Post-Construction Avian and Bat Mortality Monitoring
Alta X, LLC
Kern County, California

Final Report for the First Year of Operation
March 2014 – March 2015

Prepared for

Alta Wind X, LLC

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EXECUTIVE SUMMARY

Alta Wind X, LLC (Alta Wind X) has constructed a wind energy facility in Kern County, California, referred to as the Alta X Wind Energy Project ("Alta X" or the "Project"). Consistent with Mitigation Measure (MM) #63 of the *Alta East Wind Project Draft Environmental Impact Report* (DEIR), Alta Wind X is committed to conducting avian and bat mortality monitoring at the Project during the first, second, and third years of operation. Following construction in the spring of 2014, Alta Wind X contracted Western EcoSystems Technology, Inc. (WEST) to develop and implement a study protocol for post-construction monitoring at the Project for the purpose of estimating the impacts of the wind energy facility on birds and bats. The following report describes the methods and results of mortality monitoring conducted during the initial year of operation of the Project, March 2014 to March 2015.

As stated in MM #63 of the DEIR, the ultimate goal of the mortality monitoring study is to demonstrate that the level of incidental mortality does not result in an unanticipated long-term decline in populations of avian or bat species in the vicinity of the Project. To this end, WEST designed and implemented a 3-year study to determine the level of bird and bat mortality attributable to collisions with wind turbines at the facility on an annual basis. The monitoring study consists of four components: 1) standardized carcass surveys of selected turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remains in the field for possible detection; and 4) adjusted mortality estimates for birds and bats, calculated using the results from searcher efficiency trials and carcass removal trials to estimate the approximate level of bird and bat mortality within the Project.

A sample of 11 plots surrounding turbines was searched every two weeks at the Project. Search plots consisted of a 240-meter by 240-meter (m; 787-foot by 787-foot [ft]) plot beneath a randomly selected turbine, plus an additional area extending to the center point of the adjacent turbine or turbines if present. This level of effort included searching all or portions of 26 of the Project's 48 total turbines and covered an area equivalent to searching approximately 15 240-m by 240-m plots or 31% of Project-wide turbines. Surveyors walked parallel transects within the search plots while scanning the ground for bird and bat mortalities.

During the study 33 birds, representing 17 identifiable species, and two bats representing two identifiable species, were found during standardized carcass searches within the Project. An additional 20 bird carcasses were also found incidentally. The most common bird carcasses able to be identified to species that were found as mortalities during searches or incidentally were greater roadrunner (three mortalities) and band-tailed pigeon (three mortalities). During scheduled searches or incidentally, 15 small birds unidentifiable to species were found in addition to four unidentified warblers. Two diurnal raptor mortalities (one red-tailed hawk and one unidentified raptor) were found in total during the study. The unidentified diurnal raptor was found not to be a golden eagle. Bird mortalities were distributed throughout the year, with somewhat lower rates of mortality occurring in winter. The two bat mortalities (one hoary bat

and one Mexican free-tailed bat) were found during the fall. One hoary bat carcass was also found incidentally in the spring.

A total of 159 bird carcasses were placed for searcher efficiency trials. Overall searcher efficiency rates were 70% for small birds and 93% for large birds. A total of 153 bird carcasses and 26 bat carcasses were placed for carcass removal trials, which showed that by day 10, roughly 40% of large birds, 10% of small birds, and 3% of bats remained in the search area. The mean carcass removal time for both large and small birds varied by season. For large birds, the carcass removal time was 12.09 days in summer and fall, and 36.87 days in winter and spring. For small birds, the mean carcass removal time was 8.54 days in summer and winter, and 2.10 days in spring and fall. For bats, the mean carcass removal time was 2.92 days throughout the year.

Mortality estimates were adjusted based on the corrections for carcass removal and observer detection bias. For small birds, the probability that a carcass would remain in the search plot and be found by a searcher ranged from 0.10 during spring and fall to 0.36 during winter and summer. For large birds, this probability was higher, and ranged from 0.56 during summer and fall, to 0.81 during winter and spring. For bats, the probability that a carcass would remain in the search plot and be found by a searcher remained constant throughout the year at 0.14. Based on the 2.85-megawatt (MW) capacity of the turbines at the Project, the estimated mortality rate for birds was 4.88 birds per MW per year, with an estimated mortality rate of 0.04 diurnal raptors per MW per year. The estimated mortality rate for bats was 0.42 bats per MW per year. No state or federally listed bird or bat species or species of concern were found during the study.

STUDY PARTICIPANTS

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ACKNOWLEDGEMENTS

A number of individuals from different organizations were instrumental in the completion of the studies at Alta X. Alta Wind X, LLC, provided funding for the mortality monitoring study. The hard-working field crew at Terra-Gen Power, consisting of Katie Williams, Diane Rowe, Angelica Hansen, Marie Allen, and Karla Nelson, conducted mortality surveys beneath turbines. Josh Singleton of WEST conducted searcher efficiency trials. Karla Nelson of Terra-Gen Power did an outstanding job of submitting data in a timely manner, administering information, and coordinating with WEST project personnel.

Cover photo by WEST Biological Technician, Geoff Grisdale.

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INTRODUCTION

Alta Wind X, LLC (Alta Wind X) has constructed a wind energy facility in Kern County, California, referred to as the Alta X Wind Energy Project ("Alta X" or the "Project"). As described in Mitigation Measure (MM) #63 of the *Alta East Wind Project Draft Environmental Impact Report* (DEIR; Kern County 2012), Alta Wind X is committed to conducting post-construction avian and bat mortality monitoring at the Project during the first, second, and third years of operation. Western EcoSystems Technology, Inc. (WEST), was contracted by Alta Wind X to develop and implement a standardized protocol for post-construction monitoring for the purpose of estimating the impacts of facility operation on birds and bats. The monitoring protocols are similar to those used at other wind energy facilities throughout California and the US. Data collection and analysis follows the recommendations presented in the US Fish and Wildlife Service (USFWS) Wind Turbine Advisory Committee Guidelines (WTGAC; USFWS 2012) the California Wind Energy Guidelines (California Energy Commission [CEC] and California Department of Fish and Game [CDFG] 2007), and are based on WEST's experience studying wildlife at wind energy projects throughout the US. This report presents the results of avian and bat mortality monitoring conducted at the Project during the first year of operation, from March 2014 to March 2015.

As stated in MM #63 of the DEIR, the ultimate goal of the mortality monitoring study is to demonstrate that the level of incidental mortality does not result in an unanticipated long-term decline in populations of avian or bat species in the vicinity of the Project. To this end, WEST conducted a mortality study to determine the level of bird and bat mortality attributable to collisions with wind turbines at the facility 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 the CDFG]) and the USFWS, determines that the Project is causing unanticipated significant adverse impacts to populations of avian or bat species, the project proponents will provide supplemental mitigation as described in MM #64 (Kern County 2012).

Post-construction monitoring at the Project was conducted from March 31, 2014, through March 27, 2015. 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 are made.

STUDY AREA

The Project is located in southeastern Kern County, approximately three miles (4.8 kilometers [km]) northwest of the unincorporated city of Mojave, and 11 miles (18 km) east of the city of Tehachapi (Figure 1). The Project is composed of 48 GE 2.85-megawatt (MW) wind turbine generators (WTGs) located on a combination of privately-owned land and land administered by the Bureau of Land Management (BLM; Figure 1). The WTGs have a hub height of approximately 328 feet (ft; 100 meters [m]) and a rotor diameter of approximately 338 ft (103 m).

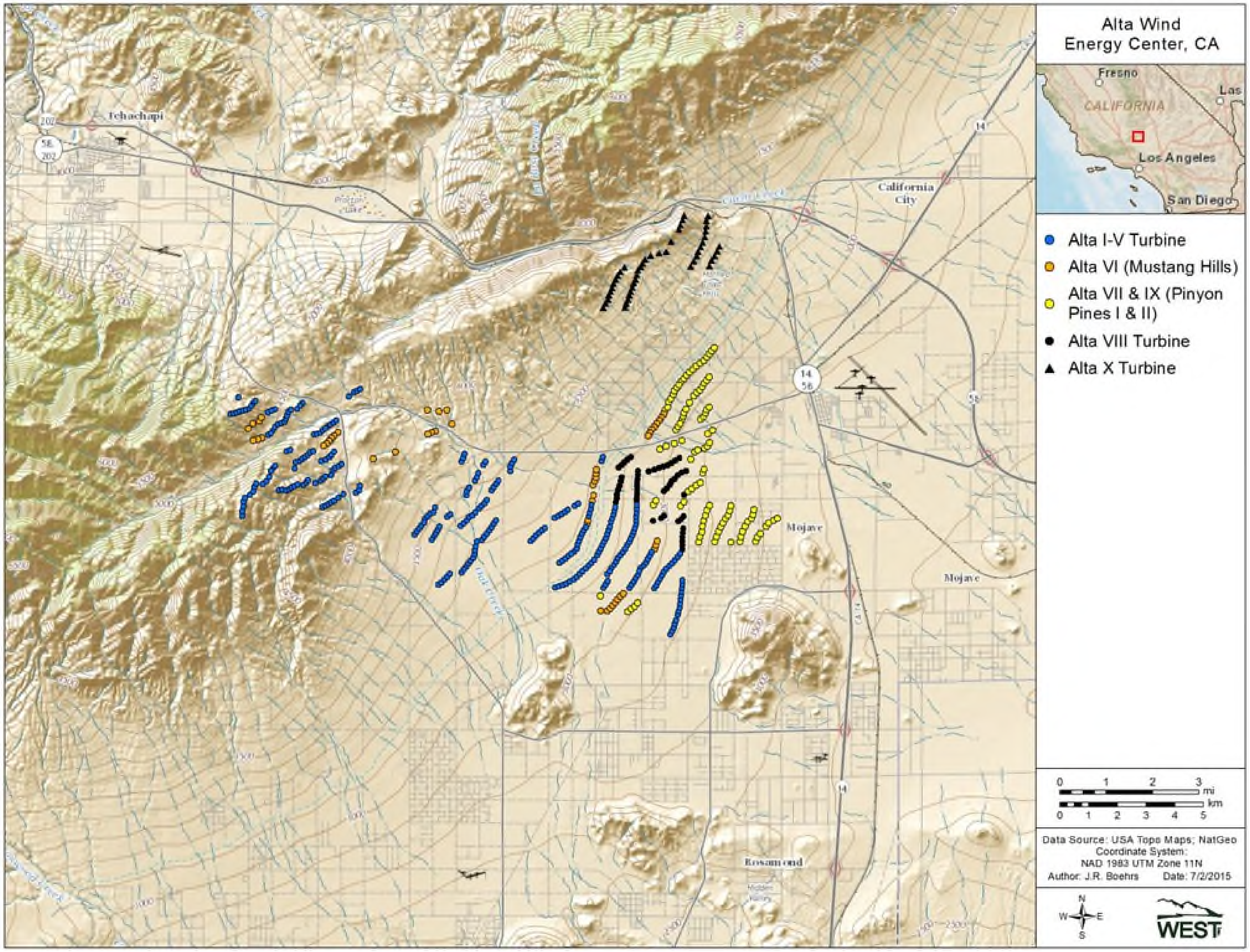

Figure 1. Location of the Alta X Wind Energy Project within the larger Alta Wind Energy Center.

The Project falls within the high desert plains and hills on the western edge of the Mojave Desert. The Tehachapi Mountains are located to the north and west of the Project site and transition into Mojave Desert towards the south and east. Elevations within the Project range from approximately 3,100 to 4,200 ft (940 to 1,280 m) above sea level, with the highest elevations occurring in the northwestern portion of the Project (Figure 1). The habitat ranges from lowland creosote (*Larrea tridentata*) scrub and Joshua tree (*Yucca brevifolia*) woodland in the southeast to juniper (*Juniperus* spp.) shrubland on the steeper, rocky slopes in the north and west. Water within the Project site is limited to a network of ephemeral drainages; there are no perennial surface water sources within the site. Highway 58 bisects the Project site, an underground portion of the Los Angeles Aqueduct runs along the southeast corner, and a network of dirt roads and off-highway vehicle (OHV) trails run throughout the site (Figure 1).

The Project lies within a region of high-density wind energy development, the Tehachapi Wind Resource Area. Alta X is part of the larger Alta Wind Energy Center, consisting of Phases I-X. Phases I-IX (Alta I-IX) lie to the south of Alta X (Figure 1), and the Rising Tree and Addison Wind Energy Facilities are currently under construction immediately to the south of the Project. Additional wind energy development lies to the south and west of the Project.

MORTALITY MONITORING STUDY

The primary objective of the mortality monitoring study is to estimate the level of bird and bat mortality attributable to collisions with wind turbines at the facility on an annual basis. Additionally, the study will determine whether the estimated mortality at the Project is lower, similar to, or higher than the average mortality observed at other wind resource areas (WRAs), both regionally and nationally, including the other phases of the Alta Wind Energy Center. The methods for the mortality study are broken into four primary components: 1) standardized carcass surveys of selected turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remains in the field for possible detection; and 4) adjusted mortality estimates for bird and bat species, calculated using the results from searcher efficiency trials and carcass removal trials to estimate the total number of bird and bat mortalities within the Project. As a result of data-sharing agreements between Terra-Gen Power and the other companies operating within the Alta Wind Energy Center, the results of carcass removal and searcher efficiency trials conducted at all phases of the Alta Wind Energy Center were pooled for the analysis.

Study Components and Field Methodology

Standardized Carcass Searches

The objective of the standardized carcass searches was to systematically search the ground beneath turbines for avian and bat mortalities that were attributable to collision with Project facilities.

Searches at turbines were conducted within a square 240-m by 240-m (787-ft by 787-ft) plot with the turbine at the center. However, because many of the turbine towers at the Project are located substantially closer together than 240 m, portions of the adjacent turbine or turbines were incorporated into the search plot at each sampled turbine in order to account for this overlap between search plots at individual turbines. Search plots at selected turbines with nearby adjacent turbines included an entire 240-m by 240-m plot under the selected turbine plus additional area extending to the center point of the adjacent turbine or turbines if present. A sample of 11 search plots was searched during the first year of monitoring (Figure 2). This level of effort included searching all or portions of 26 of the Project's 48 total turbines and covered an area equivalent to searching approximately 15 240-m by 240-m plots or 31% of Project-wide turbines (Table 1). Search plots were selected using a constrained random sample, such that the search effort was distributed throughout the entire Project and all habitats and topographies were represented. Plots were searched along parallel transects spaced six to 10 m (20 to 33 ft) apart (depending on detection ability), with the orientation of the transects based on the orientation of the topography surrounding the turbines. All turbine searches were conducted by a field crew employed by Terra-Gen Power, with field training and project oversight provided by the WEST Project Manager.

For all mortalities found, data recorded included: species, sex and age when possible, date and time encountered, Global Positioning System (GPS) location, condition of carcass, and any comments that indicated possible cause of death. All mortalities were photographed as found, including detailed close-up photos of the carcass or feathers for identification purposes, as well as photos showing location of the carcass or feather spot in relation to the closest wind turbine or other project facilities, such as overhead power lines.

Incidental mortalities found within search plots but outside of the standardized search times were documented in the same manner and were included in the overall dataset under the assumption that these mortalities would have been found during standardized searches. Incidental mortalities found outside the formal search area (e.g., near a turbine or other project infrastructure not included in the study) were also recorded following the above protocol as closely as possible; however, these mortalities were not included in the overall dataset used for estimating mortality rates. Mortalities found by maintenance personnel and others not conducting the formal searches were similarly documented. In addition to carcasses and feather spots, all injured birds and bats observed in search plots or elsewhere in the Project were recorded and treated as a mortality for analysis purposes.

Alta Wind X does not currently hold a federal Migratory Bird Collection Permit from the USFWS. As a result, study personnel were not permitted to possess any carcasses or feathers of native migratory birds encountered during searches, and 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 to avoid double-counting mortalities.

Standardized carcass surveys were conducted every two weeks during the spring (March 1 – May 28), summer (May 29 – September 7), fall (September 8 to November 16), and winter (November 16 to February 28) at each of the 11 search plots.

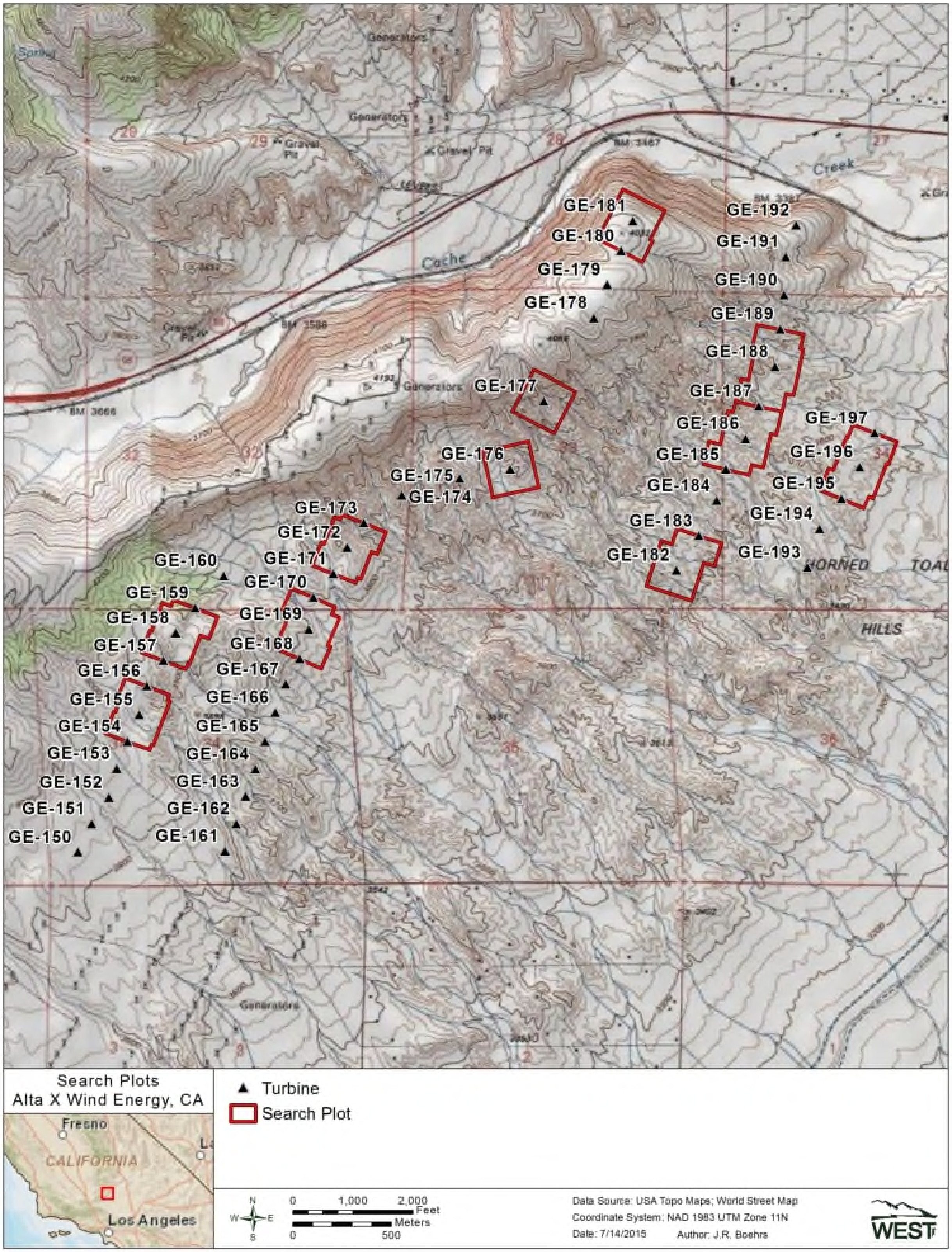

Figure 2. Location of search plots at the Alta X Wind Energy Project.

Table 1. Description of search plots, equivalent area, and equivalent number of turbines at the Alta X Wind Energy Project.

Search Plot	Total Base Area (m^2)	Total Extra Area (m^2)	Total Area Searched (m^2)
GE-155 + the adjoining halves of GE-154 and GE-156	57,600	15,965	73,565
GE-158 + the adjoining halves of GE-157 and GE-159	57,600	21,069	78,669
GE-169 + the adjoining halves of GE-168 and GE-170	57,600	22,824	80,424
GE-172 + the adjoining halves of GE-171 and GE-173	57,600	17,538	75,138
GE-176	57,600	0	57,600
GE-177	57,600	0	57,600
GE-181 + the adjoining half of GE-180	57,600	11,845	69,445
GE-182 + the adjoining half of GE-183	57,600	22,020	79,620
GE-186 + the adjoining halves of GE-185 and GE-187	57,600	32,202	89,802
GE-188 + the adjoining halves of GE-187 and GE-189	57,600	41,464	99,064
GE-196 + the adjoining halves of GE-195 and GE-197	57,600	33,835	91,435
Total	**518,400**	**169,022**	**687,422**
Equivalent Number of Turbines	**9**	**3**	**12**

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of mortalities found by searchers. Searcher efficiency trials were conducted in the same areas as carcass surveys and searcher efficiency was estimated by the size of carcass and season. Estimates of searcher efficiency were used to adjust the total number of carcasses found for those missed by searchers, correcting for detection bias.

During searcher efficiency trials, a total of 189 carcasses (56 large birds, 103 small birds, and due to a lack of bat carcasses available for the study, 30 brown mice [to represent bats]) were placed throughout the Alta Wind Energy Center on 21 separate dates between May 2013 and April 2015. Personnel conducting carcass surveys did not know when searcher efficiency trials were being conducted or the location of the trial carcasses. Bird carcasses used for searcher efficiency trials were non-native/non-protected or commercially available species (Coturnix quail [*Coturnix* spp.], mallard [*Anas platyrhynchos*], rock pigeon [*Columba livia*], and house sparrows [*Passer domesticus*]).

All 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 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 potentially detectable. Carcass removal included removal by predation or 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. A total of 179 carcasses were used for the carcass removal trials at the Alta Wind Energy Center from April 2013 through January 2015, including 70 large birds, 83 small birds, and 26 bats (or bat substitutes). Twenty-two of these carcasses (two large birds, 17 small birds, and three bats) were actual mortalities found during the mortality searches and left in the field and monitored for carcass removal trials. The remaining trial carcasses were of similar composition to those used for searcher efficiency trials.

Turbines, including searched and non-searched turbines, were randomly selected for inclusion in the removal trials. 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. 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. At the end of the 40-day period, any remaining evidence of the carcass was removed.

Statistical Analysis

<u>Quality Assurance and Quality Control</u>

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 each round of bi-weekly carcass surveys, observers were responsible for reviewing the raw data for completeness and accuracy. A Microsoft® ACCESS database was developed to store, organize, and retrieve survey data. 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, and appropriate changes in all steps were made. All data forms, field notebooks, and electronic data files were retained for reference.

<u>Mortality Surveys</u>

Estimates of facility-related mortalities are based on:

1) Observed number of carcasses found during standardized searches during the monitoring year for which the cause of death is either unknown or is probably facility-related;

2) Non-removal rates, expressed as the estimated average probability a carcass is 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 placed carcasses found by searchers during searcher efficiency trials.

Overall mortality estimates are provided for five categories: 1) small birds, 2) large birds, 3) diurnal raptors, 4) all birds, and 5) bats.

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 is either unknown or is 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 remain in the study area after 40 days

t_j the time (in days) carcass *j* remains in the study area before it is removed, as determined by the removal trials

$\bar{t}$ the average time (in days) a carcass remains in the study area before it is 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 is both available to be found during a search and is found, as determined by the removal trials and the searcher efficiency trials

m the estimated annual average number of mortalities 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 is:

$$\bar{c} = \frac{\sum_{i-1}^{n} c_i}{k \bullet A} \tag{1}$$

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 ($\bar{t}$) is the average length of time a carcass remains in the study area before it is removed:

$$\bar{t} = \frac{\sum_{j=1}^{s} t_j}{s - s_c} \tag{2}$$

Estimation of Searcher Efficiency Rates

Searcher efficiency rates are expressed as *p,* the proportion of trial carcasses that are 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*) is calculated by:

$$m = \frac{\bar{c}}{\hat{\pi}} \tag{3}$$

where $\hat{\pi}$ includes adjustments for both carcass removal (from scavenging and other means) and searcher efficiency bias. If not statistically different across seasons or plot types, data for carcass removal and searcher efficiency bias were pooled across the study to estimate $\hat{\pi}$.

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

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

This formula has been independently verified by Shoenfeld (2004). The reported estimates 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 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.

RESULTS

Avian and Bat Mortality Monitoring

Eleven search plots, representing approximately 31% of Project-wide turbines, were searched over the course of the mortality monitoring study, for a total of 282 plot searches. A total of 53 birds and three bats were found during standardized carcass surveys or incidentally (Table 2). The number, species, location, other characteristics of the bird and bat mortalities, and the mortality estimates adjusted for searcher efficiency and carcass removal biases are discussed below, and a full listing of mortalities is presented in Appendix A.

Bird Mortality

During the study, 33 birds comprising 17 identifiable species were found during scheduled searches (Table 2, Figure 3a). Twenty bird mortalities were found incidentally outside of search plots and were, therefore, not included in the mortality rate estimation (Table 2). The identifiable bird species most commonly found as mortalities during the study, including incidental finds, were band-tailed pigeon (*Patagioenas fasciata*; three mortalities) and greater roadrunner (*Geococcyx californianus*; three mortalities). Twenty-four small birds, including four unidentified warblers, three unidentified passerines, one unidentified sparrow, and one unidentified vireo, were not identifiable to species (Table 2). Three large birds found, including one diurnal raptor, were not identifiable to species (Table 2). The feathers of the unidentified diurnal raptor were examined and found not to be those of a golden eagle (*Aquila chrysaetos*). No state or federally listed bird species or species of concern were found during the study.

In general, mortalities were fairly well distributed throughout the Project. The greatest number of bird mortalities found at any one search plot was five mortalities each at plots GE-154-155-156, GE-157-158-159, GE-185-186-187, and GE-187-188-189; all other search plots had three or fewer bird mortalities during the year-long study, and one of the 11 search plots (GE-171-172-173) had no bird mortalities (Figures 2, 3a, and 4). Of the bird mortalities, 69.8% were found between 70 and 170 m (230 and 558 ft) from the turbine (Table 3, Figure 5). Bird mortalities were distributed throughout the year, with somewhat lower rates of mortality occurring in winter (Figure 6).

Table 2. Total number of bird and bat mortalities and the composition of mortalities discovered at the Alta X Wind Energy Project from March 31, 2014 – March 27, 2015.

Species	Mortalities during Scheduled Searches		Incidental Mortalities at Search Plots*		Other Incidentals		Total	
	Total	% Comp.	Total	% Comp.	Total	% Comp.	Total	% Comp.
Birds								
unidentified bird (small)	13	39.4	0	0	2	10	15	28.3
unidentified warbler	2	6.1	0	0	2	10	4	7.5
greater roadrunner	2	6.1	0	0	1	5	3	5.7
unidentified passerine	2	6.1	0	0	1	5	3	5.7
acorn woodpecker	2	6.1	0	0	0	0	2	3.8
band-tailed pigeon	1	3.0	0	0	2	10	3	5.7
dark-eyed junco	1	3.0	0	0	1	5	2	3.8
northern flicker	1	3.0	0	0	1	5	2	3.8
western tanager	1	3.0	0	0	1	5	2	3.8
white-throated swift	1	3.0	0	0	1	5	2	3.8
black-headed grosbeak	1	3.0	0	0	0	0	1	1.9
horned lark	1	3.0	0	0	0	0	1	1.9
lazuli bunting	1	3.0	0	0	0	0	1	1.9
orange-crowned warbler	1	3.0	0	0	0	0	1	1.9
spotted towhee	1	3.0	0	0	0	0	1	1.9
unidentified raptor	1	3.0	0	0	0	0	1	1.9
unidentified sparrow	1	3.0	0	0	0	0	1	1.9
unidentified large bird	0	0	0	0	2	10	2	3.8
California quail	0	0	0	0	1	5	1	1.9
common raven	0	0	0	0	1	5	1	1.9
mourning dove	0	0	0	0	1	5	1	1.9
red-tailed hawk	0	0	0	0	1	5	1	1.9
sora	0	0	0	0	1	5	1	1.9
unidentified vireo	0	0	0	0	1	5	1	1.9
Overall Birds	**33**	**100**	**0**	**0**	**20**	**100**	**53**	**100**

Table 2. Total number of bird and bat mortalities and the composition of mortalities discovered at the Alta X Wind Energy Project from March 31, 2014 – March 27, 2015.

	Mortalities during Scheduled Searches		Incidental Mortalities at Search Plots*		Other Incidentals		Total	
Species	**Total**	**% Comp.**	**Total**	**% Comp.**	**Total**	**% Comp.**	**Total**	**% Comp.**
Bats								
hoary bat	1	50	0	0	1	100	2	66.7
Mexican free-tailed bat	1	50	0	0	0	0	1	33.3
Overall Bats	**2**	**100**	**0**	**0**	**1**	**100**	**3**	**100**

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

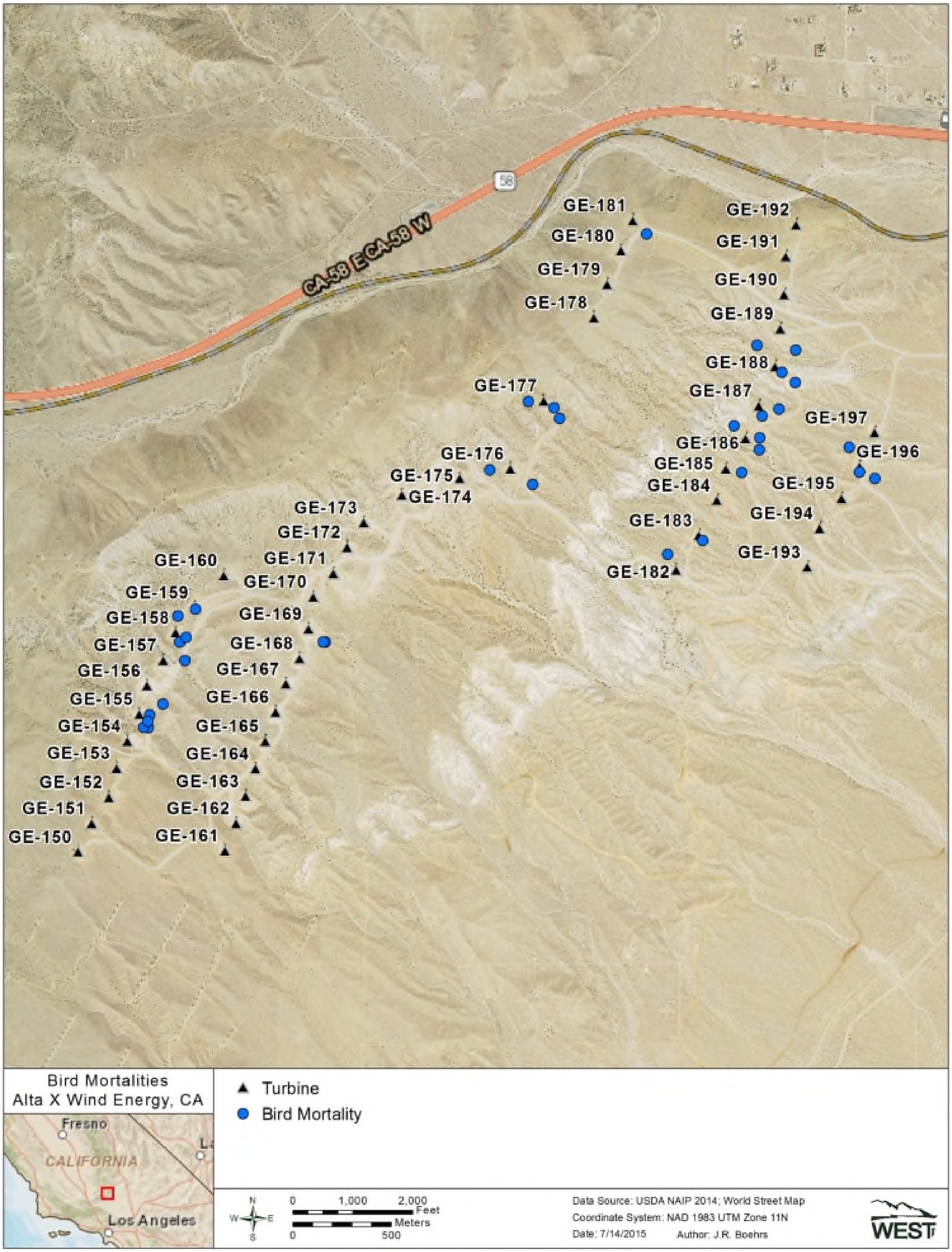

Figure 3a. Location of all bird mortalities found at the Alta X Wind Energy Project.

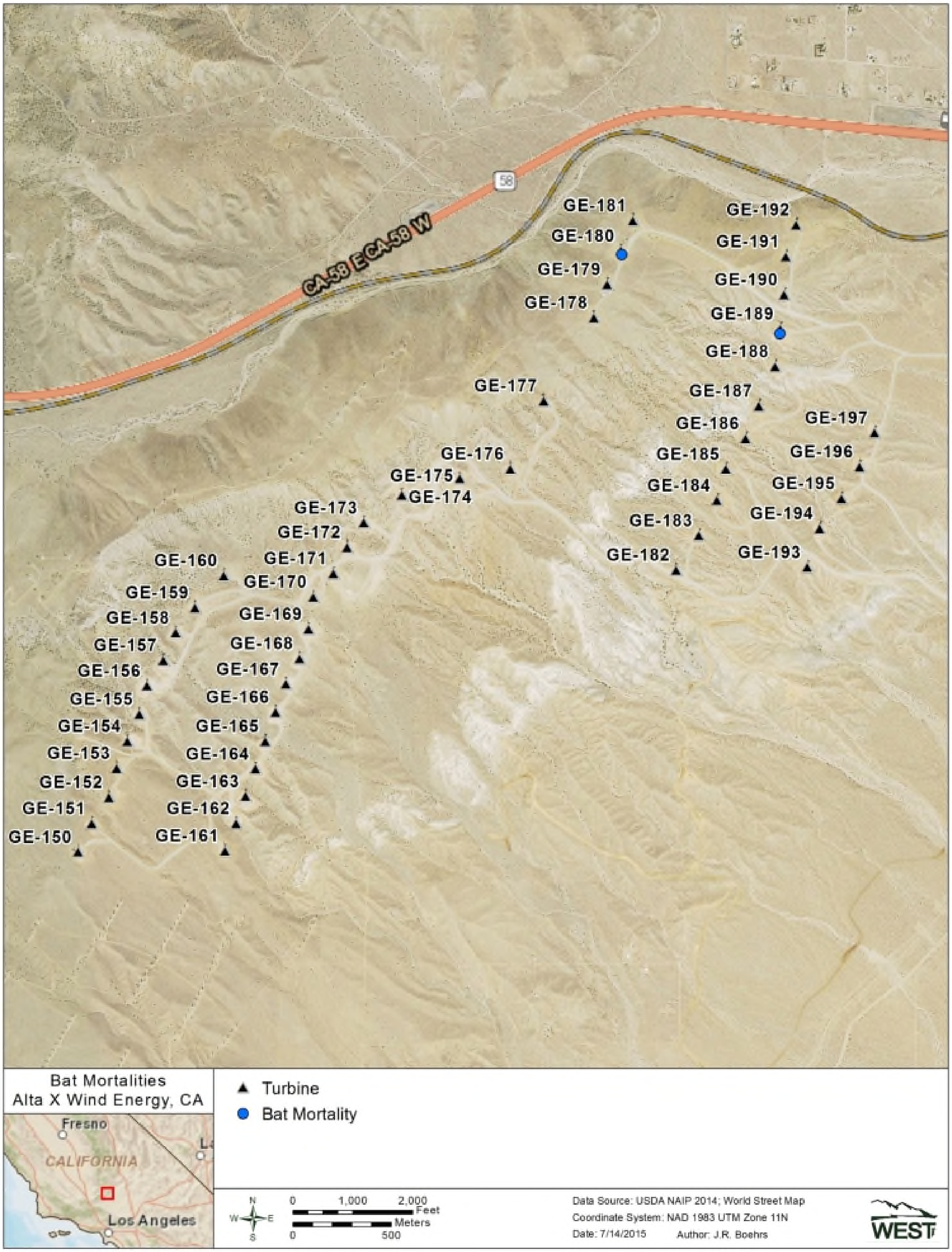

Figure 3b. Location of all bat mortalities found at the Alta X Wind Energy Project.

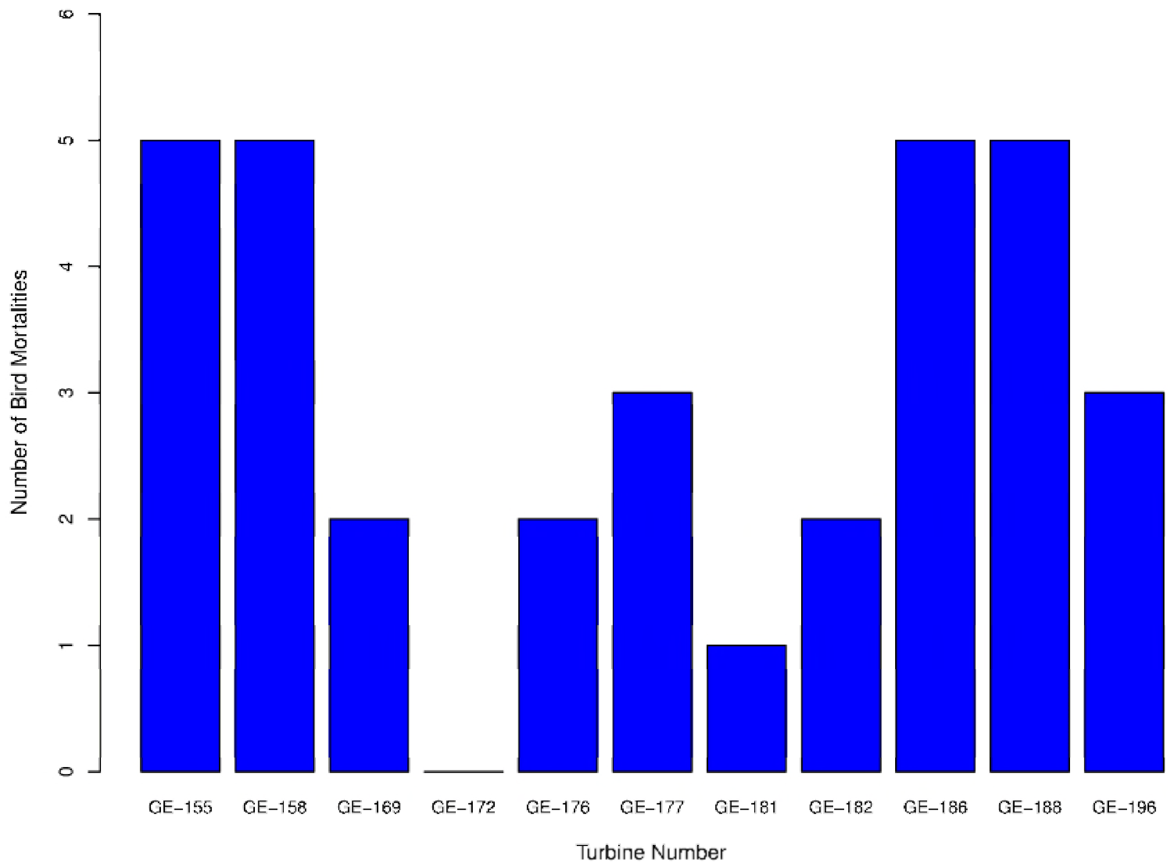

Figure 4. Number of bird mortalities by search plot at the Alta X Wind Energy Project.

Table 3. Distribution of distances from turbines of bird and bat mortalities found during scheduled searches and incidentally at the Alta X Wind Energy Project.

Distance to Turbine (m)	% Bird Mortalities	% Bat Mortalities
0 to 10	3.0	0
10 to 20	0.0	50
20 to 30	6.1	50
30 to 40	0.0	0
40 to 50	3.0	0
50 to 60	15.2	0
60 to 70	3.0	0
70 to 80	9.1	0
80 to 90	15.2	0
>90	45.5	0

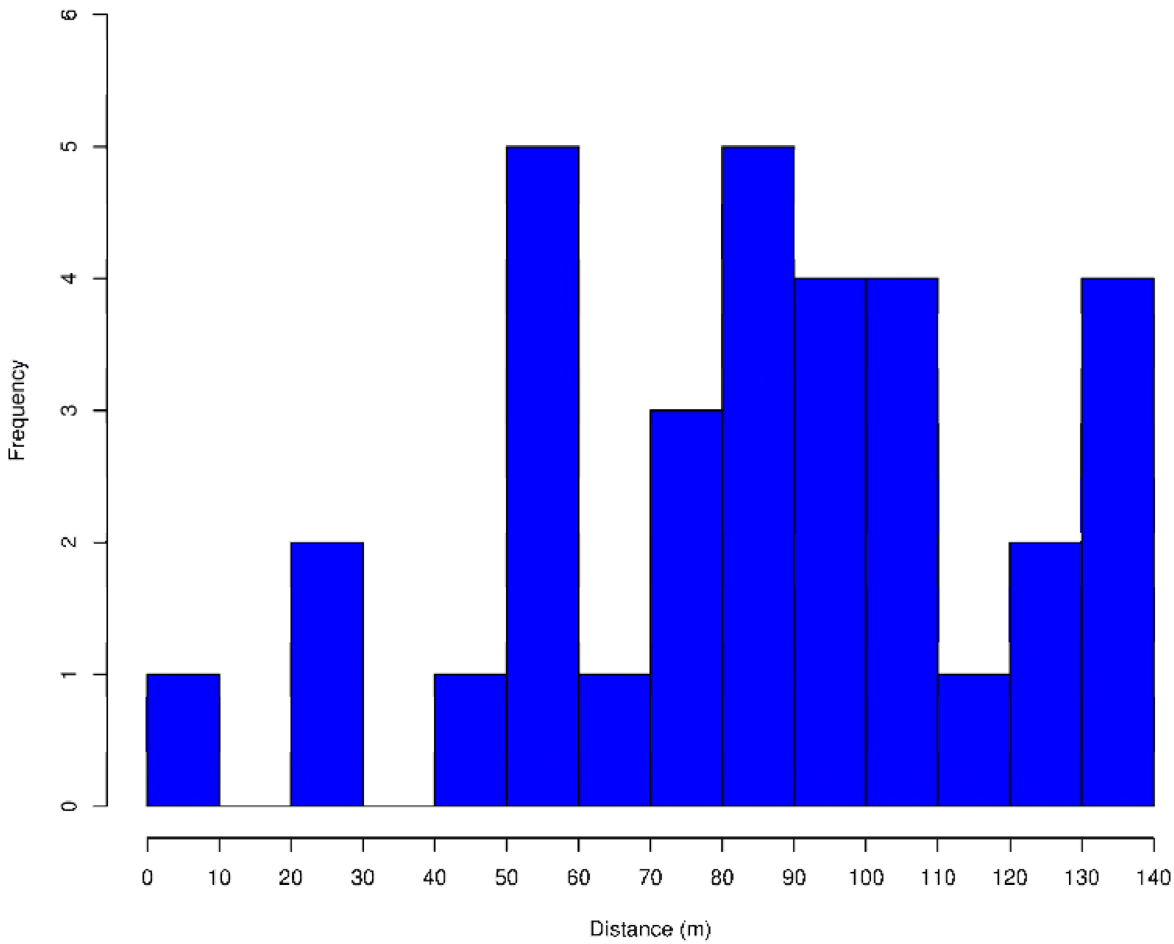

Figure 5. Distance from the turbine of bird mortalities found during scheduled searches and incidentally at the Alta X Wind Energy Project.

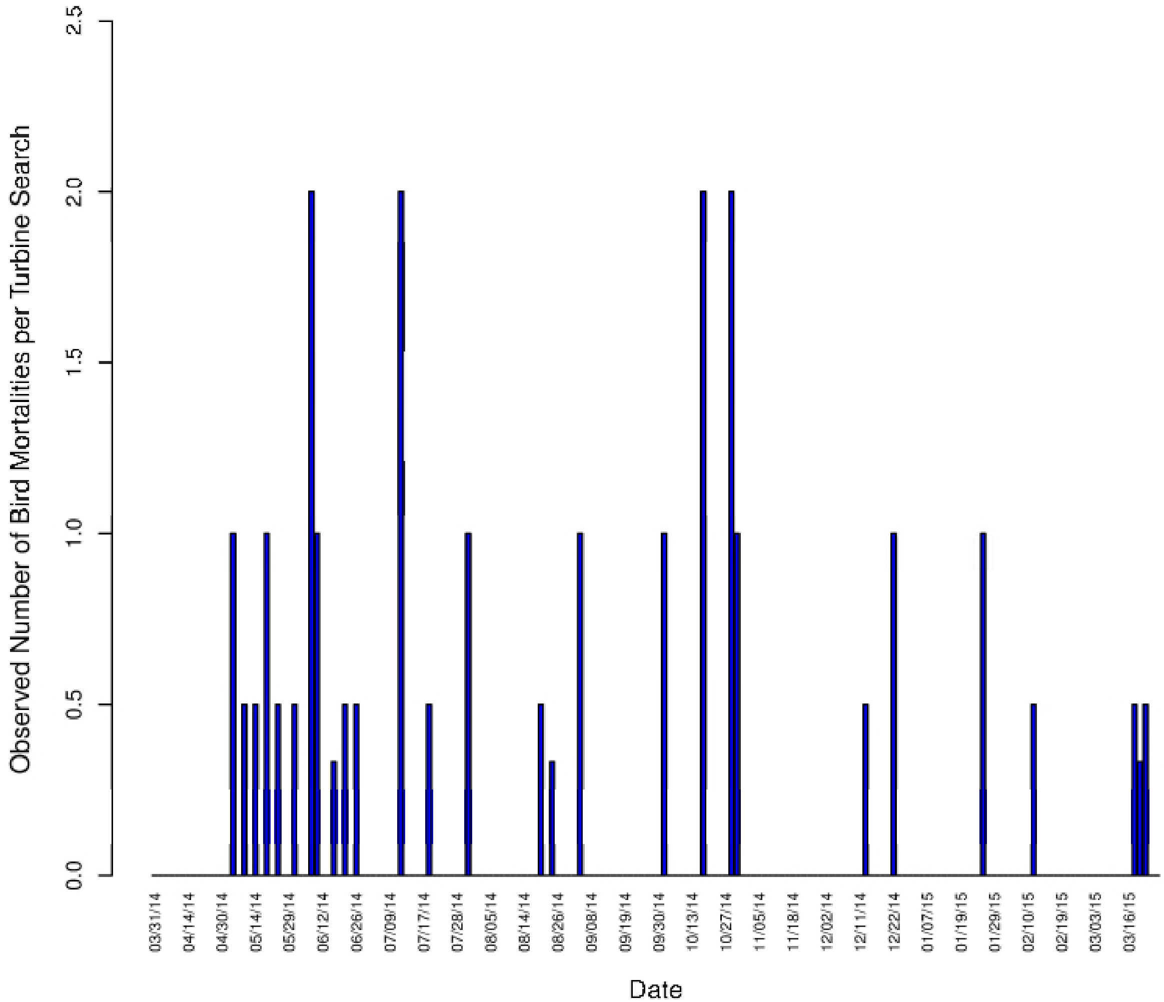

Figure 6. Timing by turbine of bird mortalities found within search plots at the Alta X Wind Energy Project.

Bat Mortality

Two bat mortalities, a hoary bat (*Lasiurus cinereus*) and a Mexican free-tailed bat (*Tadarida brasiliensis*) were found during scheduled turbine searches in the fall; one bat mortality, a hoary bat, was found incidentally during the study in the spring (Table 2, Figure 3b, Appendix A). The bat mortalities were found during the late spring and fall at search plots GE-180-181 (the hoary bat found during a scheduled search in the fall) and GE-187-188-189 (the Mexican free-tailed bat found during a scheduled search in the fall, and the hoary bat found incidentally in the spring; Figure 3b, Appendix A). No state or federally listed bat species or species of concern were found during the study.

Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the study period; a total of 159 bird carcasses were placed throughout the Alta Wind Energy Center (56 large birds and 103 small birds; Table 4). The overall searcher efficiency rate for large birds was 92.6%, compared to 69.8% for small birds (Table 4). Because no bat carcasses were available for searcher efficiency trails, brown mice were used for bat searcher efficiency trials. Thirty bat substitute (brown mice) carcasses were placed throughout the Alta Wind Energy Center. The overall searcher efficiency rate for bats was 67.9% (Table 4). Searcher efficiency trials are designed to adjust for the effects of different searchers, seasons, size classes of carcasses, and visibility classes of the setting in which carcasses may be found (ranging from easy to very difficult).

Table 4. Searcher efficiency results at the Alta X Wind Energy Project as a function of season and carcass size.

Size	Date	# Placed	# Available	# Found	% Found
	5/20/2013	3	3	2	66.7
	5/21/2013	2	2	2	100
	5/30/2013	3	3	3	100
	8/8/2013	2	2	2	100
	8/12/2013	4	2	2	100
	8/13/2013	4	4	4	100
	8/22/2013	4	4	4	100
	5/15/2014	2	2	2	100
	6/5/2014	2	2	2	100
Large Birds	7/21/2014	2	2	2	100
	8/5/2014	1	1	1	100
	9/22/2014	2	2	1	50.0
	10/20/2014	3	3	3	100
	10/27/2014	3	3	3	100
	11/6/2014	3	3	3	100
	12/1/2014	3	3	3	100
	1/19/2015	2	2	1	50.0
	1/27/2015	6	6	6	100
	2/17/2015	2	2	2	100
	4/29/2015	3	3	2	66.7
Large Bird Total		**56**	**54**	**50**	**92.6**

Table 4. Searcher efficiency results at the Alta X Wind Energy Project as a function of season and carcass size.

Size	Date	# Placed	# Available	# Found	% Found
Small Birds	5/20/2013	4	2	1	50.0
	5/21/2013	5	4	3	75.0
	5/30/2013	4	4	3	75.0
	8/8/2013	4	4	0	0
	8/12/2013	8	8	4	50.0
	8/13/2013	4	4	4	100
	8/22/2013	6	6	4	66.7
	5/15/2014	1	1	1	100
	6/5/2014	3	3	3	100
	7/21/2014	3	3	3	100
	8/5/2014	4	4	2	50.0
	9/22/2014	7	7	6	85.7
	10/20/2014	6	6	3	50.0
	10/27/2014	5	3	2	66.7
	11/6/2014	6	5	4	80.0
	12/1/2014	6	5	5	100
	1/19/2015	8	8	3	37.5
	1/27/2015	11	11	10	90.9
	2/17/2015	3	3	2	66.7
	4/29/2015	5	5	4	80.0
Small Bird Total		**103**	**96**	**67**	**69.8**
Bat Substitutes	5/15/2014	2	2	1	50.0
	6/5/2014	2	2	1	50.0
	7/21/2014	2	2	1	50.0
	8/5/2014	2	2	2	100
	9/22/2014	2	2	1	50.0
	10/20/2014	3	2	2	100
	10/27/2014	3	2	0	0
	11/6/2014	3	3	3	100
	12/1/2014	3	3	2	66.7
	1/19/2015	3	3	2	66.7
	1/27/2015	3	3	2	66.7
	2/17/2015	2	2	2	100
Bat Substitute Total		**30**	**28**	**19**	**67.9**

Carcass Removal Trials

A total of 153 bird carcasses and 30 bat substitute (brown mice) carcasses were used within the Alta Wind Energy Center during carcass removal trials in 2013-2015 (70 large birds, 83 small birds, 23 brown mice, and three bat [carcasses that were left in place when found]). By day 10, roughly 40% of large birds, 10% of small birds, and 3% of bats or bat substitutes remained in the search area. By day 30, roughly 25% of large bird carcasses, 2% of small bird carcasses, and 1% of bat or bat substitute carcasses persisted within the search area (Figure 7). The mean carcass removal time for both large and small birds varied by season. For large birds, the carcass removal time was 12.09 days in summer and fall, and 36.87 days in winter and spring. For small birds, the mean carcass removal time was 8.54 days in summer and winter, and 2.10 days in spring and fall. For bats/bat substitutes, the mean carcass removal time was 2.92 days throughout the year. (Appendix B).

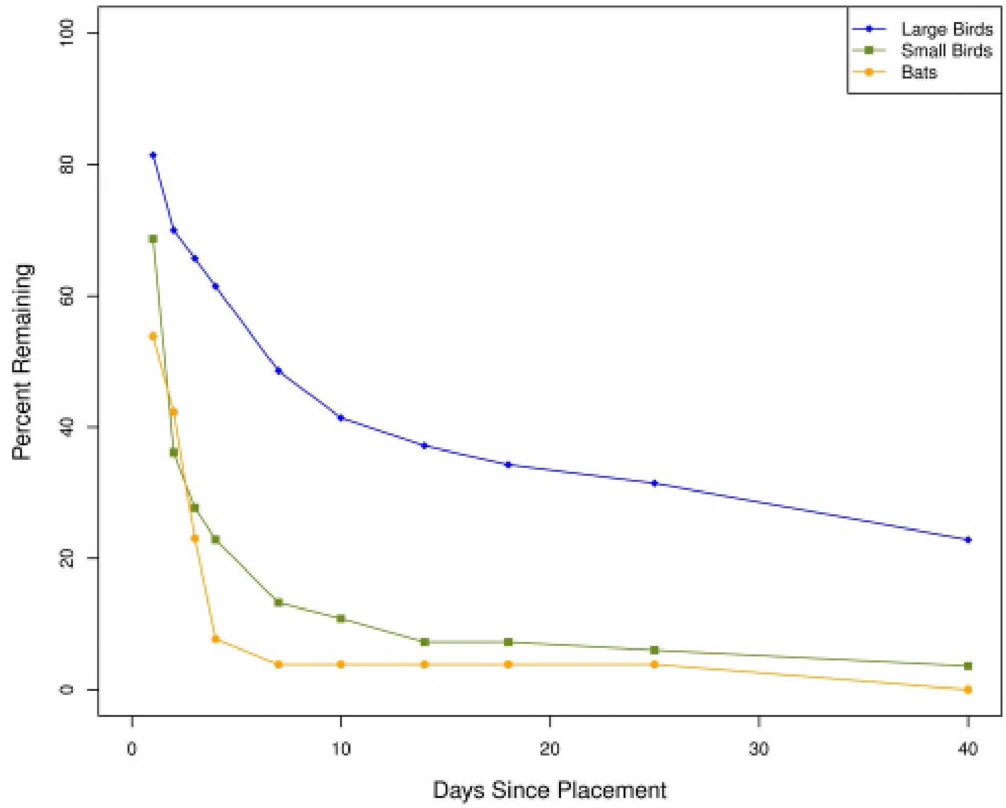

Figure 7. Carcass removal rates at the Alta Wind Energy Center.

Adjusted Mortality Estimates

Seasonal mortality estimates and 90% confidence intervals were calculated on a per turbine basis for each bird/bat category (Appendix B), and overall project-wide mortality estimates and 90% confidence intervals were calculated on a per turbine and per MW basis for each bird/bat category (Table 5). The mortality estimates were adjusted based on the corrections for carcass removal and observer detection bias (Appendix B). Because 100% of each search plot was surveyed, no search area correction factor was applied. Searcher efficiency rates were constant throughout the entire study period. For small birds, the probability that a carcass would remain in the search plot and be found by a searcher ranged from 0.10 during spring and fall to 0.36 during winter and summer. For large birds, this probability was higher, and ranged from 0.56 during summer and fall, to 0.81 during winter and spring (Appendix B). For bats, the probability that a carcass would remain in the search plot and be found by a searcher remained constant throughout the year at 0.14 (Appendix B).

Table 5. Adjusted bird and bat mortality estimates for the Alta X Wind Energy Project from March 31, 2014 – March 27, 2015. For more details concerning correction factors and confidence intervals for both bird and bat mortality estimates, refer to Appendix B.

	Adjusted Overall Mortality Estimate and 90% Confidence Intervals	
	Mean	**CI**
	# mortalities/turbine/year	
small birds	13.30	8.21-20.77
large birds	0.61	0.19-1.08
diurnal raptors	0.10	0-0.30
all birds	13.91	8.72-21.17
bats	1.19	0-3.77
	# mortalities/MW/year	
small birds	4.67	2.88-7.29
large birds	0.21	0.07-0.38
diurnal raptors	0.04	0-0.11
all birds	4.88	3.06-7.43
bats	0.42	0-1.32

Small Birds

Estimated mortality rates for small birds were highest during the spring, summer, and fall (5.62, 3.21, and 4.01 birds per turbine per season, respectively), and lower during the winter (0.46; Appendix B). Combining all seasons, the overall estimated mortality rate for small birds within the Project was 13.30 birds per turbine per year (Table 5). A detailed breakdown of small bird mortality rates and the associated correction factors is presented in Appendix B.

Large Birds

Estimated mortality rates for large birds were highest during the winter (0.21), slightly lower during the summer and fall (0.15), and lowest during the spring (0.10; Appendix B). Combining all seasons, the overall estimated mortality rate for large birds within the Project was 0.61 birds per turbine per year (Table 5). A detailed breakdown of large bird mortality rates and the associated correction factors is presented in Appendix B.

Diurnal Raptors

Estimated mortality rates for diurnal raptors was 0.10 during the winter. No raptor mortalities were found during spring, summer, or fall at the Project; therefore, the estimated mortality rate for those seasons was zero raptors/turbine/season. The overall mortality rate was 0.10 diurnal raptors/turbine/year (Appendix B).

All Birds

Estimated mortality rates for all birds were highest during the spring, summer, and fall (5.72, 3.36, and 4.16 birds per turbine per season, respectively), and lower during the winter (0.67; Appendix B). Combining all seasons, the overall estimated mortality rate for all birds within the Project was 13.91 birds per turbine per year (Table 5). A detailed breakdown of all bird mortality rates and the associated correction factors is presented in Appendix B.

<u>Bats</u>

The estimated mortality rate for bats during the fall was 1.19 bats per turbine per season. No bat mortalities were found during the winter, spring, or summer (Appendix B). The overall estimated mortality rate for bats within the Project was 0.13 bats per turbine per year. A detailed breakdown of bat mortality rates and the associated correction factors is presented in Appendix B.

Overall Mortality Estimates

An overall mortality rate estimate was calculated across all study seasons, regardless of search intervals (Table 5). Based on the 2.85-MW capacity of the turbines at the Project, the estimated mortality rate for all birds was 4.88 birds per MW per year, with an estimated mortality rate of 0.04 diurnal raptors per MW per year. The estimated mortality rate for bats was 0.42 bats per MW per year (Table 5).

DISCUSSION

The approach used for calculating adjusted mortality estimates is consistent with the approach outlined by Shoenfeld (2004) and Erickson (2006), and accounted for search interval, searcher efficiency rates, and carcass removal rates. 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 scavenging trials throughout the year. We also estimated searcher efficiency rates throughout the year to account for any biases associated with changes in conditions.

Potential Biases

There are numerous factors that could contribute to both positive and negative biases in estimating mortality rates (Erickson 2006). The overall design of this study incorporates several assumptions or factors that affect the results of the mortality estimates. First, all bird mortalities found within the standardized search plots during the study were included in the analysis. This included carcasses found during a scheduled survey as well as those found incidentally within a search plot during other activities on-site. Second, it was assumed that all carcasses found during the study were due to collision with wind turbines. True cause of death is unknown for most of the mortalities. It is possible that some of the bird mortalities were caused by predators, and some of the mortalities included in the data pool were potentially due to natural causes (background mortality). Only three bat mortalities were found either during standard searches or incidentally; it is unlikely that this mortality was due to factors not related to interaction with a wind turbine.

There are some other potential negative biases. For example, no adjustments were made for mortalities possibly occurring outside of the square plot boundaries. Plot boundaries were established a minimum distance of 120 m (394 ft) from the turbine. The search plot distance for this study was selected based on results of other studies (Higgins et al. 1996; Erickson et al. 2004; Johnson et al. 2002b, 2003a, 2004; Kerlinger et al. 2007; Young et al. 2003e, 2006), in which a distance equal to the approximate height of the turbine appeared to capture a very large percentage of mortalities. Based on the distribution of mortalities as a function of distance from turbines (Figure 5), a small percentage of bird mortalities 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 are representative of actual carcasses. This may occur if the types of birds used are larger or smaller than the carcasses of mortalities, more or less cryptic in color than the actual mortalities, etc. Rock pigeons, mallards, Coturnix quail, and house sparrows (in addition to a few native birds) were used to represent the range of bird mortalities expected. It is believed that this range captures the range of sizes and other characteristics of actual mortalities and should be a reasonable representation of scavenging rates of the birds as a group. Additionally, a combination of brown mice and bats were used to estimate carcass removal, whereas only bird carcasses were used to estimate searcher efficiency rates. It is generally not practical or feasible to obtain many of the native bird and bat species in fresh condition for these 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 (e.g., 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 mortalities. 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 is the case, and the trial carcass density is much greater than actual turbine mortality density, the trials would underestimate scavenging rates compared to rates on actual mortalities. The contrary is also possible where placing carcasses may draw in more scavengers and carcasses could be removed more quickly than normal. For this study, carcasses were placed throughout the entire Alta Wind Energy Center in an attempt to achieve a sufficient sample size without placing so many as to disrupt the natural scavenging rates.

Bird Mortality

Overall bird mortality estimates at wind energy facilities in California have ranged from 0.55 to 17.44 birds/MW/year (Figure 8), while overall bird mortality estimates at wind energy facilities across North America have ranged from 0.08 to 11.02 birds/MW/year in other regions (Appendix C1). In western North America (comprised of California, the Pacific Northwest, the Rocky Mountains, and the Southwest regions), bird mortality rates have ranged from 0.16 to 17.44 birds/MW/year (Appendix C1). The estimated annual bird mortality rates at the Project (4.88 birds/MW/year) is moderate compared to other wind energy facilities in western North America (Appendix C1). At Phases II-V of the Alta Wind Energy Center (Alta II-V), located immediately to the west of the Project, the all bird mortality rate was low, with a rate of 1.66 birds/MW/year estimated during the initial year of post-construction monitoring in 2011-2012 (Chatfield et al. 2012). The majority (75.8%) of avian mortalities at the Project were passerines, with those identifiable to species composed of both common summer and/or winter residents of the region, such as horned lark (*Eremophila alpestris*), dark-eyed junco (*Junco hyemalis*), and spotted towhee (*Pipilo maculatus*), as well as common Neotropical migrants, such as black-headed grosbeak (*Pheucticus melanocephalus*), lazuli bunting (*Passerina amoena*), and western tanager (*Piranga ludoviciana*).

Diurnal raptor mortality estimates at wind energy facilities in California have ranged from zero to 0.50 birds/MW/year (Figure 9), while estimates throughout North America have ranged from zero to 0.59 birds/MW/year in other regions, and from zero to 0.47 birds/MW/year at sites in other western regions (Appendix C2). Only one unidentified diurnal raptor was found during the study; therefore, the diurnal raptor mortality estimate for the Project was very low at 0.04 raptors/MW/year. At Alta II-V, the diurnal raptor mortality rate was also low, with an estimate of 0.05 raptors/MW/year during the 2011-2012 monitoring year (Chatfield et al. 2012). Low raptor mortality at both the Project and at the adjacent Alta II-V is consistent with low diurnal raptor use observed during pre-construction surveys conducted at both sites (0.04 diurnal raptors/hour; Erickson and Chatfield 2009; Appendix C2).

Bat Mortality

In California, bat mortality rates have ranged from 0.04 to 3.92 bats/MW/year (Figure 10). At the Project, only two bat mortalities were found during the study, resulting in an overall bat mortality rate of 0.42 bats/MW/year. This estimate is low compared to other sites within western North America where bat mortality rates have ranged from 0.08 to 11.42 bats/MW/year (Appendix C3). The bat mortality rate at the Project is generally consistent with the results of the 2011-2012 mortality study at the adjacent Alta II-V where the bat mortality rate was 0.08 bats/MW/year (Chatfield et al. 2012; Appendix C3). At the Alite Wind Energy Facility, located within the Alta Wind Energy Center, the bat mortality rate was estimated to be 0.24 bats/MW/year (Chatfield et al. 2010; Appendix C3). Based on the low levels of bat mortality observed at the Project during the first and second years of monitoring, as well as low levels of mortality observed at adjacent sites, it is unlikely that operation of this facility will result in any significant impacts to bat populations.

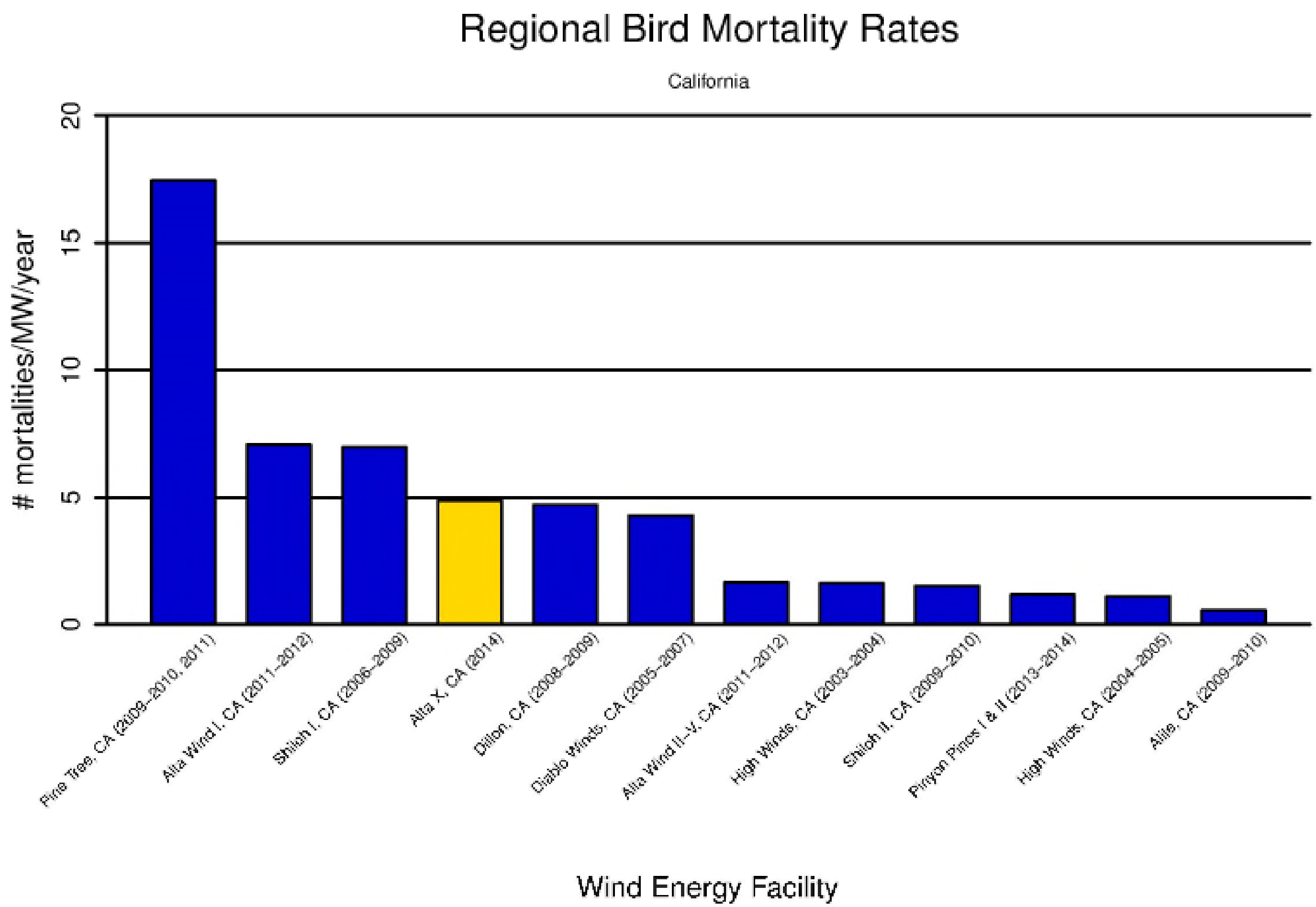

Figure 8. Mortality rates for all birds (number of birds per MW per year) at the Alta X Wind Energy Project compared with publicly-available studies at wind energy facilities in California.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Alta X, CA (14)	This study.				
Pine Tree, CA (09-10, 11)	BioResource Consultants 2012	Diablo Winds, CA (05-07)	WEST 2006, 2008	Pinyon Pines I&II, CA (13-14)	Chatfield and Russo 2014
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	High Winds, CA (04-05)	Kerlinger et al. 2006
Shiloh I, CA (06-09)	Kerlinger et al. 2009	High Winds, CA (03-04)	Kerlinger et al. 2006	Alite, CA (09-10)	Chatfield et al. 2010
Dillon, CA (08-09)	Chatfield et al. 2009	Shiloh II, CA (09-10)	Kerlinger et al. 2010b		

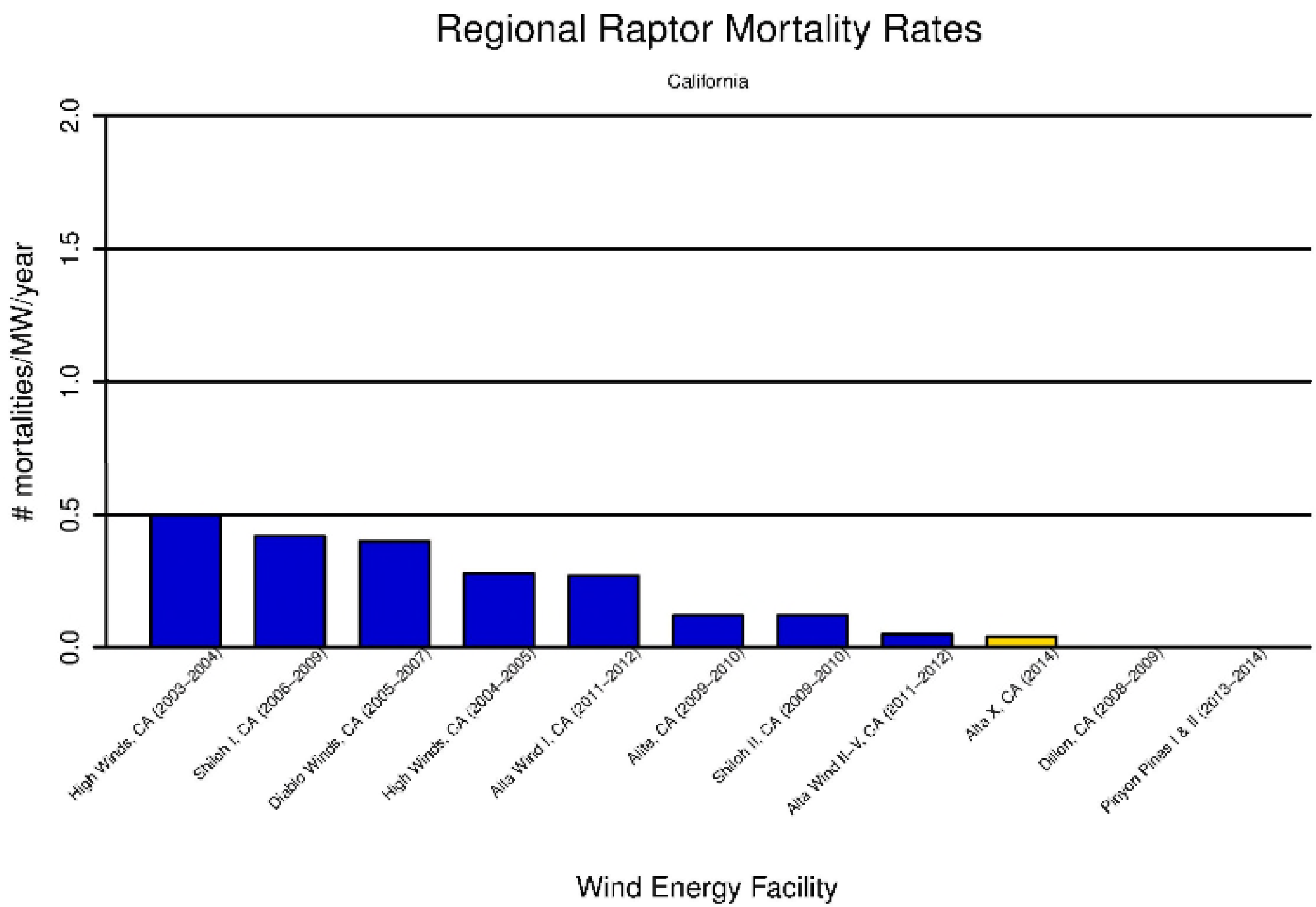

Figure 9. Mortality rates for raptors (number of raptors per MW per year) at the Alta X Wind Energy Project compared with studies from publicly-available wind energy facilities in California.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Alta X, CA (14)	This study.				
High Winds, CA (03-04)	Kerlinger et al. 2006	Alta Wind I, CA (11-12)	Chatfield et al. 2012	Dillon, CA (08-09)	Chatfield et al. 2009
Shiloh I, CA (06-09)	Kerlinger et al. 2009	Alite, CA (09-10)	Chatfield et al. 2010	Pinyon Pines I&II, CA (13-14)	Chatfield and Russo 2014
Diablo Winds, CA (05-07)	WEST 2006, 2008	Shiloh II, CA (09-10)	Kerlinger et al. 2010b		
High Winds, CA (04-05)	Kerlinger et al. 2006	Alta Wind II-V, CA (11-12)	Chatfield et al. 2012		

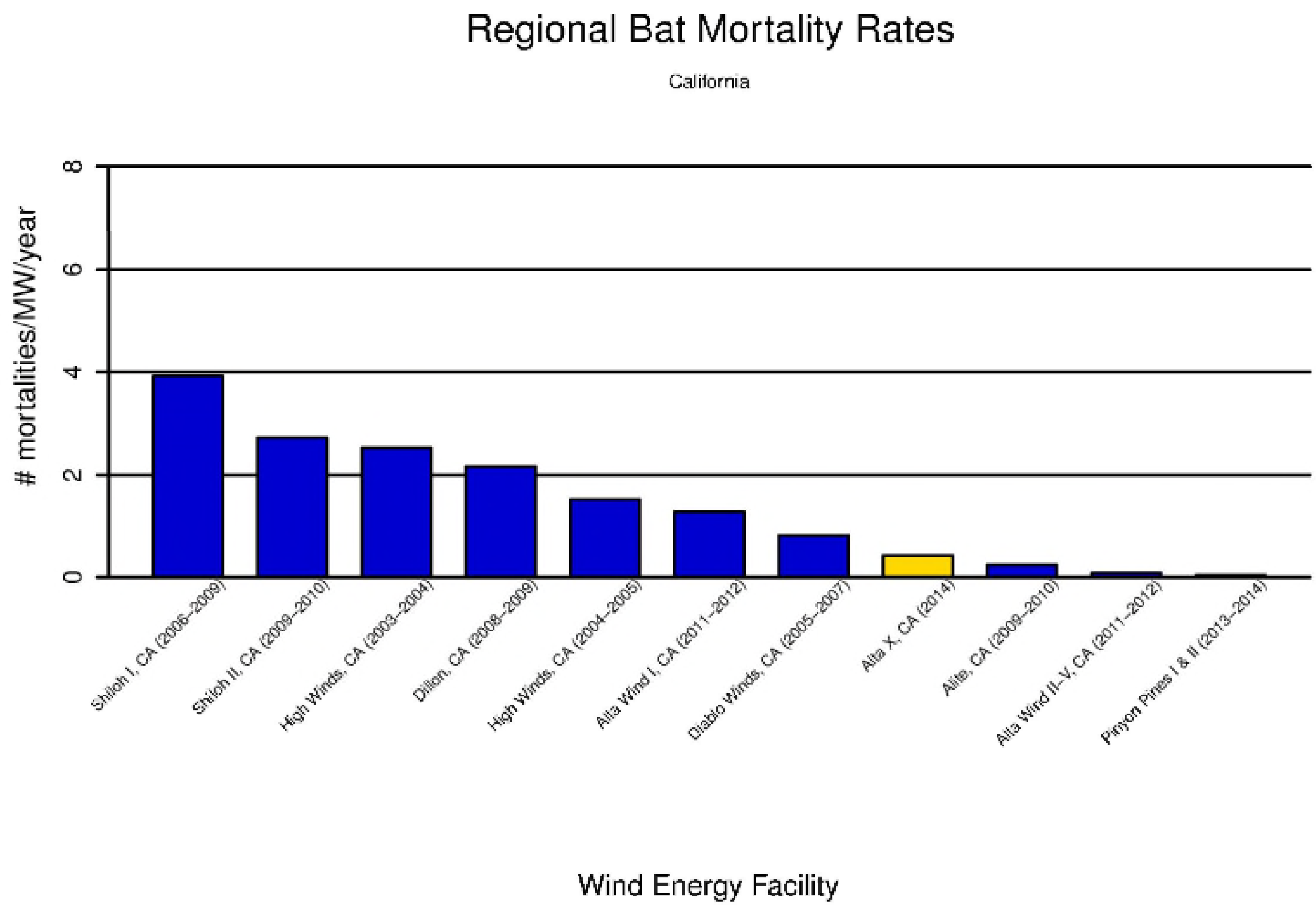

Figure 10. Mortality rates for bats (number of bats per MW per year) at the Alta X Wind Energy Project compared with studies at publicly-available wind energy facilities in California.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Alta X, CA (14)	This study.				
Shiloh I, CA (06-09)	Kerlinger et al. 2009	High Winds, CA (04-05)	Kerlinger et al. 2006	Alta Wind II-V, CA (11-12)	Chatfield et al. 2012
Shiloh II, CA (09-10)	Kerlinger et al. 2010b	Alta Wind I, CA (11-12)	Chatfield et al. 2012	Pinyon Pines I&II, CA (13-14)	Chatfield and Russo 2014
High Winds, CA (03-04)	Kerlinger et al. 2006	Diablo Winds, CA (05-07)	WEST 2006, 2008		
Dillon, CA (08-09)	Chatfield et al. 2009	Alite, CA (09-10)	Chatfield et al. 2010		

CONCLUSIONS AND RECOMMENDATIONS

Results of the first year of mortality monitoring at the Project further contribute to our understanding of the effects of wind energy on birds and bats. During the first year of monitoring, diurnal raptor and bat mortality rates were low compared to other wind energy facilities in western North America All bird mortality fell within the low to moderate range compared to other wind energy facilities in western North America. Based on the levels of bird and bat mortality observed at the Project during the first year of monitoring, it is unlikely that operation of this facility will result in any significant impacts to bird and bat populations. Additional monitoring will be conducted at the Project in Year 2 (March 2015 – March 2016) and Year 3 (March 2016 – March 2017) of operations. The results of the surveys conducted to date do not suggest the need for deviation from the established protocol during the second year of mortality surveys. As additional years of the study are completed and results from post-construction mortality studies at other wind energy facilities in the Tehachapi Wind Resource Area become available, a clearer picture of the impacts will emerge.

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Appendix A. Complete Listing of Mortalities for the Alta X Wind Energy Project for Studies Conducted from March 31, 2014 – March 27, 2015

Appendix A. Complete listing of mortalities for the Alta X Wind Energy Project.

Date	Common Name	Location	Distance from Turbine (m)	Type of Find	Search Type	Condition
04/15/14	hoary bat	GE-188	0	Incidental find	bi-weekly	intact
04/21/14	unidentified small bird	GE-172	143	scheduled carcass search	bi-weekly	feather spot
04/30/14	common raven	GE-158	157	scheduled carcass search	bi-weekly	intact
05/05/14	western tanager	INC	172	incidental find	bi-weekly	intact
05/07/14	unidentified small bird	GE-188	140	scheduled carcass search	bi-weekly	feather spot
05/12/14	western tanager	GE-176	140	scheduled carcass search	bi-weekly	feather spot
05/14/14	mourning dove	GE-169	156	scheduled carcass search	bi-weekly	scavenged
05/14/14	unidentified small bird	GE-169	109	scheduled carcass search	bi-weekly	feather spot
05/19/14	unidentified small bird	GE-158	53	scheduled carcass search	bi-weekly	feather spot
05/21/14	black-headed grosbeak	GE-186	53	scheduled carcass search	bi-weekly	feather spot
06/02/14	greater roadrunner	GE-177	75	scheduled carcass search	bi-weekly	feather spot
06/09/14	lazuli bunting	GE-155	57	scheduled carcass search	bi-weekly	feather spot
06/09/14	unidentified small bird	GE-155	81	scheduled carcass search	bi-weekly	feather spot
06/10/14	horned lark	GE-196	83	scheduled carcass search	bi-weekly	feather spot
06/10/14	unidentified small bird	GE-158	109	scheduled carcass search	bi-weekly	feather spot
06/16/14	band-tailed pigeon	INC	0	incidental find	bi-weekly	feather spot
06/18/14	unidentified small bird	GE-177	61	scheduled carcass search	bi-weekly	feather spot
06/23/14	unidentified passerine	GE-155	123	scheduled carcass search	bi-weekly	feather spot
06/26/14	greater roadrunner	GE-186	58	scheduled carcass search	bi-weekly	feather spot
06/26/14	band-tailed pigeon	GE-186	105	scheduled carcass search	bi-weekly	feather spot
06/26/14	unidentified small bird	GE-158	136	scheduled carcass search	bi-weekly	feather spot
07/11/14	unidentified small bird	GE-186	89	scheduled carcass search	bi-weekly	feather spot
07/11/14	orange-crowned warbler	GE-186	81	scheduled carcass search	bi-weekly	intact
07/21/14	unidentified sparrow	GE-181	96	scheduled carcass search	bi-weekly	intact
07/30/14	white-throated swift	GE-196	25	scheduled carcass search	bi-weekly	intact
08/01/14	white-throated swift	INC	23	incidental find	bi-weekly	intact
08/08/14	unidentified warbler	INC	127	incidental find	bi-weekly	intact
08/20/14	acorn woodpecker	GE-158	6	scheduled carcass search	bi-weekly	intact
08/25/14	acorn woodpecker	GE-186	73	scheduled carcass search	bi-weekly	intact
08/28/14	unidentified warbler	INC	90	incidental find	bi-weekly	intact
09/03/14	unidentified small bird	GE-188	136	scheduled carcass search	bi-weekly	feather spot
09/22/14	unidentified large bird	INC	28	incidental find	bi-weekly	feather spot
10/01/14	Mexican free-tailed bat	GE-188	59	scheduled carcass search	bi-weekly	intact
10/01/14	dark-eyed junco	GE-188	21	scheduled carcass search	bi-weekly	
10/01/14	spotted towhee	GE-188	140	scheduled carcass search	bi-weekly	intact
10/01/14	unidentified vireo	GE-188	44	scheduled carcass search	bi-weekly	feather spot

Appendix A. Complete listing of mortalities for the Alta X Wind Energy Project.

Date	Common Name	Location	Distance from Turbine (m)	Type of Find	Search Type	Condition
10/02/14	hoary bat	GE-181	18	scheduled carcass search	bi-weekly	intact
10/07/14	northern flicker	GE-176	69	scheduled carcass search	bi-weekly	feather spot
10/10/14	unidentified passerine	INC	29	incidental find	bi-weekly	feather spot
10/13/14	California quail	GE-155	14	scheduled carcass search	bi-weekly	feather spot
10/15/14	unidentified small bird	GE-188	133	scheduled carcass search	bi-weekly	feather spot
10/15/14	unidentified warbler	GE-188	106	scheduled carcass search	bi-weekly	feather spot
10/16/14	unidentified small bird	GE-186	63	scheduled carcass search	bi-weekly	feather spot
10/28/14	unidentified warbler	GE-155	75	scheduled carcass search	bi-weekly	feather spot
10/28/14	northern flicker	GE-155	57	scheduled carcass search	bi-weekly	feather spot
10/29/14	unidentified small bird	GE-158	112	scheduled carcass search	bi-weekly	feather spot
12/15/14	unidentified passerine	GE-182	28	scheduled carcass search	bi-weekly	
12/22/14	unidentified raptor	GE-186	90	scheduled carcass search	bi-weekly	feather spot
01/23/15	unidentified small bird	GE-176	102	scheduled carcass search	bi-weekly	feather spot
02/11/15	greater roadrunner	GE-177	126	scheduled carcass search	bi-weekly	feather spot
03/08/15	red-tailed hawk	INC	15	incidental find	bi-weekly	dismembered
03/16/15	unidentified large bird	GE-186	144	scheduled carcass search	bi-weekly	feather spot
03/18/15	sora	INC	94	incidental find	bi-weekly	feather spot
03/18/15	unidentified small bird	GE-182	19	scheduled carcass search	bi-weekly	intact
03/20/15	dark-eyed junco	GE-169	99	scheduled carcass search	bi-weekly	intact
03/26/15	band-tailed pigeon	GE-196	94	scheduled carcass search	bi-weekly	intact

Appendix B. Complete Bird and Bat Mortality Table for the Alta X Wind Energy Project for Studies Conducted from March 31, 2014 – March 27, 2015

Appendix B. Correction factors and bird and bat mortality rates by season for studies conducted within the Alta X Facility from March 31, 2014 – March 27, 2015.

	Spring		Summer	(12 effective turbines searched)	Fall		Winter	
Parameter	**Mean**	**CI**	**Mean**	**CI**	**Mean**	**CI**	**Mean**	**CI**
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	-
A (bats)	1.00	-	1.00	-	1.00	-	1.00	-
Observer Detection Rate								
p (small birds)	0.70	0.62-0.78	0.70	0.62-0.78	0.70	0.62-0.78	0.70	0.62-0.78
p (large birds)	0.93	0.87-0.98	0.93	0.87-0.98	0.93	0.87-0.98	0.93	0.87-0.98
p (bats)	0.68	0.54-0.82	0.68	0.54-0.82	0.68	0.54-0.82	0.68	0.54-0.82
Mean Carcass Removal Time (Days)								
$\bar{t}$ (small birds)	2.10	1.52-2.72	8.54	4.89-13.73	2.10	1.52-2.72	8.54	4.89-13.73
$\bar{t}$ (large birds)	36.87	22.31-63.28	12.09	8.19-17.14	12.09	8.19-17.14	36.87	22.31-63.28
$\bar{t}$ (bats)	2.92	1.42-5.35	2.92	1.42-5.35	2.92	1.42-5.35	2.92	1.42-5.35
Observed Mortality Rates (Mortalities/Turbine/Season)								
small birds	0.58	0.33-0.84	1.17	0.58-1.67	0.42	0.08-0.83	0.17	0-0.33
large birds	0.08	0-0.25	0.08	0-0.25	0.08	0-0.25	0.17	0-0.33
raptors	0	-	0	-	0	-	0.08	0-0.30
bats	0	-	0	-	0.17	0-0.33	0	0-0
Average Probability of Carcass Availability and Detected								
small birds	0.10	0.07-0.14	0.36	0.23-0.49	0.10	0.07-0.14	0.36	0.23-0.49
large birds	0.81	0.71-0.89	0.56	0.45-0.66	0.56	0.45-0.66	0.81	0.71-0.89
bats	0.14	0.32-0.50	0.14	0.06-0.25	0.14	0.32-0.50	0.14	0.06-0.25
Observed Adjusted Mortality Rates (Mortalities/Turbine/Season)								
small birds	5.62	2.79-9.52	3.21	1.62-5.67	4.01	0.71-8.92	0.46	0-1.08
large birds	0.10	0-0.30	0.15	0-0.41	0.15	0-0.41	0.21	0-0.44
raptors	0	-	0	-	0	-	0.10	0-0.30
all birds	5.72	2.89-9.62	3.36	1.74-5.80	4.16	0.79-9.04	0.67	0.18-1.30
bats	0	-	0	-	1.19	0-3.77	0	-

Overall Adjusted Mortality Rates (Mortalities/Turbine/Study Period)

	Mean	**CI**
small birds	13.30	8.21-20.77
large birds	0.61	0.19-1.08
raptors	0.10	0-0.30
all birds	13.91	8.72-21.17
bats	1.19	0-3.77

Appendix C. North American Mortality Summary Tables

Appendix C1. Wind energy facilities in North America with mortality data for all bird species, by geographic region. Mortality estimate presented as number of bird mortalities per megawatt (MW) per year.

Wind Energy Facility	Mortality Estimate	No. of Turbines	Total MW
Alta X, CA (2014)	**4.88**	**100**	**300**
California			
Pine Tree, CA (2009-2010, 2011)	17.44	90	135
Alta Wind I, CA (2011-2012)	7.07	100	150
Shiloh I, CA (2006-2009)	6.96	100	150
Dillon, CA (2008-2009)	4.71	45	45
Diablo Winds, CA (2005-2007)	4.29	31	20.46
Alta Wind II-V, CA (2011-2012)	1.66	190	570
High Winds, CA (2003-2004)	1.62	90	162
Shiloh II, CA (2009-2010)	1.51	75	150
Pinyon Pines I & II (2013-2014)	1.18	100	300
High Winds, CA (2004-2005)	1.10	90	162
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
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
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

Appendix C1. Wind energy facilities in North America with mortality data for all bird species, by geographic region. Mortality estimate presented as number of bird mortalities per megawatt (MW) per year.

Wind Energy Facility	Mortality Estimate	No. of Turbines	Total MW
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
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
Buffalo Ridge II, SD (2011-2012)	1.99	105	210
Kewaunee County, WI (1999-2001)	1.95	31	20.46
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
PrairieWinds SD1 (Crow Lake), SD (2011-2012)	1.41	108	162
Wessington Springs, SD (2010)	0.89	34	51
Top of Iowa, IA (2004)	0.81	89	80
Grand Ridge I, IL (2009-2010)	0.48	66	99
Top of Iowa, IA (2003)	0.42	89	80
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

Appendix C1. Wind energy facilities in North America with mortality data for all bird species, by geographic region. Mortality estimate presented as number of bird mortalities per megawatt (MW) per year.

Wind Energy Facility	Mortality Estimate	No. of Turbines	Total MW
Northeast			
Criterion, MD (2011)	6.40	28	70
Mount Storm, WV (2011)	4.24	132	264
Mount Storm, WV (2009)	3.85	132	264
Lempster, NH (2009)	3.38	12	24
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
Noble Altona, NY (2010)	1.84	65	97.5
Mars Hill, ME (2008)	1.76	28	42
High Sheldon, NY (2010)	1.76	75	112.5
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
Munnsville, NY (2008)	1.48	23	34.5
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 C1 (*continued*). Wind energy facilities in North America with mortality data for all bird species.

Data from the following sources:

Wind Energy Facility	Estimate Reference	Wind Energy Facility	Estimate Reference
Alta X, CA (14)	This study.		
Alite, CA (09-10)	Chatfield et al. 2010	Klondike II, OR (05-06)	NWC and WEST 2007
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Klondike III, OR (Phase I; 07-09)	Gritski et al. 2010
Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Klondike IIIa, OR (Phase II; 08-10)	Gritski et al. 2011
Barton I & II, IA (10-11)	Derby et al. 2011a	Leaning Juniper, OR (06-08)	Gritski et al. 2008
Barton Chapel, TX (09-10)	WEST 2011	Lempster, NH (09)	Tidhar et al. 2010
Beech Ridge, WV (12)	Tidhar et al. 2013b	Lempster, NH (10)	Tidhar et al. 2011
Big Horn, WA (06-07)	Kronner et al. 2008	Linden Ranch, WA (10-11)	Enz and Bay 2011
Big Smile, OK (12-13)	Derby et al. 2013b	Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Maple Ridge, NY (07)	Jain et al. 2009a
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Maple Ridge, NY (07-08)	Jain et al. 2009d
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Marengo I, WA (09-10)	URS Corporation 2010b
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Marengo II, WA (09-10)	URS Corporation 2010c
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Mars Hill, ME (07)	Stantec 2008
Buffalo Gap I, TX (06)	Tierney 2007	Mars Hill, ME (08)	Stantec 2009a
Buffalo Gap II, TX (07-08)	Tierney 2009	Moraine II, MN (09)	Derby et al. 2010d
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000a	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000a	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000a	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000a	Nine Canyon, WA (02-03)	Erickson et al. 2003b
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000a	Noble Altona, NY (10)	Jain et al. 2011b
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a	Noble Bliss, NY (08)	Jain et al. 2009e
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000a	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)	Jain et al. 2009c
Casselman, PA (08)	Arnett et al. 2009a	Noble Clinton, NY (09)	Jain et al. 2010b
Casselman, PA (09)	Arnett et al. 2010	Noble Ellenburg, NY (08)	Jain et al. 2009b
Cedar Ridge, WI (09)	BHE Environmental 2010	Noble Ellenburg, NY (09)	Jain et al. 2010c
Cedar Ridge, WI (10)	BHE Environmental 2011	Noble Wethersfield, NY (10)	Jain et al. 2011a
Cohocton/Dutch Hill, NY (09)	Stantec 2010	NPPD Ainsworth, NE (06)	Derby et al. 2007
Cohocton/Dutch Hill, NY (10)	Stantec 2011	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Combine Hills, OR (Ph. I; 04-05)	Young et al. 2006	Pine Tree, CA (09-10, 11)	BioResource Consultants 2012
Combine Hills, OR (11)	Enz et al. 2012	Pinyon Pines I & II, CA (13-14)	Chatfield and Russo 2014
Criterion, MD (11)	Young et al. 2012a	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Criterion, MD (12)	Young et al. 2013	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011c
Diablo Winds, CA (05-07)	WEST 2006, 2008	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Dillon, CA (08-09)	Chatfield et al. 2009	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
Dry Lake I, AZ (09-10)	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)	Jeffrey et al. 2009b	Rugby, ND (10-11)	Derby et al. 2011b
Elkhorn, OR (10)	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. 2010b
Elm Creek II, MN (11-12)	Derby et al. 2012b	Stateline, OR/WA (01-02)	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	Stateline, OR/WA (03)	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b	Stateline, OR/WA (06)	Erickson et al. 2007
Foote Creek Rim, WY (Ph. I; 01-02)	Young et al. 2003b	Stetson Mountain I, ME (09)	Stantec 2009c
Fowler I, IN (09)	Johnson et al. 2010a	Stetson Mountain I, ME (11)	Normandeau Associates 2011
Goodnoe, WA (09-10)	URS Corporation 2010a	Stetson Mountain II, ME (10)	Normandeau Associates 2010
Grand Ridge, IL (09-10)	Derby et al. 2010g	Summerview, Alb (05-06)	Brown and Hamilton 2006b
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Top of Iowa, IA (03)	Jain 2005
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Top of Iowa, IA (04)	Jain 2005
High Sheldon, NY (10)	Tidhar et al. 2012a	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
High Sheldon, NY (11)	Tidhar et al. 2012b	Vansycle, OR (99)	Erickson et al. 2000b
High Winds, CA (03-04)	Kerlinger et al. 2006	Vantage, WA (10-11)	Ventus 2012
High Winds, CA (04-05)	Kerlinger et al. 2006	Wessington Springs, SD (09)	Derby et al. 2010f
Hopkins Ridge, WA (06)	Young et al. 2007	Wessington Springs, SD (10)	Derby et al. 2011d
Hopkins Ridge, WA (08)	Young et al. 2009c	White Creek, WA (07-11)	Downes and Gritski 2012b
Kewaunee County, WI (99-01)	Howe et al. 2002	Wild Horse, WA (07)	Erickson et al. 2008
Kittitas Valley, WA (11-12)	Stantec 2012	Windy Flats, WA (10-11)	Enz et al. 2011
Klondike, OR (02-03)	Johnson et al. 2003b	Winnebago, IA (09-10)	Derby et al. 2010e

Appendix C2. Wind energy facilities in North America with use and mortality data for raptors. Use estimate presented as number of raptors per plot per 20-minute survey. Raptor mortality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Raptor Mortality Estimate	No. of Turbines	Total MW
Alta X, CA (2014)	**0.04**	**0.04**	**100**	**300**
California				
High Winds, CA (2003-2004)	2.34	0.50	90	162
Shiloh I, CA (2006-2009)		0.42	100	150
Diablo Winds, CA (2005-2007)	2.16	0.40	31	20.46
High Winds, CA (2004-2005)	2.34	0.28	90	162
Alta Wind I, CA (2011-2012)	0.19	0.27	100	150
Alite, CA (2009-2010)		0.12	8	24
Shiloh II, CA (2009-2010)		0.12	75	150
Alta Wind II-V, CA (2011-2012)	0.04	0.05	190	570
Dillon, CA (2008-2009)		0	45	45
Pinyon Pines I & II (2013-2014)		0	100	300
Pacific Northwest				
White Creek, WA (2007-2011)		0.47	89	204.7
Vantage, WA (2010-2011)		0.29	60	90
Tuolumne (Windy Point I), WA (2009-2010)	0.77	0.29	62	136.6
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
Klondike II, OR (2005-2006)	0.50	0.06	50	75
Klondike IIIa (Phase II), OR (2008-2010)		0.06	51	76.5
Elkhorn, OR (2008)	1.07	0.06	61	101
Marengo II, WA (2009-2010)		0.05	39	70.2
Combine Hills, OR (2011)	0.75	0.05	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	0.32	0.05	76	174.8
Pebble Springs, OR (2009-2010)		0.04	47	98.7
Windy Flats, WA (2010-2011)		0.04	114	262.2
Nine Canyon, WA (2002-2003)	0.35	0.03	37	48.1
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
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)	0.75	0	41	41
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

Appendix C2. Wind energy facilities in North America with use and mortality data for raptors. Use estimate presented as number of raptors per plot per 20-minute survey. Raptor mortality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Raptor Mortality Estimate	No. of Turbines	Total MW
	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
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
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
NPPD Ainsworth, NE (2006)		0.06	36	20.5
Wessington Springs, SD (2009)	0.23	0.06	34	51
Rugby, ND (2010-2011)		0.06	71	149
PrairieWinds ND1 (Minot), ND (2010)		0.05	80	115.5
PrairieWinds ND1 (Minot), ND (2011)		0.05	80	115.5
Kewaunee County, WI (1999-2001)		0	31	20.46
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
Top of Iowa, IA (2003)		0	89	80
Grand Ridge I, IL (2009-2010)	0.20	0	66	99
Elm Creek, MN (2009-2010)		0	67	100
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
PrairieWinds SD1 (Crow Lake), SD (2011-2012)		0	108	162
Buffalo Ridge II, SD (2011-2012)		0	105	210
Fowler I, IN (2009)		0	162	301
	Southern Plains			
Barton Chapel, TX (2009-2010)		0.25	60	120
Buffalo Gap I, TX (2006)		0.1	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

Appendix C2. Wind energy facilities in North America with use and mortality data for raptors. Use estimate presented as number of raptors per plot per 20-minute survey. Raptor mortality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Raptor Mortality Estimate	No. of Turbines	Total MW
	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
Lempster, NH (2009)		0	12	24
Lempster, NH (2010)		0	12	24
Stetson Mountain II, ME (2010)		0	17	25.5
Casselman, PA (2008)		0	23	34.5
Casselman, PA (2009)		0	23	34.5
Mars Hill, ME (2007)		0	28	42
Mars Hill, ME (2008)		0	28	42
Stetson Mountain I, ME (2009)		0	38	57
Stetson Mountain I, ME (2011)		0	38	57
Noble Altona, NY (2010)		0	65	97.5
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
Mount Storm, WV (2009)		0	132	264
	Southeast			
Buffalo Mountain, TN (2000-2003)		0	3	1.98
Buffalo Mountain, TN (2005)		0	18	28.98

Appendix C2 (*continued*). Wind energy facilities in North America with use and mortality data for raptors.

Data from the following sources:

Facility	Use Estimate	Mortality Estimate	Facility	Use Estimate	Mortality Estimate
Alta X, CA (14)	Erickson and Chatfield 2009	This study.			
Alite, CA (09-10)		Chatfield et al. 2010	Klondike II, OR (05-06)	Johnson et al. 2002a	NWC and WEST 2007
Alta Wind I, CA (11-12)	Erickson and Chatfield 2009	Chatfield et al. 2012	Klondike III (Phase I), OR (07-09)		Gritski et al. 2010
Alta Wind II-V, CA (11-12)	Erickson and Chatfield 2009	Chatfield et al. 2012	Klondike IIIa (Phase II), OR (08-10)		Gritski et al. 2011
Barton I & II, IA (10-11)		Derby et al. 2011a	Leaning Juniper, OR (06-08)	Kronner et al. 2005	Gritski et al. 2008
Barton Chapel, TX (09-10)		WEST 2011	Lempster, NH (09)		Tidhar et al. 2010
Beech Ridge, WV (12)		Tidhar et al. 2013b	Lempster, NH (10)		Tidhar et al. 2011
Big Horn, WA (06-07)	Johnson and Erickson 2004	Kronner et al. 2008	Linden Ranch, WA (10-11)		Enz and Bay 2011
Big Smile, OK (12-13)		Derby et al. 2013b	Locust Ridge, PA (Phase II; 09)		Arnett et al. 2011
Biglow Canyon, OR (Phase I; 08)	WEST 2005b	Jeffrey et al. 2009a	Locust Ridge, PA (Phase II; 10)		Arnett et al. 2011
Biglow Canyon, OR (Phase I; 09)	WEST 2005b	Enk et al. 2010	Maple Ridge, NY (07-08)		Jain et al. 2009d
Biglow Canyon, OR (Phase II; 09-10)	WEST 2005b	Enk et al. 2011a	Marengo I, WA (09-10)		URS Corporation 2010b
Biglow Canyon, OR (Phase II; 10-11)	WEST 2005b	Enk et al. 2012b	Marengo II, WA (09-10)		URS Corporation 2010c
Biglow Canyon, OR (Phase III; 10-11)	WEST 2005b	Enk et al. 2012a	Mars Hill, ME (07)		Stantec 2008
Blue Sky Green Field, WI (08; 09)		Gruver et al. 2009	Mars Hill, ME (08)		Stantec 2009a
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 (09)		Young et al. 2009a, 2010b
Buffalo Mountain, TN (00-03)		Nicholson et al. 2005	Mount Storm, WV (10)		Young et al. 2010a, 2011b
Buffalo Mountain, TN (05)		Fiedler et al. 2007	Mount Storm, WV (11)		Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase I; 96)		Johnson et al. 2000a	Mountaineer, WV (03)		Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase I; 97)		Johnson et al. 2000a	Munnsville, NY (08)		Stantec 2009b
Buffalo Ridge, MN (Phase I; 98)		Johnson et al. 2000a	Nine Canyon, WA (02-03)	Erickson et al. 2001	Erickson et al. 2003b
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000a	Noble Altona, NY (10)		Jain et al. 2011b
Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000a	Noble Bliss, NY (08)		Jain et al. 2009e
Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000a	Noble Bliss, NY (09)		Jain et al. 2010a
Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000a	Noble Chateaugay, NY (10)		Jain et al. 2011c
Buffalo Ridge I, SD (09-10)		Derby et al. 2010b	Noble Clinton, NY (08)		Jain et al. 2009c
Buffalo Ridge II, SD (11-12)		Derby et al. 2012a	Noble Clinton, NY (09)		Jain et al. 2010b
Casselman, PA (08)		Arnett et al. 2009a	Noble Ellenburg, NY (08)		Jain et al. 2009b
Casselman, PA (09)		Arnett et al. 2010	Noble Ellenburg, NY (09)		Jain et al. 2010c
Cedar Ridge, WI (09)		BHE Environmental 2010	Noble Wethersfield, NY (10)		Jain et al. 2011a
Cedar Ridge, WI (10)		BHE Environmental 2011	NPPD Ainsworth, NE (06)		Derby et al. 2007
Cohocton/Dutch Hill, NY (09)		Stantec 2010	Pebble Springs, OR (09-10)		Gritski and Kronner 2010b
Cohocton/Dutch Hills, NY (10)		Stantec 2011	Pinyon Pines I&II, CA (13-14)		Chatfield and Russo 2014
Combine Hills, OR (Phase I; 04-05)	Young et al. 2003c	Young et al. 2006	Pioneer Prairie I, IA (Phase II; 11-12)		Chodachek et al. 2012
Combine Hills, OR (11)	Young et al. 2003c	Enz et al. 2012	PrairieWinds ND1 (Minot), ND (10)		Derby et al. 2011c
Criterion, MD (11)		Young et al. 2012a	PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012c
Diablo Winds, CA (05-07)	WEST 2006, 2008	WEST 2006, 2008	PrairieWinds SD1 (Crow Lake), SD (11-12)		Derby et al. 2012d
Dillon, CA (08-09)		Chatfield et al. 2009	Red Hills, OK (12-13)		Derby et al. 2013c
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Thompson et al. 2011	Ripley, Ont (08)		Jacques Whitford 2009

Appendix C2 (*continued*). Wind energy facilities in North America with use and mortality data for raptors.

Data from the following sources:

Facility	Use Estimate	Mortality Estimate	Facility	Use Estimate	Mortality Estimate
Dry Lake II, AZ (11-12)		Thompson and Bay 2012	Rugby, ND (10-11)		Derby et al. 2011b
Elkhorn, OR (08)	WEST 2005a	Jeffrey et al. 2009b	Shiloh I, CA (06-09)		Kerlinger et al. 2009
Elkhorn, OR (10)	WEST 2005a	Enk et al. 2011b	Shiloh II, CA (09-10)		Kerlinger et al. 2010b
Elm Creek, MN (09-10)		Derby et al. 2010c	Stateline, OR/WA (01-02)	Erickson et al. 2003a	Erickson et al. 2004
Elm Creek II, MN (11-12)		Derby et al. 2012b	Stateline, OR/WA (03)	Erickson et al. 2003a	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 99)	Johnson et al. 2000b	Young et al. 2003b	Stateline, OR/WA (06)	Erickson et al. 2003a	Erickson et al. 2007
Foote Creek Rim, WY (Phase I; 00)	Johnson et al. 2000b	Young et al. 2003b	Stetson Mountain I, ME (09)		Stantec 2009c
Foote Creek Rim, WY (Phase I; 01-02)	Johnson et al. 2000b	Young et al. 2003b	Stetson Mountain I, ME (11)		Normandeau Associates 2011
Fowler I, IN (09)		Johnson et al. 2010a	Stetson Mountain II, ME (10)		Normandeau Associates 2010
Goodnoe, WA (09-10)		URS Corporation 2010a	Summerview, Alb (05-06)		Brown and Hamilton 2006b
Grand Ridge I, IL (09-10)	Derby et al. 2009	Derby et al. 2010g	Top of Iowa, IA (03)		Jain 2005
Harvest Wind, WA (10-12)		Downes and Gritski 2012a	Top of Iowa, IA (04)		Jain 2005
Hay Canyon, OR (09-10)		Gritski and Kronner 2010a	Tuolumne (Windy Point I), WA (09-10)	Johnson et al. 2006	Enz and Bay 2010
High Sheldon, NY (10)		Tidhar et al. 2012a	Vansycle, OR (99)	WCIA and WEST 1997	Erickson et al. 2000b
High Sheldon, NY (11)		Tidhar et al. 2012b	Vantage, WA (10-11)		Ventus 2012
High Winds, CA (03-04)	Kerlinger et al. 2005	Kerlinger et al. 2006	Wessington Springs, SD (09)	Derby et al. 2008	Derby et al. 2010f
High Winds, CA (04-05)	Kerlinger et al. 2005	Kerlinger et al. 2006	Wessington Springs, SD (10)	Derby et al. 2008	Derby et al. 2011d
Hopkins Ridge, WA (06)	Young et al. 2003a	Young et al. 2007	White Creek, WA (07-11)		Downes and Gritski 2012b
Hopkins Ridge, WA (08)	Young et al. 2003a	Young et al. 2009c	Wild Horse, WA (07)	Erickson et al. 2003c	Erickson et al. 2008
Kewaunee County, WI (99-01)		Howe et al. 2002	Windy Flats, WA (10-11)		Enz et al. 2011
Kittitas Valley, WA (11-12)		Stantec 2012	Winnebago, IA (09-10)		Derby et al. 2010e
Klondike, OR (02-03)	Johnson et al. 2002a	Johnson et al. 2003b			

Appendix C3. Wind energy facilities in North America with comparable activity and mortality data for bats, separated by geographic region. Bat activity presented as number of bat passes per detector-night. Mortality estimate given as number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Mortality Estimate	No. of Turbines	Total MW
Alta X, CA (2014)	**0.78**	**6/26/2009 - 10/31/2009**	**0.42**	**100**	**300**
		California			
Shiloh I, CA (2006-2009)			3.92	100	150
Shiloh II, CA (2009-2010)			2.72	75	150
High Winds, CA (2003-2004)			2.51	90	162
Dillon, CA (2008-2009)			2.17	45	45
High Winds, CA (2004-2005)			1.52	90	162
Alta Wind I, CA (2011-2012)	4.42[A]	6/26/2009 - 10/31/2009	1.28	100	150
Diablo Winds, CA (2005-2007)			0.82	31	20.46
Alite, CA (2009-2010)			0.24	8	24
Alta Wind II-V, CA (2011-2012)	0.78	6/26/2009 - 10/31/2009	0.08	190	570
Pinyon Pines I & II (2013-2014)			0.04	100	300
		Pacific Northwest			
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
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
Klondike II, OR (2005-2006)			0.41	50	75
Windy Flats, WA (2010-2011)			0.41	114	262.2
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

Appendix C3. Wind energy facilities in North America with comparable activity and mortality data for bats, separated by geographic region. Bat activity presented as number of bat passes per detector-night. Mortality estimate given as number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Mortality Estimate	No. of Turbines	Total MW
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
Foote Creek Rim, WY (Phase I; 2001-2002)	2.20[B,C]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.20[B,C]	6/15/00-9/1/00	1.05	69	41.4
Southwest					
Dry Lake I, AZ (2009-2010)	8.80	4/29/10-11/10/10	3.43	30	63
Dry Lake II, AZ (2011-2012)	11.50	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
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
Fowler I, II, III, IN (2011)			20.19	355	600
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)	2.20[B]	6/15/01-9/15/01	4.35	143	107.25
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.20[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

Appendix C3. Wind energy facilities in North America with comparable activity and mortality data for bats, separated by geographic region. Bat activity presented as number of bat passes per detector-night. Mortality estimate given as number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Mortality Estimate	No. of Turbines	Total MW
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
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)	1.90[B]	6/15/02-9/15/02	1.81	138	103.5
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.90[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
PrairieWinds ND1 (Minot), ND (2011)			1.39	80	115.5
PrairieWinds SD1, SD (2011-2012)			1.23	108	162
NPPD Ainsworth, NE (2006)			1.16	36	20.5
Buffalo Ridge, MN (Phase I; 1999)			0.74	73	25
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)			2.90	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					
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

Appendix C3. Wind energy facilities in North America with comparable activity and mortality data for bats, separated by geographic region. Bat activity presented as number of bat passes per detector-night. Mortality estimate given as number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Mortality Estimate	No. of Turbines	Total MW
Maple Ridge, NY (2012)			7.30	195	321.75
Mount Storm, WV (Fall 2008)	35.20	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
Maple Ridge, NY (2007-2008)			4.96	195	321.75
Noble Clinton, NY (2009)	1.90[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)	16.10[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
Noble Ellenburg, NY (2008)			3.46	54	80
Noble Clinton, NY (2008)	2.10[D]	8/8/08-09/31/08	3.14	67	100
Lempster, NH (2009)			3.11	12	24
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
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; 0.3G	7/10/09-10/15/09	1.40	38	57
Mars Hill, ME (2008)			0.45	28	42
Stetson Mountain I, ME (2011)			0.28	38	57
Kibby, ME (2011)			0.12	44	132
Southeast					
Buffalo Mountain, TN (2005)			39.70	18	28.98
Buffalo Mountain, TN (2000-2003)	23.70[C]		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 C3 (*continued*). Wind energy facilities in North America with comparable activity and mortality data for bats.

Data from the following sources:

Facility	Activity Estimate	Mortality Estimate	Facility	Activity Estimate	Mortality Estimate
Alta X, CA (14)	Solick et al. 2010b	This study.			
Alite, CA (09-10)		Chatfield et al. 2010	Kibby, ME (11)		Stantec 2012
Alta Wind I, CA (11-12)	Solick et al. 2010b	Chatfield et al. 2012	Kittitas Valley, WA (11-12)		Stantec Consulting Services 2012
Alta Wind II-V, CA (11-12)	Solick et al. 2010b	Chatfield et al. 2012	Klondike, OR (02-03)		Johnson et al. 2003a
Barton I & II, IA (10-11)		Derby et al. 2011a	Klondike II, OR (05-06)		NWC and WEST 2007
Barton Chapel, TX (09-10)		WEST 2011	Klondike III (Phase I), OR (07-09)		Gritski et al. 2010
Beech Ridge, WV (12)		Tidhar et al. 2013b	Klondike IIIa (Phase II), OR (08-10)		Gritski et al. 2011
Big Horn, WA (06-07)		Kronner et al. 2008	Leaning Juniper, OR (06-08)		Gritski et al. 2008
Big Smile, OK (12-13)		Derby et al. 2013b	Lempster, NH (09)		Tidhar et al. 2010
Biglow Canyon, OR (Phase I; 08)		Jeffrey et al. 2009a	Lempster, NH (10)		Tidhar et al. 2011
Biglow Canyon, OR (Phase I; 09)		Enk et al. 2010	Linden Ranch, WA (10-11)		Enz and Bay 2011
Biglow Canyon, OR (Phase II; 09-10)		Enk et al. 2011a	Locust Ridge, PA (Phase II; 09)		Arnett et al. 2011
Biglow Canyon, OR (Phase II; 10-11)		Enk et al. 2012b	Locust Ridge, PA (Phase II; 10)		Arnett et al. 2011
Biglow Canyon, OR (Phase III; 10-11)		Enk et al. 2012a	Maple Ridge, NY (06)		Jain et al. 2007
Blue Sky Green Field, WI (08; 09)	Gruver 2008	Gruver et al. 2009	Maple Ridge, NY (07)		Jain et al. 2009a
Buffalo Gap I, TX (06)		Tierney 2007	Maple Ridge, NY (07-08)		Jain et al. 2009d
Buffalo Gap II, TX (07-08)		Tierney 2009	Maple Ridge, NY (12)		Tidhar et al. 2013a
Buffalo Mountain, TN (00-03)	Fiedler 2004	Nicholson et al. 2005	Marengo I, WA (09-10)		URS Corporation 2010b
Buffalo Mountain, TN (05)		Fiedler et al. 2007	Marengo II, WA (09-10)		URS Corporation 2010c
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000a	Mars Hill, ME (07)		Stantec 2008
Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000a	Mars Hill, ME (08)		Stantec 2009a
Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000a	Moraine II, MN (09)		Derby et al. 2010d
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (Fall 08)	Young et al. 2009b	Young et al. 2009b
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (09)	Young et al. 2009a, 2010b	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000a	Mount Storm, WV (10)	Young et al. 2010a, 2011b	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (11)		Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mountaineer, WV (03)		Kerns and Kerlinger 2004
Buffalo Ridge I, SD (09-10)		Derby et al. 2010b	Munnsville, NY (08)		Stantec 2009b
Buffalo Ridge II, SD (11-12)		Derby et al. 2012a	Nine Canyon, WA (02-03)		Erickson et al. 2003b
Casselman, PA (08)		Arnett et al. 2009a	Noble Altona, NY (10)		Jain et al. 2011b
Casselman, PA (09)		Arnett et al. 2010	Noble Bliss, NY (08)		Jain et al.2009e
Casselman Curtailment, PA (08)		Arnett et al. 2009b	Noble Bliss, NY (09)		Jain et al. 2010a
Cedar Ridge, WI (09)	BHE Environmental 2008	BHE Environmental 2010	Noble Chateaugay, NY (10)		Jain et al. 2011c
Cedar Ridge, WI (10)	BHE Environmental 2008	BHE Environmental 2011	Noble Clinton, NY (08)	Reynolds 2010a	Jain et al. 2009c
Cohocton/Dutch Hill, NY (09)		Stantec 2010	Noble Clinton, NY (09)	Reynolds 2010a	Jain et al. 2010b
Cohocton/Dutch Hills, NY (10)		Stantec 2011	Noble Ellenburg, NY (08)		Jain et al. 2009b
Combine Hills, OR (Phase I; 04-05)		Young et al. 2006	Noble Ellenburg, NY (09)	Reynolds 2010b	Jain et al. 2010c
Combine Hills, OR (11)		Enz et al. 2012	Noble Wethersfield, NY (10)		Jain et al. 2011a
Crescent Ridge, IL (05-06)		Kerlinger et al. 2007	NPPD Ainsworth, NE (06)		Derby et al. 2007
Criterion, MD (11)		Young et al. 2012a	Pebble Springs, OR (09-10)		Gritski and Kronner 2010b
Criterion, MD (12)		Young et al. 2013	Pioneer Prairie I, IA (Phase II; 11-12)		Chodachek et al. 2012
Crystal Lake II, IA (09)		Derby et al. 2010a	Pinyon Pines I&II, CA (13-14)		Chatfield and Russo 2014
Diablo Winds, CA (05-07)		WEST 2006, 2008	PrairieWinds ND1 (Minot), ND (10)		Derby et al. 2011c
Dillon, CA (08-09)		Chatfield et al. 2009	PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012c
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Thompson et al. 2011	PrairieWinds SD1 (Crow Lake), SD (11-12)		Derby et al. 2012d
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Thompson and Bay 2012	Red Hills, OK (12-13)		Derby et al. 2013c

Appendix C3 (*continued*). Wind energy facilities in North America with comparable activity and mortality data for bats.

Data from the following sources:

Facility	Activity Estimate	Mortality Estimate	Facility	Activity Estimate	Mortality Estimate
Elkhorn, OR (08)		Jeffrey et a. 2009b	Ripley, Ont (08)		Jacques Whitford 2009
Elkhorn, OR (10)		Enk et al. 2011b	Rugby, ND (10-11)		Derby et al. 2011b
Elm Creek, MN (09-10)		Derby et al. 2010c	Shiloh I, CA (06-09)		Kerlinger et al. 2009
Elm Creek II, MN (11-12)		Derby et al. 2012b	Shiloh II, CA (09-10)		Kerlinger et al. 2010b
Foote Creek Rim, WY (Phase I; 99)		Young et al. 2003b	Stateline, OR/WA (01-02)		Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 00)	Gruver 2002	Young et al. 2003b, 2003d	Stateline, OR/WA (03)		Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 01-02)	Gruver 2002	Young et al. 2003b, 2003d	Stateline, OR/WA (06)		Erickson et al. 2007
Forward Energy Center, WI (08-10)	Watt and Drake 2011	Grodsky and Drake 2011	Stetson Mountain I, ME (09)	Stantec 2009c	Stantec 2009c
Fowler I, IN (09)		Johnson et al. 2010a	Stetson Mountain I, ME (11)		Normandeau Associates 2011
Fowler III, IN (09)		Johnson et al. 2010b	Stetson Mountain II, ME (10)		Normandeau Associates 2010
Fowler I, II, III, IN (10)		Good et al. 2011	Summerview, Alb (05-06)		Brown and Hamilton 2006b
Fowler I, II, III, IN (11)		Good et al. 2012	Summerview, Alb (06; 07)	Baerwald 2008	Baerwald 2008
Fowler I, II, III, IN (12)		Good et al. 2013	Top of Iowa, IA (03)		Jain 2005
Goodnoe, WA (09-10)		URS Corporation 2010a	Top of Iowa, IA (04)	Jain 2005	Jain 2005
Grand Ridge I, IL (09-10)		Derby et al. 2010g	Tuolumne (Windy Point I), WA (09-10)		Enz and Bay 2010
Harrow, Ont (10)		NRSI 2011	Vansycle, OR (99)		Erickson et al. 2000a
Harvest Wind, WA (10-12)		Downes and Gritski 2012a	Vantage, WA (10-11)		Ventus 2012
Hay Canyon, OR (09-10)		Gritski and Kronner 2010a	Wessington Springs, SD (09)		Derby et al. 2010f
High Sheldon, NY (10)		Tidhar et al. 2012a	Wessington Springs, SD (10)		Derby et al. 2011d
High Sheldon, NY (11)		Tidhar et al. 2012b	White Creek, WA (07-11)		Downes and Gritski 2012b
High Winds, CA (03-04)		Kerlinger et al. 2006	Wild Horse, WA (07)		Erickson et al. 2008
High Winds, CA (04-05)		Kerlinger et al. 2006	Windy Flats, WA (10-11)		Enz et al. 2011
Hopkins Ridge, WA (06)		Young et al. 2007	Winnebago, IA (09-10)		Derby et al. 2010e
Hopkins Ridge, WA (08)		Young et al. 2009c	Wolfe Island, Ont (July-December 09)		Stantec Ltd. 2010b
Judith Gap, MT (06-07)		TRC 2008	Wolfe Island, Ont (July-December 10)		Stantec Ltd. 2011b
Judith Gap, MT (09)		Poulton and Erickson 2010	Wolfe Island, Ont (July-December 11)		Stantec Ltd. 2012
Kewaunee County, WI (99-01)		Howe et al. 2002			

Appendix C4. 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
Barton I & II, IA (2010-2011)	5.50	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
Big Horn, WA (2006-2007)	2.54	0.11	1.90	Agriculture/grassland	Kronner et al. 2008
Big Smile, OK (2012-2013)	0.09	0	2.90	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	0.10	0.10	Grassland	Tierney 2007
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)	1.10	0	39.70	Forest	Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 1996)	4.14	0	NA	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1997)	2.51	0	NA	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1998)	3.14	0	NA	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1999)	1.43	0.47	0.74	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1998)	2.47	0	2.16	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1999)	3.57	0	2.59	Agriculture	Johnson et al. 2000a
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

Appendix C4. 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 Ridge, MN (Phase III; 1999)	5.93	0	2.72	Agriculture	Johnson et al. 2000a
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	0.20	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. 2009a
Casselman, PA (2009)	2.88	0	8.60	Forest, pasture, grassland	Arnett et al. 2010
Casselman Curtailment, PA (2008)	NA	NA	4.40	Forest	Arnett et al. 2009b
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
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 2011
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)	6.40	0.02	15.61	Forest, agriculture	Young et al. 2012a
Criterion, MD (2012)	2.14	NA	7.62	Forest, agriculture	Young et al. 2013
Crystal Lake II, IA (2009)	NA	NA	7.42	Agriculture	Derby et al. 2010a
Diablo Winds, CA (2005-2007)	4.29	0.40	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

Appendix C4. 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
Foote Creek Rim, WY (Phase I; 1999)	3.40	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. 2013
Fowler III, IN (2009)	NA	NA	1.84	Agriculture	Johnson et al. 2010b
Goodnoe, WA (2009-2010)	1.40	0.17	0.34	Grassland and shrub-steppe	URS Corporation 2010a
Grand Ridge I, IL (2009-2010)	0.48	0	2.10	Agriculture	Derby et al. 2010g
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	0.50	2.51	Agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2004-2005)	1.10	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	3.20	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 2012
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. 2003a
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

Appendix C4. 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
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
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 (2007-2008)	2.07	0.03	4.96	Agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007)	2.34	NA	6.49	Agriculture/forested	Jain et al. 2009d
Maple Ridge, NY (2012)	NA	NA	7.30	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
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)	2.60	0.10	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
Nine Canyon, WA (2002-2003)	2.76	0.03	2.47	Agriculture/grassland	Erickson et al. 2003b
Noble Altona, NY (2010)	1.84	0	4.34	Forest	Jain et al. 2011b
Noble Bliss, NY (2008)	1.30	0.10	7.80	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	0.10	3.14	Agriculture/forest	Jain et al. 2009c
Noble Clinton, NY (2009)	1.11	0.16	4.50	Agriculture/forest	Jain et al. 2010b
Noble Ellenburg, NY (2008)	0.83	0.11	3.46	Agriculture/forest	Jain et al. 2009b

Appendix C4. 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
Noble Ellenburg, NY (2009)	2.66	0.25	3.91	Agriculture/forest	Jain et al. 2010c
Noble Wethersfield, NY (2010)	1.70	0.13	16.30	Agriculture	Jain et al. 2011a
NPPD Ainsworth, NE (2006)	1.63	0.06	1.16	Agriculture/grassland	Derby et al. 2007
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
Pinyon Pines I & II (2013-2014)	1.18	0	0.04	Scrub and woodland	Chatfield and Russo 2014
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	0	10.06	Agriculture, grassland	Chodachek et al. 2012
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
Red Hills, OK (2012-2013)	0.08	0.04	0.11	Grassland	Derby et al. 2013c
Ripley, Ont (2008)	3.09	0.10	4.67	Agriculture	Jacques Whitford 2009
Rugby, ND (2010-2011)	3.82	0.06	1.60	Agriculture	Derby et al. 2011b
Shiloh I, CA (2006-2009)	6.96	0.42	3.92	Agriculture/grassland	Kerlinger et al. 2010a
Shiloh II, CA (2009-2010)	1.51	0.12	2.72	Agriculture	Kerlinger et al. 2010b
Stateline, OR/WA (2001-2002)	3.17	0.09	1.09	Agriculture/grassland	Erickson et al. 2004
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	1.40	Forest	Stantec 2009c
Stetson Mountain I, ME (2011)	1.18	0	0.28	Forested	Normandeau Associates 2011
Stetson Mountain II, ME (2010)	1.42	0	1.65	Forested	Normandeau Associates 2010
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 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)	3.20	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	0.40	Shrub-steppe, grassland	Ventus Environmental Solutions 2012

Appendix C4. 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
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	9.50	Grassland	Stantec Ltd. 2011b
Wolfe Island, Ont (July-December 2011)	NA	NA	2.49	Grassland	Stantec Ltd. 2012

Appendix C5. 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 Wind I, CA (2011-2012)	100	150	80	25	120-m radius circle	12.5 months	Every two weeks
Alta Wind II-V, CA (2011-2012)	190	570	NA	41	120-m radius circle	14.5 months	Every two weeks
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 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	NA	17 (plus one met tower)	100 x 100	1 year	Weekly (spring, summer, fall), monthly (winter)
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	NA	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	NA	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)

Appendix C5. 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
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		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
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)

Appendix C5. 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 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)
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

Appendix C5. 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
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
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
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 C5. 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
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

Appendix C5. 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
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)
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)
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

Appendix C5. 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
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)
Leaning Juniper, OR (2006-2008)	67	100.5	80	17	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (winter, summer)
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)

Appendix C5. 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 (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
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)
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
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
Nine Canyon, WA (2002-2003)	37	48.1	60	37	90-m radius	1 year	Bi-monthly (spring, summer, fall), monthly (winter)
Noble Altona, NY (2010)	65	97.5	80	22	120 m x 120 m	Spring, summer, fall	Daily, weekly
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)

Appendix C5. 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 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
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
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
Pinyon Pines I & II (2013-2014)	100	300	90	25 plots/31 turbines	240 x 240m	1 year	Every two weeks
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)
PrairieWinds ND1 (Minot), ND (2010)	80	115.5	89	35	minimum of 100 m x 100 m	3 seasons	Bi-monthly

Appendix C5. 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
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)
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)
Prince Wind Farm, Ont (2006)	126	189	80	38	63-m radius	4 months	Daily, weekly
Prince Wind Farm, Ont (2007)	126	189	80	38 turbines from January 1st - July 8th, 126 turbines from July 9th-October 31st	63- to 45-m radius	10 months	Daily, weekly
Prince Wind Farm, Ont (2008)	126	189	80	126	45m radius	6.5 months	Daily, 3x/week, 2x/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	NA	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.
Rugby, ND (2010-2011)	71	149	78	32	200 m x 200 m	1 year	Weekly (spring, fall; migratory turbines), monthly (non-migratory turbines)
San Gorgonio, CA (1997-1998; 1999-2000)	3000	NA	24.4-42.7	NA	50-m radius	2 years	Quarterly

Appendix C5. 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
Searsburg, VT (1997)	11	7	65	11	20- to 55-m radius	Spring, fall	Weekly (fall migration)
Shiloh I, CA (2006-2009)	100	150	65	100	105-m radius	3 years	Weekly
Shiloh II, CA (2009-2010)	75	150	33 turbs = 115; 42 turbs = 125	25	100m radius	1 yr	Once/week
SMUD Solano, CA (2004-2005)	22	15	65	22	60-m radius	1 year	Bi-monthly
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, 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
Stetson Mountain I, ME (2011)	38	57	80	19	varied	6 months	Weekly
Stetson Mountain II, ME (2010)	17	25.5	80	17	varied	6 months	Weekly (3 turbines twice a week)
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 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

Appendix C5. 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
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
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	NA	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
Wolfe Island, Ont (July-December 2011)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly

Appendix C5 (*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	Leaning Juniper, OR (06-08)	Gritski et al. 2008
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Lempster, NH (09)	Tidhar et al. 2010
Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Lempster, NH (10)	Tidhar et al. 2011
Barton I & II, IA (10-11)	Derby et al. 2011a	Linden Ranch, WA (10-11)	Enz and Bay 2011
Barton Chapel, TX (09-10)	WEST 2011	Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011
Beech Ridge, WV (12)	Tidhar et al. 2013b	Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011
Beech Ridge, WV (13)	Kagan et al. 2014	Madison, NY (01-02)	Kerlinger 2002b
Big Horn, WA (06-07)	Kronner et al. 2008	Maple Ridge, NY (06)	Jain et al. 2007
Big Smile, OK (12-13)	Derby et al. 2013b	Maple Ridge, NY (07)	Jain et al. 2009a
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Maple Ridge, NY (07-08)	Jain et al. 2009d
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Maple Ridge, NY (12)	Tidhar et al. 2013a
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Marengo I, WA (09-10)	URS Corporation 2010b
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Marengo II, WA (09-10)	URS Corporation 2010c
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Mars Hill, ME (07)	Stantec 2008
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Mars Hill, ME (08)	Stantec 2009a
Buena Vista, CA (08-09)	Insignia Environmental 2009	McBride, Alb (04)	Brown and Hamilton 2004
Buffalo Gap I, TX (06)	Tierney 2007	Melancthon, Ont (Phase I; 07)	Stantec Ltd. 2008
Buffalo Gap II, TX (07-08)	Tierney 2009	Meyersdale, PA (04)	Arnett et al. 2005
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Moraine II, MN (09)	Derby et al. 2010d
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Mount Storm, WV (Fall 08)	Young et al. 2009b
Buffalo Ridge, MN (94-95)	Osborn et al. 1996, 2000	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000a	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000a	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000a	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000a	Mountaineer, WV (04)	Arnett et al. 2005
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000a	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a	Nine Canyon, WA (02-03)	Erickson et al. 2003b
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Noble Altona, NY (10)	Jain et al. 2011b
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Noble Bliss, NY (08)	Jain et al.2009e
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000a	Noble Bliss, NY (09)	Jain et al. 2010a
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Noble Bliss/Wethersfield, NY (11)	Kerlinger et al. 2011
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Noble Chateaugay, NY (10)	Jain et al. 2011c
Buffalo Ridge I, SD (09-10)	Derby et al. 2010b	Noble Clinton, NY (08)	Jain et al. 2009c
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Noble Clinton, NY (09)	Jain et al. 2010b
Casselman, PA (08)	Arnett et al. 2009a	Noble Ellenburg, NY (08)	Jain et al. 2009b
Casselman, PA (09)	Arnett et al. 2010	Noble Ellenburg, NY (09)	Jain et al. 2010c
Casselman Curtailment, PA (08)	Arnett et al. 2009b	Noble Wethersfield, NY (10)	Jain et al. 2011a
Castle River, Alb. (01)	Brown and Hamilton 2006a	NPPD Ainsworth, NE (06)	Derby et al. 2007
Castle River, Alb. (02)	Brown and Hamilton 2006a	Oklahoma Wind Energy Center, OK (04; 05)	Piorkowski and O'Connell 2010
Cedar Ridge, WI (09)	BHE Environmental 2010	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Cedar Ridge, WI (10)	BHE Environmental 2011	Pine Tree, CA (09-10, 11)	BioResource Consultants 2012
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 2011	Pinyon Pines I&II, CA (13-14)	Chatfield and Russo 2014
Combine Hills, OR (Phase 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
Condon, OR	Fishman Ecological Services 2003	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
Crescent Ridge, IL (05-06)	Kerlinger et al. 2007	PrairieWinds SD1 (Crow Lake), SD (12-13)	Derby et al. 2013a
Criterion, MD (11)	Young et al. 2012a	PrairieWinds SD1 (Crow Lake), SD (13-14)	Bay et al. 2015
Criterion, MD (12)	Young et al. 2013	Prince Wind Farm, Ont (06)	Natural Resource Solutions 2009
Crystal Lake II, IA (09)	Derby et al. 2010a	Prince Wind Farm, Ont (07)	Natural Resource Solutions 2009
Diablo Winds, CA (05-07)	WEST 2006, 2008	Prince Wind Farm, Ont (08)	Natural Resource Solutions 2009
Dillon, CA (08-09)	Chatfield et al. 2009	Red Canyon, TX (06-07)	Miller 2008
Dry Lake I, AZ (09-10)	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)	Jeffrey et a. 2009b	Ripley, Ont (08-09)	Golder Associates 2010
Elkhorn, OR (10)	Enk et al. 2011b	Rugby, ND (10-11)	Derby et al. 2011b
Elm Creek, MN (09-10)	Derby et al. 2010c	San Gorgonio, CA (97-98; 99-00)	Anderson et al. 2005
Elm Creek II, MN (11-12)	Derby et al. 2012b	Searsburg, VT (97)	Kerlinger 2002a
Erie Shores, Ont. (06)	James 2008	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. 2010b
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b	SMUD Solano, CA (04-05)	Erickson and Sharp 2005
Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003b	Stateline, OR/WA (01-02)	Erickson et al. 2004
Forward Energy Center, WI (08-10)	Grodsky and Drake 2011	Stateline, OR/WA (03)	Erickson et al. 2004
Fowler I, IN (09)	Johnson et al. 2010a	Stateline, OR/WA (06)	Erickson et al. 2007
Fowler I, II, III, IN (10)	Good et al. 2011	Steel Winds I, NY (07)	Grehan 2008

Appendix C5 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Fowler I, II, III, IN (11)	Good et al. 2012	Stetson Mountain I, ME (09)	Stantec 2009c
Fowler I, II, III, IN (12)	Good et al. 2013	Stetson Mountain I, ME (11)	Normandeau Associates 2011
Fowler III, IN (09)	Johnson et al. 2010b	Stetson Mountain II, ME (10)	Normandeau Associates 2010
Goodnoe, WA (09-10)	URS Corporation 2010a	Summerview, Alb (05-06)	Brown and Hamilton 2006b
Grand Ridge I, IL (09-10)	Derby et al. 2010g	Summerview, Alb (06; 07)	Baerwald 2008
Harrow, Ont (10)	Natural Resource Solutions 2011	Tehachapi, CA (96-98)	Anderson et al. 2004
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Top of Iowa, IA (03)	Jain 2005
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Top of Iowa, IA (04)	Jain 2005
High Sheldon, NY (10)	Tidhar et al. 2012a	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
High Sheldon, NY (11)	Tidhar et al. 2012b	Vansycle, OR (99)	Erickson et al. 2000a
High Winds, CA (03-04)	Kerlinger et al. 2006	Vantage, WA (10-11)	Ventus Environmental Solutions 2012
High Winds, CA (04-05)	Kerlinger et al. 2006	Vasco, CA (12-13)	Brown et al. 2013
Hopkins Ridge, WA (06)	Young et al. 2007	Wessington Springs, SD (09)	Derby et al. 2010f
Hopkins Ridge, WA (08)	Young et al. 2009c	Wessington Springs, SD (10)	Derby et al. 2011d
Jersey Atlantic, NJ (08)	NJAS 2008a, 2008b, 2009	White Creek, WA (07-11)	Downes and Gritski 2012b
Judith Gap, MT (06-07)	TRC 2008	Wild Horse, WA (07)	Erickson et al. 2008
Judith Gap, MT (09)	Poulton and Erickson 2010	Windy Flats, WA (10-11)	Enz et al. 2011
Kewaunee County, WI (99-01)	Howe et al. 2002	Winnebago, IA (09-10)	Derby et al. 2010e
Kibby, ME (11)	Stantec 2012	Wolfe Island, Ont (May-June 09)	Stantec Ltd. 2010a
Kittitas Valley, WA (11-12)	Stantec Consulting 2012	Wolfe Island, Ont (July-December 09)	Stantec Ltd. 2010b
Klondike, OR (02-03)	Johnson et al. 2003b	Wolfe Island, Ont (January-June 10)	Stantec Ltd. 2011a
Klondike II, OR (05-06)	NWC and WEST 2007	Wolfe Island, Ont (July-December 10)	Stantec Ltd. 2011b
Klondike III, OR (Phase I; 07-09)	Gritski et al. 2010	Wolfe Island, Ont (January-June 11)	Stantec Ltd. 2011c
Klondike IIIa, OR (Phase II; 08-10)	Gritski et al. 2011	Wolfe Island, Ont (July-December 11)	Stantec Ltd. 2012