project on birds and bats. The study protocol was similar to those used at other wind energy facilities throughout California and the western US. Data collection and analysis followed the recommendations presented in the US Fish and Wildlife Service (USFWS) Wind Turbine Advisory Committee *Land-Based Wind Energy Guidelines* (USFWS 2012) the California Wind Energy Guidelines (California Energy Commission [CEC] and California Department of Fish and Game [CDFG] 2007), and was based on WEST's experience studying wildlife at wind energy projects throughout the US. The first two years of bird and bat mortality monitoring at Alta I-V were conducted from March 2011 to June 2012 (Chatfield et al. 2012) and March 2013 to March 2014 (Chatfield et al. 2014). This report presents the results from the third and final year of mortality monitoring conducted from March 2015 to March 2016.

The primary objective of the mortality monitoring study was to estimate the level of bird and bat mortality attributable to collisions with wind turbines at the Project on an annual basis. If, after three years of post-construction mortality monitoring, the Kern County Planning Department, in consultation with the California Department of Fish and Wildlife (CDFW, formerly CDFG) and the USFWS, determines the Project is resulting in unanticipated significant adverse impacts to the population of an avian or bat species, the Project proponent will provide supplemental mitigation, as described in Mitigation Measure 4.4-13 (Kern County Planning Department 2009).

In addition to site-specific data, this report presents existing information and results of post-construction studies conducted at other wind energy facilities in the region and throughout the US. Where possible, comparisons with regional and local studies were made.

STUDY AREA

The Project is located within the larger Alta Wind Energy Center, located approximately four miles (6.4 kilometers [km]) west of the town of Mojave in south-central Kern County, California (Figure 1). The Project spans approximately 10 miles (16.1 km) from east to west (Figure 2). Alta I consists of 100 GE sle 1.5-megawatt (MW) turbines, while Alta II – V consists of 190 Vestas V90 3.0-MW turbines, for an overall Project nameplate capacity of 720 MW. Additional phases of the Alta Wind Energy Center located in the surrounding area and currently in operation include: Alta VI (Mustang Hills), Alta VII (Pinyon Pines I), Alta VIII, Alta IX (Pinyon

Pines II), and Alta X (Figure 1). Existing wind energy facilities are also present to the north, northeast, and southwest of the Project, with additional projects proposed to the east and south.

The Project is located at the intersection of two ecological regions: the western Mojave Desert to the southeast, and the Tehachapi Mountains in the southern Sierra Nevada to the northwest. Topography of the Project site ranges from ridges and valleys with moderate to steep slopes, to nearly level alluvial plains and pediments. Elevations within the Project site vary dramatically, ranging from about 2,800 feet (ft; 853 meters [m]) in the southeast to approximately 5,500 ft (1,676 m) in the southwest (Figure 2).

The western-most phase of the Project, Alta I, encompasses a broad elevation range (Figure 2), resulting in a diversity of vegetation communities. At the lower elevations of Alta I, habitat is dominated by lowland Joshua tree/creosote (*Yucca brevifolia/Larrea tridentate*) scrub, while the central and northern portions consist of rolling hills of rabbitbrush (*Chrysothamnus nauseosus*), buckwheat (*Erigonum sp.*), and annual grasslands punctuated by areas of arroyo willow (*Salix lasiolepis*) and scrub oak (*Quercus berberidifolia*). At the highest elevations in the southwest of Alta I, California juniper (*Juniperus californicus*) transitions to two-leaf pinyon pine (*Pinus edulis*) and foothill pine (*P. sabiniana*) woodlands. Alta I is bisected by Oak Creek Canyon, which is characterized by a valley oak (*Q. lobata*)/mixed willow (*Salix* spp.) riparian area that typically contains water on a seasonal basis. Several perennial springs are also present within Alta I.

Alta II-V comprises the central and eastern portions of the Project (Figure 2) and is composed of high plains desert alluvial fan and wide basin topography. The habitat is predominately creosote scrub with areas of Joshua tree woodland. No permanent water exists in this portion of the Project; however, a number of washes with intermittent water flow are present throughout the area. Alta II-V is bisected by underground portions of the Los Angeles Aqueduct, two transmission lines, railroad tracks, and a network of dirt roads/trails from past off-highway vehicle (OHV) use.

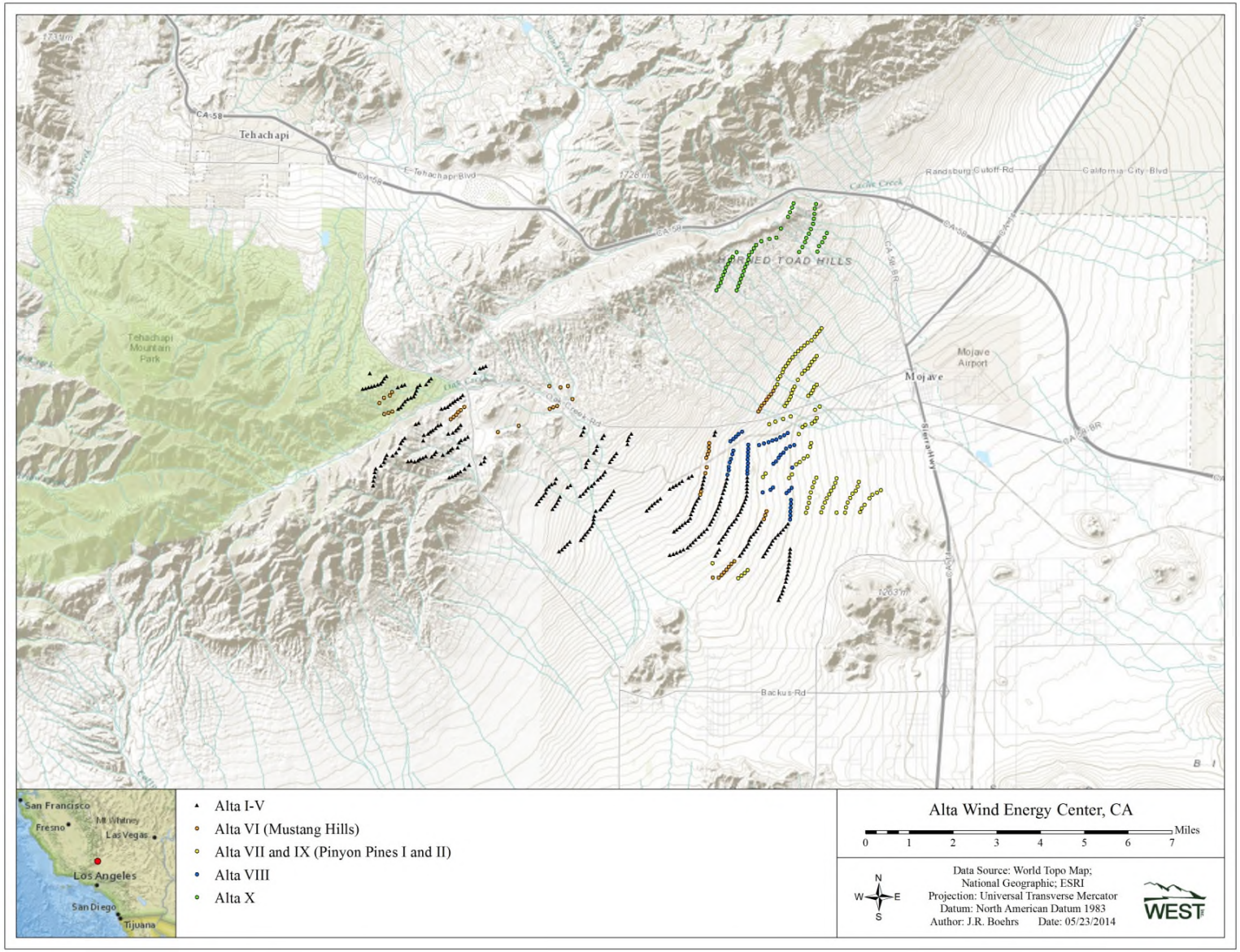

Figure 1. Location of the Alta Wind Energy Center.

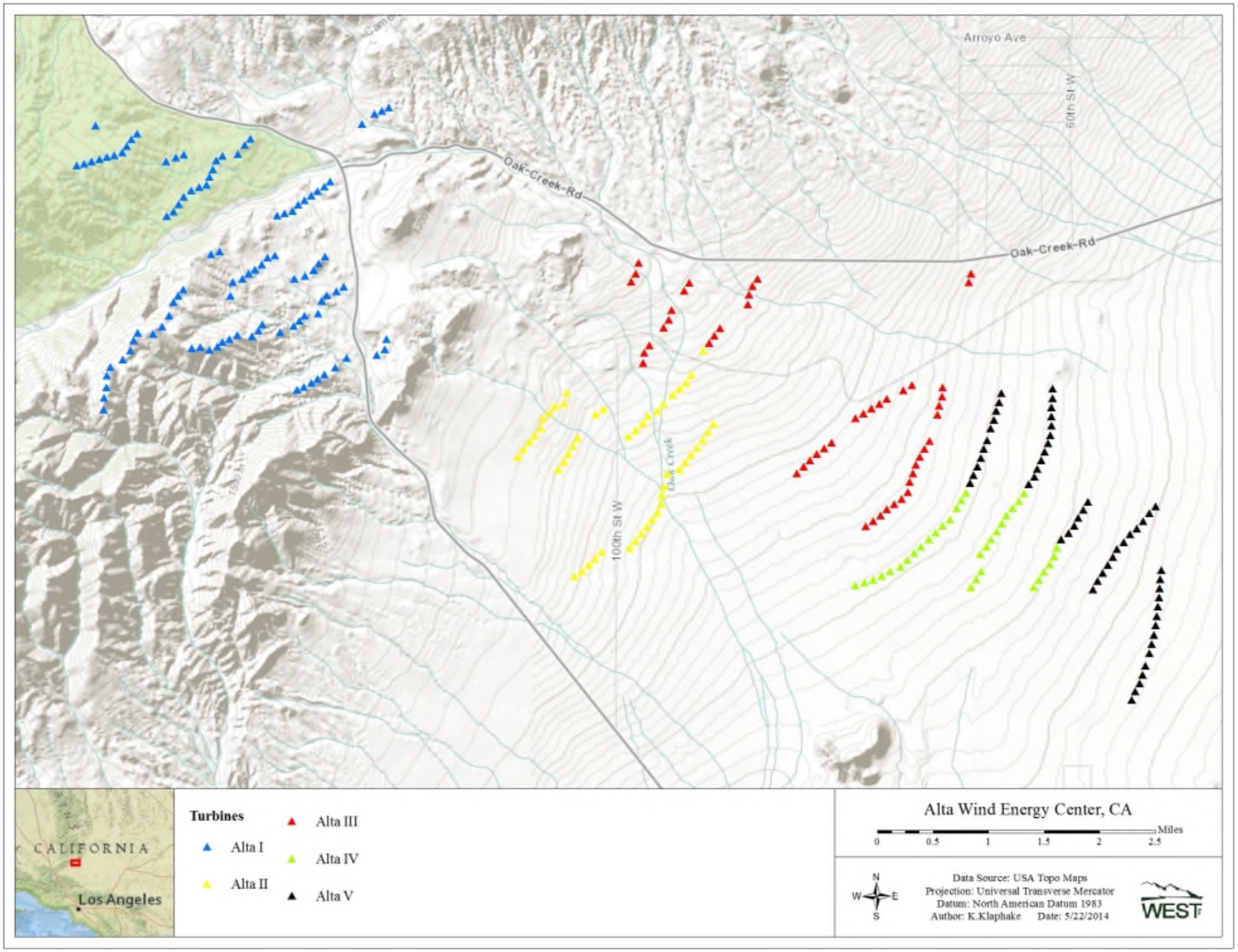

Figure 2. Location of turbines within Alta I-V.

METHODS

Bird and Bat Mortality Study

The primary objective of the mortality monitoring study was to estimate the level of bird and bat mortality attributable to collisions with wind turbines at the Project on an annual basis. The methods for the mortality study were broken into four primary components: 1) standardized casualty surveys beneath selected turbines; 2) searcher efficiency trials to estimate the percentage of casualties found by searchers; 3) carcass removal trials to estimate the length of time that a casualty remained in the field for possible detection; and 4) calculation of adjusted mortality estimates for bird and bat species using the results of searcher efficiency and carcass removal trials.

There were three scenarios under which casualties were found in the Project: 1) during the standardized casualty searches; 2) by study personnel who were on site, but not conducting a standardized search (i.e., an incidental find); and 3) by facility personnel or others on site for other purposes (also an incidental find). Casualties found by study personnel were recorded by the methods described below, regardless of timing (i.e., during a standardized survey or not). All casualties found within a search plot, even if the casualty was not found during a scheduled search, were included in the dataset under the broad assumption that these casualties would have been found during subsequent standardized surveys.

The total number of bird and bat casualties was estimated by adjusting for search interval, removal bias (length of stay in the field), and searcher efficiency bias (percent found). For carcasses where the cause of death was not apparent, it was assumed that the casualty was the result of collision with a wind turbine and the casualty was included in the analysis. This approach likely led to an overestimate of the true number of facility-related casualties; however, most wind energy facilities have used this conservative approach because of the relatively high costs associated with obtaining accurate estimates of natural or reference mortality (see Johnson et al. 2000).

Study Components and Field Methodology

Standardized Carcass Searches

Standardized carcass searches were conducted at a sample of 55 turbine search plots (approximately 19% of the Project's 290 turbines) from March 10, 2015 through March 4, 2016. This was the same set of turbines surveyed during the first and second years of monitoring (2011-2012, 2013-2014, respectively). Turbines were selected for sampling using a systematic design with a random start to ensure the search effort was spread throughout the entire Project. The 55 selected turbines consisted of 25 GE1.5sle (1.5-MW) turbines located within Alta I (Figure 3a) and 30 Vestas V90 (3.0-MW) turbines within Alta II-V (Figure 3b).

Circular plots with a 120-m (394-ft) radius were established around each of the sampled turbines and systematically searched for casualties. This search plot size is consistent with that

recommended in the USFWS *Land-Based Wind Energy Guidelines* (USFWS 2012; i.e., search plot width of twice the rotor tip height), is consistent with search plots used at other projects with comparable turbines in the region, and is nearly twice the size of that recommended by the California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development (California Wind Energy Guidelines; CEC and CDFG 2007; i.e., search plot width equal to rotor tip height). Each plot was searched along parallel transects spaced six to 10 m (20 to 33 ft) apart (depending on detection ability), with the orientation of transects based on the orientation of the topography surrounding the turbines. All turbine searches were conducted by a field crew employed by Alta Windpower, with Project oversight provided by WEST. Standardized casualty surveys were conducted every two to four weeks during the spring (March 5 to June 3), summer (June 4 to September 2), fall (September 3 to November 23), and winter (November 24 to March 4) at each of the sampled turbines.

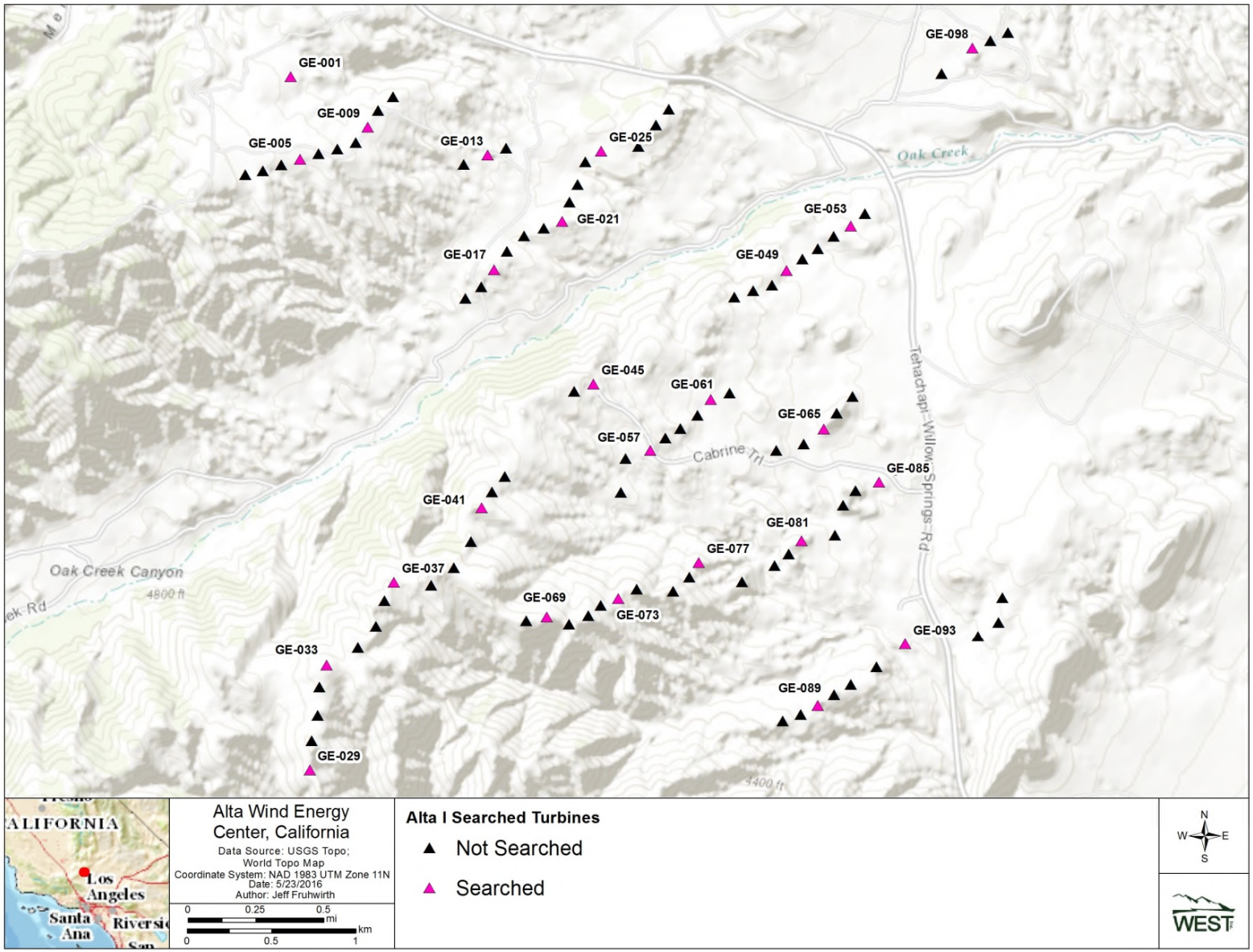

Figure 3a. Location of the 25 turbines searched within Alta I during the third year of monitoring in 2015-2016.

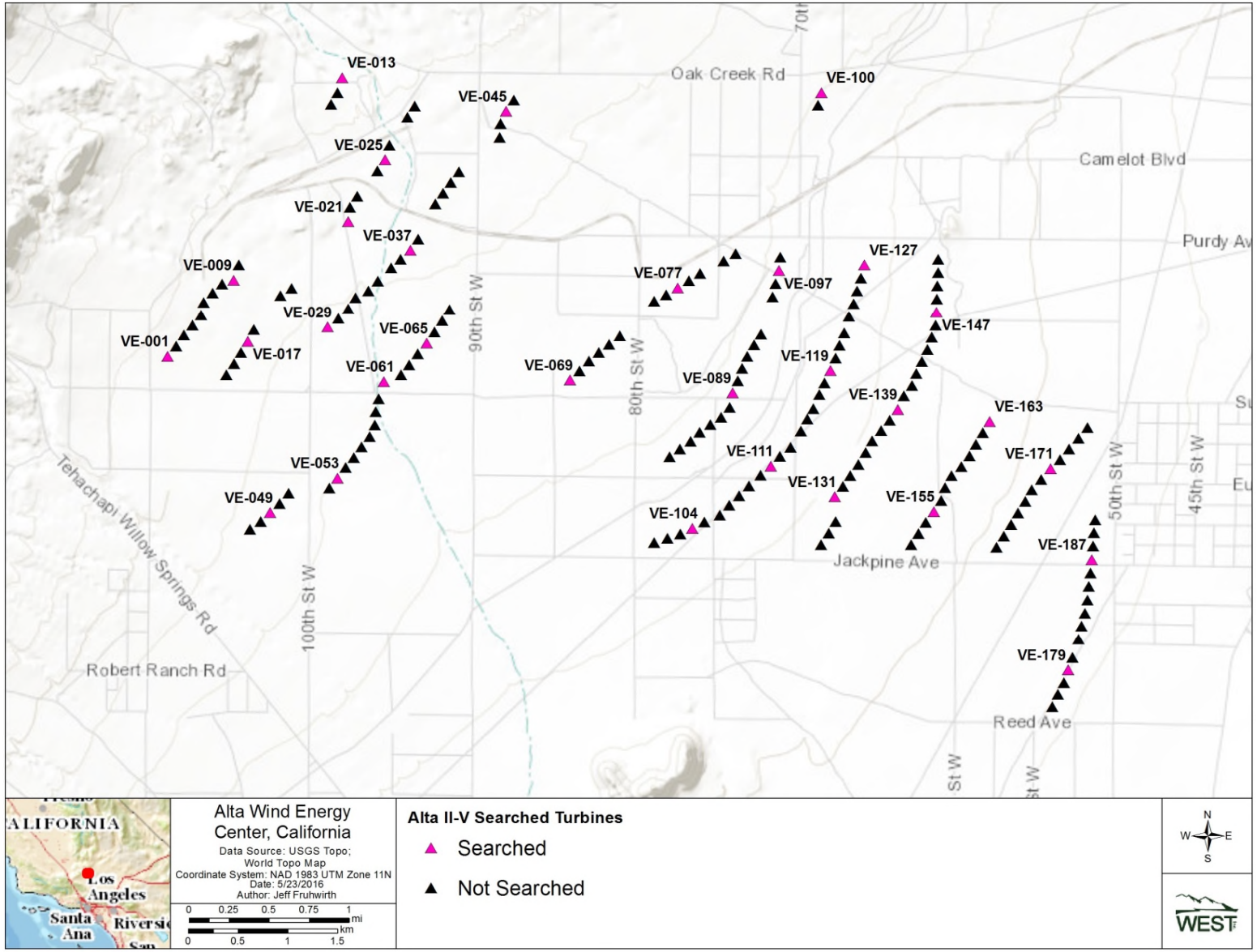

Figure 3b. Location of the 30 turbines searched within Alta II-V during the third year of monitoring in 2015-2016.

The following data were recorded for all casualties found: species, sex and age when possible, date and time encountered, location, condition of casualty, and any comments that indicated possible cause of death. All casualties were photographed as found, including detailed close-up photos of the carcass for identification purposes, as well as photos showing the location of the casualty in relation to the closest wind turbine or other project facilities, such as overhead power lines. The condition of each carcass found was recorded using the following categories:

- Intact - a carcass that was completely intact, was not badly decomposed, and showed no sign of being fed upon by a predator or scavenger.
- Scavenged - an entire carcass, which showed signs of being fed upon by a predator or scavenger, or a portion(s) of a carcass in one location (e.g., wings, skeletal remains, portion of a carcass, etc.), or a carcass that was heavily infested by insects.
- Feather Spot - 10 or more feathers or two or more primaries at one location, indicating a bird casualty had been there.

In addition to carcasses, any injured bird or bat observed in the search plots was recorded and treated as a casualty. Casualties found outside the formal search area by study personnel were treated following the above protocol as closely as possible. Casualties observed in non-search areas (e.g., near a turbine not included in the search plots), or observed within search areas but outside of the standard search period, were coded as incidental discoveries and were documented in a similar fashion as those found during standard searches. Casualties found by maintenance personnel and other personnel not conducting the formal searches were similarly documented and included in the overall dataset.

Alta Windpower did not hold a federal Migratory Bird Collection Permit from the USFWS, therefore, study personnel were not permitted to possess the remains of any native migratory birds encountered during searches. As such, all bird and bat carcasses were left in the field as found. Because of this, care was taken to take detailed photos of the carcasses for purposes of identification and to accurately record the condition and location of all carcasses so as to avoid double-counting casualties.

Searcher Efficiency Trials

Searcher efficiency trials were conducted at the Alta Wind Energy Center with the objective of estimating the percentage of casualties found by searchers. Searcher efficiency trials were conducted at Alta I-V and adjacent phases of the Alta Wind Energy Center (Mustang Hills, Alta VIII, Alta X, and Pinyon Pines I & II wind projects; see figure 1) during 2013/2014 and 2015/2016. Searcher efficiency trials were conducted in the same areas as carcass surveys and searcher efficiency was estimated by the type of carcass (bird or bat) and size of carcass (birds only). Estimates of searcher efficiency were used to adjust the total number of casualties found for those missed by searchers, correcting for detection bias.

Personnel conducting carcass surveys did not know when searcher efficiency trials were being conducted or the location of the trial carcasses. Carcasses used for searcher efficiency trials

included brown-headed cowbirds [*Molothrus ater*], and non-native/non-protected or commercially available species (Coturnix quail [*Coturnix* spp.], mallard [*Anas platyrhynchos*], rock pigeon [*Columba livia*], and house sparrows [*Passer domesticus*]). Due to a lack of bat carcasses available for the study, small bird carcasses and/or domestic mice (*Mus musculus*) were used to simulate bats.

Searcher efficiency trial carcasses were placed at random locations within the search area prior to that day's scheduled carcass survey. Each trial carcass was discreetly marked on a leg with electrical tape so that it could be identified as a study carcass after it was found. The number and location of the searcher efficiency carcasses found during the carcass survey were recorded. The number of carcasses available for detection during each trial was determined immediately after the trial by the person responsible for distributing the carcasses.

Carcass Removal Trials

The objective of carcass removal trials was to estimate the average length of time a carcass remained in the study area and was therefore available for detection. Carcass removal included removal by scavenging, or removal by other less likely means, such as burial by wind-blown sand. Estimates of carcass removal were used to adjust the total number of carcasses found for those removed from the study area, correcting for removal bias.

Trials were spread throughout the year to incorporate the effects of varying weather, climatic conditions, and scavenger densities. Carcass removal trials were conducted at Alta I-V and adjacent phases of the Alta Wind Energy Center (Mustang Hills, Alta VIII, Alta X, and Pinyon Pines I & II wind projects) during 2013/2014 and 2015/2016. Removal trial carcasses were of similar composition to those used for searcher efficiency trials, except that 20 carcasses (four large birds, 12 small birds, and five bats) of actual casualties found during the searches were left in the field and monitored for carcass removal trials.

Removal trials were conducted at both searched turbines and non-searched turbines. Trial carcasses were randomly placed at selected turbines within a plot of similar size to the actual search plots. Personnel conducting carcass searches monitored the trial birds over a 40-day period, checking the carcasses every day for the first four days of the trial, and then again on days seven, 10, 14, 18, 24, 30, and 40, although this schedule varied somewhat depending on weather and coordination with the other survey work. Removal trial carcasses were marked discreetly (e.g., with dark electrical tape around one or both legs) for recognition by searchers and other personnel, and left at the location until the end of the carcass removal trial.

Statistical Analysis

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, observers were responsible for inspecting data forms for completeness, accuracy, and legibility. A sample of records from an electronic database was compared to the raw data forms and any errors detected were corrected. Irregular codes or data suspected as questionable

were discussed with the observer and/or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

Data Compilation and Storage

A Microsoft® ACCESS database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined format to facilitate subsequent QA/QC and data analysis. All data forms, field notebooks, and electronic data files were retained for reference.

Mortality Surveys

Estimates of facility-related mortality are based on:

1. Observed number of casualties found during standardized searches during the monitoring year, for which the cause of death was either unknown or was probably facility-related;
2. Non-removal rates, expressed as the estimated average probability a carcass was expected to remain in the study area and be available for detection by the searchers during removal trials; and
3. Searcher efficiency, expressed as the proportion of planted carcasses found by searchers during searcher efficiency trials.

All casualties located within surveyed areas or incidentally throughout the Project area, regardless of species, were recorded and, if possible, a cause of death was determined based on a cursory field inspection. The total number of bird and bat carcasses was estimated by adjusting for removal and searcher efficiency bias. If the cause of death was not apparent, a "worst case" estimate was made by attributing mortality to the operation of the Project.

Mortality estimates were calculated for six categories: 1) small birds, 2) large birds, 3) raptors, 4) all birds, 5) all birds excluding upland game birds and domestic fowl; and 6) bats. A separate estimate excluding upland game birds and domestic fowl (e.g., California quail [*Callipepla californica*], and chicken [*Gallus domesticus*]) from the overall bird mortality estimate was calculated due the likelihood that many, if not all of these casualties (i.e., feather spots), were due to natural causes (i.e., predation) rather than as a result of collision with turbine blades. Overall and seasonal mortality estimates were calculated separately for Alta I and Alta II-V due to differences in habitat and topography, as well as the different turbine types used for Alta I and Alta II-V. To calculate the annual Project-wide mortality rate for each of the above bird/bat categories, the seasonal average, weighted by the number of turbines searched in each turbine group (GE or Vestas turbines) was calculated and summed across seasons.

Definition of Variables

The following variables are used in the equations below:

- c_i the number of carcasses detected at plot *i* for the study period of interest (e.g., one monitoring year), for which the cause of death was either unknown or was attributed to the facility
- n the number of search plots
- k the number of turbines searched (including the turbines centered within each search plot)
- $\bar{c}$ the average number of carcasses observed per turbine per monitoring year
- s the number of carcasses used in removal trials
- s_c the number of carcasses in removal trials that remained in the study area after 40 days
- t_i the time (in days) a carcass remained in the study area before it was removed, as determined by the removal trials
- $\bar{t}$ the average time (in days) a carcass remained in the study area before it was removed, as determined by the removal trials
- p the estimated proportion of detectable carcasses found by searchers, as determined by the searcher efficiency trials
- I the average interval between standardized carcass searches, in days
- A proportion of the search area of a turbine actually searched
- $\hat{\pi}$ the estimated probability that a carcass was both available to be found during a search and was found, as determined by the removal trials and the searcher efficiency trials
- m the estimated annual average number of casualties per turbine per year, adjusted for removal and searcher efficiency bias

Observed Number of Carcasses

The estimated average number of carcasses ($\bar{c}$) observed per turbine per monitoring year was:

$$\bar{c} = \frac{\sum_{i=1}^{n} c_i}{k \cdot A} \qquad (1)$$

Estimation of Carcass Non-Removal Rates

Estimates of carcass non-removal rates are used to adjust carcass counts for removal bias. Mean carcass removal time ($\bar{t}$) was the average length of time a carcass remained in the study area before it was removed:

$$\bar{t} = \frac{\sum_{i=1}^{s} t_i}{s - s_c} \quad (2)$$

Estimation of Searcher Efficiency Rates

Searcher efficiency rates are expressed as *p,* the proportion of trial carcasses that were detected by searchers in the searcher efficiency trials. These rates were estimated by carcass size and season.

Estimation of Facility-Related Mortality Rates

The estimated per turbine annual mortality rate (*m*) was calculated by:

$$m = \frac{\bar{c}}{\hat{\pi}} \quad (3)$$

where $\hat{\pi}$ includes adjustments for both carcass removal (from scavenging and other means) and searcher efficiency bias. Data for carcass removal and searcher efficiency bias was pooled across the study to estimate $\hat{\pi}$.

$\hat{\pi}$ was calculated as follows:

$$\hat{\pi} = \frac{\bar{t} \cdot p}{I} \cdot \left[\frac{\exp\left(I / \bar{t} \right) - 1}{\exp\left(I / \bar{t} \right) - 1 + p} \right]$$

Confidence Interval Calculations

The final reported estimates of *m* and associated standard errors and 90% confidence intervals were calculated 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. For each bootstrap sample, $\bar{c}$, $\bar{t}$, *p*, $\hat{\pi}$, and *m* were calculated. A total of 1,000 bootstrap samples were used. The reported estimates are the mathematical means of the 1,000 bootstrap estimates. The standard deviation of the bootstrap estimates is the estimated standard error. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates are estimates of the lower limit and upper limit of 90% confidence intervals.

Area Correction

To account for the close proximity of turbines at Alta I-V, an adjustment was done to the number of turbines searched. Through the use of geographic information systems (GIS), the area searched within plots that overlapped with plots of the same size at nearby turbine was totaled and converted to an equivalent number of additional turbine search plots. This accounted for the fact that some search plots were capturing casualties from more than one turbine. For Alta I the additional number of turbines searched due to overlapping search plots resulted in an added equivalent of 13.47 turbines. Alta II-V had an equivalent of 15.65 additional turbines searched. The total number of effective turbines searched was 38.47 for Alta I and 45.65 for Alta II-V. This totals 84.12 equivalent turbine searches out of a total of 290 turbines at the Project, or 29% of all Project turbines.

RESULTS

Avian and Bat Mortality Surveys

Fifty-five turbine search plots were searched from March 10, 2015 – March 4, 2016. Each of the 55 search plots was searched approximately every two to three weeks (18-21 visits over the course of 12 consecutive months) and resulted in 1,094 plot searches over the yearlong study.

A total of 65 birds and five bats were found during standardized carcass surveys or incidentally at the Project during the third year of monitoring (Table 1). The number, species, location, other characteristics of the bird and bat casualties, and the mortality estimates adjusted for searcher efficiency and carcass removal biases are discussed below, and a full listing of casualties is presented in Appendix A.

Bird Casualties

Fifty-one birds representing 21 identifiable species were found during scheduled searches (Table 1, Figures 4a and 4b). One red-tailed hawk (*Buteo jamaicensis*) casualty was found incidentally within a search plot and 13 bird casualties were found incidentally outside of search plots (Table 1). Incidentals casualties found outside of search plots represented 10 identified bird species, six of which were not identified among the fatalities found on search plots.

The bird species found most frequently within search plots included unidentified small birds (13 casualties) and California quail (eight casualties). All other bird species encountered had four or fewer recorded casualties. Diurnal raptor and owl casualties included one American kestrel (*Falco sparverius*), four red-tailed hawks, one golden eagle (*Aquila chrysaetos*), and one unidentified owl (Table 1). Of the bird casualties recorded during the third year of the mortality monitoring study, only the golden eagle is designated as a state sensitive species (California fully protected species; CDFW 2016). Golden eagle is also protected under the Bald and Golden Eagle Protection Act (BGEPA 1940).

Table 1. Number of bird and bat casualties and the composition of casualties discovered at Alta I-V from March 10, 2015 – March 4, 2016.

Species	Casualties during Scheduled Searches		Incidental Casualties at Search Plots*		Other Incidentals		Total	
	Total	% Comp.	Total	% Comp.	Total	% Comp.	Total	% Comp.
Birds								
unidentified bird (small)	13	25.5	0	0	1	7.7	14	21.5
California quail	8	15.7	0	0	1	7.7	9	13.8
mourning dove	4	7.8	0	0	0	0	4	6.2
red-tailed hawk	3	5.9	1	100	1	7.7	5	7.7
greater roadrunner	3	5.9	0	0	2	15.4	5	7.7
unidentified warbler	3	5.9	0	0	0	0	3	4.6
common raven	2	3.9	0	0	1	7.7	3	4.6
horned lark	2	3.9	0	0	0	0	2	3.1
mountain bluebird	2	3.9	0	0	0	0	2	3.1
unidentified sparrow	2	3.9	0	0	0	0	2	3.1
western bluebird	2	3.9	0	0	0	0	2	3.1
American kestrel	1	2.0	0	0	0	0	1	1.5
American robin	1	2.0	0	0	0	0	1	1.5
black-headed grosbeak	1	2.0	0	0	0	0	1	1.5
domestic chicken	1	2.0	0	0	0	0	1	1.5
golden eagle	1	2.0	0	0	0	0	1	1.5
mallard	1	2.0	0	0	0	0	1	1.5
western scrub-jay	1	2.0	0	0	0	0	1	1.5
American coot	0	0	0	0	1	7.7	1	1.5
Cassin's finch	0	0	0	0	1	7.7	1	1.5
Eurasian collared dove	0	0	0	0	1	7.7	1	1.5
house finch	0	0	0	0	1	7.7	1	1.5
turkey vulture	0	0	0	0	1	7.7	1	1.5
unidentified owl	0	0	0	0	1	7.7	1	1.5
western tanager	0	0	0	0	1	7.7	1	1.5
Overall Birds	**51**	**100**	**1**	**100**	**13**	**100**	**65**	**100**
Bats								
Mexican free-tailed bat	3	100	0	0	0	0	3	60.0
hoary bat	0	0	0	0	2	100	2	40.0
Overall Bats	**3**	**100**	**0**	**0**	**2**	**100**	**5**	**100**

*Casualties found incidentally on turbine search plots were included in analyses.

The greatest number of casualties found at any single search plot was five casualties found at plot GE-025 within Alta I. These casualties consisted of two unidentified small birds, one western scrub-jay (*Aphelocoma californica*), one California quail, and one domestic chicken (*Gallus gallus domesticus*; Appendix A). Bird casualties at the other Alta I search plots ranged from one to three casualties per plot (Figures 4a and 5). No fatalities were found at eight of the 25 plots searched in Alta I. Among the 30 search plots within Alta II-V, the highest number of casualties found was two, which occurred at three plots (Figures 4b and 5). A single casualty was found at each of 11 plots within Alta II-V, while no casualties were found at 16 of the 30 plots in Alta II-V (Figures 4b and 5).

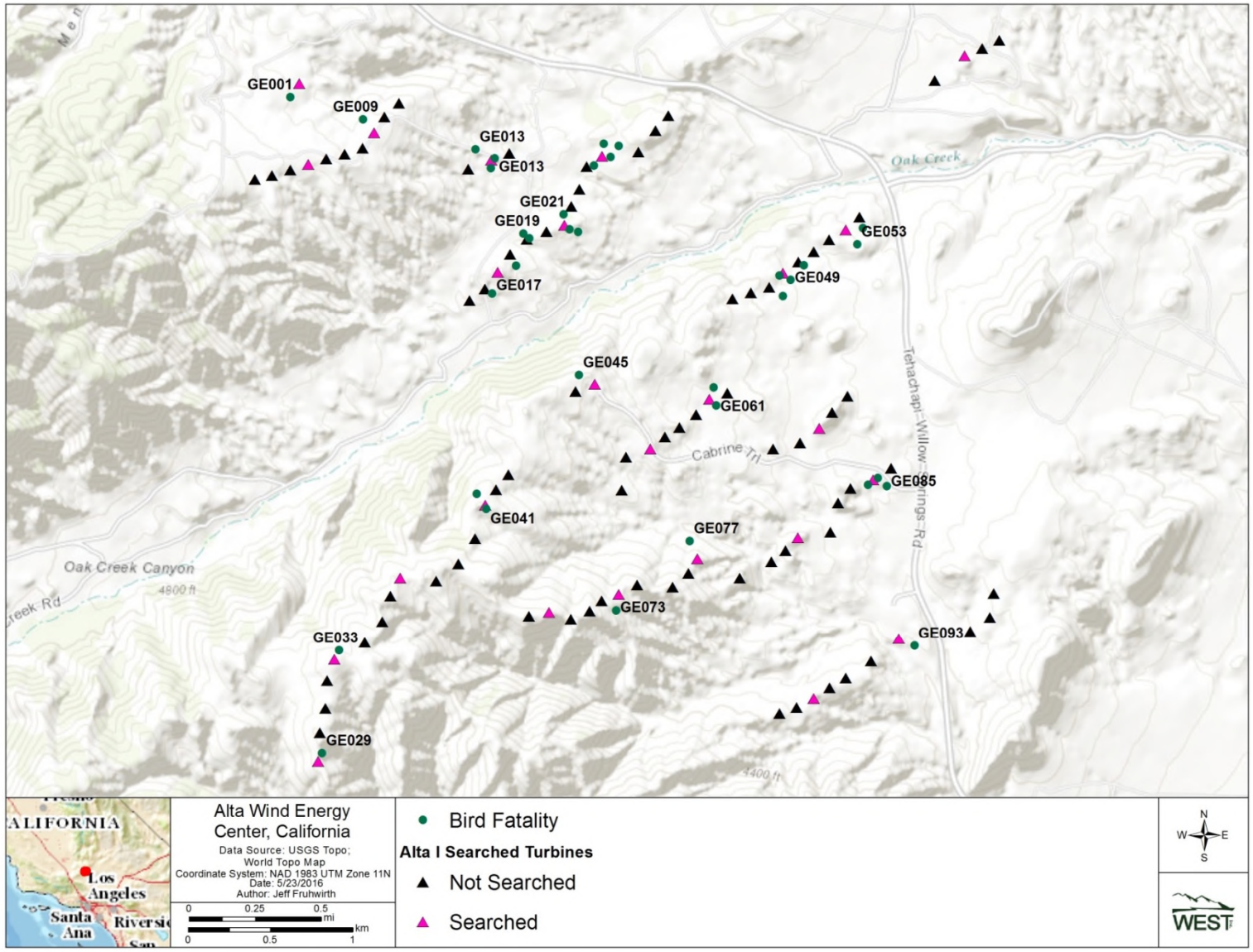

Figure 4a. Location of bird casualties found within search plots at Alta I from March 10, 2015 – March 4, 2016.

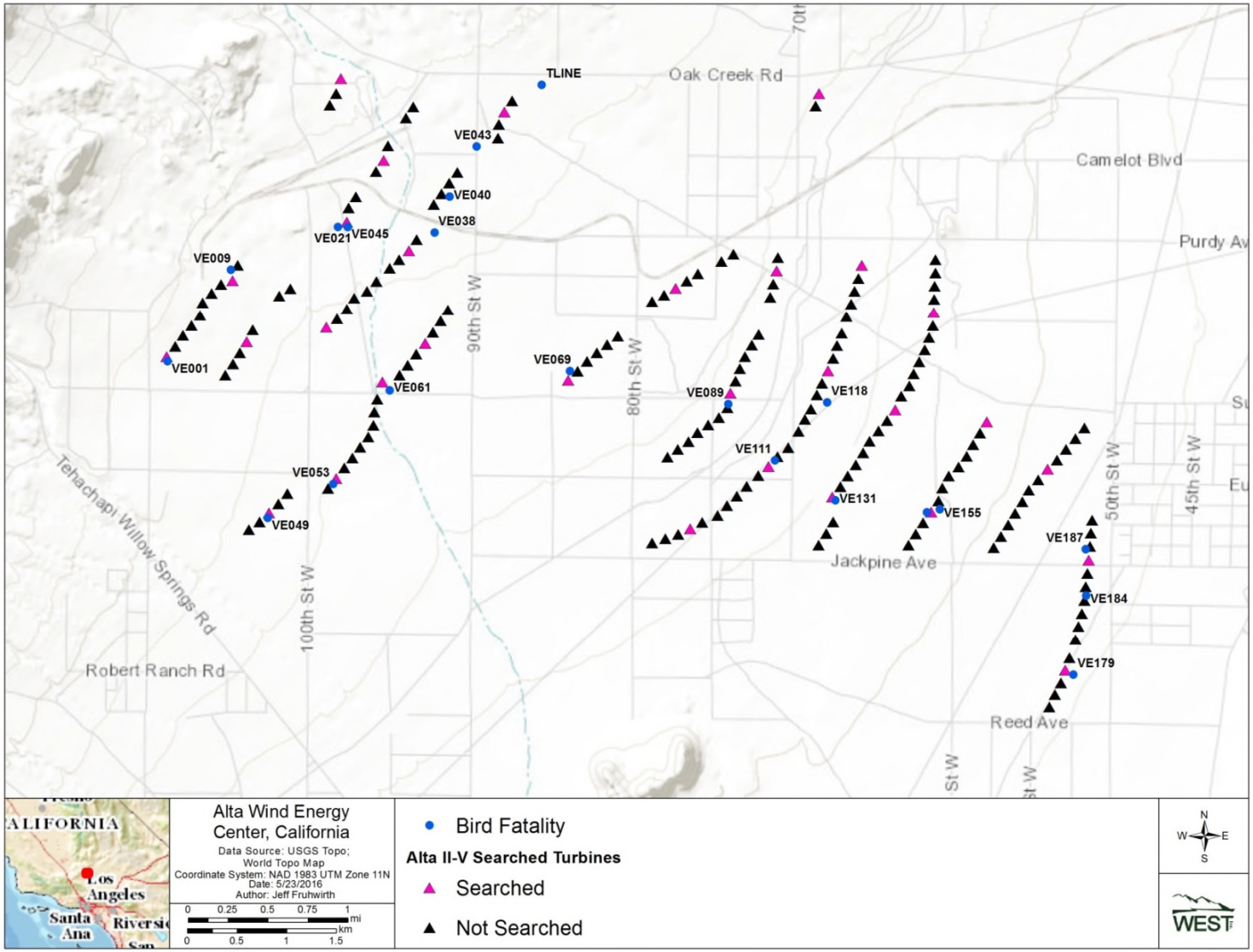

Figure 4b. Location of bird casualties found within search plots at Alta II-V from March 10, 2015 – March 4, 2016.

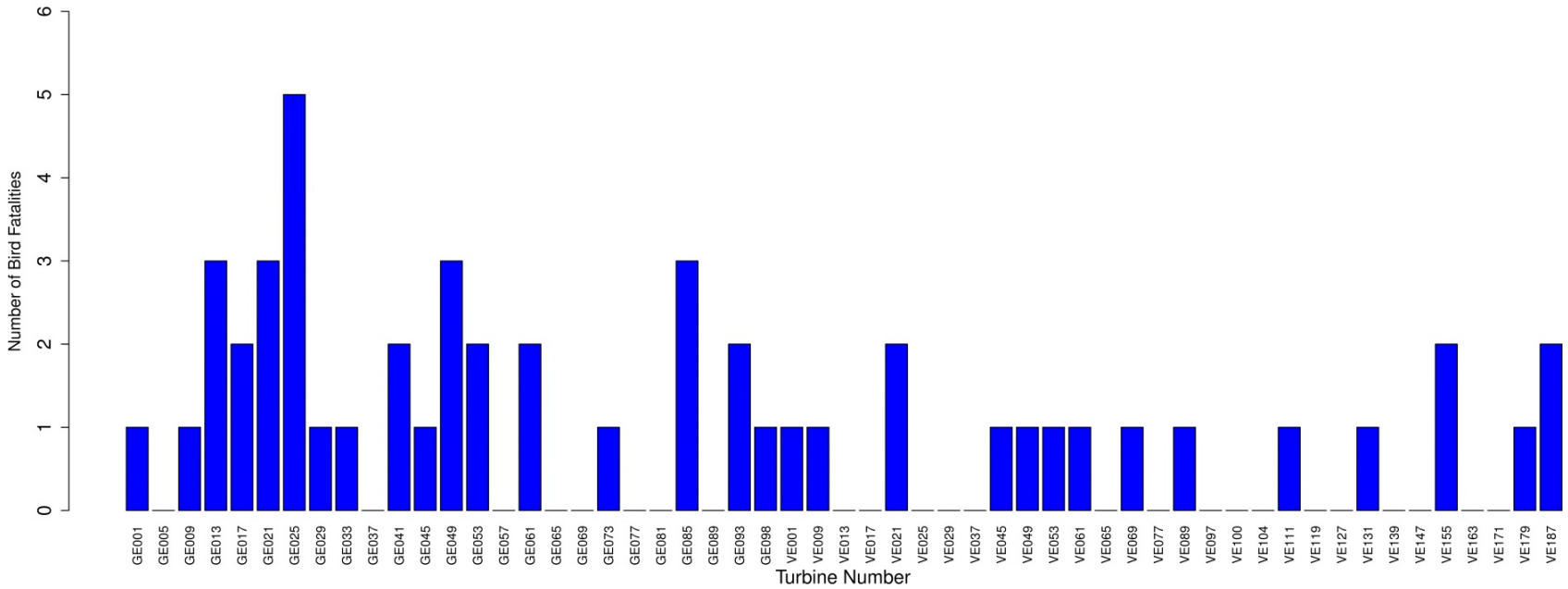

Figure 5. Number of bird casualties by search plot at Alta I-V. Data include only those casualties found within searched plots from March 10, 2015 – March 4, 2016.

Of the bird casualties, 49.0% were found within 60 m (197 ft) of turbines, while 42.9% were found between 60 m and 110 m (361 ft) of turbines (Table 2, Figure 6). Bird casualties were distributed throughout the spring, summer, fall, and winter seasons, with the greatest number of casualties found during the winter and spring (Figure 7). Diurnal raptors casualties were found during the spring (three casualties) and summer (three casualties; Appendix A).

Table 2. Distribution of distances of bird and bat casualties from turbines at Alta I-V. Data include only those casualties found within search plots from March 10, 2015 – March 4, 2016.

Distance to Turbine (m)	% Bird Casualties	% Bat Casualties
0 to 10	0	33.3
10 to 20	2.0	0
20 to 30	6.1	0
30 to 40	6.1	66.7
40 to 50	10.2	0
50 to 60	24.5	0
60 to 70	10.2	0
70 to 80	6.1	0
80 to 90	6.1	0
90 to 100	14.3	0
100 to 110	6.1	0
110 to 120	8.2	0
>120	0	0

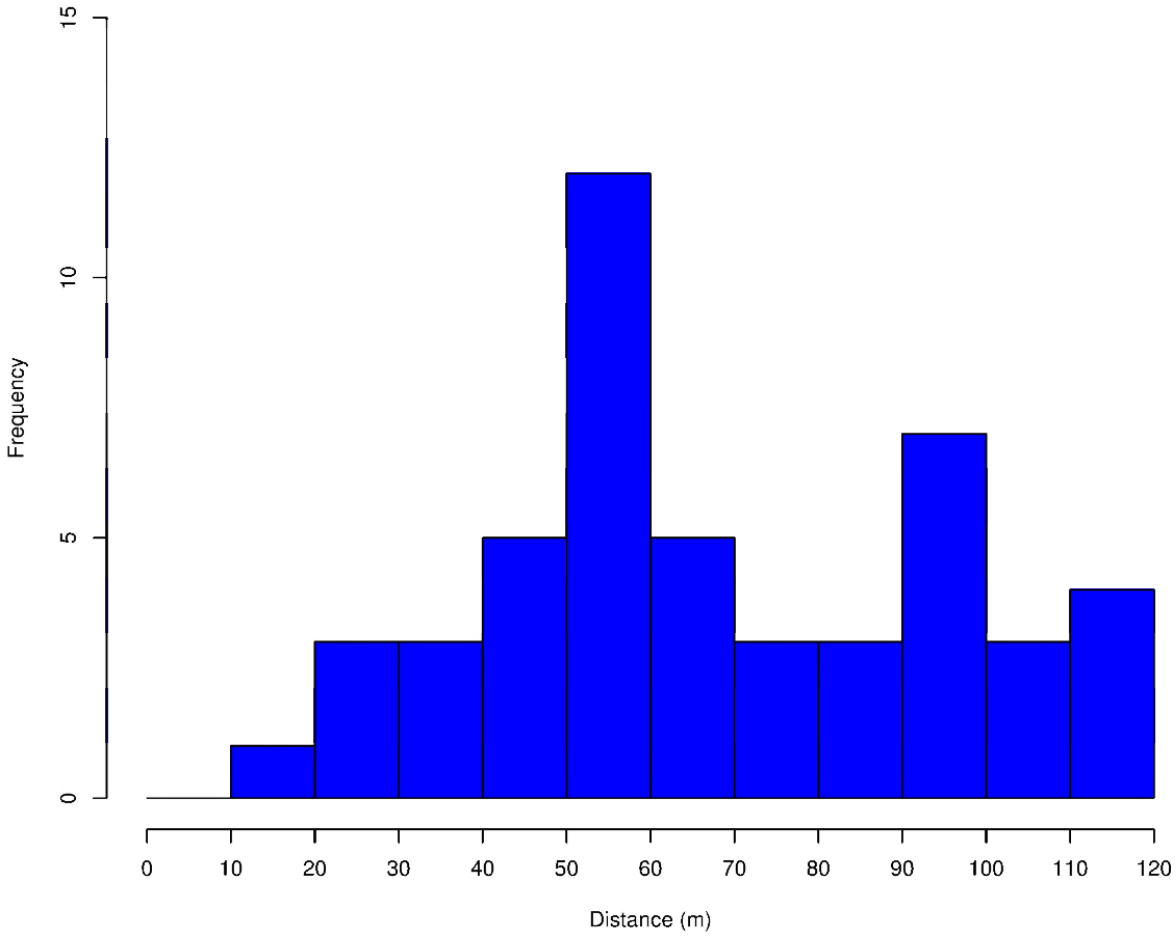

Figure 6. Distance of bird casualties from the turbine at Alta I-V. Data include only those casualties found within search plots from March 10, 2015 – March 4, 2016.

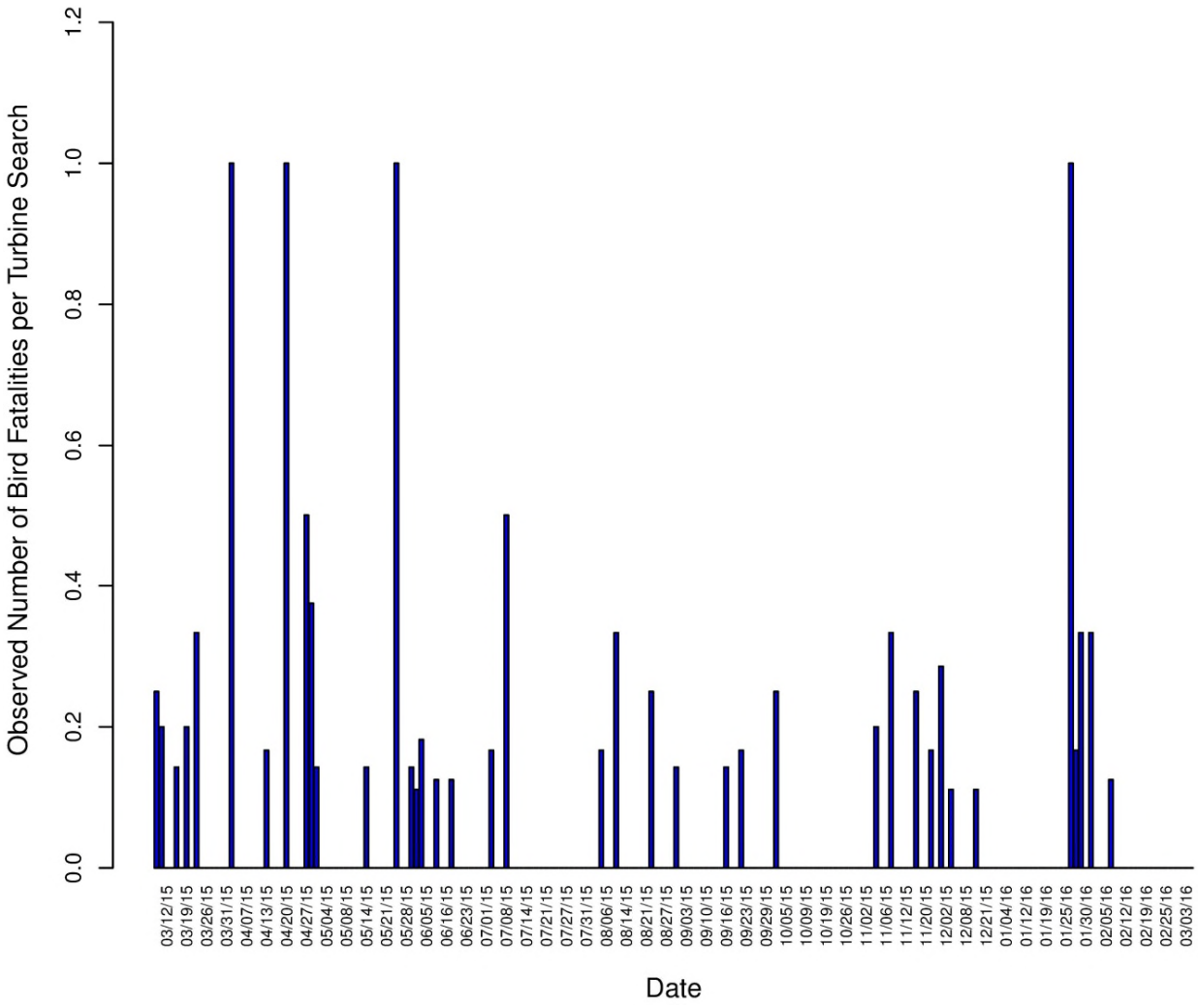

Figure 7. Timing of bird casualties found within search plots at Alta I-V during standard carcass searches from March 10, 2015 – March 4, 2016.

Bat Casualties

Three Mexican free-tailed bat casualties (*Tadarida brasiliensis*) were found on search plots during scheduled searches and two hoary bat (*Lasiurus cinereus*) casualties were found incidentally outside of search plots (Table 1). One Mexican free-tailed bat casualty was found during the early summer (June 30), approximately 36 m (118 ft) from turbine GE-089, while the other two were found during the fall (both on September 9), approximately seven m (23 ft) and 32 m (104 ft) from turbine GE-041. One of the incidentally found hoary bats was found 56 m (184 ft) from turbine VE058 in May, while the other incidental hoary bat was found in late September and was 46 m (151 ft) from turbine GE068.

Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the Alta Wind Energy Center on 19 dates from May 2014 – February 2016 and included the placement of 251 trial carcasses (67 large

birds, 140 small birds and 44 bats/mice; Table 3). Searcher efficiency rates did not differ significantly across years or seasons, therefore all searcher efficiency data were pooled and a single searcher efficiency rate was calculated for each casualty size class (small bird, large bird, bat). The overall searcher efficiency rate for large birds was 94.0%, compared to 82.1% for small birds and 68.4% for bats/mice (Table 3).

Table 3. Searcher efficiency results at the Alta Wind Energy Center, May 2014 – February 2016.

Size	# Placed	# Available	# Found	% Found
Small Birds	140	123	101	82.1
Large Birds	67	67	63	94.0
Bats	44	38	26	68.4

Carcass Removal Trials

A total of 319 carcasses were placed within the Alta Wind Energy Center during carcass removal trials in 2014-2016 (110 large birds, 157 small birds, and 52 bats/mice). Differences among years and Project phases were assessed using a permutation test and no significant differences were found; therefore, data were pooled across years and phases and single estimates of carcass removal calculated for each casualty size class (large bird, small bird, and bat). By day 10, roughly 55% of large birds remained in the search area, while only 7% of small birds and 10% of bats remained. By day 30, roughly 40% of large bird carcasses remained, while only 5% of small birds and no bats persisted within the search area (Figure 8). The mean carcass removal time for large birds was 23.89 days during all seasons (Appendix B). For small birds and bats, mean carcass removal rates were 3.18 and 1.95 days, respectively, with no significant seasonal variation (Appendices B and C).

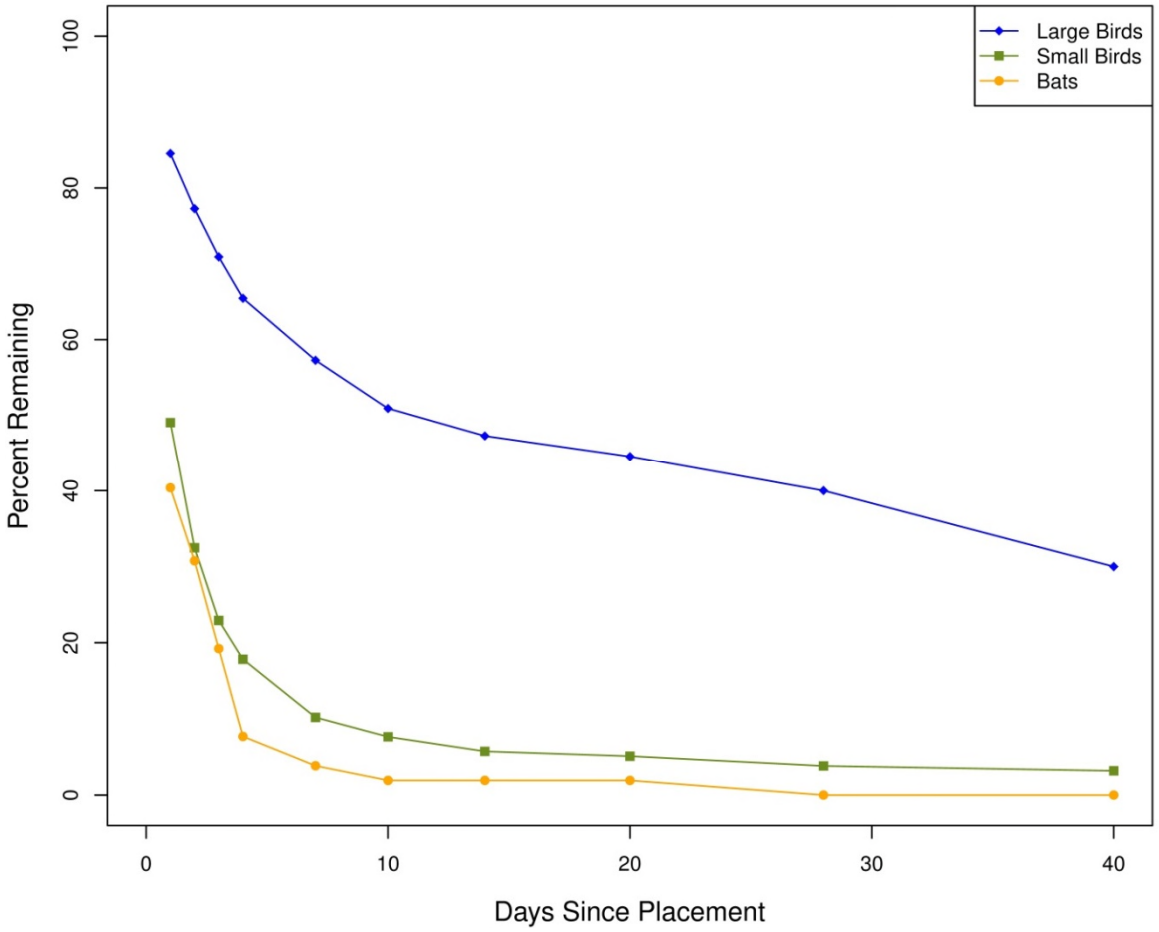

Figure 8. Carcass removal rates at the Alta Wind Energy Center, April 2014 – April 2016.

Adjusted Mortality Estimates

Seasonal mortality estimates and 90% confidence intervals were calculated on a per turbine basis for each bird/bat category (Appendices B and C). Seasonal mortality estimates were calculated separately for the 25 GE turbines within Alta I (Appendix B1) and the 30 Vestas turbines within Alta II-V (Appendix B2). The mortality estimates were adjusted based on the corrections for carcass removal and observer detection bias. Because 100% of the plot was searched for each sampled turbine, no search area correction factor was applied; however, an effective number of turbines searched was used to adjust for plots that effectively searched captured fatalities from more than one turbine (i.e., plots that overlapped with similar sized search plots applied to adjacent turbines). The mean search interval was 18.0 days at Alta I and 18.25 days at Alta II-V. Given the mean search interval and estimated searcher efficiency and carcass removal rates, the probability that a carcass would both remain in a search plot and be found by a searcher was 0.14, 0.68, and 0.07 for small birds, large birds, and bats, respectively (Appendices B and C).

Overall Project-wide mortality rate estimates, based on the sample of 55 Project-wide turbines, were calculated on a per MW/year basis across all study seasons, regardless of turbine type. To calculate the annual Project-wide mortality rate for each bird/bat category, the seasonal average, weighted by the number of searched turbines in each turbine group (GE or Vestas), was calculated and summed across seasons. Additionally, mortality estimates were calculated on a per MW basis by season and separately for Alta I and Alta II-V (Appendices B and C).

Small Birds

The estimated Project-wide mortality rate for small birds was 1.21 birds/MW/year (Table 4), with an overall estimate of 2.16 birds/MW/year for Alta I and 0.41 birds/MW/year for Alta II-V (Appendix B). At Alta I, the highest seasonal mortality rate for small birds was observed during the spring (1.32 birds/MW/study period), with mortality ranging from 0.12 to 0.36 birds/MW/study period during the other seasons (Appendix B1). At Alta II-V, the highest seasonal mortality rate was also observed during the spring (0.20 birds/MW/study period), with mortality ranging from zero in the summer to 0.10 birds/MW in the fall and winter (Appendix B2).

Large Birds

The estimated Project-wide mortality rate for large birds was 0.24 birds/MW/year (Table 4) with an overall estimate of 0.41 birds/MW/year for Alta I and 0.10 birds/MW/year for Alta II-V (Appendix B). At Alta I, the highest seasonal mortality rates for large birds were observed during the summer (0.18 birds/MW/study period) and fall (0.13), with lower mortality observed in the spring and winter (0.05 birds/MW/study period; Appendix B1). At Alta II-V, the highest seasonal mortality rate was observed during the spring (0.04 birds/MW/study period), with lower mortality in the summer (0.02), fall (0.01), and winter (0.02; Appendix B2).

Diurnal Raptors

The estimated Project-wide mortality rate for diurnal raptors was 0.07 birds/MW/year (Table 4), with an overall estimate of 0.15 raptors/MW/year for Alta I (Appendix B). No diurnal raptor casualties were found at Alta II-V during the third year of monitoring. At Alta I, seasonal mortality rates for diurnal raptors were 0.10 raptors/MW/study period in the summer and 0.05 raptors/MW/study period in the spring; no diurnal raptor casualties were found during the fall or winter at Alta I (Appendix B1).

All Birds

The estimated Project-wide mortality rate for all birds was 1.45 birds/MW/year (Table 4), with an overall estimate of 2.57 birds/MW/year at Alta I and 0.51 birds/MW/year at Alta II-V (Appendix B). Within Alta I, the highest seasonal mortality rate for all birds was observed during the spring (1.32 birds/MW/study period), with mortality ranging from 0.25 to 0.54 birds/MW/study period during the other seasons (Appendix B1). At Alta II-V, the highest seasonal mortality rate was observed during the spring (0.25 birds/MW/study period), and ranged from 0.02 to 0.12 birds/MW/study period during the other seasons (Appendix B2).

Excluding upland game birds and domestic fowl from the Project-wide all bird mortality rate yields an estimate of 1.36 birds/MW/year (Table 4). Seventy-seven percent of upland game birds and domestic fowl casualties were found at Alta I, with the greatest number of casualties found during the spring (approximately 50%; Appendix A).

Bats

The estimated Project-wide mortality rate for bats was 0.32 bats/MW/year (Table 4), with an estimate of 0.70 bats/MW/year at Alta I (Appendix C1). No bat casualties were found at Alta II-V during the third year of monitoring. At Alta I, bat mortality was only observed during the fall and summer (0.47 and 0.23 bats/MW/study period, respectively; Appendix C1).

Table 4. Adjusted project-wide bird and bat mortality estimates for Alta I-V from March 10, 2015 – March 4, 2016. For more details concerning correction factors and confidence intervals for both bird and bat mortality estimates, as well as a breakdown of mortality estimates for Alta I and Alta II-V, refer to Appendices B and C.

	Adjusted Project-Wide Mortality Estimate	
Group	**#/MW/year**	**90% Confidence Interval**
Small Birds	1.21	0.74 – 1.84
Large Birds	0.24	0.15 – 0.33
Diurnal Raptors	0.07	0.03 – 0.12
All Birds	1.45	0.96 – 2.07
All Birds Excluding Upland Game Birds and Domestic Fowl	1.36	0.87 – 1.97
Bats	0.32	-

DISCUSSION

The approach used for calculating adjusted mortality estimates was consistent with the approach outlined by Shoenfeld (2004) and Erickson et al. (2005a), and accounted for search interval, searcher efficiency, and carcass removal. It is hypothesized that scavenging could change through time at a given site and must be accounted for when attempting to estimate mortality rates. We accounted for this by conducting carcass removal trials throughout the year and also compared data to past previous years; combining data to enhance samples sizes when appropriate (i.e., when there were no significant differences among seasons or years). We also estimated searcher efficiency rates throughout the study period to account for any biases associated with changes in conditions and again compared data to prior years.

Potential Biases

There are a number of factors that could contribute to both positive and negative biases in estimating mortality rates (Erickson 2006). This section identifies many of the more common biases associated with post-construction mortality monitoring studies and the measures taken to address these biases. The overall design of this study incorporates several assumptions or factors that affect the results of the mortality estimates. First, all bird casualties found within the standardized search plots during the study were included in the analysis, which may have increased the estimates compared to only using birds found during scheduled search efforts.

Second, it was assumed that all carcasses found during the study were due to collision with wind turbines, whereas the true cause of death was unknown for most of the carcasses. It is possible that some of the bird carcasses found were the result of predators, and some of the casualties included in the data pool were potentially due to natural causes (background mortality). This is particularly true for ground nesting species such as California quail and greater roadrunner (*Geococcyx californianus*), which rarely fly within the rotor swept area. This factor would lead to an overestimate of avian mortality rates. Unlike birds, it is considered unlikely that the two bat casualties found during the study were due to factors unrelated to interactions with wind turbines.

There are some other potential negative biases. For example, no adjustments were made for carcasses possibly occurring outside of the plot boundaries. The search plot radius (120 m) for this study was selected based on results of other studies (Higgins et al. 1996; Erickson et al. 2004; Johnson et al. 2002b, 2003b, 2004; Kerlinger et al. 2007; Young et al. 2003c, 2005) in which a distance equal to the approximate height of the turbine appeared to capture a very large percentage of carcasses. Based on the distribution of carcasses as a function of distance from turbines (Table 2 and Figure 6), a comparatively small percentage of bird and bat carcasses possibly fell outside the search plots and may have been missed. This factor would lead to an underestimate of mortality rates.

Other potential biases are associated with the experimental carcasses used in searcher efficiency and carcass removal trials and whether or not they were representative of actual carcasses. This may occur if the types of birds used were larger or smaller than the carcasses of turbine-related casualties, more or less cryptic in color than the actual casualties, etc. Mallard hens, *Coturnix* quail, rock pigeons, brown-headed cowbirds, and house sparrows were used to represent the range of bird carcasses expected. It is believed that this range captures the range of sizes and other characteristics of actual casualties and should be a reasonable representation of scavenging rates and detection rates of the birds as a group. Additionally, a number of fresh bird and bat carcasses encountered during the study were left in the field and incorporated into the carcass removal trials.

Concern has also been raised regarding how the number of carcasses placed in the field for carcass removal trials on a given day could lead to biased estimates of scavenging rates (Smallwood 2007, Smallwood et al. 2010). Hypothetically, this would lead to underestimating true scavenging rates if the scavenger densities are low enough such that scavenging rates for these placed carcasses are lower than for actual casualties. The logic is that if the trials are based on too many carcasses on a given day, scavengers are unable to access all trial carcasses, whereas they could access all wind turbine collisions. If this were the case, and the trial carcass density was much greater than actual turbine mortality density, the trials would underestimate scavenging rates compared to rates on actual casualties. The contrary is also possible, where placing carcasses may draw in more scavengers, and carcasses could be removed more quickly than normal. The number placed for this study attempted to achieve a sufficient sample size without placing too many carcasses that would disrupt the natural scavenging rates.

Overall Bird Casualties

Overall bird mortality estimates at wind energy facilities across North America have ranged from 0.08 to 17.44 birds/MW/year (Appendix D1). The estimated annual bird mortality for the third year of post-construction mortality monitoring at the Project (1.36 birds/MW/year) is comparatively lower than other wind energy facilities in California, the Pacific Northwest, the Rocky Mountains, and the Southwest regions of North America (Figure 9). The 2015/2016 study year had the lowest mortality rate of the three years of study at the Project (Figure 9). The second year of the study, 2013/2014, was the highest at 7.08 birds/MW/year (Chatfield et al. 2014) and Year 1 studies reported 4.00 birds/MW/year (Chatfield et al. 2012). One factor that may have contributed to higher mortality estimates for all bird categories during the second year of study (2013/2014), but especially for small birds, was a longer search interval used during the study period. Although the search interval was originally scheduled to be two weeks, due to unanticipated crew shortages and safety concerns (e.g., lightning, snow, extreme high winds), search intervals were as long as four weeks during some months. Because scavenging rates for small birds were quite high (the average seasonal removal rates were 2.20 to 5.04 days), the longer search intervals could have had the effect of over-inflating mortality estimates. Search intervals in Year 1 (2011/2012) and Year 3 (2015-2016) were consistently lower at approximately two weeks.

Climatic conditions could also have some influence on the annual variation in mortality rates. California has been in a severe drought in recent years, and the extremely dry conditions could have impacted bird use throughout the region. Lower bird use could have influenced the lower mortality rates observed during Year 3 (2015/2016) studies; however, given the variation in the three years of study at Alta I-V, it appears that overall bird mortality is generally consistent with what might be expected for the region (Figure 9).

The species composition of bird and bat casualties during Year 3 of monitoring was largely consistent with prior years. During Year 2 of the study, large birds composed 35.7% of overall bird mortality, while diurnal raptors composed only 3.9% of overall bird mortality and owls composed 3.1% of overall bird mortality. Approximately 27.2% of large bird mortality in Year 3 was attributable to upland game birds (California quail) compared to 39% in Year 2 (California quail and chukar [*Alectoris chukar*]). Unidentified casualties composed 21.5% of all bird casualties in Year 3 and 59.3% of all passerines and other small birds. Some small bird casualties were common residents of the Project, including western scrub-jay and horned lark (*Eremophila alpestris*), whereas many other small bird casualties, such as western tanager (*Piranga ludoviciana*) and black-headed grosbeak (*Pheucticus melanocephalus*), were likely migrants through the region (Appendix A). Seasonal mortality rates for each of the bird categories were higher during spring, summer, and winter at Alta I compared with those observed at Alta II-V. Small bird mortality at Alta I (2.05 birds/MW/year) was nearly five times the rate at Alta II-V (0.39 birds/MW/year), a similar pattern to that observed during Year 2 (see *Yearly Comparison* below). Similarly, large bird mortality at Alta I in Year 3 (0.40 birds/MW/year) was four times the rate observed at Alta II-V (0.10 birds/MW/year; Appendix B).

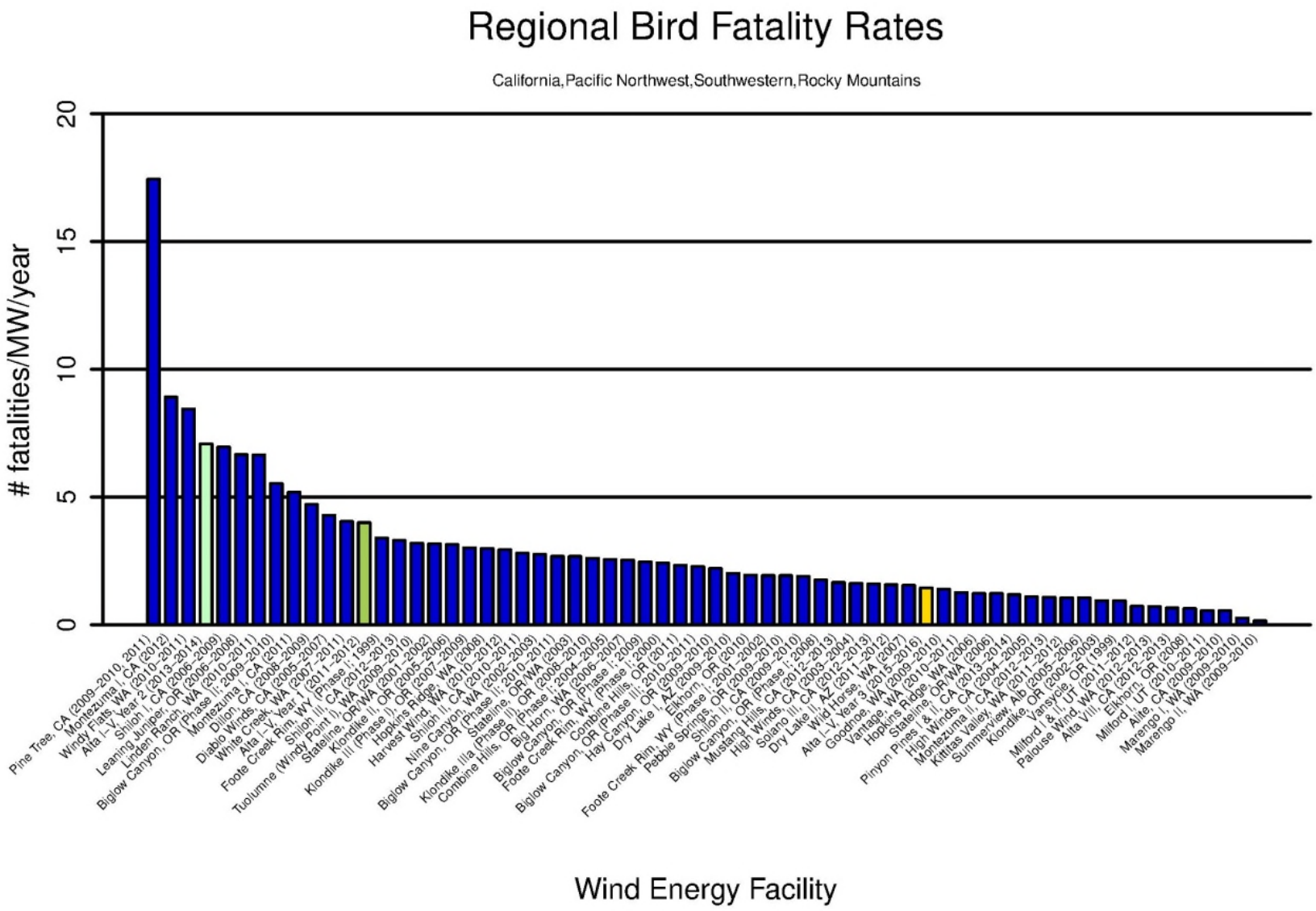

Figure 9. Mortality rates for all birds (number of birds per MW per year) at Alta I-V (Years 1, 2, and 3 of the study) compared with mortality rates from publicly-available studies at wind energy facilities in western North America.

Figure 9 (*continued*). Mortality rates for all birds (number of birds per MW per year) at Alta I-V (Years 1, 2 and 3 of the study) compared with mortality rates from publicly-available studies at wind energy facilities in western North America.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Alta I-V, Year 1 (2011-2012) Alta I-V, Year 2 (2013-2014) Alta I-V, Year 3 (2015-2016	Chatfield et al. 2012 Chatfield et al. 2014 This study.				
Pine Tree, CA (2009-2010, 2011)	BioResource Consultants 2012	Biglow Canyon, OR (Phase II; 2010-2011)	Enk et al. 2012b	Goodnoe, WA (2009-2010)	URS Corporation 2010a
Montezuma I, CA (2012)	ICF International 2013	Stateline, OR/WA (2003)	Erickson et al. 2004	Vantage, WA (2010-2011)	Ventus Environmental Solutions 2012
Windy Flats, WA (2010-2011)	Enz et al. 2011	Klondike IIIa (Phase II), OR (2008-2010)	Gritski et al. 2011	Hopkins Ridge, WA (2006)	Young et al. 2007
Shiloh I, CA (2006-2009)	Kerlinger et al. 2009	Combine Hills, OR (Phase I; 2004-2005)	Young et al. 2006	Stateline, OR/WA (2006)	Erickson et al. 2007
Leaning Juniper, OR (2006-2008)	Gritski et al. 2008	Big Horn, WA (2006-2007)	Kronner et al. 2008	Pinyon Pines I & II, CA (2013-2014)	Chatfield and Russo 2014
Linden Ranch, WA (2010-2011)	Enz and Bay 2011	Biglow Canyon, OR (Phase I; 2009)	Enk et al. 2010	High Winds, CA (2004-2005)	Kerlinger et al. 2006
Biglow Canyon, OR (Phase II; 2009-2010)	Enk et al. 2011a	Foote Creek Rim, WY (Phase I; 2000)	Young et al. 2003b	Montezuma II, CA (2012-2013)	Harvey & Associates 2013
Montezuma I, CA (2011)	ICF International 2012	Combine Hills, OR (2011)	Enz et al. 2012	Kittitas Valley, WA (2011-2012)	Stantec Consulting Services 2012
Dillon, CA (2008-2009)	Chatfield et al. 2009	Biglow Canyon, OR (Phase III; 2010-2011)	Enk et al. 2012a	Summerview, Alb (2005-2006)	Brown and Hamilton 2006b
Diablo Winds, CA (2005-2007)	WEST 2006, 2008	Hay Canyon, OR (2009-2010)	Gritski and Kronner 2010a	Klondike, OR (2002-2003)	Johnson et al. 2003b
White Creek, WA (2007-2011)	Downes and Gritski 2012b	Dry Lake I, AZ (2009-2010)	Thompson et al. 2011	Vansycle, OR (1999)	Erickson et al. 2000a
Foote Creek Rim, WY (Phase I; 1999)	Young et al. 2003b	Elkhorn, OR (2010)	Enk et al. 2011b	Milford I & II, UT (2011-2012)	Stantec 2012b
Shiloh III, CA (2012-2013)	Kerlinger et al. 2013b	Foote Creek Rim, WY (Phase I; 2001-2002)	Young et al. 2003b	Palouse Wind, WA (2012-2013)	Stantec 2013a
Tuolumne (Windy Point I), WA (2009-2010)	Enz and Bay 2010	Pebble Springs, OR (2009-2010)	Gritski and Kronner 2010b	Alta VIII, CA (2012-2013)	Chatfield and Bay 2014
Stateline, OR/WA (2001-2002)	Erickson et al. 2004	Shiloh II, CA (2009-2010)	Kerlinger et al. 2010, 2013a	Elkhorn, OR (2008)	Jeffrey et al. 2009b
Klondike II, OR (2005-2006)	NWC and WEST 2007	Biglow Canyon, OR (Phase I; 2008)	Jeffrey et al. 2009a	Milford I, UT (2010-2011)	Stantec 2011b
Klondike III (Phase I), OR (2007-2009)	Gritski et al. 2010	Mustang Hills, CA (2012-2013)	Chatfield and Bay 2014	Alite, CA (2009-2010)	Chatfield et al. 2010
Hopkins Ridge, WA (2008)	Young et al. 2009c	High Winds, CA (2003-2004)	Kerlinger et al. 2006	Marengo I, WA (2009-2010)	URS Corporation 2010b
Harvest Wind, WA (2010-2012)	Downes and Gritski 2012a	Solano III, CA (2012-2013)	AECOM 2013	Marengo II, WA (2009-2010)	URS Corporation 2010c
Shiloh II, CA (2010-2011)	Kerlinger et al. 2013a	Dry Lake II, AZ (2011-2012)	Thompson and Bay 2012		
Nine Canyon, WA (2002-2003)	Erickson et al. 2003a	Wild Horse, WA (2007)	Erickson et al. 2008		

Within Alta I, approximately 14.7% of bird mortality (five casualties) occurred at one turbine, GE-025. Similar to Year 2, half of the casualties in Year 3 occurred at five turbines (GE-013, GE-021, GE-025, GE-049, and GE-085), four of which were also among the five highest mortality turbines in Year 2. It is possible that the relatively high mortality at GE-021 was the result of higher bird use within the oak scrub and willow riparian habitats present within this turbine string, as compared with bird use within the grassland and rabbitbrush scrub habitats in the surrounding region. During Year 1 and Year 3 of the study, turbine GE-025, experienced the highest mortality (10 and five casualties, respectively) of any searched turbine (see Chatfield et al. 2012). One trend observed in the spatial distribution of casualties at Alta I during both the first and second years of monitoring was a greater number of casualties found at turbines located at or near the eastern end of turbine strings, and situated above Tehachapi-Willow Springs Road. During Year 3, this spatial distribution was not present. The most apparent spatial pattern in Year 3 was the location of a higher proportion of bird casualties along the turbine strings bordering Oak Creek Canyon, to the west of Tehachapi-Willow Springs Road (see figure 4a).

Diurnal raptor mortality estimates at wind energy facilities in California have ranged from zero to 1.06 birds/MW/year, which encompasses the range of estimates throughout North America (Appendix D2). The overall diurnal raptor mortality estimate at the Project in 2015/2016 (0.07 raptors/MW/year) was low compared to other wind energy facilities in the California, Pacific Northwest, Rocky Mountain, and Southwest regions of North America, and also considerably lower than diurnal raptor mortality estimated for the first (0.15 birds/MW/year) and second (0.07 birds/MW/year) years of monitoring at the Project (Figure 10; Appendix D2). The diurnal raptor casualties found during Year 3 of the study consisted of one American kestrel, five red-tailed hawk (three found during scheduled searches and two incidentally), and one golden eagle (Table 1). In addition to the diurnal raptors, one unidentified owl casualty found incidentally.

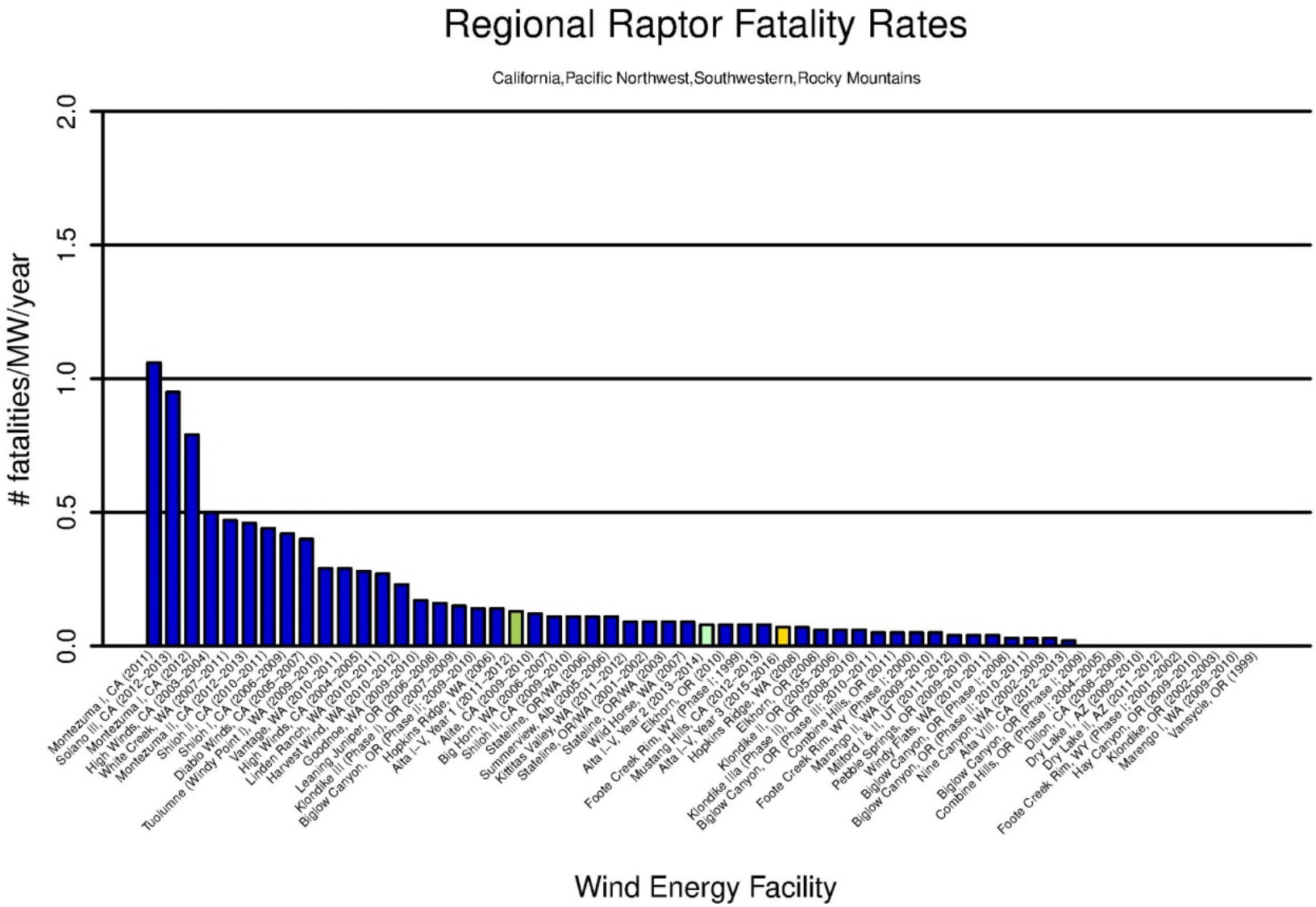

Figure 10. Mortality rates for raptors (number of raptors per MW per year) at Alta I-V (Years 1, 2, and 3 of the study) compared with mortality rates from publicly-available studies at wind energy facilities in western North America.

Figure 10 (*continued*). Mortality rates for raptors (number of raptors per MW per year) at Alta I-V (Years 1, 2 and 3 of the study) compared with mortality rates from publicly-available studies at wind energy facilities in western North America.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Alta I-V, Year 1 (2011-2012) Alta I-V, Year 2 (2013-2014) Alta I-V, Year 3 (2015-2016	Chatfield et al. 2012 Chatfield et al. 2014 This study.				
Montezuma I, CA (2011)	ICF International 2012	Alite, CA (2009-2010)	Chatfield et al. 2010	Marengo II, WA (2009-2010)	URS Corporation 2010c
Solano III, CA (2012-2013)	AECOM 2013	Big Horn, WA (2006-2007)	Kronner et al. 2008	Milford I & II, UT (2011-2012)	Stantec 2012b
Montezuma I, CA (2012)	ICF International 2013	Shiloh II, CA (2009-2010)	Kerlinger et al. 2010, 2013a	Pebble Springs, OR (2009-2010)	Gritski and Kronner 2010b
High Winds, CA (2003-2004)	Kerlinger et al. 2006	Stateline, OR/WA (2006)	Erickson et al. 2007	Windy Flats, WA (2010-2011)	Enz et al. 2011
White Creek, WA (2007-2011)	Downes and Gritski 2012b	Summerview, Alb (2005-2006)	Brown and Hamilton 2006b	Biglow Canyon, OR (Phase I; 2008)	Jeffrey et al. 2009a
Montezuma II, CA (2012-2013)	Harvey & Associates 2013	Kittitas Valley, WA (2011-2012)	Stantec Consulting Services 2012	Biglow Canyon, OR (Phase II; 2010-2011)	Enk et al. 2012b
Shiloh II, CA (2010-2011)	Kerlinger et al. 2013a	Stateline, OR/WA (2001-2002)	Erickson et al. 2004	Nine Canyon, WA (2002-2003)	Erickson et al. 2003a
Shiloh I, CA (2006-2009)	Kerlinger et al. 2009	Stateline, OR/WA (2003)	Erickson et al. 2004	Alta VIII, CA (2012-2013)	Chatfield and Bay 2014
Diablo Winds, CA (2005-2007)	WEST 2006, 2008	Wild Horse, WA (2007)	Erickson et al. 2008	Biglow Canyon, OR (Phase I; 2009)	Enk et al. 2010
Tuolumne (Windy Point I), WA (2009-2010)	Enz and Bay 2010	Elkhorn, OR (2010)	Enk et al. 2011b	Combine Hills, OR (Phase I; 2004-2005)	Young et al. 2006
Vantage, WA (2010-2011)	Ventus Environmental Solutions 2012	Foote Creek Rim, WY (Phase I; 1999)	Young et al. 2003b	Dillon, CA (2008-2009)	Chatfield et al. 2009
High Winds, CA (2004-2005)	Kerlinger et al. 2006	Mustang Hills, CA (2012-2013)	Chatfield and Bay 2014	Dry Lake I, AZ (2009-2010)	Thompson et al. 2011
Linden Ranch, WA (2010-2011)	Enz and Bay 2011	Hopkins Ridge, WA (2008)	Young et al. 2009c	Dry Lake II, AZ (2011-2012)	Thompson and Bay 2012
Harvest Wind, WA (2010-2012)	Downes and Gritski 2012a	Elkhorn, OR (2008)	Jeffrey et al. 2009b	Foote Creek Rim, WY (Phase I; 2001-2002)	Young et al. 2003b
Goodnoe, WA (2009-2010)	URS Corporation 2010a	Klondike II, OR (2005-2006)	NWC and WEST 2007	Hay Canyon, OR (2009-2010)	Gritski and Kronner 2010a
Leaning Juniper, OR (2006-2008)	Gritski et al. 2008	Klondike IIIa (Phase II), OR (2008-2010)	Gritski et al. 2011	Klondike, OR (2002-2003)	Johnson et al. 2003b
Klondike III (Phase I), OR (2007-2009)	Gritski et al. 2010	Biglow Canyon, OR (Phase III; 2010-2011)	Enk et al. 2012a	Marengo I, WA (2009-2010)	URS Corporation 2010b
Biglow Canyon, OR (Phase II; 2009-2010)	Enk et al. 2011a	Combine Hills, OR (2011)	Enz et al. 2012	Vansycle, OR (1999)	Erickson et al. 2000a
Hopkins Ridge, WA (2006)	Young et al. 2007	Foote Creek Rim, WY (Phase I; 2000)	Young et al. 2003b		

Based on the relatively low to moderate estimate of bird mortality at Alta II–V during the three years of monitoring (2011/2012, 2013/2014, 2015/2016; Figure 9), it is unlikely that operation of this portion of the facility will result in any significant impacts to bird populations. Alta II-V had relatively low morality (2.79 or fewer birds/MW/year) across all three study years compared to Alta I and other regional projects (see Figure 9). While considerably higher overall mortality rates were observed at Alta I during Year 2, over a third (39%) of the casualties found were upland game birds, which generally do not fly within the rotor swept zone (Chatfield et al. 2014). As such, many of these casualties were likely the result of natural causes (e.g., predation) rather than turbine-related incidents. Additionally, at least one of the casualties found at Alta I was a domestic fowl species (i.e., a chicken), likely from a nearby homestead and also likely the result of predation. While a number of these upland game bird and domestic fowl casualties may not be turbine-related, WEST has taken a conservative approach and included all casualties found within search plots in our estimation of mortality rates. This has been standard practice for most post-construction mortality studies at wind energy facilities, due to the difficulty of determining actual cause of death for many of the avian mortalities (e.g., feather spots) found during these studies.

Diurnal raptor mortality at both Alta I and Alta II-V was lower in Years 2 and 3 than that observed during the initial year of monitoring. Although no golden eagle casualties were observed at the Project during Year 2 (Chatfield et al. 2014), one was found during a turbine search in Year 3, and two were found incidentally during Year 1 (Chatfield et al. 2012). Among the owl species, a single great horned owl (*Bubo virginianus*) was found during a carcass search in Year 1 and a single unidentified owl was found incidentally in Year 3, while two burrowing owls and one barn owl were found on search plots in Year 2. Overall, raptor mortality has been relatively low across the three years of study and are within the lower range of that reported for projects in California (see Appendix D2).

Bat Casualties

Bat mortality at the Project during all years of monitoring has been among the lowest recorded at wind energy facilities in California and other western states (see Appendix D3). Bat mortality has ranged from 0.08 to 3.92 bats/MW/year in California and from zero to 11.42 bats/MW/year throughout western North America (Figure 11; Appendix D3). To date, the higher rate of bat mortality observed at some wind energy facilities in the Midwest and eastern US have not been observed at facilities in California. Bat mortality rates outside of California have ranged from 0.10 to 40.20 bats/MW/year (Appendix D3). Only four bats (one hoary bat found incidentally and three Mexican free-tailed bats found during searches) were found at Alta I during the third year of monitoring, whereas one hoary bat was found incidentally at Alta II-V. All bat casualties found in Year 1 (Chatfield et al. 2012) and Year 2 were at Alta I (Chatfield et al. 2014). Based on the relatively low levels of bat mortality observed during the three years of monitoring, it is unlikely that operation of this facility will result in any significant impacts to bat populations.

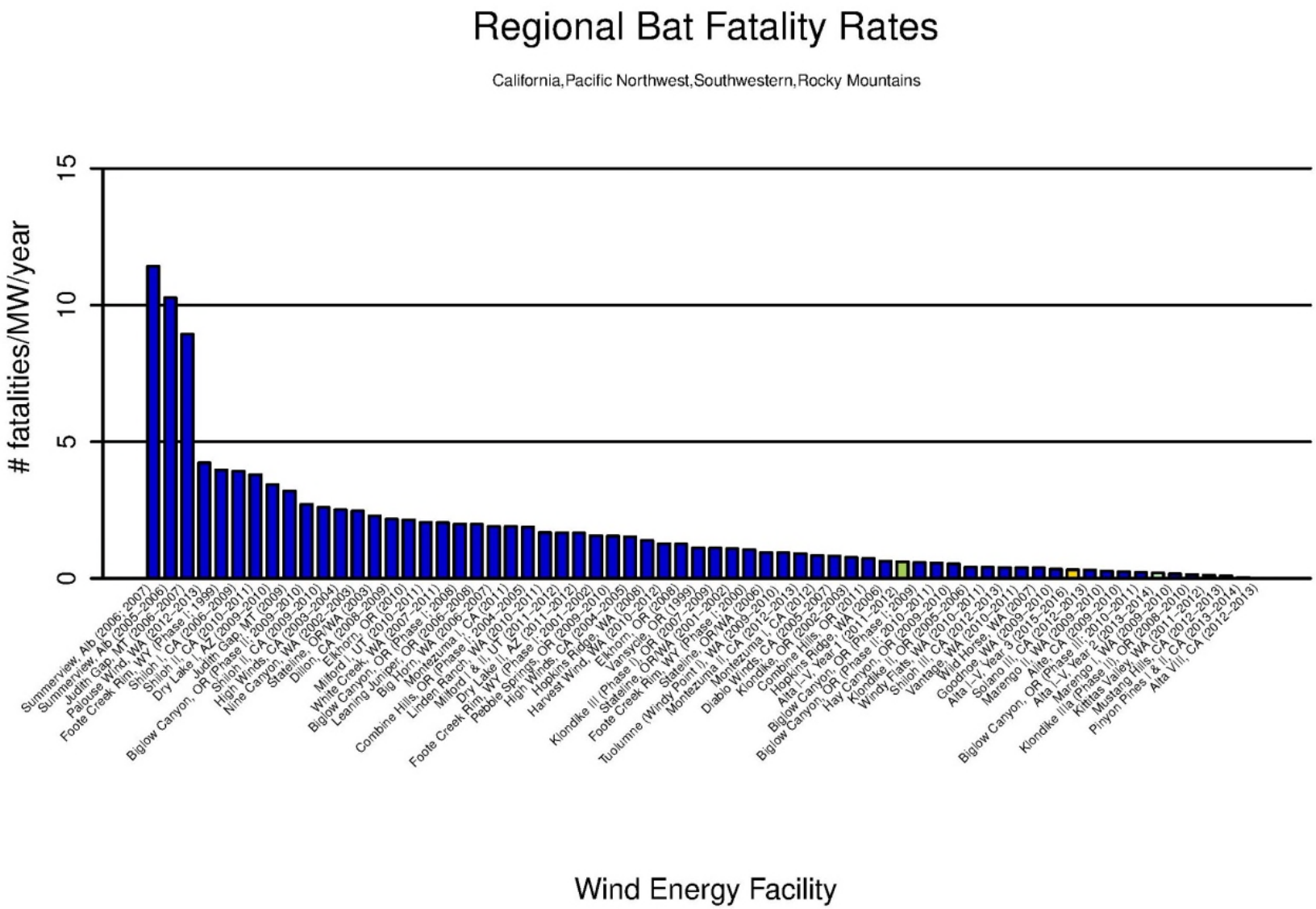

Figure 11. Mortality rates for bats (number of bats per MW per year) at Alta I-V (Years 1, 2, and 3 of the study) compared with mortality rates from publicly-available studies at wind energy facilities in western North America.

Figure 11 (continued). Mortality rates for bats (number of bats per MW per year) at Alta I-V (Years 1, 2 and 3 of the study) compared with mortality rates from publicly-available studies at wind energy facilities in western North America.

Data from the following sources:

Facility, Location	Reference	Facility, Location	Reference	Facility, Location	Reference
Alta I-V, Year 1 (2011-2012) Alta I-V, Year 2 (2013-2014) Alta I-V, Year 3 (2015-2016	Chatfield et al. 2012 Chatfield et al. 2014 This study.				
Summerview, Alb (2006; 2007)	Baerwald 2008	Montezuma I, CA (2011)	ICF International 2012	Combine Hills, OR (2011)	Enz et al. 2012
Summerview, Alb (2005-2006)	Brown and Hamilton 2006b	Combine Hills, OR (Phase I; 2004-2005)	Young et al. 2006	Hopkins Ridge, WA (2006)	Young et al. 2007
Judith Gap, MT (2006-2007)	TRC 2008	Linden Ranch, WA (2010-2011)	Enz and Bay 2011	Biglow Canyon, OR (Phase I; 2009)	Enk et al. 2010
Palouse Wind, WA (2012-2013)	Stantec 2013a	Milford I & II, UT (2011-2012)	Stantec 2012b	Biglow Canyon, OR (Phase II; 2010-2011)	Enk et al. 2012b
Foote Creek Rim, WY (Phase I; 1999)	Young et al. 2003b	Dry Lake II, AZ (2011-2012)	Thompson and Bay 2012	Hay Canyon, OR (2009-2010)	Gritski and Kronner 2010a
Shiloh I, CA (2006-2009)	Kerlinger et al. 2009	Foote Creek Rim, WY (Phase I; 2001-2002)	Young et al. 2003b	Klondike II, OR (2005-2006)	NWC and WEST 2007
Shiloh II, CA (2010-2011)	Kerlinger et al. 2013a	Pebble Springs, OR (2009-2010)	Gritski and Kronner 2010b	Windy Flats, WA (2010-2011)	Enz et al. 2011
Dry Lake I, AZ (2009-2010)	Thompson et al. 2011	High Winds, CA (2004-2005)	Kerlinger et al. 2006	Shiloh III, CA (2012-2013)	Kerlinger et al. 2013b
Judith Gap, MT (2009)	Poulton and Erickson 2010	Hopkins Ridge, WA (2008)	Young et al. 2009c	Vantage, WA (2010-2011)	Ventus Environmental Solutions 2012
Biglow Canyon, OR (Phase II; 2009-2010)	Enk et al. 2011a	Harvest Wind, WA (2010-2012)	Downes and Gritski 2012a	Wild Horse, WA (2007)	Erickson et al. 2008
Shiloh II, CA (2009-2010)	Kerlinger et al. 2010, 2013a	Elkhorn, OR (2008)	Jeffrey et al. 2009b	Goodnoe, WA (2009-2010)	URS Corporation 2010a
High Winds, CA (2003-2004)	Kerlinger et al. 2006	Vansycle, OR (1999)	Erickson et al. 2000a	Solano III, CA (2012-2013)	AECOM 2013
Nine Canyon, WA (2002-2003)	Erickson et al. 2003a	Klondike III (Phase I), OR (2007-2009)	Gritski et al. 2010	Marengo II, WA (2009-2010)	URS Corporation 2010c
Stateline, OR/WA (2003)	Erickson et al. 2004	Stateline, OR/WA (2001-2002)	Erickson et al. 2004	Alite, CA (2009-2010)	Chatfield et al. 2010
Dillon, CA (2008-2009)	Chatfield et al. 2009	Foote Creek Rim, WY (Phase I; 2000)	Young et al. 2003b	Biglow Canyon, OR (Phase III; 2010-2011)	Enk et al. 2012a
Elkhorn, OR (2010)	Enk et al. 2011b	Stateline, OR/WA (2006)	Erickson et al. 2007	Marengo I, WA (2009-2010)	URS Corporation 2010b
Milford I, UT (2010-2011)	Stantec 2011b	Tuolumne (Windy Point I), WA (2009-2010)	Enz and Bay 2010	Klondike IIIa (Phase II), OR (2008-2010)	Gritski et al. 2011
White Creek, WA (2007-2011)	Downes and Gritski 2012b	Montezuma II, CA (2012-2013)	Harvey & Associates 2013	Kittitas Valley, WA (2011-2012)	Stantec Consulting Services 2012
Biglow Canyon, OR (Phase I; 2008)	Jeffrey et al. 2009a	Montezuma I, CA (2012)	ICF International 2013	Mustang Hills, CA (2012-2013)	Chatfield and Bay 2014
Leaning Juniper, OR (2006-2008)	Gritski et al. 2008	Diablo Winds, CA (2005-2007)	WEST 2006, 2008	Pinyon Pines I & II, CA (2013-2014)	Chatfield and Russo 2014
Big Horn, WA (2006-2007)	Kronner et al. 2008	Klondike, OR (2002-2003)	Johnson et al. 2003b	Alta VIII, CA (2012-2013)	Chatfield and Bay 2014

Yearly Comparison

An objective of the third and final year of monitoring was to assess annual variability in mortality rates through comparing bird mortality to the previous two years of monitoring. Each of the three monitoring years used the Shoenfeld estimator for adjusting fatalities, allowing for an objective comparison between monitoring years.

Carcass persistence and searcher efficiency did not vary substantially across the three years of monitoring. Where the first year of monitoring was limited to using bias trial data from a single year, the two later years benefited from larger sample sizes by pooling data across years (where annual estimates were not significantly different). Searcher efficiency rates improved over time at Alta I-V and similar to carcass removal trials, the later years of study also benefited from the pooling of searcher efficiency data across years when the results were not statistically different.

Although mean removal rates were less for small birds and bats in Year 3, the higher searcher efficiency rates and lower number of observed fatalities resulted in a reduction in Project-wide mortality estimates for all bird groups in Year 3 relative to the prior two years; but an intermediate level of bat mortality (see Table 5).

Table 5. Adjusted bird and bat mortality estimates (#/MW/year) for Alta I-V for Year 1 (March 22, 2011 – June 15, 2012), Year 2 (March 4, 2013 – March 6, 2014), and Year 3 (March 10, 2015 – March 4, 2016) post-construction mortality monitoring studies. Included are adjusted Project-wide mortality estimates as well as separate adjusted estimates for Alta I and Alta II-V.

	Project-Wide Mortality Estimate		
Group	**Year 1 (2011-2012)**	**Year 2 (2013-2014)**	**Year 3 (2015-2016)**
Small Birds	3.14	6.22	1.21
Large Birds	0.86	0.87	0.24
Diurnal Raptors	0.13	0.08	0.07
All Birds	4.00	7.08	1.45
All Birds Excluding Upland Game Birds and Domestic Fowl	3.54	6.74	1.36
Bats	0.61	0.20	0.32
	Alta I Mortality Estimates		
Group	**Year 1 (2011-2012)**	**Year 2 (2013-2014)**	**Year 3 (2015-2016)**
Small Birds	5.49	10.32	2.16
Large Birds	1.57	1.72	0.41
Diurnal Raptors	0.23	0.15	0.15
All Birds	7.08	12.05	2.57
All Birds Excluding Upland Game Birds and Domestic Fowl	6.40	11.42	2.39
Bats	1.28	0.36	0.70
	Alta II-V Mortality Estimates		
Group	**Year 1 (2011-2012)**	**Year 2 (2013-2014)**	**Year 3 (2015-2016)**
Small Birds	1.39	2.66	0.41
Large Birds	0.27	0.14	0.10
Diurnal Raptors	0.05	0	0.00
All Birds	1.66	2.79	0.51
All Birds Excluding Upland Game Birds and Domestic Fowl	1.38	2.79	0.49
Bats	0.08	0	0

CONCLUSIONS

The results of the third year of mortality monitoring at the Project illustrate the annual variability inherent in bird and bat mortality. Relative to the second year of study, when bird mortality showed a relatively large increase compared to Year 1 (especially at Alta I), Year 3 study results indicate that bird mortality is not likely to be consistent with the higher estimates from Year 2, and that bird mortality rates in general appear consistent with other projects in the region. It was also suggested that the higher estimates in Year 2 could have been partly due to an increase in search interval (Chatfield et al 2014) compared to Year 1. Year 3 studies had a reduced searcher interval more in line with Year 1, which may provide some support for this hypothesis.

The three years of mortality monitoring at Alta I-V indicate that bird and bat mortality will likely vary annually over the life of the Project. However, given the relatively low mortality observed on average over the three years of study, it does not appear that Project operations will result in unanticipated impacts to bird or bat populations.

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Appendix A. Complete Casualty Listing for Alta I-V for Surveys Conducted from March 10, 2015 – March 4, 2016

Appendix A. Complete casualty listing for Alta I-V, March 10, 2015 – March 4, 2016.

Date	Common Name	Nearest Turbine	Distance from Turbine	Type of Find	Turbine Set	Turbine Brand	Condition
3/10/2015	horned lark	VE001	51	carcass search	Original 55	Vestas	Intact
3/11/2015	horned lark	VE053	66	carcass search	Original 55	Vestas	NA
3/17/2015	western bluebird	GE041	85	carcass search	Original 55	GE	Feather Spot
3/19/2015	black-headed grosbeak	GE001	98	carcass search	Original 55	GE	Feather Spot
3/19/2015	American kestrel	GE021	98	carcass search	Original 55	GE	Intact
3/23/2015	unidentified bird (small)	GE061	56	carcass search	Original 55	GE	Dismembered
3/24/2015	American coot	VE118	136	incidental find	---	Vestas	Feather Spot
3/25/2015	unidentified bird (small)	GE077	122	carcass search	Original 55	GE	Intact
4/1/2015	unidentified warbler	GE029	55	carcass search	Original 55	GE	Feather Spot
4/3/2015	red-tailed hawk	GE050	36	incidental find	---	GE	Feather Spot
4/13/2015	unidentified sparrow	GE053	114	carcass search	Original 55	GE	Feather Spot
4/15/2015	unidentified owl	SUB6B	15	incidental find	---		Feather Spot
4/20/2015	unidentified bird (small)	VE187	54	carcass search	Original 55	Vestas	Feather Spot
4/20/2015	unidentified bird (small)	VE187	54	carcass search	Original 55	Vestas	Intact
4/24/2015	Eurasian collared dove	VE038	192	incidental find	---	Vestas	Feather Spot
4/27/2015	unidentified warbler	GE013	114	carcass search	Original 55	GE	Feather Spot
4/27/2015	unidentified sparrow	GE017	86	carcass search	Original 55	GE	Feather Spot
4/27/2015	western scrub-jay	GE025	118	carcass search	Original 55	GE	Feather Spot
4/28/2015	mourning dove	VE021	100	carcass search	Original 55	Vestas	Feather Spot
4/28/2015	California quail	VE021	53	carcass search	Original 55	Vestas	Feather Spot
4/28/2015	common raven	VE049	54	carcass search	Original 55	Vestas	NA
4/29/2015	mourning dove	VE045	52	carcass search	Original 55	Vestas	Feather Spot
5/11/2015	red-tailed hawk	GE085	36	incidental find	Original 55	GE	Intact
5/14/2015	unidentified bird (small)	GE025	52	carcass search	Original 55	GE	Feather Spot
5/22/2015	western tanager	TLINE	54	incidental find	---		Intact
5/28/2015	hoary bat	VE058	56	incidental find	---	Vestas	Feather Spot
6/1/2015	unidentified bird (small)	GE073	100	carcass search	Original 55	GE	Intact
6/3/2015	unidentified warbler	GE061	66	carcass search	Original 55	GE	Feather Spot
6/4/2015	western bluebird	GE009	101	carcass search	Original 55	GE	Intact
6/4/2015	California quail	VE061	118	carcass search	Original 55	Vestas	Feather Spot
6/11/2015	red-tailed hawk	GE053	71	carcass search	Original 55	GE	Feather Spot
6/17/2015	unidentified bird (small)	GE025	72	carcass search	Original 55	GE	Feather Spot
6/19/2015	greater roadrunner	VE040	88	incidental find	---	Vestas	Dismembered
6/29/2015	common raven	SUB3A	---	incidental find	---		Feather Spot
6/30/2015	Mexican free-tailed bat	GE089	36	carcass search	Original 55	GE	Feather Spot
7/2/2015	common raven	GE017	54	carcass search	Original 55	GE	Dismembered

Appendix A. Complete casualty listing for Alta I-V, March 10, 2015 – March 4, 2016.

Date	Common Name	Nearest Turbine	Distance from Turbine	Type of Find	Turbine Set	Turbine Brand	Condition
7/8/2015	red-tailed hawk	GE085	22	carcass search	Original 55	GE	Intact
7/27/2015	Cassin's finch	VE043	225	incidental find	---	Vestas	Feather Spot
8/5/2015	mallard	VE089	33	carcass search	Original 55	Vestas	Feather Spot
8/10/2015	red-tailed hawk	GE033	61	carcass search	Original 55	GE	Feather Spot
8/24/2015	turkey vulture	GE019	40	incidental find	---	GE	Feather Spot
8/24/2015	golden eagle	GE021	43	carcass search	Original 55	GE	Intact
8/24/2015	mourning dove	GE049	25	carcass search	Original 55	GE	Intact
8/24/2015	mourning dove	GE049	40	carcass search	Original 55	GE	Intact
8/25/2015	California quail	GE019	16	incidental find	---	GE	Feather Spot
9/1/2015	unidentified bird (small)	GE085	92	carcass search	Original 55	GE	Intact
9/9/2015	Mexican free-tailed bat	GE041	32	carcass search	Original 55	GE	Feather Spot
9/9/2015	Mexican free-tailed bat	GE041	7	carcass search	Original 55	GE	Feather Spot
9/10/2015	unidentified bird (small)	O&M	172	incidental find	---		Feather Spot
9/16/2015	California quail	GE093	105	carcass search	Original 55	GE	Feather Spot
9/22/2015	California quail	GE013	51	carcass search	Original 55	GE	Feather Spot
9/22/2015	California quail	GE025	101	carcass search	Original 55	GE	Feather Spot
9/23/2015	hoary bat	GE068	46	incidental find	---	GE	Feather Spot
10/1/2015	greater roadrunner	VE155	44	carcass search	Original 55	Vestas	Feather Spot
11/4/2015	unidentified bird (small)	VE155	89	carcass search	Original 55	Vestas	Feather Spot
11/9/2015	California quail	GE093	---	carcass search	Original 55	GE	Feather Spot
11/9/2015	unidentified bird (small)	GE098	---	carcass search	Original 55	GE	Feather Spot
11/18/2015	American robin	VE009	80	carcass search	Original 55	Vestas	Feather Spot
11/23/2015	California quail	GE045	96	carcass search	Original 55	GE	Dismembered
12/1/2015	unidentified bird (small)	GE021	60	carcass search	Original 55	GE	Intact
12/1/2015	domestic chicken	GE025	50	carcass search	Original 55	GE	Feather Spot
12/3/2015	unidentified bird (small)	GE041	22	carcass search	Original 55	GE	Intact
12/10/2015	California quail	GE049	70	carcass search	Original 55	GE	Feather Spot
1/27/2016	mountain bluebird	VE179	95	carcass search	Original 55	Vestas	Feather Spot
1/28/2016	greater roadrunner	VE111	46	carcass search	Original 55	Vestas	Feather Spot
1/28/2016	greater roadrunner	VE184	51	incidental find	---	Vestas	Feather Spot
1/29/2016	mountain bluebird	VE131	47	carcass search	Original 55	Vestas	Intact
2/2/2016	greater roadrunner	VE069	62	carcass search	Original 55	Vestas	Feather Spot
2/8/2016	unidentified bird (small)	GE013	19	carcass search	Original 55	GE	Feather Spot
3/4/2016	house finch	INC	---	incidental find	---		Feather Spot

Appendix B. Complete Bird Mortality Tables for Alta I-V for Studies Conducted from March 10, 2015 – March 4, 2016

Appendix B1. Complete bird mortality table for the sample of 25 GE turbines at Alta I for studies conducted from March 10, 2015 – March 4, 2016.

	Spring	90% CI		Summer	90% CI		Fall	90% CI		Winter	90% CI	
Parameter	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**
Search Area Adjustment												
A (small birds)	1.00			1.00			1.00			1.00		
A (large birds)	1.00			1.00			1.00			1.00		
Effective Number of Turbines Searched												
	38.47			38.47			38.47			38.47		
Observer Detection												
A (small birds)	0.82	0.76	0.88	0.82	0.76	0.88	0.82	0.76	0.88	0.82	0.76	0.88
A (large birds)	0.94	0.90	0.99	0.94	0.90	0.99	0.94	0.90	0.99	0.94	0.90	0.99
Mean Carcass Removal Time (days)												
$\bar{t}$ (small birds)	3.17	2.41	4.07	3.17	2.41	4.07	3.17	2.41	4.07	3.17	2.41	4.07
$\bar{t}$ (large birds)	23.89	19.11	30.13	23.89	19.11	30.13	23.89	19.11	30.13	23.89	19.11	30.13
Observed Mortality Rates (birds/turbine/study period)												
Small birds	0.19	0.10	0.29	0.05	-	-	0.02	-	-	0.05	-	-
Large birds	0.03	-	-	0.12	0.05	0.21	0.09	-	-	0.03	-	-
Diurnal Raptors	0.03	-	-	0.07	-	-	0.00	-	-	0.00	-	-
Average Probability of Carcass Availability and Detected												
Small birds	0.14	0.11	0.19	0.14	0.11	0.19	0.14	0.11	0.19	0.14	0.11	0.19
Large birds	0.68	0.62	0.73	0.68	0.62	0.73	0.68	0.62	0.73	0.68	0.62	0.73
Adjusted Mortality Estimates (birds/turbine/study period)												
Small birds	1.98	0.94	3.29	0.54	-	-	0.18	-	-	0.54	-	-
Large birds	0.08	-	-	0.27	0.11	0.44	0.19	-	-	0.08	-	-
All Birds	2.05	1.02	3.40	0.81	0.31	1.45	0.37	0.08	0.77	0.62	-	-
All Birds (excluding Upland Game Birds and Domestic Fowl)	2.05	1.02	3.40	0.81	0.31	1.45	0.18	-	-	0.54	-	-
Diurnal Raptors	0.08	-	-	0.15	-	-	0.00	-	-	0.00	-	-
Adjusted Mortality Estimates (birds/MW/study period)												
Small birds	1.32	0.63	2.20	0.36	-	-	0.12	-	-	0.36	-	-
Large birds	0.05	-	-	0.18			0.13	-	-	0.05	-	-
All Birds	1.37	0.68	2.27	0.54	0.21	0.96	0.25	0.06	0.52	0.41	-	-
All Birds (excluding Upland Game Birds and Domestic Fowl)	1.37	0.68	2.27	0.54	0.21	0.96	0.12	-	-	0.36	-	-
Diurnal Raptors	0.05	-	-	0.10	-	-	0.00	-	-	0.00	-	-

Appendix B1. Complete bird mortality table for the sample of 25 GE turbines at Alta I for studies conducted from March 10, 2015 – March 4, 2016.

Overall Adjusted Mortality Estimates (birds/MW/year)		90 % Confidence Interval	
	Mean	Lower Limit	Upper Limit
Small Birds	2.16	1.25	3.35
Large Birds	0.41	0.24	0.59
All Birds	2.57	1.64	3.76
All Birds (excluding Upland Game Birds and Domestic Fowl)	2.39	1.46	3.60
Diurnal Raptors	0.15	0.08	0.38

Appendix B2. Complete bird mortality table for the sample of 30 Vestas turbines at Alta II-V for studies conducted from March 10, 2015 – March 4, 2016.

	Spring			Summer			Fall			Winter		
		90% CI			90% CI			90% CI			90% CI	
Parameter	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**
Search Area Adjustment												
A (small birds)	1.00			1.00			1.00			1.00		
A (large birds)	1.00			1.00			1.00			1.00		
Effective Number of Turbines Searched												
	45.65			45.65			45.65			45.65		
Observer Detection												
A (small birds)	0.82	0.76	0.88	0.82	0.76	0.88	0.82	0.76	0.88	0.82	0.76	0.88
A (large birds)	0.94	0.90	0.99	0.94	0.90	0.99	0.94	0.90	0.99	0.94	0.90	0.99
Mean Carcass Removal Time (days)												
$\bar{t}$ (small birds)	3.17	2.41	4.07	3.17	2.41	4.07	3.17	2.41	4.07	3.17	2.41	4.07
$\bar{t}$ (large birds)	23.89	19.11	30.13	23.89	19.11	30.13	23.89	19.11	30.13	23.89	19.11	30.13
Observed Mortality Rates (birds/turbine/study period)												
Small birds	0.03	-	-	0.00	-	-	0.01	-	-	0.01	-	-
Large birds	0.03	-	-	0.01	-	-	0.01	-	-	0.01	-	-
Diurnal Raptors	0.00	-	-	0.00	-	-	0.00	-	-	0.00	-	-
Average Probability of Carcass Availability and Detected												
Small birds	0.14	0.11	0.19	0.14	0.11	0.19	0.14	0.11	0.19	0.14	0.11	0.19
Large birds	0.68	0.62	0.73	0.68	0.62	0.73	0.68	0.62	0.73	0.68	0.62	0.73
Adjusted Mortality Estimates (birds/turbine/study period)												
Small birds	0.61	-	-	0.00	-	-	0.31	-	-	0.31	-	-
Large birds	0.13	-	-	0.06	-	-	0.03	-	-	0.06	-	-
All Birds	0.74	0.19	1.51	0.06	-	-	0.34	-	-	0.37	-	-
All Birds (excluding Upland Game Birds and Domestic Fowl)	0.71	0.17	1.47	0.03	-	-	0.34	-	-	0.37	-	-
Diurnal Raptors	0.00	-	-	0.00	-	-	0.00	-	-	0.00	-	-
Adjusted Mortality Estimates (birds/MW/study period)												
Small birds	0.20	-	-	0.00	-	-	0.10	-	-	0.10	-	-
Large birds	0.04	-	-	0.02	-	-	0.01	-	-	0.02	-	-
All Birds	0.25	0.06	0.50	0.02	-	-	0.11	-	-	0.12	-	-
All Birds (excluding Upland Game Birds and Domestic Fowl)	0.24	0.06	0.49	0.01	-	-	0.11	-	-	0.12	-	-
Diurnal Raptors	0.00	-	-	0.00	-	-	0.00	-	-	0.00	-	-

Appendix B2. Complete bird mortality table for the sample of 30 Vestas turbines at Alta II-V for studies conducted from March 10, 2015 – March 4, 2016.

Overall Adjusted Mortality Estimates (birds/MW/year)			
		90 % Confidence Interval	
	Mean	Lower Limit	Upper Limit
Small Birds	0.41	0.16	0.73
Large Birds	0.10	0.04	0.16
All Birds	0.51	0.25	0.85
All Birds (excluding Upland Game Birds and Domestic Fowl)	0.49	0.23	0.82
Diurnal Raptors	0.00	-	-

Appendix C. Complete Bat Mortality Table for Alta I-V for Studies Conducted from March 10, 2015 – March 4, 2016

Appendix C1. Complete bat mortality table for the sample of 25 GE turbines at Alta I for studies conducted from March 10, 2015 – March 4, 2016.

	Spring			Summer			Fall			Winter		
		90% CI			90% CI			90% CI			90% CI	
Parameter	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**
Search Area Adjustment												
A (bats)	1.00			1.00			1.00			1.00		
Effective Number of Turbines Searched												
	38.47			38.47			38.47			38.47		
Observer Detection												
A (bats)	0.68	0.55	0.82	0.68	0.55	0.82	0.68	0.55	0.82	0.68	0.55	0.82
Mean Carcass Removal Time (days)												
$\bar{t}$ (bats)	1.95	1.32	2.79	1.95	1.32	2.79	1.95	1.32	2.79	1.95	1.32	2.79
Observed Mortality Rates (bats/turbine/study period)												
Bats	0.00	-	-	0.02	-	-	0.03	-	-	0.00	-	-
Average Probability of Carcass Availability and Detected												
Bats	0.07	0.05	0.11	0.07	0.05	0.11	0.07	0.05	0.11	0.07	0.05	0.11
Adjusted Mortality Estimates (bats/turbine/study period)												
Bats	0.00	-	-	0.35	-	-	0.70	-	-	0.00	-	-
Adjusted Mortality Estimates (bats/MW/study period)												
Bats	0.00	-	-	0.23	-	-	0.47	-	-	0.00	-	-

Overall Adjusted Mortality Estimates (bats/MW/year)		90 % Confidence Interval	
	Mean	**Lower Limit**	**Upper Limit**
Bats	**0.70**	**-**	**-**

Appendix D. North American Mortality Summary Tables

Appendix D1. Wind energy facilities in North America with fatality data for all bird species, by geographic region. Fatality estimate presented as number of bird fatalities per megawatt (MW) per year.

Wind Energy Facility	Fatality Estimate	No. of Turbines	Total MW
Alta I, CA (2011/2012)	**7.07**	**100**	**150**
Alta II-V, CA (2011/2012)	**1.66**	**190**	**570**
Alta I, CA (2013/2014)	**12.05**	**100**	**150**
Alta II-V, CA (2013/2014)	**2.79**	**190**	**570**
Alta I, CA (2015/2016)	**2.57**	**100**	**150**
Alta II-V, CA (2015/2016)	**0.51**	**190**	**570**
California			
Pine Tree, CA (2009-2010, 2011)	17.44	90	135
Montezuma I, CA (2012)	8.91	16	36.8
Shiloh I, CA (2006-2009)	6.96	100	150
Montezuma I, CA (2011)	5.19	16	36.8
Dillon, CA (2008-2009)	4.71	45	45
Diablo Winds, CA (2005-2007)	4.29	31	20.46
Shiloh III, CA (2012-2013)	3.30	50	102.5
Shiloh II, CA (2010-2011)	2.80	75	150
Shiloh II, CA (2009-2010)	1.90	75	150
Mustang Hills, CA (2012-2013)	1.66	50	150
High Winds, CA (2003-2004)	1.62	90	162
Solano III, CA (2012-2013)	1.60	55	128
Pinyon Pines I & II, CA (2013-2014)	1.18	100	NA
High Winds, CA (2004-2005)	1.10	90	162
Montezuma II, CA (2012-2013)	1.08	34	78.2
Alta VIII, CA (2012-2013)	0.66	50	150
Alite, CA (2009-2010)	0.55	8	24
Pacific Northwest			
Windy Flats, WA (2010-2011)	8.45	114	262.2
Leaning Juniper, OR (2006-2008)	6.66	67	100.5
Linden Ranch, WA (2010-2011)	6.65	25	50
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	65	150
White Creek, WA (2007-2011)	4.05	89	204.7
Tuolumne (Windy Point I), WA (2009-2010)	3.20	62	136.6
Stateline, OR/WA (2001-2002)	3.17	454	299
Klondike II, OR (2005-2006)	3.14	50	75
Klondike III (Phase I), OR (2007-2009)	3.02	125	223.6
Hopkins Ridge, WA (2008)	2.99	87	156.6
Harvest Wind, WA (2010-2012)	2.94	43	98.9
Nine Canyon, WA (2002-2003)	2.76	37	48.1
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	65	150
Stateline, OR/WA (2003)	2.68	454	299
Klondike IIIa (Phase II), OR (2008-2010)	2.61	51	76.5
Combine Hills, OR (Phase I; 2004-2005)	2.56	41	41
Big Horn, WA (2006-2007)	2.54	133	199.5
Biglow Canyon, OR (Phase I; 2009)	2.47	76	125.4
Combine Hills, OR (2011)	2.33	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	76	174.8
Hay Canyon, OR (2009-2010)	2.21	48	100.8
Elkhorn, OR (2010)	1.95	61	101
Pebble Springs, OR (2009-2010)	1.93	47	98.7
Biglow Canyon, OR (Phase I; 2008)	1.76	76	125.4
Wild Horse, WA (2007)	1.55	127	229

Appendix D1. Wind energy facilities in North America with fatality data for all bird species, by geographic region. Fatality estimate presented as number of bird fatalities per megawatt (MW) per year.

Wind Energy Facility	Fatality Estimate	No. of Turbines	Total MW
Goodnoe, WA (2009-2010)	1.40	47	94
Vantage, WA (2010-2011)	1.27	60	90
Hopkins Ridge, WA (2006)	1.23	83	150
Stateline, OR/WA (2006)	1.23	454	299
Kittitas Valley, WA (2011-2012)	1.06	48	100.8
Klondike, OR (2002-2003)	0.95	16	24
Vansycle, OR (1999)	0.95	38	24.9
Palouse Wind, WA (2012-2013)	0.72	58	104.4
Elkhorn, OR (2008)	0.64	61	101
Marengo I, WA (2009-2010)	0.27	78	140.4
Marengo II, WA (2009-2010)	0.16	39	70.2
Rocky Mountains			
Foote Creek Rim, WY (Phase I; 1999)	3.40	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.42	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	69	41.4
Summerview, Alb (2005-2006)	1.06	39	70.2
Milford I & II, UT (2011-2012)	0.73	107	160.5 (58.5 Phase I, 102 Phase II)
Milford I, UT (2010-2011)	0.56	58	145
Southwest			
Dry Lake I, AZ (2009-2010)	2.02	30	63
Dry Lake II, AZ (2011-2012)	1.57	31	65
Midwest			
Wessington Springs, SD (2009)	8.25	34	51
Blue Sky Green Field, WI (2008; 2009)	7.17	88	145
Cedar Ridge, WI (2009)	6.55	41	67.6
Buffalo Ridge, MN (Phase III; 1999)	5.93	138	103.5
Moraine II, MN (2009)	5.59	33	49.5
Barton I & II, IA (2010-2011)	5.50	80	160
Buffalo Ridge I, SD (2009-2010)	5.06	24	50.4
Buffalo Ridge, MN (Phase I; 1996)	4.14	73	25
Winnebago, IA (2009-2010)	3.88	10	20
Rugby, ND (2010-2011)	3.82	71	149
Cedar Ridge, WI (2010)	3.72	41	68
Elm Creek II, MN (2011-2012)	3.64	62	148.8
Buffalo Ridge, MN (Phase II; 1999)	3.57	143	107.25
Buffalo Ridge, MN (Phase I; 1998)	3.14	73	25
Ripley, Ont (2008)	3.09	38	76
Fowler I, IN (2009)	2.83	162	301
Buffalo Ridge, MN (Phase I; 1997)	2.51	73	25
Buffalo Ridge, MN (Phase II; 1998)	2.47	143	107.25
PrairieWinds SD1, SD (2012-2013)	2.01	108	162
Buffalo Ridge II, SD (2011-2012)	1.99	105	210
Kewaunee County, WI (1999-2001)	1.95	31	20.46
PrairieWinds SD1, SD (2013-2014)	1.66	108	162
NPPD Ainsworth, NE (2006)	1.63	36	20.5
PrairieWinds ND1 (Minot), ND (2011)	1.56	80	115.5
Elm Creek, MN (2009-2010)	1.55	67	100
PrairieWinds ND1 (Minot), ND (2010)	1.48	80	115.5
Buffalo Ridge, MN (Phase I; 1999)	1.43	73	25

Appendix D1. Wind energy facilities in North America with fatality data for all bird species, by geographic region. Fatality estimate presented as number of bird fatalities per megawatt (MW) per year.

Wind Energy Facility	Fatality Estimate	No. of Turbines	Total MW
PrairieWinds SD1, SD (2011-2012)	1.41	108	162
Wessington Springs, SD (2010)	0.89	34	51
Rail Splitter, IL (2012-2013)	0.84	67	100.5
Top of Iowa, IA (2004)	0.81	89	80
Top Crop I & II (2012-2013)	0.60	200 (68 Phase I, 132 Phase II)	300 (102 Phase I, 198 Phase II)
Big Blue, MN (2013)	0.60	18	36
Grand Ridge I, IL (2009-2010)	0.48	66	99
Top of Iowa, IA (2003)	0.42	89	80
Big Blue, MN (2014)	0.37	18	36
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	62	102.3
Southern Plains			
Buffalo Gap I, TX (2006)	1.32	67	134
Barton Chapel, TX (2009-2010)	1.15	60	120
Buffalo Gap II, TX (2007-2008)	0.15	155	233
Big Smile, OK (2012-2013)	0.09	66	132
Red Hills, OK (2012-2013)	0.08	82	123
Northeast			
Stetson Mountain I, ME (2013)	6.95	38	57
Criterion, MD (2011)	6.40	28	70
Mount Storm, WV (2011)	4.24	132	264
Pinnacle, WV (2012)	3.99	23	55.2
Mount Storm, WV (2009)	3.85	132	264
Record Hill, ME (2012)	3.70	22	50.6
Criterion, MD (2013)	3.49	28	70
Lempster, NH (2009)	3.38	12	24
Stetson Mountain II, ME (2012)	3.37	17	25.5
Rollins, ME (2012)	2.90	40	60
Casselman, PA (2009)	2.88	23	34.5
Mountaineer, WV (2003)	2.69	44	66
Stetson Mountain I, ME (2009)	2.68	38	57
Noble Ellenburg, NY (2009)	2.66	54	80
Lempster, NH (2010)	2.64	12	24
Mount Storm, WV (2010)	2.60	132	264
Maple Ridge, NY (2007)	2.34	195	321.75
Noble Bliss, NY (2009)	2.28	67	100
Criterion, MD (2012)	2.14	28	70
Maple Ridge, NY (2007-2008)	2.07	195	321.75
Record Hill, ME (2014)	1.84	22	50.6
Noble Altona, NY (2010)	1.84	65	97.5
High Sheldon, NY (2010)	1.76	75	112.5
Mars Hill, ME (2008)	1.76	28	42
Noble Wethersfield, NY (2010)	1.70	84	126
Mars Hill, ME (2007)	1.67	28	42
Noble Chateaugay, NY (2010)	1.66	71	106.5
Noble Clinton, NY (2008)	1.59	67	100
High Sheldon, NY (2011)	1.57	75	112.5
Casselman, PA (2008)	1.51	23	34.5
Beech Ridge, WV (2013)	1.48	67	100.5
Munnsville, NY (2008)	1.48	23	34.5

Appendix D1. Wind energy facilities in North America with fatality data for all bird species, by geographic region. Fatality estimate presented as number of bird fatalities per megawatt (MW) per year.

Wind Energy Facility	Fatality Estimate	No. of Turbines	Total MW
Stetson Mountain II, ME (2010)	1.42	17	25.5
Cohocton/Dutch Hill, NY (2009)	1.39	50	125
Cohocton/Dutch Hills, NY (2010)	1.32	50	125
Noble Bliss, NY (2008)	1.30	67	100
Beech Ridge, WV (2012)	1.19	67	100.5
Stetson Mountain I, ME (2011)	1.18	38	57
Noble Clinton, NY (2009)	1.11	67	100
Locust Ridge, PA (Phase II; 2009)	0.84	51	102
Noble Ellenburg, NY (2008)	0.83	54	80
Locust Ridge, PA (Phase II; 2010)	0.76	51	102
Southeast			
Buffalo Mountain, TN (2000-2003)	11.02	3	1.98
Buffalo Mountain, TN (2005)	1.10	18	28.98

Appendix D1 (*continued*). Wind energy facilities in North America with fatality data for all bird species.

Data from the following sources:

Wind Energy Facility	Fatality Reference	Wind Energy Facility	Fatality Reference
Alta I, CA (2011/2012)	Chatfield et al. 2012		
Alta II-V, CA (2011/2012)	Chatfield et al. 2012		
Alta I, CA (2013/2014)	Chatfield et al. 2014		
Alta II-V, CA (2013/2014)	Chatfield et al. 2014		
Alta I, CA (2015/2016)	This study		
Alta II-V, CA (2015/2016)	This study		
Alite, CA (09-10)	Chatfield et al. 2010	Maple Ridge, NY (07)	Jain et al. 2009a
Alta VIII, CA (12-13)	Chatfield and Bay 2014	Maple Ridge, NY (07-08)	Jain et al. 2009d
Barton I & II, IA (10-11)	Derby et al. 2011a	Marengo I, WA (09-10)	URS Corporation 2010b
Barton Chapel, TX (09-10)	WEST 2011	Marengo II, WA (09-10)	URS Corporation 2010c
Beech Ridge, WV (12)	Tidhar et al. 2013b	Mars Hill, ME (07)	Stantec 2008
Beech Ridge, WV (13)	Young et al. 2014b	Mars Hill, ME (08)	Stantec 2009a
Big Blue, MN (13)	Fagen Engineering 2014	Milford I & II, UT (11-12)	Stantec 2012b
Big Blue, MN (14)	Fagen Engineering 2015	Milford I, UT (10-11)	Stantec 2011b
Big Horn, WA (06-07)	Kronner et al. 2008	Montezuma I, CA (11)	ICF International 2012
Big Smile, OK (12-13)	Derby et al. 2013b	Montezuma I, CA (12)	ICF International 2013
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Montezuma II, CA (12-13)	Harvey & Associates 2013
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Moraine II, MN (09)	Derby et al. 2010d
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Buffalo Gap I, TX (06)	Tierney 2007	Munnsville, NY (08)	Stantec 2009b
Buffalo Gap II, TX (07-08)	Tierney 2009	Mustang Hills, CA (12-13)	Chatfield and Bay 2014
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Nine Canyon, WA (02-03)	Erickson et al. 2003a
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Noble Altona, NY (10)	Jain et al. 2011b
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000	Noble Bliss, NY (08)	Jain et al. 2009e
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000	Noble Bliss, NY (09)	Jain et al. 2010a
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000	Noble Chateaugay, NY (10)	Jain et al. 2011c
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000	Noble Clinton, NY (08)	Jain et al. 2009c
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000	Noble Clinton, NY (09)	Jain et al. 2010b
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	Noble Ellenburg, NY (08)	Jain et al. 2009b
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000	Noble Ellenburg, NY (09)	Jain et al. 2010c
Buffalo Ridge I, SD (09-10)	Derby et al. 2010b	Noble Wethersfield, NY (10)	Jain et al. 2011a
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	NPPD Ainsworth, NE (06)	Derby et al. 2007
Casselman, PA (08)	Arnett et al. 2009b	Palouse Wind, WA (12-13)	Stantec 2013a
Casselman, PA (09)	Arnett et al. 2010	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Cedar Ridge, WI (09)	BHE Environmental 2010	Pine Tree, CA (09-10, 11)	BioResource Consultants 2012
Cedar Ridge, WI (10)	BHE Environmental 2011	Pinnacle, WV (12)	Hein et al. 2013a
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Pinyon Pines I & II, CA (13-14)	Chatfield and Russo 2014
Cohocton/Dutch Hill, NY (10)	Stantec 2011a	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Combine Hills, OR (Ph. I; 04-05)	Young et al. 2006	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011c
Combine Hills, OR (11)	Enz et al. 2012	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Criterion, MD (11)	Young et al. 2012a	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
Criterion, MD (12)	Young et al. 2013	PrairieWinds SD1 (Crow Lake), SD (12-13)	Derby et al. 2013a
Criterion, MD (13)	Young et al. 2014a	PrairieWinds SD1, SD (13-14)	Derby et al. 2014b
Diablo Winds, CA (05-07)	WEST 2006, 2008	Rail Splitter, IL (12-13)	Good et al. 2013b
Dillon, CA (08-09)	Chatfield et al. 2009	Record Hill, ME (12)	Stantec 2013b
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Record Hill, ME (14)	Stantec 2015
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Red Hills, OK (12-13)	Derby et al. 2013c
Elkhorn, OR (08)	Jeffrey et al. 2009b	Ripley, Ont (08)	Jacques Whitford 2009
Elkhorn, OR (10)	Enk et al. 2011b	Rollins, ME (12)	Stantec 2013c
Elm Creek, MN (09-10)	Derby et al. 2010c	Rugby, ND (10-11)	Derby et al. 2011b
Elm Creek II, MN (11-12)	Derby et al. 2012b	Shiloh I, CA (06-09)	Kerlinger et al. 2009
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	Shiloh II, CA (09-10)	Kerlinger et al. 2010
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b	Shiloh II, CA (10-11)	Kerlinger et al. 2013a
Foote Creek Rim, WY (Ph. I; 01-02)	Young et al. 2003b	Shiloh III, CA (12-13)	Kerlinger et al. 2013b
Fowler I, IN (09)	Johnson et al. 2010a	Solano III, CA (12-13)	AECOM 2013
Goodnoe, WA (09-10)	URS Corporation 2010a	Stateline, OR/WA (01-02)	Erickson et al. 2004
Grand Ridge, IL (09-10)	Derby et al. 2010g	Stateline, OR/WA (03)	Erickson et al. 2004
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Stateline, OR/WA (06)	Erickson et al. 2007
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Stetson Mountain I, ME (09)	Stantec 2009c
High Sheldon, NY (10)	Tidhar et al. 2012a	Stetson Mountain I, ME (11)	Normandeau Associates 2011
High Sheldon, NY (11)	Tidhar et al. 2012b	Stetson Mountain I, ME (13)	Stantec 2014

Appendix D1 (*continued*). Wind energy facilities in North America with fatality data for all bird species.

Data from the following sources:

Wind Energy Facility	Fatality Reference	Wind Energy Facility	Fatality Reference
High Winds, CA (03-04)	Kerlinger et al. 2006	Stetson Mountain II, ME (10)	Normandeau Associates 2010
High Winds, CA (04-05)	Kerlinger et al. 2006	Stetson Mountain II, ME (12)	Stantec 2013e
Hopkins Ridge, WA (06)	Young et al. 2007	Summerview, Alb (05-06)	Brown and Hamilton 2006b
Hopkins Ridge, WA (08)	Young et al. 2009c	Top Crop I & II, IL (12-13)	Good et al. 2013a
Kewaunee County, WI (99-01)	Howe et al. 2002	Top of Iowa, IA (03)	Jain 2005
Kittitas Valley, WA (11-12)	Stantec 2012	Top of Iowa, IA (04)	Jain 2005
Klondike, OR (02-03)	Johnson et al. 2003a	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
Klondike II, OR (05-06)	NWC and WEST 2007	Vansycle, OR (99)	Erickson et al. 2000b
Klondike III, OR (Phase I; 07-09)	Gritski et al. 2010	Vantage, WA (10-11)	Ventus 2012
Klondike IIIa, OR (Phase II; 08-10)	Gritski et al. 2011	Wessington Springs, SD (09)	Derby et al. 2010f
Leaning Juniper, OR (06-08)	Gritski et al. 2008	Wessington Springs, SD (10)	Derby et al. 2011d
Lempster, NH (09)	Tidhar et al. 2010	White Creek, WA (07-11)	Downes and Gritski 2012b
Lempster, NH (10)	Tidhar et al. 2011	Wild Horse, WA (07)	Erickson et al. 2008
Linden Ranch, WA (10-11)	Enz and Bay 2011	Windy Flats, WA (10-11)	Enz et al. 2011
Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011	Winnebago, IA (09-10)	Derby et al. 2010e
Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011		

Appendix D2. Wind energy facilities in North America with use and fatality data for raptors. Use estimate presented as number of raptors per plot per 20-minute survey. Raptor fatality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	No. of Turbines	Total MW
Alta I, CA (2011/2012)	**0.19**	**0.27**	**100**	**150**
Alta II-V, CA (2011/2012)	**0.04**	**0.05**	**190**	**570**
Alta I, CA (2013/2014)	**0.19**	**0.15**	**100**	**150**
Alta II-V, CA (2013/2014)	**0.04**	**0**	**190**	**570**
Alta I, CA (2015/2016)	**0.19**	**0.15**	**100**	**150**
Alta II-V, CA (2015/2016)	**0.04**	**0**	**190**	**570**
California				
Montezuma I, CA (2011)		1.06	16	36.8
Solano III, CA (2012-2013)		0.95	55	128
Montezuma I, CA (2012)		0.79	16	36.8
High Winds, CA (2003-2004)	2.337	0.50	90	162
Montezuma II, CA (2012-2013)		0.46	34	78.2
Shiloh II, CA (2010-2011)		0.44	75	150
Shiloh I, CA (2006-2009)		0.42	100	150
Diablo Winds, CA (2005-2007)	2.161	0.40	31	20.46
High Winds, CA (2004-2005)	2.337	0.28	90	162
Alite, CA (2009-2010)		0.12	8	24
Shiloh II, CA (2009-2010)		0.11	75	150
Mustang Hills, CA (2012-2013)		0.08	50	150
Alta VIII, CA (2012-2013)		0.02	50	150
Dillon, CA (2008-2009)		0	45	45
Pacific Northwest				
White Creek, WA (2007-2011)		0.47	89	204.7
Tuolumne (Windy Point I), WA (2009-2010)	0.77	0.29	62	136.6
Vantage, WA (2010-2011)		0.29	60	90
Linden Ranch, WA (2010-2011)		0.27	25	50
Harvest Wind, WA (2010-2012)		0.23	43	98.9
Goodnoe, WA (2009-2010)		0.17	47	94
Leaning Juniper, OR (2006-2008)	0.52	0.16	67	100.5
Klondike III (Phase I), OR (2007-2009)		0.15	125	223.6
Hopkins Ridge, WA (2006)	0.70	0.14	83	150
Biglow Canyon, OR (Phase II; 2009-2010)	0.32	0.14	65	150
Big Horn, WA (2006-2007)	0.51	0.11	133	199.5
Stateline, OR/WA (2006)	0.48	0.11	454	299
Kittitas Valley, WA (2011-2012)		0.09	48	100.8
Wild Horse, WA (2007)	0.29	0.09	127	229
Stateline, OR/WA (2001-2002)	0.48	0.09	454	299
Stateline, OR/WA (2003)	0.48	0.09	454	299
Elkhorn, OR (2010)	1.07	0.08	61	101
Hopkins Ridge, WA (2008)	0.70	0.07	87	156.6
Elkhorn, OR (2008)	1.07	0.06	61	101
Klondike II, OR (2005-2006)	0.50	0.06	50	75
Klondike IIIa (Phase II), OR (2008-2010)		0.06	51	76.5
Combine Hills, OR (2011)	0.75	0.05	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	0.32	0.05	76	174.8
Marengo II, WA (2009-2010)		0.05	39	70.2
Windy Flats, WA (2010-2011)		0.04	114	262.2

Appendix D2. Wind energy facilities in North America with use and fatality data for raptors. Use estimate presented as number of raptors per plot per 20-minute survey. Raptor fatality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	No. of Turbines	Total MW
Pebble Springs, OR (2009-2010)		0.04	47	98.7
Biglow Canyon, OR (Phase I; 2008)	0.32	0.03	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)	0.32	0.03	65	150
Nine Canyon, WA (2002-2003)	0.35	0.03	37	48.1
Hay Canyon, OR (2009-2010)		0	48	100.8
Biglow Canyon, OR (Phase I; 2009)	0.32	0	76	125.4
Marengo I, WA (2009-2010)		0	78	140.4
Klondike, OR (2002-2003)	0.50	0	16	24
Vansycle, OR (1999)	0.66	0	38	24.9
Combine Hills, OR (Phase I; 2004-2005)	0.74	0	41	41
Rocky Mountains				
Summerview, Alb (2005-2006)		0.11	39	70.2
Foote Creek Rim, WY (Phase I; 1999)	0.55	0.08	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	0.55	0.05	69	41.4
Milford I & II, UT (2011-2012)		0.04	107	160.5 (58.5 Phase I, 102 Phase II)
Foote Creek Rim, WY (Phase I; 2001-2002)	0.55	0	69	41.4
Southwest				
Dry Lake I, AZ (2009-2010)	0.13	0	30	63
Dry Lake II, AZ (2011-2012)		0	31	65
Midwest				
Buffalo Ridge, MN (Phase I; 1999)		0.47	73	25
Moraine II, MN (2009)		0.37	33	49.5
Winnebago, IA (2009-2010)		0.27	10	20
Buffalo Ridge I, SD (2009-2010)		0.20	24	50.4
Cedar Ridge, WI (2009)		0.18	41	67.6
PrairieWinds SD1, SD (2013-2014)		0.17	108	162
Top of Iowa, IA (2004)		0.17	89	80
Cedar Ridge, WI (2010)		0.13	41	68
Ripley, Ont (2008)		0.10	38	76
Wessington Springs, SD (2010)	0.23	0.07	34	51
Rugby, ND (2010-2011)		0.06	71	149
NPPD Ainsworth, NE (2006)		0.06	36	20.5
Wessington Springs, SD (2009)	0.23	0.06	34	51
PrairieWinds ND1 (Minot), ND (2011)		0.05	80	115.5
PrairieWinds ND1 (Minot), ND (2010)		0.05	80	115.5
PrairieWinds SD1, SD (2012-2013)		0.03	108	162
Elm Creek, MN (2009-2010)		0	67	100
Rail Splitter, IL (2012-2013)		0	67	100.5
Pioneer Prairie I, IA (Phase II; 2011-2012)		0	62	102.3
Buffalo Ridge, MN (Phase III; 1999)		0	138	103.5
Buffalo Ridge, MN (Phase II; 1998)		0	143	107.25
Buffalo Ridge, MN (Phase II; 1999)		0	143	107.25
Blue Sky Green Field, WI (2008; 2009)		0	88	145
Elm Creek II, MN (2011-2012)		0	62	148.8
Barton I & II, IA (2010-2011)		0	80	160

Appendix D2. Wind energy facilities in North America with use and fatality data for raptors. Use estimate presented as number of raptors per plot per 20-minute survey. Raptor fatality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	No. of Turbines	Total MW
PrairieWinds SD1, SD (2011-2012)		0	108	162
Kewaunee County, WI (1999-2001)		0	31	20.46
Buffalo Ridge II, SD (2011-2012)		0	105	210
Buffalo Ridge, MN (Phase I; 1996)		0	73	25
Buffalo Ridge, MN (Phase I; 1997)		0	73	25
Buffalo Ridge, MN (Phase I; 1998)		0	73	25
Fowler I, IN (2009)		0	162	301
Big Blue, MN (2013)		0	18	36
Big Blue, MN (2014)		0	18	36
Top of Iowa, IA (2003)		0	89	80
Grand Ridge I, IL (2009-2010)	0.195	0	66	99
Southern Plains				
Barton Chapel, TX (2009-2010)		0.25	60	120
Buffalo Gap I, TX (2006)		0.10	67	134
Red Hills, OK (2012-2013)		0.04	82	123
Big Smile, OK (2012-2013)		0	66	132
Buffalo Gap II, TX (2007-2008)		0	155	233
Northeast				
Munnsville, NY (2008)		0.59	23	34.5
Noble Ellenburg, NY (2009)		0.25	54	80
Noble Clinton, NY (2009)		0.16	67	100
Noble Wethersfield, NY (2010)		0.13	84	126
Noble Bliss, NY (2009)		0.12	67	100
Noble Ellenburg, NY (2008)		0.11	54	80
Noble Bliss, NY (2008)		0.10	67	100
Noble Clinton, NY (2008)		0.10	67	100
Mount Storm, WV (2010)		0.10	132	264
Noble Chateaugay, NY (2010)		0.08	71	106.5
Cohocton/Dutch Hills, NY (2010)		0.08	50	125
Mountaineer, WV (2003)		0.07	44	66
High Sheldon, NY (2010)		0.06	75	112.5
Mount Storm, WV (2011)		0.03	132	264
Maple Ridge, NY (2007-2008)		0.03	195	321.75
Criterion, MD (2011)		0.02	28	70
Beech Ridge, WV (2012)		0.01	67	100.5
Beech Ridge, WV (2013)		0.01	67	100.5
Locust Ridge, PA (Phase II; 2009)		0	51	102
Locust Ridge, PA (Phase II; 2010)		0	51	102
High Sheldon, NY (2011)		0	75	112.5
Cohocton/Dutch Hill, NY (2009)		0	50	125
Lempster, NH (2009)		0	12	24
Lempster, NH (2010)		0	12	24
Stetson Mountain II, ME (2010)		0	17	25.5
Stetson Mountain II, ME (2012)		0	17	25.5
Mount Storm, WV (2009)		0	132	264
Casselman, PA (2009)		0	23	34.5
Casselman, PA (2008)		0	23	34.5
Mars Hill, ME (2007)		0	28	42

Appendix D2. Wind energy facilities in North America with use and fatality data for raptors. Use estimate presented as number of raptors per plot per 20-minute survey. Raptor fatality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	No. of Turbines	Total MW
Mars Hill, ME (2008)		0	28	42
Pinnacle, WV (2012)		0	23	55.2
Stetson Mountain I, ME (2011)		0	38	57
Stetson Mountain I, ME (2009)		0	38	57
Stetson Mountain I, ME (2013)		0	38	57
Noble Altona, NY (2010)		0	65	97.5
Southeast				
Buffalo Mountain, TN (2000-2003)		0	3	1.98
Buffalo Mountain, TN (2005)		0	18	28.98

Appendix D2 (*continued*). Wind energy facilities in North America with use and fatality data for raptors.

Data from the following sources:

Facility	Use Estimate	Fatality Estimate	Facility	Use Estimate	Fatality Estimate
Alta I, CA (2011/2012)	Erickson and Chatfield 2009	Chatfield et al. 2012			
Alta II-V, CA (2011/2012)	Erickson and Chatfield 2009	Chatfield et al. 2012			
Alta I, CA (2013/2014)	Erickson and Chatfield 2009	Chatfield et al. 2014			
Alta II-V, CA (2013/2014)	Erickson and Chatfield 2009	Chatfield et al. 2014			
Alta I, CA (2015/2016)	Erickson and Chatfield 2009	This study.			
Alta II-V, CA (2015/2016)	Erickson and Chatfield 2009	This study.			
Alite, CA (09-10)		Chatfield et al. 2010	Lempster, NH (10)		Tidhar et al. 2011
Alta VIII, CA (12-13)		Chatfield and Bay 2014	Linden Ranch, WA (10-11)		Enz and Bay 2011
Barton I & II, IA (10-11)		Derby et al. 2011a	Locust Ridge, PA (Phase II; 09)		Arnett et al. 2011
Barton Chapel, TX (09-10)		WEST 2011	Locust Ridge, PA (Phase II; 10)		Arnett et al. 2011
Beech Ridge, WV (12)		Tidhar et al. 2013b	Maple Ridge, NY (07-08)		Jain et al. 2009d
Beech Ridge, WV (13)		Young et al. 2014b	Marengo I, WA (09-10)		URS Corporation 2010b
Big Blue, MN (13)		Fagen Engineering 2014	Marengo II, WA (09-10)		URS Corporation 2010c
Big Blue, MN (14)		Fagen Engineering 2015	Mars Hill, ME (07)		Stantec 2008
Big Horn, WA (06-07)	Johnson and Erickson 2004	Kronner et al. 2008	Mars Hill, ME (08)		Stantec 2009a
Big Smile, OK (12-13)		Derby et al. 2013b	Milford I & II, UT (11-12)		Stantec 2012b
Biglow Canyon, OR (Phase I; 08)	WEST 2005b	Jeffrey et al. 2009a	Montezuma I, CA (11)		ICF International 2012
Biglow Canyon, OR (Phase I; 09)	WEST 2005b	Enk et al. 2010	Montezuma I, CA (12)		ICF International 2013
Biglow Canyon, OR (Phase II; 09-10)	WEST 2005b	Enk et al. 2011a	Montezuma II, CA (12-13)		Harvey & Associates 2013
Biglow Canyon, OR (Phase II; 10-11)	WEST 2005b	Enk et al. 2012b	Moraine II, MN (09)		Derby et al. 2010d
Biglow Canyon, OR (Phase III; 10-11)	WEST 2005b	Enk et al. 2012a	Mount Storm, WV (09)		Young et al. 2009a, 2010b
Blue Sky Green Field, WI (08; 09)		Gruver et al. 2009	Mount Storm, WV (10)		Young et al. 2010a, 2011b
Buffalo Gap I, TX (06)		Tierney 2007	Mount Storm, WV (11)		Young et al. 2011a, 2012b
Buffalo Gap II, TX (07-08)		Tierney 2009	Mountaineer, WV (03)		Kerns and Kerlinger 2004
Buffalo Mountain, TN (00-03)		Nicholson et al. 2005	Munnsville, NY (08)		Stantec 2009b
Buffalo Mountain, TN (05)		Fiedler et al. 2007	Mustang Hills, CA (12-13)		Chatfield and Bay 2014
Buffalo Ridge, MN (Phase I; 96)		Johnson et al. 2000	Nine Canyon, WA (02-03)	Erickson et al. 2001	Erickson et al. 2003a
Buffalo Ridge, MN (Phase I; 97)		Johnson et al. 2000	Noble Altona, NY (10)		Jain et al. 2011b
Buffalo Ridge, MN (Phase I; 98)		Johnson et al. 2000	Noble Bliss, NY (08)		Jain et al. 2009e
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000	Noble Bliss, NY (09)		Jain et al. 2010a
Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000	Noble Chateaugay, NY (10)		Jain et al. 2011c
Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000	Noble Clinton, NY (08)		Jain et al. 2009c
Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000	Noble Clinton, NY (09)		Jain et al. 2010b
Buffalo Ridge I, SD (09-10)		Derby et al. 2010b	Noble Ellenburg, NY (08)		Jain et al. 2009b
Buffalo Ridge II, SD (11-12)		Derby et al. 2012a	Noble Ellenburg, NY (09)		Jain et al. 2010c
Casselman, PA (08)		Arnett et al. 2009b	Noble Wethersfield, NY (10)		Jain et al. 2011a
Casselman, PA (09)		Arnett et al. 2010	NPPD Ainsworth, NE (06)		Derby et al. 2007
Cedar Ridge, WI (09)		BHE Environmental 2010	Pebble Springs, OR (09-10)		Gritski and Kronner 2010b
Cedar Ridge, WI (10)		BHE Environmental 2011	Pinnacle, WV (12)		Hein et al. 2013a
Cohocton/Dutch Hill, NY (09)		Stantec 2010	Pioneer Prairie I, IA (Phase II; 11-12)		Chodachek et al. 2012
Cohocton/Dutch Hills, NY (10)		Stantec 2011a	PrairieWinds ND1 (Minot), ND (10)		Derby et al. 2011c

Appendix D2 (*continued*). Wind energy facilities in North America with use and fatality data for raptors.

Data from the following sources:

Facility	Use Estimate	Fatality Estimate	Facility	Use Estimate	Fatality Estimate
Combine Hills, OR (Phase I; 04-05)	Young et al. 2003c	Young et al. 2006	PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012c
Combine Hills, OR (11)	Young et al. 2003c	Enz et al. 2012	PrairieWinds SD1 (Crow Lake), SD (11-12)		Derby et al. 2012d
Criterion, MD (11)		Young et al. 2012a	PrairieWinds SD1 (Crow Lake), SD (12-13)		Derby et al. 2013a
Diablo Winds, CA (05-07)	WEST 2006, 2008	WEST 2006, 2008	PrairieWinds SD1, SD (13-14)		Derby et al. 2014a
Dillon, CA (08-09)		Chatfield et al. 2009	Rail Splitter, IL (12-13)		Good et al. 2013b
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Thompson et al. 2011	Red Hills, OK (12-13)		Derby et al. 2013c
Dry Lake II, AZ (11-12)		Thompson and Bay 2012	Ripley, Ont (08)		Jacques Whitford 2009
Elkhorn, OR (08)	WEST 2005a	Jeffrey et a. 2009b	Rugby, ND (10-11)		Derby et al. 2011b
Elkhorn, OR (10)	WEST 2005a	Enk et al. 2011b	Shiloh I, CA (06-09)		Kerlinger et al. 2009
Elm Creek, MN (09-10)		Derby et al. 2010c	Shiloh II, CA (09-10)		Kerlinger et al. 2010
Elm Creek II, MN (11-12)		Derby et al. 2012b	Shiloh II, CA (10-11)		Kerlinger et al. 2013a
Foote Creek Rim, WY (Phase I; 99)	Gruver 2002	Young et al. 2003b	Solano III, CA (12-13)		AECOM 2013
Foote Creek Rim, WY (Phase I; 00)	Gruver 2002	Young et al. 2003b, 2003d	Stateline, OR/WA (01-02)	Erickson et al. 2003c	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 01-02)	Gruver 2002	Young et al. 2003b, 2003d	Stateline, OR/WA (03)	Erickson et al. 2003c	Erickson et al. 2004
Fowler I, IN (09)		Johnson et al. 2010a	Stateline, OR/WA (06)	Erickson et al. 2003c	Erickson et al. 2007
Goodnoe, WA (09-10)		URS Corporation 2010a	Stetson Mountain I, ME (09)		Stantec 2009c
Grand Ridge I, IL (09-10)	Derby et al. 2009	Derby et al. 2010g	Stetson Mountain I, ME (11)		Normandeau Associates 2011
Harvest Wind, WA (10-12)		Downes and Gritski 2012a	Stetson Mountain I, ME (13)		Stantec 2014
Hay Canyon, OR (09-10)		Gritski and Kronner 2010a	Stetson Mountain II, ME (10)		Normandeau Associates 2010
High Sheldon, NY (10)		Tidhar et al. 2012a	Stetson Mountain II, ME (12)		Stantec 2013e
High Sheldon, NY (11)		Tidhar et al. 2012b	Summerview, Alb (05-06)		Brown and Hamilton 2006b
High Winds, CA (03-04)	Kerlinger et al. 2005	Kerlinger et al. 2006	Top of Iowa, IA (03)		Jain 2005
High Winds, CA (04-05)	Kerlinger et al. 2005	Kerlinger et al. 2006	Top of Iowa, IA (04)		Jain 2005
Hopkins Ridge, WA (06)	Young et al. 2003a	Young et al. 2007	Tuolumne (Windy Point I), WA (09-10)	Johnson et al. 2006	Enz and Bay 2010
Hopkins Ridge, WA (08)	Young et al. 2003a	Young et al. 2009c	Vansycle, OR (99)	WCIA and WEST 1997	Erickson et al. 2000b
Kewaunee County, WI (99-01)		Howe et al. 2002	Vantage, WA (10-11)		Ventus 2012
Kittitas Valley, WA (11-12)		Stantec 2012	Wessington Springs, SD (09)	Derby et al. 2008	Derby et al. 2010f
Klondike, OR (02-03)	Johnson et al. 2002a	Johnson et al. 2003a	Wessington Springs, SD (10)	Derby et al. 2008	Derby et al. 2011d
Klondike II, OR (05-06)	Johnson et al. 2002a	NWC and WEST 2007	White Creek, WA (07-11)		Downes and Gritski 2012b
Klondike III (Phase I), OR (07-09)		Gritski et al. 2010	Wild Horse, WA (07)	Erickson et al. 2003b	Erickson et al. 2008
Klondike IIIa (Phase II), OR (08-10)		Gritski et al. 2011	Windy Flats, WA (10-11)		Enz et al. 2011
Leaning Juniper, OR (06-08)	Kronner et al. 2005	Gritski et al. 2008	Winnebago, IA (09-10)		Derby et al. 2010e
Lempster, NH (09)		Tidhar et al. 2010			

Appendix D3. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Bat activity presented as number of bat passes per detector-night. Fatality estimate given as number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Alta I, CA (2011/2012)	**4.42[A]**	**6/26/09 -10/31/09**	**1.28**	**100**	**150**
Alta II-V, CA (2011/2012)	**0.78**	**6/26/09 -10/31/09**	**0.08**	**190**	**570**
Alta I, CA (2013/2014)	**4.42[A]**	**6/26/09 -10/31/09**	**0.36**	**100**	**150**
Alta II-V, CA (2013/2014)	**0.78**	**6/26/09 -10/31/09**	**0**	**190**	**570**
Alta I, CA (2015/2016)	**4.42[A]**	**6/26/09 -10/31/09**	**0.70**	**100**	**150**
Alta II-V, CA (2015/2016)	**0.78**	**6/26/09 -10/31/09**	**0**	**190**	**570**
		California			
Shiloh I, CA (2006-2009)			3.92	100	150
Shiloh II, CA (2010-2011)			3.80	75	150
Shiloh II, CA (2009-2010)			2.60	75	150
High Winds, CA (2003-2004)			2.51	90	162
Dillon, CA (2008-2009)			2.17	45	45
Montezuma I, CA (2011)			1.90	16	36.8
High Winds, CA (2004-2005)			1.52	90	162
Montezuma II, CA (2012-2013)			0.91	34	78.2
Montezuma I, CA (2012)			0.84	16	36.8
Diablo Winds, CA (2005-2007)			0.82	31	20.46
Shiloh III, CA (2012-2013)			0.40	50	102.5
Solano III, CA (2012-2013)			0.31	55	128
Alite, CA (2009-2010)			0.24	8	24
Mustang Hills, CA (2012-2013)			0.10	50	150
Pinyon Pines I & II, CA (2013-2014)			0.04	100	NA
Alta VIII, CA (2012-2013)			0.00	50	150
		Pacific Northwest			
Palouse Wind, WA (2012-2013)			4.23	58	104.4
Biglow Canyon, OR (Phase II; 2009-2010)			2.71	65	150
Nine Canyon, WA (2002-2003)			2.47	37	48.1
Stateline, OR/WA (2003)			2.29	454	299
Elkhorn, OR (2010)			2.14	61	101
White Creek, WA (2007-2011)			2.04	89	204.7
Biglow Canyon, OR (Phase I; 2008)			1.99	76	125.4
Leaning Juniper, OR (2006-2008)			1.98	67	100.5
Big Horn, WA (2006-2007)			1.90	133	199.5
Combine Hills, OR (Phase I; 2004-2005)			1.88	41	41
Linden Ranch, WA (2010-2011)			1.68	25	50
Pebble Springs, OR (2009-2010)			1.55	47	98.7
Hopkins Ridge, WA (2008)			1.39	87	156.6
Harvest Wind, WA (2010-2012)			1.27	43	98.9
Elkhorn, OR (2008)			1.26	61	101
Vansycle, OR (1999)			1.12	38	24.9
Klondike III (Phase I), OR (2007-2009)			1.11	125	223.6
Stateline, OR/WA (2001-2002)			1.09	454	299
Stateline, OR/WA (2006)			0.95	454	299
Tuolumne (Windy Point I), WA (2009-2010)			0.94	62	136.6

Appendix D3. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Bat activity presented as number of bat passes per detector-night. Fatality estimate given as number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Klondike, OR (2002-2003)			0.77	16	24
Combine Hills, OR (2011)			0.73	104	104
Hopkins Ridge, WA (2006)			0.63	83	150
Biglow Canyon, OR (Phase I; 2009)			0.58	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)			0.57	65	150
Hay Canyon, OR (2009-2010)			0.53	48	100.8
Windy Flats, WA (2010-2011)			0.41	114	262.2
Klondike II, OR (2005-2006)			0.41	50	75
Vantage, WA (2010-2011)			0.40	60	90
Wild Horse, WA (2007)			0.39	127	229
Goodnoe, WA (2009-2010)			0.34	47	94
Marengo II, WA (2009-2010)			0.27	39	70.2
Biglow Canyon, OR (Phase III; 2010-2011)			0.22	76	174.8
Marengo I, WA (2009-2010)			0.17	78	140.4
Klondike IIIa (Phase II), OR (2008-2010)			0.14	51	76.5
Kittitas Valley, WA (2011-2012)			0.12	48	100.8
Rocky Mountains					
Summerview, Alb (2006; 2007)	7.65[B]	07/15/06-07-09/30/06-07	11.42	39	70.2
Summerview, Alb (2005-2006)			10.27	39	70.2
Judith Gap, MT (2006-2007)			8.93	90	135
Foote Creek Rim, WY (Phase I; 1999)			3.97	69	41.4
Judith Gap, MT (2009)			3.20	90	135
Milford I, UT (2010-2011)			2.05	58	145
Milford I & II, UT (2011-2012)			1.67	107	160.5 (58.5 Phase I, 102 Phase II)
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2[B,C]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2[B,C]	6/15/00-9/1/00	1.05	69	41.4
Southwest					
Dry Lake I, AZ (2009-2010)	8.8	4/29/10-11/10/10	3.43	30	63
Dry Lake II, AZ (2011-2012)	11.5	5/11/11-10/26/11	1.66	31	65
Midwest					
Cedar Ridge, WI (2009)	9.97[B,C,D,E]	7/16/07-9/30/07	30.61	41	67.6
Top Crop I & II (2012-2013)			26.85	200 (68 Phase I, 132 Phase II)	300 (102 Phase I, 198 Phase II)
Blue Sky Green Field, WI (2008; 2009)	7.7[E]	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	9.97[B,C,D,E]	7/16/07-9/30/07	24.12	41	68
Rail Splitter, IL (2012-2013)			22.53	67	100.5
Fowler I, II, III, IN (2011)			20.19	355	600

Appendix D3. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Bat activity presented as number of bat passes per detector-night. Fatality estimate given as number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Fowler I, II, III, IN (2010)			18.96	355	600
Forward Energy Center, WI (2008-2010)	6.97	8/5/08-11/08/08	18.17	86	129
Harrow, Ont (2010)			11.13	24 (four 6-turb facilities)	39.6
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Pioneer Prairie I, IA (Phase II; 2011-2012)			10.06	62	102.3
Fowler I, IN (2009)			8.09	162	301
Crystal Lake II, IA (2009)			7.42	80	200
Top of Iowa, IA (2003)			7.16	89	80
Kewaunee County, WI (1999-2001)			6.45	31	20.46
Ripley, Ont (2008)			4.67	38	76
Winnebago, IA (2009-2010)			4.54	10	20
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2[B]	6/15/01-9/15/01	4.35	143	107.25
Pioneer Prairie II, IA (2013)			3.83	62	102.3
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2[B]	6/15/01-9/15/01	3.71	138	103.5
Crescent Ridge, IL (2005-2006)			3.27	33	49.5
Fowler I, II, III, IN (2012)			2.96	355	600
Elm Creek II, MN (2011-2012)			2.81	62	148.8
Buffalo Ridge II, SD (2011-2012)			2.81	105	210
Buffalo Ridge, MN (Phase III; 1999)			2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)			2.59	143	107.25
Moraine II, MN (2009)			2.42	33	49.5
Buffalo Ridge, MN (Phase II; 1998)			2.16	143	107.25
PrairieWinds ND1 (Minot), ND (2010)			2.13	80	115.5
Grand Ridge I, IL (2009-2010)			2.10	66	99
Big Blue, MN (2013)			2.04	18	36
Barton I & II, IA (2010-2011)			1.85	80	160
Fowler III, IN (2009)			1.84	60	99
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9[B]	6/15/02-9/15/02	1.81	138	103.5
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9[B]	6/15/02-9/15/02	1.64	143	107.25
Rugby, ND (2010-2011)			1.60	71	149
Elm Creek, MN (2009-2010)			1.49	67	100
Wessington Springs, SD (2009)			1.48	34	51
Big Blue, MN (2014)			1.43	18	36
PrairieWinds ND1 (Minot), ND (2011)			1.39	80	115.5
PrairieWinds SD1 (Crow Lake), SD (2011-2012)			1.23	108	162

Appendix D3. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Bat activity presented as number of bat passes per detector-night. Fatality estimate given as number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
NPPD Ainsworth, NE (2006)			1.16	36	20.5
PrairieWinds SD1, SD (2012-2013)			1.05	108	162
Buffalo Ridge, MN (Phase I; 1999)			0.74	73	25
PrairieWinds SD1, SD (2013-2014)			0.52	108	162
Wessington Springs, SD (2010)			0.41	34	51
Buffalo Ridge I, SD (2009-2010)			0.16	24	50.4
Southern Plains					
Barton Chapel, TX (2009-2010)			3.06	60	120
Big Smile, OK (2012-2013)			2.9	66	132
Buffalo Gap II, TX (2007-2008)			0.14	155	233
Red Hills, OK (2012-2013)			0.11	82	123
Buffalo Gap I, TX (2006)			0.10	67	134
Northeast					
Pinnacle, WV (2012)			40.20	23	55.2
Mountaineer, WV (2003)			31.69	44	66
Mount Storm, WV (2009)	30.09	7/15/09-10/7/09	17.53	132	264
Noble Wethersfield, NY (2010)			16.30	84	126
Criterion, MD (2011)			15.61	28	70
Mount Storm, WV (2010)	36.67[F]	4/18/10-10/15/10	15.18	132	264
Locust Ridge, PA (Phase II; 2010)			14.38	51	102
Locust Ridge, PA (Phase II; 2009)			14.11	51	102
Casselman, PA (2008)			12.61	23	34.5
Maple Ridge, NY (2006)			11.21	120	198
Cohocton/Dutch Hills, NY (2010)			10.32	50	125
Wolfe Island, Ont (July-December 2010)			9.50	86	197.8
Cohocton/Dutch Hill, NY (2009)			8.62	50	125
Casselman, PA (2009)			8.60	23	34.5
Noble Bliss, NY (2008)			7.80	67	100
Criterion, MD (2012)			7.62	28	70
Mount Storm, WV (2011)			7.43	132	264
Maple Ridge, NY (2012)			7.30	195	321.75
Mount Storm, WV (Fall 2008)	35.2	7/20/08-10/12/08	6.62	82	164
Maple Ridge, NY (2007)			6.49	195	321.75
Wolfe Island, Ont (July-December 2009)			6.42	86	197.8
Criterion, MD (2013)			5.32	28	70
Maple Ridge, NY (2007-2008)			4.96	195	321.75
Noble Clinton, NY (2009)	1.9[D]	8/1/09-09/31/09	4.50	67	100
Casselman Curtailment, PA (2008)			4.40	23	35.4
Noble Altona, NY (2010)			4.34	65	97.5
Noble Ellenburg, NY (2009)	16.1[D]	8/16/09-09/15/09	3.91	54	80
Noble Bliss, NY (2009)			3.85	67	100
Lempster, NH (2010)			3.57	12	24

Appendix D3. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Bat activity presented as number of bat passes per detector-night. Fatality estimate given as number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Noble Ellenburg, NY (2008)			3.46	54	80
Noble Clinton, NY (2008)	2.1[D]	8/8/08-09/31/08	3.14	67	100
Lempster, NH (2009)			3.11	12	24
Record Hill, ME (2012)	24.6	4/16/12-10/23/12	2.96	22	50.6
Mars Hill, ME (2007)			2.91	28	42
Wolfe Island, Ont (July-December 2011)			2.49	86	197.8
Noble Chateaugay, NY (2010)			2.44	71	106.5
High Sheldon, NY (2010)			2.33	75	112.5
Stetson Mountain II, ME (2012)			2.27	17	25.5
Beech Ridge, WV (2012)			2.03	67	100.5
Munnsville, NY (2008)			1.93	23	34.5
High Sheldon, NY (2011)			1.78	75	112.5
Stetson Mountain II, ME (2010)			1.65	17	25.5
Stetson Mountain I, ME (2009)	28.5; 0.3[G]	7/10/09-10/15/09	1.40	38	57
Beech Ridge, WV (2013)			0.58	67	100.5
Record Hill, ME (2014)			0.55	22	50.6
Mars Hill, ME (2008)			0.45	28	42
Stetson Mountain I, ME (2011)			0.28	38	57
Stetson Mountain I, ME (2013)			0.18	38	57
Rollins, ME (2012)			0.18	40	60
Kibby, ME (2011)			0.12	44	132
Southeast					
Buffalo Mountain, TN (2005)			39.70	18	28.98
Buffalo Mountain, TN (2000-2003)	23.7[B]		31.54	3	1.98

A = Average of ground-based detectors at CPC Proper (Phase I) for late summer/fall period only

B = Activity rate was averaged across phases and/or years

C = Activity rate calculated by WEST from data presented in referenced report

D= Activity rate based on data collected at various heights all other activity rates are from ground-based units only

E = Activity rate based on pre-construction monitoring; data for all other activity and fatality rates were collected concurrently

F = Activity rate based on data collected from ground-based units excluding reference stations during the spring, summer and fall seasons

G = The overall activity rate of 28.5 is from reference stations located along forest edges which may be attractive to bats; the activity rate of 0.3 is from one unit placed on a nacelle

Appendix D3 (*continued*). Wind energy facilities in North America with comparable activity and fatality data for bats.

Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Alta I, CA (2011/2012)	Solick et al. 2010b	Chatfield et al. 2012			
Alta II-V, CA (2011/2012)	Solick et al. 2010b	Chatfield et al. 2012			
Alta I, CA (2013/2014)	Solick et al. 2010b	Chatfield et al. 2014			
Alta II-V, CA (2013/2014)	Solick et al. 2010b	Chatfield et al. 2014			
Alta I, CA (2015/2016)	Solick et al. 2010b	This study,			
Alta II-V, CA (2015/2016)	Solick et al. 2010b	This study.			
Alite, CA (09-10)		Chatfield et al. 2010	Linden Ranch, WA (10-11)		Enz and Bay 2011
Alta VIII, CA (12-13)		Chatfield and Bay 2014	Locust Ridge, PA (Phase II; 09)		Arnett et al. 2011
Barton I & II, IA (10-11)		Derby et al. 2011a	Locust Ridge, PA (Phase II; 10)		Arnett et al. 2011
Barton Chapel, TX (09-10)		WEST 2011	Maple Ridge, NY (06)		Jain et al. 2007
Beech Ridge, WV (12)		Tidhar et al. 2013b	Maple Ridge, NY (07)		Jain et al. 2009a
Beech Ridge, WV (13)		Young et al. 2014b	Maple Ridge, NY (07-08)		Jain et al. 2009d
Big Blue, MN (13)		Fagen Engineering 2014	Maple Ridge, NY (12)		Tidhar et al. 2013a
Big Blue, MN (14)		Fagen Engineering 2015	Marengo I, WA (09-10)		URS Corporation 2010b
Big Horn, WA (06-07)		Kronner et al. 2008	Marengo II, WA (09-10)		URS Corporation 2010c
Big Smile, OK (12-13)		Derby et al. 2013b	Mars Hill, ME (07)		Stantec 2008
Biglow Canyon, OR (Phase I; 08)		Jeffrey et al. 2009a	Mars Hill, ME (08)		Stantec 2009a
Biglow Canyon, OR (Phase I; 09)		Enk et al. 2010	Milford I, UT (10-11)		Stantec 2011b
Biglow Canyon, OR (Phase II; 09-10)		Enk et al. 2011a	Milford I & II, UT (11-12)		Stantec 2012b
Biglow Canyon, OR (Phase II; 10-11)		Enk et al. 2012b	Montezuma I, CA (11)		ICF International 2012
Biglow Canyon, OR (Phase III; 10-11)		Enk et al. 2012a	Montezuma I, CA (12)		ICF International 2013
Blue Sky Green Field, WI (08; 09)	Gruver 2008	Gruver et al. 2009	Montezuma II, CA (12-13)		Harvey & Associates 2013
Buffalo Gap I, TX (06)		Tierney 2007	Moraine II, MN (09)		Derby et al. 2010d
Buffalo Gap II, TX (07-08)		Tierney 2009	Mount Storm, WV (Fall 08)	Young et al. 2009b	Young et al. 2009b
Buffalo Mountain, TN (00-03)	Fiedler 2004	Nicholson et al. 2005	Mount Storm, WV (09)	Young et al. 2009a, 2010b	Young et al. 2009a, 2010b
Buffalo Mountain, TN (05)		Fiedler et al. 2007	Mount Storm, WV (10)	Young et al. 2010a, 2011b	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000	Mount Storm, WV (11)		Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000	Mountaineer, WV (03)		Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000	Munnsville, NY (08)		Stantec 2009b
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mustang Hills, CA (12-13)		Chatfield and Bay 2014
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Nine Canyon, WA (02-03)		Erickson et al. 2003a
Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000	Noble Altona, NY (10)		Jain et al. 2011b
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Noble Bliss, NY (08)		Jain et al.2009e
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Noble Bliss, NY (09)		Jain et al. 2010a
Buffalo Ridge I, SD (09-10)		Derby et al. 2010b	Noble Chateaugay, NY (10)		Jain et al. 2011c
Buffalo Ridge II, SD (11-12)		Derby et al. 2012a	Noble Clinton, NY (08)	Reynolds 2010a	Jain et al. 2009c
Casselman, PA (08)		Arnett et al. 2009b	Noble Clinton, NY (09)	Reynolds 2010a	Jain et al. 2010b
Casselman, PA (09)		Arnett et al. 2010	Noble Ellenburg, NY (08)		Jain et al. 2009b
Casselman Curtailment, PA (08)		Arnett et al. 2009a	Noble Ellenburg, NY (09)	Reynolds 2010b	Jain et al. 2010c
Cedar Ridge, WI (09)	BHE Environmental 2008	BHE Environmental 2010	Noble Wethersfield, NY (10)		Jain et al. 2011a
Cedar Ridge, WI (10)	BHE Environmental 2008	BHE Environmental 2011	NPPD Ainsworth, NE (06)		Derby et al. 2007
Cohocton/Dutch Hill, NY (09)		Stantec 2010	Palouse Wind, WA (12-13)		Stantec 2013a
Cohocton/Dutch Hills, NY (10)		Stantec 2011a	Pebble Springs, OR (09-10)		Gritski and Kronner 2010b
Combine Hills, OR (Phase I; 04-05)		Young et al. 2006	Pinnacle, WV (12)		Hein et al. 2013a
Combine Hills, OR (11)		Enz et al. 2012	Pinyon Pines I&II, CA (13-14)		Chatfield and Russo 2014
Crescent Ridge, IL (05-06)		Kerlinger et al. 2007	Pioneer Prairie I, IA (Phase II; 11-12)		Chodachek et al. 2012
Criterion, MD (11)		Young et al. 2012a	Pioneer Prairie II, IA (13)		Chodachek et al. 2014
Criterion, MD (12)		Young et al. 2013	PrairieWinds ND1 (Minot), ND (10)		Derby et al. 2011c
Criterion, MD (13)		Young et al. 2014a	PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012c

Appendix D3 (*continued*). Wind energy facilities in North America with comparable activity and fatality data for bats.

Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Crystal Lake II, IA (09)		Derby et al. 2010a	PrairieWinds SD1 (Crow Lake), SD (11-12)		Derby et al. 2012d
Diablo Winds, CA (05-07)		WEST 2006, 2008	PrairieWinds SD1 (Crow Lake), SD (12-13)		Derby et al. 2013a
Dillon, CA (08-09)		Chatfield et al. 2009	PrairieWinds SD1, SD (13-14)		Derby et al. 2014a
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Thompson et al. 2011	Rail Splitter, IL (12-13)		Good et al. 2013b
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Thompson and Bay 2012	Record Hill, ME (12)	Stantec 2013b	Stantec 2013b
Elkhorn, OR (08)		Jeffrey et a. 2009b	Record Hill, ME (14)		Stantec 2015
Elkhorn, OR (10)		Enk et al. 2011b	Red Hills, OK (12-13)		Derby et al. 2013c
Elm Creek, MN (09-10)		Derby et al. 2010c	Ripley, Ont (08)		Jacques Whitford 2009
Elm Creek II, MN (11-12)		Derby et al. 2012b	Rollins, ME (12)		Stantec 2013c
Foote Creek Rim, WY (Phase I; 99)		Young et al. 2003b	Rugby, ND (10-11)		Derby et al. 2011b
Foote Creek Rim, WY (Phase I; 00)	Gruver 2002	Young et al. 2003b, 2003d	Shiloh I, CA (06-09)		Kerlinger et al. 2009
Foote Creek Rim, WY (Phase I; 01-02)	Gruver 2002	Young et al. 2003b, 2003d	Shiloh II, CA (09-10)		Kerlinger et al. 2010
Forward Energy Center, WI (08-10)	Watt and Drake 2011	Grodsky and Drake 2011	Shiloh II, CA (10-11)		Kerlinger et al. 2013a
Fowler I, IN (09)		Johnson et al. 2010a	Shiloh III, CA (12-13)		Kerlinger et al. 2013b
Fowler III, IN (09)		Johnson et al. 2010b	Solano III, CA (12-13)		AECOM 2013
Fowler I, II, III, IN (10)		Good et al. 2011	Stateline, OR/WA (01-02)		Erickson et al. 2004
Fowler I, II, III, IN (11)		Good et al. 2012	Stateline, OR/WA (03)		Erickson et al. 2004
Fowler I, II, III, IN (12)		Good et al. 2013c	Stateline, OR/WA (06)		Erickson et al. 2007
Goodnoe, WA (09-10)		URS Corporation 2010a	Stetson Mountain I, ME (09)	Stantec 2009c	Stantec 2009c
Grand Ridge I, IL (09-10)		Derby et al. 2010g	Stetson Mountain I, ME (11)		Normandeau Associates 2011
Harrow, Ont (10)		NRSI 2011	Stetson Mountain I, ME (13)		Stantec 2014
Harvest Wind, WA (10-12)		Downes and Gritski 2012a	Stetson Mountain II, ME (10)		Normandeau Associates 2010
Hay Canyon, OR (09-10)		Gritski and Kronner 2010a	Stetson Mountain II, ME (12)		Stantec 2013e
High Sheldon, NY (10)		Tidhar et al. 2012a	Summerview, Alb (05-06)		Brown and Hamilton 2006b
High Sheldon, NY (11)		Tidhar et al. 2012b	Summerview, Alb (06; 07)	Baerwald 2008	Baerwald 2008
High Winds, CA (03-04)		Kerlinger et al. 2006	Top Crop I & II, IL (12-13)		Good et al. 2013a
High Winds, CA (04-05)		Kerlinger et al. 2006	Top of Iowa, IA (03)		Jain 2005
Hopkins Ridge, WA (06)		Young et al. 2007	Top of Iowa, IA (04)	Jain 2005	Jain 2005
Hopkins Ridge, WA (08)		Young et al. 2009c	Tuolumne (Windy Point I), WA (09-10)		Enz and Bay 2010
Judith Gap, MT (06-07)		TRC 2008	Vansycle, OR (99)		Erickson et al. 2000a
Judith Gap, MT (09)		Poulton and Erickson 2010	Vantage, WA (10-11)		Ventus 2012
Kewaunee County, WI (99-01)		Howe et al. 2002	Wessington Springs, SD (09)		Derby et al. 2010f
Kibby, ME (11)		Stantec 2012a	Wessington Springs, SD (10)		Derby et al. 2011d
Kittitas Valley, WA (11-12)		Stantec Consulting Services 2012	White Creek, WA (07-11)		Downes and Gritski 2012b
Klondike, OR (02-03)		Johnson et al. 2003b	Wild Horse, WA (07)		Erickson et al. 2008
Klondike II, OR (05-06)		NWC and WEST 2007	Windy Flats, WA (10-11)		Enz et al. 2011
Klondike III (Phase I), OR (07-09)		Gritski et al. 2010	Winnebago, IA (09-10)		Derby et al. 2010e
Klondike IIIa (Phase II), OR (08-10)		Gritski et al. 2011	Wolfe Island, Ont (July-December 09)		Stantec Ltd. 2010b
Leaning Juniper, OR (06-08)		Gritski et al. 2008	Wolfe Island, Ont (July-December 10)		Stantec Ltd. 2011b
Lempster, NH (09)		Tidhar et al. 2010	Wolfe Island, Ont (July-December 11)		Stantec Ltd. 2012
Lempster, NH (10)		Tidhar et al. 2011			

Appendix D4. Fatality estimates for North American wind energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Alite, CA (2009-2010)	0.55	0.12	0.24	Shrub/scrub & grassland	Chatfield et al. 2010
Alta Wind I, CA (2011-2012)	7.07	0.27	1.28	Woodland, grassland, shrubland	Chatfield et al. 2012
Alta Wind II-V, CA (2011-2012)	1.66	0.05	0.08	Desert scrub	Chatfield et al. 2012
Alta Wind I, CA (2013-2014)	12.05	0.15	0.36	Woodland, grassland, shrubland	Chatfield et al. 2014
Alta Wind II-V, CA (2013-2014)	2.79	0	0	Desert scrub	Chatfield et al. 2014
Alta Wind I-V, CA (2013-2014)	7.8	0.08	0.2	Woodland, grassland, shrubland, desert scrub	Chatfield et al. 2014
Alta I, CA (2015-2016)	2.57	0.15	0.70	Woodland, grassland, shrubland	This study.
Alta II-V, CA (2015-2016)	0.51	0	0	Desert scrub	This study
Alta I-V, CA (2015-2016)	1.29	0.07	0.3	Woodland, grassland, shrubland, desert scrub	This study.
Alta VIII, CA (2012-2013)	0.66	0.02	0	Grassland and riparian	Chatfield and Bay 2014
Barton I & II, IA (2010-2011)	5.5	0	1.85	Agriculture	Derby et al. 2011a
Barton Chapel, TX (2009-2010)	1.15	0.25	3.06	Agriculture/forest	WEST 2011
Beech Ridge, WV (2012)	1.19	0.01	2.03	Forest	Tidhar et al. 2013b
Beech Ridge, WV (2013)	1.48	0.01	0.58	Forest	Young et al. 2014b
Big Blue, MN (2013)	0.6	0	2.04	Agriculture	Fagen Engineering 2014
Big Blue, MN (2014)	0.37	0	1.43	Agriculture	Fagen Engineering 2015
Big Horn, WA (2006-2007)	2.54	0.11	1.9	Agriculture/grassland	Kronner et al. 2008
Big Smile, OK (2012-2013)	0.09	0	2.9	Grassland, agriculture	Derby et al. 2013b
Biglow Canyon, OR (Phase I; 2008)	1.76	0.03	1.99	Agriculture/grassland	Jeffrey et al. 2009a
Biglow Canyon, OR (Phase I; 2009)	2.47	0	0.58	Agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	0.14	2.71	Agriculture	Enk et al. 2011a
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	0.03	0.57	Grassland/shrub-steppe, agriculture	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	0.05	0.22	Grassland/shrub-steppe, agriculture	Enk et al. 2012a
Blue Sky Green Field, WI (2008; 2009)	7.17	0	24.57	Agriculture	Gruver et al. 2009
Buffalo Gap I, TX (2006)	1.32	0.1	0.1	Grassland	Tierney 2007

Appendix D4. Fatality estimates for North American wind energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Buffalo Gap II, TX (2007-2008)	0.15	0	0.14	Forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	11.02	0	31.54	Forest	Nicholson et al. 2005
Buffalo Mountain, TN (2005)	1.1	0	39.7	Forest	Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 1996)	4.14	0	NA	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1997)	2.51	0	NA	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1998)	3.14	0	NA	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1999)	1.43	0.47	0.74	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1998)	2.47	0	2.16	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1999)	3.57	0	2.59	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	NA	NA	4.35	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	NA	NA	1.64	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 1999)	5.93	0	2.72	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	NA	NA	3.71	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	NA	NA	1.81	Agriculture	Johnson et al. 2004
Buffalo Ridge I, SD (2009-2010)	5.06	0.2	0.16	Agriculture/grassland	Derby et al. 2010b
Buffalo Ridge II, SD (2011-2012)	1.99	0	2.81	Agriculture, grassland	Derby et al. 2012a
Casselman, PA (2008)	1.51	0	12.61	Forest	Arnett et al. 2009b
Casselman, PA (2009)	2.88	0	8.6	Forest, pasture, grassland	Arnett et al. 2010
Casselman Curtailment, PA (2008)	NA	NA	4.4	Forest	Arnett et al. 2009a
Cedar Ridge, WI (2009)	6.55	0.18	30.61	Agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	3.72	0.13	24.12	Agriculture	BHE Environmental 2011

Appendix D4. Fatality estimates for North American wind energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Cohocton/Dutch Hill, NY (2009)	1.39	0	8.62	Agriculture/forest	Stantec 2010
Cohocton/Dutch Hills, NY (2010)	1.32	0.08	10.32	Agriculture, forest	Stantec 2011a
Combine Hills, OR (Phase I; 2004-2005)	2.56	0	1.88	Agriculture/grassland	Young et al. 2006
Combine Hills, OR (2011)	2.33	0.05	0.73	Grassland/shrub-steppe, agriculture	Enz et al. 2012
Crescent Ridge, IL (2005-2006)	NA	NA	3.27	Agriculture	Kerlinger et al. 2007
Criterion, MD (2011)	6.4	0.02	15.61	Forest, agriculture	Young et al. 2012a
Criterion, MD (2012)	2.14	NA	7.62	Forest, agriculture	Young et al. 2013
Criterion, MD (2013)	3.49	NA	5.32	Forest, agriculture	Young et al. 2014a
Crystal Lake II, IA (2009)	NA	NA	7.42	Agriculture	Derby et al. 2010a
Diablo Winds, CA (2005-2007)	4.29	0.4	0.82	NA	WEST 2006, 2008
Dillon, CA (2008-2009)	4.71	0	2.17	Desert	Chatfield et al. 2009
Dry Lake I, AZ (2009-2010)	2.02	0	3.43	Desert grassland/forested	Thompson et al. 2011
Dry Lake II, AZ (2011-2012)	1.57	0	1.66	Desert grassland/forested	Thompson and Bay 2012
Elkhorn, OR (2008)	0.64	0.06	1.26	Shrub/scrub & agriculture	Jeffrey et al. 2009b
Elkhorn, OR (2010)	1.95	0.08	2.14	Shrub/scrub & agriculture	Enk et al. 2011b
Elm Creek, MN (2009-2010)	1.55	0	1.49	Agriculture	Derby et al. 2010c
Elm Creek II, MN (2011-2012)	3.64	0	2.81	Agriculture, grassland	Derby et al. 2012b
Foote Creek Rim, WY (Phase I; 1999)	3.4	0.08	3.97	Grassland	Young et al. 2003b
Foote Creek Rim, WY (Phase I; 2000)	2.42	0.05	1.05	Grassland	Young et al. 2003b
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	0	1.57	Grassland	Young et al. 2003b
Forward Energy Center, WI (2008-2010)	NA	NA	18.17	Agriculture	Grodsky and Drake 2011
Fowler I, IN (2009)	2.83	0	8.09	Agriculture	Johnson et al. 2010a
Fowler I, II, III, IN (2010)	NA	NA	18.96	Agriculture	Good et al. 2011
Fowler I, II, III, IN (2011)	NA	NA	20.19	Agriculture	Good et al. 2012
Fowler I, II, III, IN (2012)	NA	NA	2.96	Agriculture	Good et al. 2013c
Fowler III, IN (2009)	NA	NA	1.84	Agriculture	Johnson et al. 2010b
Goodnoe, WA (2009-2010)	1.4	0.17	0.34	Grassland and shrub-steppe	URS Corporation 2010a
Grand Ridge I, IL (2009-2010)	0.48	0	2.1	Agriculture	Derby et al. 2010g

Appendix D4. Fatality estimates for North American wind energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Harrow, Ont (2010)	NA	NA	11.13	Agriculture	Natural Resource Solutions Inc. (NRSI) 2011
Harvest Wind, WA (2010-2012)	2.94	0.23	1.27	Grassland/shrub-steppe	Downes and Gritski 2012a
Hay Canyon, OR (2009-2010)	2.21	0	0.53	Agriculture	Gritski and Kronner 2010a
High Sheldon, NY (2010)	1.76	0.06	2.33	Agriculture	Tidhar et al. 2012a
High Sheldon, NY (2011)	1.57	0	1.78	Agriculture	Tidhar et al. 2012b
High Winds, CA (2003-2004)	1.62	0.5	2.51	Agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2004-2005)	1.1	0.28	1.52	Agriculture/grassland	Kerlinger et al. 2006
Hopkins Ridge, WA (2006)	1.23	0.14	0.63	Agriculture/grassland	Young et al. 2007
Hopkins Ridge, WA (2008)	2.99	0.07	1.39	Agriculture/grassland	Young et al. 2009c
Judith Gap, MT (2006-2007)	NA	NA	8.93	Agriculture/grassland	TRC 2008
Judith Gap, MT (2009)	NA	NA	3.2	Agriculture/grassland	Poulton and Erickson 2010
Kewaunee County, WI (1999-2001)	1.95	0	6.45	Agriculture	Howe et al. 2002
Kibby, ME (2011)	NA	NA	0.12	Forest; commercial forest	Stantec 2012a
Kittitas Valley, WA (2011-2012)	1.06	0.09	0.12	Sagebrush-steppe, grassland	Stantec Consulting Services 2012
Klondike, OR (2002-2003)	0.95	0	0.77	Agriculture/grassland	Johnson et al. 2003b
Klondike II, OR (2005-2006)	3.14	0.06	0.41	Agriculture/grassland	NWC and WEST 2007
Klondike III (Phase I), OR (2007-2009)	3.02	0.15	1.11	Agriculture/grassland	Gritski et al. 2010
Klondike IIIa (Phase II), OR (2008-2010)	2.61	0.06	0.14	Grassland/shrub-steppe and agriculture	Gritski et al. 2011
Leaning Juniper, OR (2006-2008)	6.66	0.16	1.98	Agriculture	Gritski et al. 2008
Lempster, NH (2009)	3.38	0	3.11	Grasslands/forest/rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	2.64	0	3.57	Grasslands/forest/rocky embankments	Tidhar et al. 2011
Linden Ranch, WA (2010-2011)	6.65	0.27	1.68	Grassland/shrub-steppe, agriculture	Enz and Bay 2011
Locust Ridge, PA (Phase II; 2009)	0.84	0	14.11	Grassland	Arnett et al. 2011

Appendix D4. Fatality estimates for North American wind energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Locust Ridge, PA (Phase II; 2010)	0.76	0	14.38	Grassland	Arnett et al. 2011
Maple Ridge, NY (2006)	NA	NA	11.21	Agriculture/forested	Jain et al. 2007
Maple Ridge, NY (2007)	2.34	NA	6.49	Agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007-2008)	2.07	0.03	4.96	Agriculture/forested	Jain et al. 2009d
Maple Ridge, NY (2012)	NA	NA	7.3	Agriculture/forested	Tidhar et al. 2013a
Marengo I, WA (2009-2010)	0.27	0	0.17	Agriculture	URS Corporation 2010b
Marengo II, WA (2009-2010)	0.16	0.05	0.27	Agriculture	URS Corporation 2010c
Mars Hill, ME (2007)	1.67	0	2.91	Forest	Stantec 2008
Mars Hill, ME (2008)	1.76	0	0.45	Forest	Stantec 2009a
Milford I, UT (2010-2011)	0.56	NA	2.05	Desert shrub	Stantec 2011b
Milford I & II, UT (2011-2012)	0.73	0.04	1.67	Desert shrub	Stantec 2012b
Montezuma I, CA (2011)	5.19	1.06	1.9	Agriculture and grasslands	ICF International 2012
Montezuma I, CA (2012)	8.91	0.79	0.84	Agriculture and grasslands	ICF International 2013
Montezuma II, CA (2012-2013)	1.08	0.46	0.91	Agriculture	Harvey & Associates 2013
Moraine II, MN (2009)	5.59	0.37	2.42	Agriculture/grassland	Derby et al. 2010d
Mount Storm, WV (Fall 2008)	NA	NA	6.62	Forest	Young et al. 2009b
Mount Storm, WV (2009)	3.85	0	17.53	Forest	Young et al. 2009a, 2010b
Mount Storm, WV (2010)	2.6	0.1	15.18	Forest	Young et al. 2010a, 2011b
Mount Storm, WV (2011)	4.24	0.03	7.43	Forest	Young et al. 2011a, 2012b
Mountaineer, WV (2003)	2.69	0.07	31.69	Forest	Kerns and Kerlinger 2004
Munnsville, NY (2008)	1.48	0.59	1.93	Agriculture/forest	Stantec 2009b
Mustang Hills, CA (2012-2013)	1.66	0.08	0.1	Grasslands and Riparian	Chatfield and Bay 2014
Nine Canyon, WA (2002-2003)	2.76	0.03	2.47	Agriculture/grassland	Erickson et al. 2003a
Noble Altona, NY (2010)	1.84	0	4.34	Forest	Jain et al. 2011b
Noble Bliss, NY (2008)	1.3	0.1	7.8	Agriculture/forest	Jain et al. 2009e
Noble Bliss, NY (2009)	2.28	0.12	3.85	Agriculture/forest	Jain et al. 2010a
Noble Chateaugay, NY (2010)	1.66	0.08	2.44	Agriculture	Jain et al. 2011c
Noble Clinton, NY (2008)	1.59	0.1	3.14	Agriculture/forest	Jain et al. 2009c
Noble Clinton, NY (2009)	1.11	0.16	4.5	Agriculture/forest	Jain et al. 2010b
Noble Ellenburg, NY (2008)	0.83	0.11	3.46	Agriculture/forest	Jain et al. 2009b
Noble Ellenburg, NY (2009)	2.66	0.25	3.91	Agriculture/forest	Jain et al. 2010c
Noble Wethersfield, NY (2010)	1.7	0.13	16.3	Agriculture	Jain et al. 2011a
NPPD Ainsworth, NE (2006)	1.63	0.06	1.16	Agriculture/grassland	Derby et al. 2007

Appendix D4. Fatality estimates for North American wind energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Palouse Wind, WA (2012-2013)	0.72	NA	4.23	Agriculture and grasslands	Stantec 2013a
Pebble Springs, OR (2009-2010)	1.93	0.04	1.55	Grassland	Gritski and Kronner 2010b
Pine Tree, CA (2009-2010, 2011)	17.44	NA	NA	Grassland	BioResource Consultants 2012
Pinnacle, WV (2012)	3.99	0	40.2	Forest	Hein et al. 2013a
Pinyon Pines I & II, CA (2013-2014)	1.18	NA	0.04	NA	Chatfield and Russo 2014
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	0	10.06	Agriculture, grassland	Chodachek et al. 2012
Pioneer Prairie II, IA (2013)	NA	NA	3.83	Agriculture	Chodachek et al. 2014
PrairieWinds ND1 (Minot), ND (2010)	1.48	0.05	2.13	Agriculture	Derby et al. 2011c
PrairieWinds ND1 (Minot), ND (2011)	1.56	0.05	1.39	Agriculture, grassland	Derby et al. 2012c
PrairieWinds SD1, SD (2011-2012)	1.41	0	1.23	Grassland	Derby et al. 2012d
PrairieWinds SD1, SD (2012-2013)	2.01	0.03	1.05	Grassland	Derby et al. 2013a
PrairieWinds SD1, SD (2013-2014)	1.66	0.17	0.52	Grassland	Derby et al. 2014a
Rail Splitter, IL (2012-2013)	0.84	0	22.53	Agriculture	Good et al. 2013b
Record Hill, ME (2012)	3.7	NA	2.96	Forest	Stantec 2013b
Record Hill, ME (2014)	1.84	NA	0.55	Forest	Stantec 2015
Red Hills, OK (2012-2013)	0.08	0.04	0.11	Grassland	Derby et al. 2013c
Ripley, Ont (2008)	3.09	0.1	4.67	Agriculture	Jacques Whitford 2009
Rollins, ME (2012)	2.9	NA	0.18	Forest	Stantec 2013c
Rugby, ND (2010-2011)	3.82	0.06	1.6	Agriculture	Derby et al. 2011b
Shiloh I, CA (2006-2009)	6.96	0.42	3.92	Agriculture/grassland	Kerlinger et al. 2009
Shiloh II, CA (2009-2010)	1.9	0.11	2.6	Agriculture	Kerlinger et al. 2010, 2013a
Shiloh II, CA (2010-2011)	2.8	0.44	3.8	Agriculture	Kerlinger et al. 2013a
Shiloh III, CA (2012-2013)	3.3	NA	0.4	NA	Kerlinger et al. 2013b
Solano III, CA (2012-2013)	1.6	0.95	0.31	NA	AECOM 2013
Stateline, OR/WA (2001-2002)	3.17	0.09	1.09	Agriculture/grassland	Erickson et al. 2004

Appendix D4. Fatality estimates for North American wind energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Stateline, OR/WA (2003)	2.68	0.09	2.29	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2006)	1.23	0.11	0.95	Agriculture/grassland	Erickson et al. 2007
Stetson Mountain I, ME (2009)	2.68	0	1.4	Forest	Stantec 2009c
Stetson Mountain I, ME (2011)	1.18	0	0.28	Forest	Normandeau Associates 2011
Stetson Mountain I, ME (2013)	6.95	0	0.18	Forest	Stantec 2014
Stetson Mountain II, ME (2010)	1.42	0	1.65	Forest	Normandeau Associates 2010
Stetson Mountain II, ME (2012)	3.37	0	2.27	Forest	Stantec 2013e
Summerview, Alb (2005-2006)	1.06	0.11	10.27	Agriculture	Brown and Hamilton 2006b
Summerview, Alb (2006; 2007)	NA	NA	11.42	Agriculture/grassland	Baerwald 2008
Top Crop I & II (2012-2013)	0.6	NA	26.85	Agriculture	Good et al. 2013a
Top of Iowa, IA (2003)	0.42	0	7.16	Agriculture	Jain 2005
Top of Iowa, IA (2004)	0.81	0.17	10.27	Agriculture	Jain 2005
Tuolumne (Windy Point I), WA (2009-2010)	3.2	0.29	0.94	Grassland/shrub-steppe, agriculture and forest	Enz and Bay 2010
Vansycle, OR (1999)	0.95	0	1.12	Agriculture/grassland	Erickson et al. 2000a
Vantage, WA (2010-2011)	1.27	0.29	0.4	Shrub-steppe, grassland	Ventus Environmental Solutions 2012
Wessington Springs, SD (2009)	8.25	0.06	1.48	Grassland	Derby et al. 2010f
Wessington Springs, SD (2010)	0.89	0.07	0.41	Grassland	Derby et al. 2011d
White Creek, WA (2007-2011)	4.05	0.47	2.04	Grassland/shrub-steppe, agriculture	Downes and Gritski 2012b
Wild Horse, WA (2007)	1.55	0.09	0.39	Grassland	Erickson et al. 2008
Windy Flats, WA (2010-2011)	8.45	0.04	0.41	Grassland/shrub-steppe, agriculture	Enz et al. 2011
Winnebago, IA (2009-2010)	3.88	0.27	4.54	Agriculture/grassland	Derby et al. 2010e
Wolfe Island, Ont (July-December 2009)	NA	NA	6.42	Grassland	Stantec Ltd. 2010b
Wolfe Island, Ont (July-December 2010)	NA	NA	9.5	Grassland	Stantec Ltd. 2011b
Wolfe Island, Ont (July-December 2011)	NA	NA	2.49	Grassland	Stantec Ltd. 2012

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Alite, CA (2009-2010)	8	24	80	8	200 m x 200 m	1 year	Weekly (spring, fall), bi-monthly (summer, winter)
Alta VIII, CA (2012-2013)	50	150	90	12 plots (equivalent to 15 turbines)	240 x 240 m	1 year	Bi-weekly
Barton I & II, IA (2010-2011)	80	160	100	35 (9 turbines were dropped in June 2010 due to landowner issues) 26 turbines were searched for the remainder of the study	200 m x 200 m	1 year	Weekly (spring, fall; migratory turbines), monthly (summer, winter; non-migratory turbines)
Barton Chapel, TX (2009-2010)	60	120	78	30	200 m x 200 m	1 year	10 turbines weekly, 20 monthly
Beech Ridge, WV (2012)	67	100.5	80	67	40 m radius	7 months	Every two days
Beech Ridge, WV (2013)	67	100.5	80	67	40 m radius	7.5 months	Every two days
Big Blue, MN (2013)	18	36	78 or 90 (according to Gamesa website)	18	200m diameter	NA	Weekly, monthly (Nov and Dec)
Big Blue, MN (2014)	18	36	78 or 90 (according to Gamesa website)	18	200m diameter	NA	Weekly, monthly (Nov and Dec)
Big Horn, WA (2006-2007)	133	199.5	80	133	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Big Smile, OK (2012-2013)	66	132	78	17 (plus one met tower)	100 x 100	1 year	Weekly (spring, summer, fall), monthly (winter)

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Biglow Canyon, OR (Phase I; 2008)	76	125.4	80	50	110 m x 110 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase I; 2009)	76	125.4	80	50	110 m x 110 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2009-2010)	65	150	80	50	250 m x 250 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2010-2011)	65	150	80	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Biglow Canyon, OR (Phase III; 2010-2011)	76	174.8	80	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Blue Sky Green Field, WI (2008; 2009)	88	145	80	30	160 m x 160 m	Fall, spring	Daily(10 turbines), weekly (20 turbines)
Buena Vista, CA (2008-2009)	38	38	45-55	38	75-m radius	1 year	Monthly to bi-monthly starting in September 2008
Buffalo Gap I, TX (2006)	67	134	78	21	215 m x 215 m	10 months	Every 3 weeks
Buffalo Gap II, TX (2007-2008)	155	233	80	36	215 m x 215 m	14 months	Every 21 days
Buffalo Mountain, TN (2000-2003)	3	1.98	65	3	50-m radius	3 years	Bi-weekly, weekly, bi-monthly
Buffalo Mountain, TN (2005)	18	28.98	V47 = 65; V80 = 78	18	50-m radius	1 year	Bi-weekly, weekly, bi-monthly, and 2 to 5 day intervals

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Buffalo Ridge, MN (1994-1995)	73	25	37	1994:10 plots (3 turbines/plot), 20 addition plots in Sept & Oct 1994, 1995: 30 turbines search every other week (Jan-Mar), 60 searched weekly (Apr, July, Aug) 73 searched weekly (May-June and Sept-Oct), 30 searched weekly (Nov-Dec)	100 x 100m	20 months	Varies. See number turbines searched or page 44 of report
Buffalo Ridge, MN (Phase I; 1996)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1997)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1998)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1999)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1998)	143	107.25	50	40	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1999)	143	107.25	50	40	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	143	107.25	50	83	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	143	107.25	50	103	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase III; 1999)	138	103.5	50	30	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	138	103.5	50	83	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	138	103.5	50	103	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge I, SD (2009-2010)	24	50.4	79	24	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Buffalo Ridge II, SD (2011-2012)	105	210	78	65 (60 road and pad, 5 turbine plots)	100 x 100m	1 year	Weekly (spring, summer, fall), monthly (winter)
Casselman, PA (2008)	23	34.5	80	10	126 m x 120 m	7 months	Daily
Casselman, PA (2009)	23	34.5	80	10	126 m x 120 m	7.5 months	Daily searches
Casselman Curtailment, PA (2008)	23	35.4	80	12 experimental; 10 control	126 m x 120 m	2.5 months	Daily
Castle River, Alb (2001-2002)	60	39.6	50	60	50-m radius	2 years	Weekly, bi-weekly
Castle River, Alb (2001-2002)	60	39.6	50	60	50-m radius	2 years	Weekly, bi-weekly
Cedar Ridge, WI (2009)	41	67.6	80	20	160 m x 160 m	Spring, summer, fall	Daily, every 4 days; late fall searched every 3 days
Cedar Ridge, WI (2010)	41	68	80	20	160 m x 160 m	1 year	Five turbines were surveyed daily, 15 turbines surveyed every 4 days in rotating groups each day. All 20 surveyed every three days during late fall
Cohocton/Dutch Hill, NY (2009)	50	125	80	17	130 m x 130 m	Spring, summer, fall	Daily (5 turbines), weekly (12 turbines)
Cohocton/Dutch Hills, NY (2010)	50	125	80	17	120 m x 120 m	Spring, summer, fall	Daily, weekly

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Combine Hills, OR (Phase I; 2004-2005)	41	41	53	41	90-m radius	1 year	Monthly
Combine Hills, OR (2011)	104	104	53	52 (plus 1 MET tower)	180 m x 180 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Condon, OR	84	NA	NA	NA	NA	NA	NA
Crescent Ridge, IL (2005-2006)	33	49.5	80	33	70-m radius	1 year	Weekly (fall, spring)
Criterion, MD (2011)	28	70	80	28	40-50m radius	7.3 months	Daily
Criterion, MD (2012)	28	70	80	14	40-50m radius	7.5 months	Weekly
Criterion, MD (2013)	28	70	80	14	40-50m radius	7.5 months	Weekly
Crystal Lake II, IA (2009)	80	200	80	16 turbines through week 6, and then 15 for duration of study	100 m x 100 m	Spring, summer, fall	3 times per week for 26 weeks
Diablo Winds, CA (2005-2007)	31	20.46	50 and 55	31	75 m x 75 m	2 years	Monthly
Dillon, CA (2008-2009)	45	45	69	15	200 m x 200 m	1 year	Weekly, bi-monthly in winter
Dry Lake I, AZ (2009-2010)	30	63	78	15	160 m x 160 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Dry Lake II, AZ (2011-2012)	31	65	78	31: 5 (full plot), 26 (road & pad)	160 m x 160 m	1 year	Twice weekly (spring, summer, fall), weekly (winter)
Elkhorn, OR (2008)	61	101	80	61	220 m x 220 m	1 year	Monthly
Elkhorn, OR (2010)	61	101	80	31	220 m x 220 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Elm Creek, MN (2009-2010)	67	100	80	29	200 m x 200 m	1 year	Weekly, monthly

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Elm Creek II, MN (2011-2012)	62	148.8	80	30	200 x 200m (2 random migration search areas 100 x 100m)	1 year	20 searched every 28 days, 10 turbines every 7 days during migration)
Erie Shores, Ont (2006)	66	99	80	66	40-m radius	2 years	Weekly, bi-monthly, 2-3 times weekly (migration)
Foote Creek Rim, WY (Phase I; 1999)	69	41.4	40	69	126 m x 126 m	1 year	Monthly
Foote Creek Rim, WY (Phase I; 2000)	69	41.4	40	69	126 m x 126 m	1 year	Monthly
Foote Creek Rim, WY (Phase I; 2001-2002)	69	41.4	40	69	126 m x 126 m	1 year	Monthly
Forward Energy Center, WI (2008-2010)	86	129	80	29	160 m x 160 m	2 years	11 turbines daily, 9 every 3 days, 9 every 5 days
Fowler I, IN (2009)	162	301	78 (Vestas), 80 (Clipper)	25	160 m x 160 m	Spring, summer, fall	Weekly, bi-weekly
Fowler I, II, III, IN (2010)	355	600	Vestas = 80, Clipper = 80, GE = 80	36 turbines, 100 road and pads	80 m x 80 m for turbines ; 40-m radius for roads and pads	Spring, fall	Daily, weekly
Fowler I, II, III, IN (2011)	355	600	Vestas = 80, Clipper = 80, GE = 80	177 road and pads (spring), 9 turbines & 168 roads and pads (fall)	turbines (80 m circular plot), roads and pads (out to 80 m)	Spring, fall	Daily, weekly
Fowler I, II, III, IN (2012)	355	600	Vestas = 80, Clipper = 80, GE = 80	118 roads and pads	roads and pads (out to 80 m)	2.5 months	Weekly
Fowler III, IN (2009)	60	99	78	12	160 m x 160 m	10 weeks	Weekly, bi-weekly

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Goodnoe, WA (2009-2010)	47	94	80	24	180 m x 180 m	1 year	14 days during migration periods, 28 days during non-migration periods
Grand Ridge I, IL (2009-2010)	66	99	80	30	160 m x 160 m	1 year	Weekly, monthly
Harrow, Ont (2010)	24 (four 6-turb facilities)	39.6	NA	12 in July, 24 Aug-Oct	50-m radius from turbine base	4 months	Twice-weekly
Harvest Wind, WA (2010-2012)	43	98.9	80	32	180 m x 180 m & 240 m x 240 m	2 years	Twice a week, weekly and monthly
Hay Canyon, OR (2009-2010)	48	100.8	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Heritage Garden I, MI (2012-2014)	14	28	90	14	120x120 m except one plot that was 280x280 m	2 years	Weekly (spring, summer, and fall) and bi-weekly (winter)
High Sheldon, NY (2010)	75	112.5	80	25	115 m x 115 m	7 months	Daily (8 turbines), weekly (17 turbines)
High Sheldon, NY (2011)	75	112.5	80	25	115 m x 115 m	7 months	Daily (8 turbines), weekly (17 turbines)
High Winds, CA (2003-2004)	90	162	60	90	75-m radius	1 year	Bi-monthly
High Winds, CA (2004-2005)	90	162	60	90	75-m radius	1 year	Bi-monthly
Hopkins Ridge, WA (2006)	83	150	67	41	180 m x 180 m	1 year	Monthly, weekly (subset of 22 turbines spring and fall migration)
Hopkins Ridge, WA (2008)	87	156.6	67	41-43	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Jersey Atlantic, NJ (2008)	5	7.5	80	5	130 m x 120 m	9 months	Weekly
Judith Gap, MT (2006-2007)	90	135	80	20	190 m x 190 m	7 months	Monthly
Judith Gap, MT (2009)	90	135	80	30	100 m x 100 m	5 months	Bi-monthly
Kewaunee County, WI (1999-2001)	31	20.46	65	31	60 m x 60 m	2 years	Bi-weekly (spring, summer), daily (spring, fall migration), weekly (fall, winter)
Kibby, ME (2011)	44	132	124	22 turbines	75-m diameter circular plots	22 weeks	Avg 5-day
Kittitas Valley, WA (2011-2012)	48	100.8	80	48	100 m x 102 m	1 year	Bi-weekly from Aug 15 - Oct 31 and March 16 - May 15; every 4 weeks from Nov 1 - March 15 and May 16 - Aug 14
Klondike, OR (2002-2003)	16	24	80	16	140 m x 140 m	1 year	Monthly
Klondike II, OR (2005-2006)	50	75	80	25	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (summer, winter)
Klondike III (Phase I), OR (2007-2009)	125	223.6	GE = 80; Siemens= 80, Mitsubishi = 80	46	240 m x 240 m (1.5MW) 252 m x 252 m (2.3MW)	2 year	Bi-monthly (spring, fall migration), monthly (summer, winter)
Klondike IIIa (Phase II), OR (2008-2010)	51	76.5	GE = 80	34	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (summer, winter)
Lakefield Wind, MN (2012)	137	205.5	80	26	100 m x 100 m	7.5 months	3 times per week
Leaning Juniper, OR (2006-2008)	67	100.5	80	17	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (winter, summer)

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Lempster, NH (2009)	12	24	78	4	120 m x 130 m	6 months	Daily
Lempster, NH (2010)	12	24	78	12	120 m x 130 m	6 months	Weekly
Linden Ranch, WA (2010-2011)	25	50	80	25	110 m x 110 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Locust Ridge, PA (Phase II; 2009)	51	102	80	15	120m x 126m	6.5 months	Daily
Locust Ridge, PA (Phase II; 2010)	51	102	80	15	120m x 126m	6.5 months	Daily
Madison, NY (2001-2002)	7	11.55	67	7	60-m radius	1 year	Weekly (spring, fall), monthly (summer)
Maple Ridge, NY (2006)	120	198	80	50	130 m x 120 m	5 months	Daily (10 turbines), every 3 days (10 turbines), weekly (30 turbines)
Maple Ridge, NY (2007)	195	321.75	80	64	130 m x 120 m	7 months	Weekly
Maple Ridge, NY (2007-2008)	195	321.75	80	64	130 m x 120 m	7 months	Weekly
Maple Ridge, NY (2012)	195	321.75	80	105 (5 turbines, 100 roads/pads)	100 m x 100 m	3 months	Weekly
Marengo I, WA (2009-2010)	78	140.4	67	39	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Marengo II, WA (2009-2010)	39	70.2	67	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Mars Hill, ME (2007)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	Spring, summer, fall	Daily (2 random turbines), weekly (all turbines): extended plot searched once per season

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Mars Hill, ME (2008)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	Spring, summer, fall	Weekly: extended plot searched once per season
McBride, Alb (2004)	114	75	50	114	4 parallel transects 120-m wide	1 year	Weekly, bi-weekly
Melancthon, Ont (Phase I; 2007)	45	NA	NA	45	35m radius	5 months	Weekly, twice weekly
Meyersdale, PA (2004)	20	30	80	20	130 m x 120 m	6 weeks	Daily (half turbines), weekly (half turbines)
Milford I, UT (2010-2011)	58	145	80	24	120x120	NA	Weekly
Milford I & II, UT (2011-2012)	107	160.5 (58.5 Phase I, 102 Phase II)	80	43	120x120	NA	Every 10.5 days
Montezuma I, CA (2011)	16	36.8	80	16	105 m radius	1 year	Weekly and bi-Weekly
Montezuma I, CA (2012)	16	36.8	80	16	105 m radius	1 year	Weekly and bi-Weekly
Montezuma II, CA (2012-2013)	34	78.2	80	17	105 m radius	1 year	Weekly
Moraine II, MN (2009)	33	49.5	82.5	30	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Mount Storm, WV (2009)	132	264	78	44	varied	4.5 months	Weekly (28 turbines), daily (16 turbines)
Mount Storm, WV (2010)	132	264	78	24	20 to 60 m from turbine	6 months	Daily
Mount Storm, WV (2011)	132	264	78	24	varied	6 months	Daily
Mount Storm, WV (Fall 2008)	82	164	78	27	varied	3 months	Weekly (18 turbines), daily (9 turbines)
Mountaineer, WV (2003)	44	66	80	44	60-m radius	7 months	Weekly, monthly

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Mountaineer, WV (2004)	44	66	80	44	130 m x 120 m	6 weeks	Daily, weekly
Munnsville, NY (2008)	23	34.5	69.5	12	120 m x 120 m	Spring, summer, fall	Weekly
Mustang Hills, CA (2012-2013)	50	150	90	13 plots (equivalent to 15 turbines)	240 x 240 m	1 year	Bi-weekly
Nine Canyon, WA (2002-2003)	37	48.1	60	37	90-m radius	1 year	Bi-monthly (spring, summer, fall), monthly (winter)
Nine Canyon II, WA (2004)	12	15.6	60	12	90 m x 90 m	3 months	Once every two weeks
Noble Altona, NY (2010)	65	97.5	80	22	120 m x 120 m	Spring, summer, fall	Daily, weekly
Noble Altona, NY (2011)	65	97.5	80	22	120m x 120m	2 months	Daily
Noble Bliss, NY (2008)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Bliss, NY (2009)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Weekly, 8 turbines searched daily from July 1 to August 15
Noble Bliss/Wethersfield, NY (2011)	151	226	80	48 (24 from each site:12 ag, 12 forest)	road & pad 70 m out from turbine	2 months	Daily
Noble Chateaugay, NY (2010)	71	106.5	80	24	120 m x 120 m	Spring, summer, fall	Weekly
Noble Clinton, NY (2008)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Clinton, NY (2009)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Daily (8 turbines), weekly (15 turbines), all turbines weekly from July 1 to August 15

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Noble Ellenburg, NY (2008)	54	80	80	18	120 m x 120 m	Spring, summer, fall	Daily (6 turbines), 3-day (6 turbines), weekly (6 turbines)
Noble Ellenburg, NY (2009)	54	80	80	18	120 m x 120 m	Spring, summer, fall	Daily (6 turbines), weekly (12 turbines), all turbines weekly from July 1 to August 15
Noble Wethersfield, NY (2010)	84	126	80	28	120 m x 120 m	Spring, summer, fall	Weekly
NPPD Ainsworth, NE (2006)	36	20.5	70	36	220 m x 220 m	Spring, summer, fall	Bi-monthly
Oklahoma Wind Energy Center, OK (2004; 2005)	68	102	70	68	20m radius	3 months (2 years)	Bi-monthly
Pacific, CA (2012-2013)	70	140	78.5	20	126 m radius	NA	Twice weekly (fall), and biweekly
Palouse Wind, WA (2012-2013)	58	104.4	80, 90, or 105 M (according to the Vestas website)	19	120m x 120m	1 year	Monthly (winter) and weekly (spring-fall)
Pebble Springs, OR (2009-2010)	47	98.7	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Pine Tree, CA (2009-2010, 2011)	90	135	65	40	100 m radius	1.5 year	Bi-weekly, weekly
Pinnacle, WV (2012)	23	55.2	80	11	126 m x 120m	9 months	Weekly
Pinnacle Operational Mitigation Study (2012)	23	55.2	80	12	126m x 120m	2.5 months	Daily

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Pinyon Pines I & II, CA (2013-2014)	100	NA	90	25 plots (approx.. 31 turbines)	240x240 m	NA	Bi-weekly
Pioneer Prairie II, IA (2013)	62	102.3	80	62	80x80 m (5 turbines), road and pad within 100 m of turbine (57 turbines)	NA	Weekly
Pioneer Prairie I, IA (Phase II; 2011-2012)	62	102.3	80	62 (57 road/pad) 5 full search plots	80 x 80m	1 year	Weekly (spring and fall), every two weeks (summer), monthly (winter)
Pioneer Trail, IL (2012-2013)	94	150.5	NA	50	80x80m	Fall, spring	Weekly
Prairie Rose, MN (2014)	119	200	80	10	100x100m	6 months	Weekly
PrairieWinds SD1, SD (2012-2013)	108	162	80	50	200 x 200m	1 year	Bi-weekly
PrairieWinds SD1, SD (2013-2014)	108	162	80	45	200 x 200m	1 year	Twice monthly (spring, summer, fall), monthly (winter)
PrairieWinds ND1 (Minot), ND (2010)	80	115.5	89	35	minimum of 100 m x 100 m	3 seasons	Bi-monthly
PrairieWinds ND1 (Minot), ND (2011)	80	115.5	80	35	minimum 100 x 100m	3 season	Twice monthly
PrairieWinds SD1, SD (2011-2012)	108	162	80	50	200 x 200m	1 year	Twice monthly (spring, summer, fall), monthly (winter)
Rail Splitter, IL (2012-2013)	67	100.5	80	34	60 m radius	1 year	Weekly (spring, summer, and fall) and bi-weekly (winter)

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Record Hill, ME (2012)	22	50.6	80	22	126.5x126.5	5 months	Three times every two weeks
Record Hill, ME (2014)	22	50.6	80	10	varied due to steep terrain and heavily vegetated areas	4.5 months	Daily for 5 days a week
Red Canyon, TX (2006-2007)	56	84	70	28	200 m x 200 m in fall and winter; 160 m x 160 m in spring and summer	1 year	Every 14 days in fall and winter; 7 days in spring, 3 days in summer
Red Hills, OK (2012-2013)	82	123	80	20 (plus one met tower)	100 x 100	1 year	Weekly (spring, summer, fall), monthly (winter)
Ripley, Ont (2008)	38	76	64	38	80 m x 80 m	Spring, fall	Twice weekly for odd turbines; weekly for even turbines.
Ripley, Ont (2008-2009)	38	76	64	38	80 m x 80 m	6 weeks	Twice weekly for odd turbines; weekly for even turbines.
Rollins, ME (2012)	40	60	80	20	varied; turbine laydown area and gravel access roads out to 60m	6 months	Weekly
Roth Rock, MD (2011)	20	50	80	10	80m x 80m	3 months	Daily
Rugby, ND (2010-2011)	71	149	78	32	200 m x 200 m	1 year	Weekly (spring, fall; migratory turbines), monthly (non-migratory turbines)

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
San Gorgonio, CA (1997-1998; 1999-2000)	3000	NA	24.4-42.7	NA	50-m radius	2 years	Quarterly
Searsburg, VT (1997)	11	7	65	11	20- to 55-m radius	Spring, fall	Weekly (fall migration)
Sheffield, VT (2012)	16	40	80	8	126m x 120m	3 months	Daily
Sheffield Operational Mitigation Study (2012)	16	40	80	16	126m x 120m	4 months	Daily
Shiloh I, CA (2006-2009)	100	150	65	100	105-m radius	3 years	Weekly
Shiloh II, CA (2009-2010)	75	150	80	25	100m radius	1 year	Weekly
Shiloh II, CA (2010-2011)	75	150	80	25	100 m radius	1 year	Weekly
Shiloh III, CA (2012-2013)	50	102.5	78.5	25	100 m radius	NA	Weekly
SMUD Solano, CA (2004-2005)	22	15	65	22	60-m radius	1 year	Bi-monthly
Solano III, CA (2012-2013)	55	128	80	19	100 m radius	NA	Bi-Weekly
Spruce Mountain, ME (2012)	10	20	78	10	100 m x 100 m	7 months	Weekly
Stateline, OR/WA (2001-2002)	454	299	50	124	minimum 126 m x 126 m	17 months	Bi-weekly, monthly
Stateline, OR/WA (2003)	454	299	50	153	minimum 126 m x 126 m	1 year	Bi-weekly, monthly
Stateline, OR/WA (2006)	454	299	50	39	variable turbine strings	1 year	Bi-weekly
Steel Winds I & II, NY (2012)	14	35	80	8 (1 was just gravel pad)	120m x 120m	6 months	Weekly, bi-weekly (November only)
Steel Winds I, NY (2007)	8	20	80	8	176m x 176m	6.5 months	Every 10 days (spring, fall) every 21 days (summer)
Stetson Mountain I, ME (2009)	38	57	80	19	76-m diameter	27 weeks (spring, summer, fall)	Weekly

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Stetson Mountain I, ME (2011)	38	57	80	19	79.45x79.45m	6 months	Weekly
Stetson Mountain I, ME (2013)	38	57	80	19	76 m diameter	6 months	Weekly
Stetson Mountain II, ME (2010)	17	25.5	80	17	74.5x74.5m	6 months	Weekly (3 turbines twice a week)
Stetson Mountain II, ME (2012)	17	25.5	80	17	laydown area and road up to 60m	6 months	Weekly
Summerview, Alb (2005-2006)	39	70.2	67	39	140 m x 140 m	1 year	Weekly, bi-weekly (May to July, September)
Summerview, Alb (2006; 2007)	39	70.2	65	39	52-m radius; 2 spiral transects 7 m apart	Summer, fall (2 years)	Daily (10 turbines), weekly (29 turbines)
Tehachapi, CA (1996-1998)	3300	NA	14.7 to 57.6	201	50-m radius	20 months	Quarterly
Top Crop I & II (2012-2013)	68 (Phase I, 132 Phase II)	300 (102 Phase I, 198 Phase II)	65 Phase I, 80 Phase II	100	61 m radius	1 year	Weekly (spring, summer, and fall) and bi-weekly (winter)
Top of Iowa, IA (2003)	89	80	71.6	26	76 m x 76 m	Spring, summer, fall	Once every 2 to 3 days
Top of Iowa, IA (2004)	89	80	71.6	26	76 m x 76 m	Spring, summer, fall	Once every 2 to 3 days
Tuolumne (Windy Point I), WA (2009-2010)	62	136.6	80	21	180 m x 180 m	1 year	Monthly throughout the year, a sub-set of 10 turbines were also searched weekly during the spring, summer, and fall
Vansycle, OR (1999)	38	24.9	50	38	126 m x 126 m	1 year	Monthly

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Vantage, WA (2010-2011)	60	90	80	30	240 m x 240 m	1 year	Monthly, a subset of 10 searched weekly during migration
Vasco, CA (2012-2013)	34	78.2	80	34	105-m radius	1 year	Weekly, monthly
Wessington Springs, SD (2009)	34	51	80	20	200 m x 200 m	Spring, summer, fall	Bi-monthly
Wessington Springs, SD (2010)	34	51	80	20	200 m x 200 m	8 months	Bi-weekly (spring, summer, fall)
White Creek, WA (2007-2011)	89	204.7	80	89	180 m x 180 m & 240 m x 240 m	4 years	Twice a week, weekly and monthly
Wild Horse, WA (2007)	127	229	67	64	110 m from two turbines in plot	1 year	Monthly, weekly (fall, spring migration at 16 turbines)
Windy Flats, WA (2010-2011)	114	262.2	80	36 (plus 1 MET tower)	180 m x 180 m (120m at MET tower)	1 year	Monthly (spring, summer, fall, and winter), weekly (spring and fall migration)
Winnebago, IA (2009-2010)	10	20	78	10	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Wolfe Island, Ont (May-June 2009)	86	197.8	80	86	60-m radius	Spring	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2009)	86	197.8	80	86	60-m radius	Summer, fall	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2010)	86	197.8	80	86	60-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2010)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2011)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly

Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Wolfe Island, Ont (July-December 2011)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2012)	86	197.8	NA	86	50-m radius	NA	Half searched twice weekly, half searched weekly

Appendix D5 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Alite, CA (09-10)	Chatfield et al. 2010	Marengo II, WA (09-10)	URS Corporation 2010c
Alta VIII, CA (12-13)	Chatfield and Bay 2014	Mars Hill, ME (07)	Stantec 2008
Barton I & II, IA (10-11)	Derby et al. 2011a	Mars Hill, ME (08)	Stantec 2009a
Barton Chapel, TX (09-10)	WEST 2011	McBride, Alb (04)	Brown and Hamilton 2004
Beech Ridge, WV (12)	Tidhar et al. 2013b	Melancthon, Ont (Phase I; 07)	Stantec Ltd. 2008
Beech Ridge, WV (13)	Young et al. 2014b	Meyersdale, PA (04)	Arnett et al. 2005
Big Blue, MN (13)	Fagen Engineering 2014	Milford I, UT (10-11)	Stantec 2011b
Big Blue, MN (14)	Fagen Engineering 2015	Milford I & II, UT (11-12)	Stantec 2012b
Big Horn, WA (06-07)	Kronner et al. 2008	Montezuma I, CA (11)	ICF International 2012
Big Smile, OK (12-13)	Derby et al. 2013b	Montezuma I, CA (12)	ICF International 2013
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Montezuma II, CA (12-13)	Harvey & Associates 2013
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Moraine II, MN (09)	Derby et al. 2010d
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Mount Storm, WV (Fall 08)	Young et al. 2009b
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Buena Vista, CA (08-09)	Insignia Environmental 2009	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Buffalo Gap I, TX (06)	Tierney 2007	Mountaineer, WV (04)	Arnett et al. 2005
Buffalo Gap II, TX (07-08)	Tierney 2009	Munnsville, NY (08)	Stantec 2009b
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Mustang Hills, CA (12-13)	Chatfield and Bay 2014
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Nine Canyon, WA (02-03)	Erickson et al. 2003a
Buffalo Ridge, MN (94-95)	Osborn et al. 1996, 2000	Nine Canyon II, WA (04)	Erickson et al. 2005b
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000	Noble Altona, NY (10)	Jain et al. 2011b
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000	Noble Altona, NY (11)	Kerlinger et al. 2011b
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000	Noble Bliss, NY (08)	Jain et al.2009e
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000	Noble Bliss, NY (09)	Jain et al. 2010a
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000	Noble Bliss/Wethersfield, NY (11)	Kerlinger et al. 2011a
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	Noble Chateaugay, NY (10)	Jain et al. 2011c
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Noble Clinton, NY (08)	Jain et al. 2009c
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Noble Clinton, NY (09)	Jain et al. 2010b
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000	Noble Ellenburg, NY (08)	Jain et al. 2009b
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Noble Ellenburg, NY (09)	Jain et al. 2010c
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Noble Wethersfield, NY (10)	Jain et al. 2011a
Buffalo Ridge I, SD (09-10)	Derby et al. 2010b	NPPD Ainsworth, NE (06)	Derby et al. 2007
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Oklahoma Wind Energy Center, OK (04; 05)	Piorkowski and O'Connell 2010
Casselman, PA (08)	Arnett et al. 2009b	Pacific, CA (12-13)	Sapphos 2014
Casselman, PA (09)	Arnett et al. 2010	Palouse Wind, WA (12-13)	Stantec 2013a
Casselman Curtailment, PA (08)	Arnett et al. 2009a	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Castle River, Alb. (01)	Brown and Hamilton 2006a	Pine Tree, CA (09-10, 11)	BioResource Consultants 2012
Castle River, Alb. (02)	Brown and Hamilton 2006a	Pinnacle, WV (12)	Hein et al. 2013a
Cedar Ridge, WI (09)	BHE Environmental 2010	Pinnacle Operational Mitigation Study (12)	Hein et al. 2013b
Cedar Ridge, WI (10)	BHE Environmental 2011	Pinyon Pines I & II, CA (13-14)	Chatfield and Russo 2014
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Cohocton/Dutch Hills, NY (10)	Stantec 2011a	Pioneer Prairie II, IA (13)	Chodachek et al. 2014
Combine Hills, OR (Phase I; 04-05)	Young et al. 2006	Pioneer Trail, IL (12-13)	ARCADIS 2013
Combine Hills, OR (11)	Enz et al. 2012	Prairie Rose, MN (14)	Chodachek et al. 2015
Condon, OR	Fishman Ecological Services 2003	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011c
Crescent Ridge, IL (05-06)	Kerlinger et al. 2007	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Criterion, MD (11)	Young et al. 2012a	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
Criterion, MD (12)	Young et al. 2013	PrairieWinds SD1 (Crow Lake), SD (12-13)	Derby et al. 2013a
Criterion, MD (13)	Young et al. 2014a	PrairieWinds SD1 (Crow Lake), SD (13-14)	Derby et al. 2014b
Crystal Lake II, IA (09)	Derby et al. 2010a	Rail Splitter, IL (12-13)	Good et al. 2013b
Diablo Winds, CA (05-07)	WEST 2006, 2008	Record Hill, ME (12)	Stantec 2013b
Dillon, CA (08-09)	Chatfield et al. 2009	Record Hill, ME (14)	Stantec 2015
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Red Canyon, TX (06-07)	Miller 2008
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Red Hills, OK (12-13)	Derby et al. 2013c
Elkhorn, OR (08)	Jeffrey et a. 2009b	Ripley, Ont (08)	Jacques Whitford 2009
Elkhorn, OR (10)	Enk et al. 2011b	Ripley, Ont (08-09)	Golder Associates 2010
Elm Creek, MN (09-10)	Derby et al. 2010c	Rollins, ME (12)	Stantec 2013c
Elm Creek II, MN (11-12)	Derby et al. 2012b	Roth Rock, MD (11)	Atwell 2012
Erie Shores, Ont. (06)	James 2008	Rugby, ND (10-11)	Derby et al. 2011b
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	San Gorgonio, CA (97-98; 99-00)	Anderson et al. 2005
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b	Searsburg, VT (97)	Kerlinger 2002a
Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003b	Sheffield, VT (12)	Martin et al. 2013

Appendix D5 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Forward Energy Center, WI (08-10)	Grodsky and Drake 2011	Sheffield Operational Mitigation Study (12)	Martin et al. 2013
Fowler I, IN (09)	Johnson et al. 2010a	Shiloh I, CA (06-09)	Kerlinger et al. 2009
Fowler I, II, III, IN (10)	Good et al. 2011	Shiloh II, CA (09-10)	Kerlinger et al. 2010
Fowler I, II, III, IN (11)	Good et al. 2012	Shiloh II, CA (10-11)	Kerlinger et al. 2013a
Fowler I, II, III, IN (12)	Good et al. 2013c	Shiloh III, CA (12-13)	Kerlinger et al. 2013b
Fowler III, IN (09)	Johnson et al. 2010b	SMUD Solano, CA (04-05)	Erickson and Sharp 2005
Goodnoe, WA (09-10)	URS Corporation 2010a	Solano III, CA (12-13)	AECOM 2013
Grand Ridge I, IL (09-10)	Derby et al. 2010g	Spruce Mountain, ME (12)	Tetra Tech 2013
Harrow, Ont (10)	Natural Resource Solutions 2011	Stateline, OR/WA (01-02)	Erickson et al. 2004
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Stateline, OR/WA (03)	Erickson et al. 2004
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Stateline, OR/WA (06)	Erickson et al. 2007
Heritage Garden I, MI (12-14)	Kerlinger et al. 2014	Steel Winds I, NY (07)	Grehan 2008
High Sheldon, NY (10)	Tidhar et al. 2012a	Steel Winds I & II, NY (12)	Stantec 2013d
High Sheldon, NY (11)	Tidhar et al. 2012b	Stetson Mountain I, ME (09)	Stantec 2009c
High Winds, CA (03-04)	Kerlinger et al. 2006	Stetson Mountain I, ME (11)	Normandeau Associates 2011
High Winds, CA (04-05)	Kerlinger et al. 2006	Stetson Mountain I, ME (13)	Stantec 2014
Hopkins Ridge, WA (06)	Young et al. 2007	Stetson Mountain II, ME (10)	Normandeau Associates 2010
Hopkins Ridge, WA (08)	Young et al. 2009c	Stetson Mountain II, ME (12)	Stantec 2013e
Jersey Atlantic, NJ (08)	NJAS 2008a, 2008b, 2009	Summerview, Alb (05-06)	Brown and Hamilton 2006b
Judith Gap, MT (06-07)	TRC 2008	Summerview, Alb (06; 07)	Baerwald 2008
Judith Gap, MT (09)	Poulton and Erickson 2010	Tehachapi, CA (96-98)	Anderson et al. 2004
Kewaunee County, WI (99-01)	Howe et al. 2002	Top Crop I & II, IL (12-13)	Good et al. 2013a
Kibby, ME (11)	Stantec 2012a	Top of Iowa, IA (03)	Jain 2005
Kittitas Valley, WA (11-12)	Stantec Consulting 2012	Top of Iowa, IA (04)	Jain 2005
Klondike, OR (02-03)	Johnson et al. 2003b	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
Klondike II, OR (05-06)	NWC and WEST 2007	Vansycle, OR (99)	Erickson et al. 2000a
Klondike III (Phase I), OR (07-09)	Gritski et al. 2010	Vantage, WA (10-11)	Ventus Environmental Solutions 2012
Klondike IIIa (Phase II), OR (08-10)	Gritski et al. 2011	Vasco, CA (12-13)	Brown et al. 2013
Lakefield Wind, MN (12)	MPUC 2012	Wessington Springs, SD (09)	Derby et al. 2010f
Leaning Juniper, OR (06-08)	Gritski et al. 2008	Wessington Springs, SD (10)	Derby et al. 2011d
Lempster, NH (09)	Tidhar et al. 2010	White Creek, WA (07-11)	Downes and Gritski 2012b
Lempster, NH (10)	Tidhar et al. 2011	Wild Horse, WA (07)	Erickson et al. 2008
Linden Ranch, WA (10-11)	Enz and Bay 2011	Windy Flats, WA (10-11)	Enz et al. 2011
Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011	Winnebago, IA (09-10)	Derby et al. 2010e
Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011	Wolfe Island, Ont (May-June 09)	Stantec Ltd. 2010a
Madison, NY (01-02)	Kerlinger 2002b	Wolfe Island, Ont (July-December 09)	Stantec Ltd. 2010b
Maple Ridge, NY (06)	Jain et al. 2007	Wolfe Island, Ont (January-June 10)	Stantec Ltd. 2011a
Maple Ridge, NY (07)	Jain et al. 2009a	Wolfe Island, Ont (July-December 10)	Stantec Ltd. 2011b
Maple Ridge, NY (07-08)	Jain et al. 2009d	Wolfe Island, Ont (January-June 11)	Stantec Ltd. 2011c
Maple Ridge, NY (12)	Tidhar et al. 2013a	Wolfe Island, Ont (July-December 11)	Stantec Ltd. 2012
Marengo I, WA (09-10)	URS Corporation 2010b	Wolfe Island, Ont (January-June 12)	Stantec Ltd. 2014