Post-Construction Avian and Bat Mortality Monitoring at the Alta X Wind Energy Project Kern County, California

Final Report for the Second Year of Operation

April 2015 – April 2016

Prepared for

Alta Wind X, LLC

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WEST Inc.

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 "Project"). Consistent with 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 second year of operation of the Project, April 2015 to April 2016.

As stated in the DEIR, the goal of the mortality monitoring study is determine the level of incidental injury and mortality to 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 consisted 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 search plots surrounding selected 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 19 birds, representing 11 identifiable species, and two bats representing two identifiable species, were found during standardized carcass searches within the Project. An additional three bird carcasses and one bat carcass were found incidentally. The most common bird species found during searches or incidentally were northern flicker (three mortalities) and mourning dove (two mortalities). No diurnal raptor mortalities were found during the second year of operation. Bird mortalities were distributed throughout the year, with the highest rates occurring in spring for both large birds and small birds. The two bat mortalities (one California myotis and one Mexican free-tailed bat) were found during summer and winter, respectively. One hoary bat carcass was also found incidentally in the fall.

A total of 239 bird carcasses were included in searcher efficiency trials. Overall searcher efficiency rates were 81% for small birds and 94% for large birds. A total of 320 carcasses were used in carcass removal trials (110 large birds, 157 small birds, 46 mice, and seven bats), which showed that by day 10, roughly 45% of large birds, 5% 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 and ranged from 19.03 days in fall to 30.42 days in the winter for large birds and from 2.38 days to 3.81 days for small birds. For bats/bat substitutes, the mean carcass removal times ranged from 1.42 days in the fall to 2.27 days in the winter.

Mortality estimates were adjusted 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 fall to 0.16 during winter. For large birds, this probability was higher, and ranged from 0.60 during fall, to 0.72 during winter. For bats, the probability that a carcass would remain in the search plot and be found by a searcher remained low and ranged between 0.05 in summer and fall to 0.08 in winter. Based on the 2.85-megawatt (MW) capacity of the turbines at the Project, the estimated mortality rate for birds was 2.17 birds/MW/year. No raptor mortalities were found during the study period, therefor the raptor fatality estimate was zero/MW/year. The estimated mortality rate for bats was 0.8 bats per MW per year.

Estimated overall bird mortality decreased from 3.96 birds/MW/year in Year 1 to 2.17 birds/MW/year in Year 2, which was primarily the result of a relatively large reduction in small bird mortality compared to a small increase in large bird mortality. Raptor fatality rates were consistently low across years, with only one diurnal raptor mortality found during the two years of study, while bat mortality estimates increased from Year 1 to Year 2, even though the same number of fatalities (two) was found each year.

Results of the second year of mortality monitoring at Alta X illustrate the annual variability inherent in estimating bird and bat mortality. Although bird and bat mortality during the first and second years of monitoring did vary some, diurnal raptor and bat mortality estimates were generally low compared to other wind energy facilities in California, while all bird mortality was considered to be more moderate among California projects. Results from the two years of monitoring at Alta X do not suggest that levels of bird and bat mortality will result in substantial impacts to bird and bat populations. However, a third year of mortality monitoring is ongoing at Alta X (2016-2017), which upon completion, will be assessed along with the first two years of data to provide a clearer picture of the impacts of Alta X on birds and bats.

STUDY PARTICIPANTS

Western EcoSystems Technology

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REPORT REFERENCE

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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 "Project"). As described in 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) *Land-Based Wind Energy Guidelines* (WEG; USFWS 2012) and the *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development* (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 second year of operation, from April 2015 to April 2016.

The goal of the mortality monitoring study was to determine the level of incidental injury and mortality to populations of avian or bat species in the vicinity of the Project (Kern County 2012). 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 the DEIR (Kern County 2012).

Year 2 of post-construction mortality monitoring at the Project was conducted from April 10, 2015, through April 7, 2016. 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). Alta X comprises 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). The WTGs have a hub height of approximately 328 feet (ft; 100 meters [m]) and a rotor diameter of approximately 338 ft (103 m).

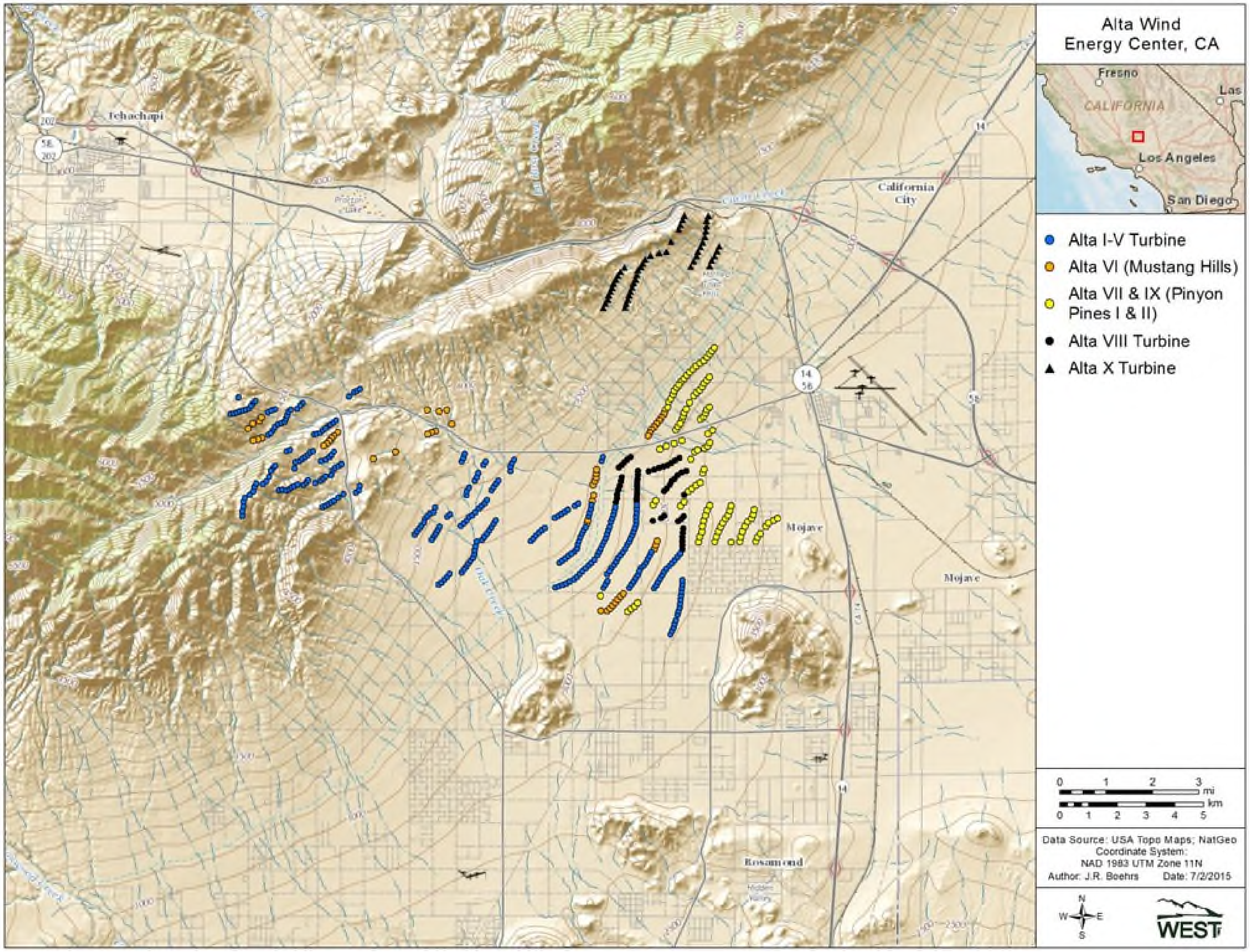

Figure 1. Location of the Alta X Wind Energy Project within the larger Alta Wind Energy Center.

The Project is located 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 and transition into Mojave Desert to 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 waters within the Project. Highway 58 passes just north the Project, 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 is located within a region of high-density wind energy development, known as the Tehachapi Wind Resource Area (WRA). Alta X is part of the larger Alta Wind Energy Center, which consists of nine additional phases (Alta I-IX), which are all located to the south of Alta X (Figure 1). The Rising Tree Wind Energy Facility is located immediately south of the Project. Additional wind energy facilities are located to the south and west of the Project.

METHODS

Bird and Bat Mortality Monitoring

The primary objectives of the mortality monitoring study were to estimate the level of bird and bat mortality attributable to collisions with wind turbines at the facility on an annual basis and assess whether the estimated mortality at the Project was lower, similar to, or higher than the average mortality observed at other WRAs, both regionally and within the western US. The methods for the mortality study were divided 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 remained in the field for possible detection; and 4) calculation of adjusted mortality estimates for bird and bat species using the results from searcher efficiency and carcass removal trials.

Standardized Carcass Searches

The objective of the standardized carcass searches was to systematically search the ground beneath turbines for avian and bat mortalities assumed to have been caused by Project facilities.

Searches at turbines were conducted within square plots measuring a minimum 240-m by 240-m (787-ft by 787-ft) 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 an additional area that extended to the center point of the adjacent turbine or turbines if present. Search plots were originally selected using a constrained random sample, such that the search effort was distributed throughout Alta X and all habitats and topographies were represented. Carcass searches were conducted at the same 11 plots 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 turbines and covered an area equivalent to searching approximately 15 240-m by 240-m plots, or 31% of turbines (Table 1). 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 WEST.

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 the location of the carcass or feather spot in relation to the closest wind turbine or other project facilities, such as overhead power lines. The condition of each carcass found was recorded using the following categories:

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

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.

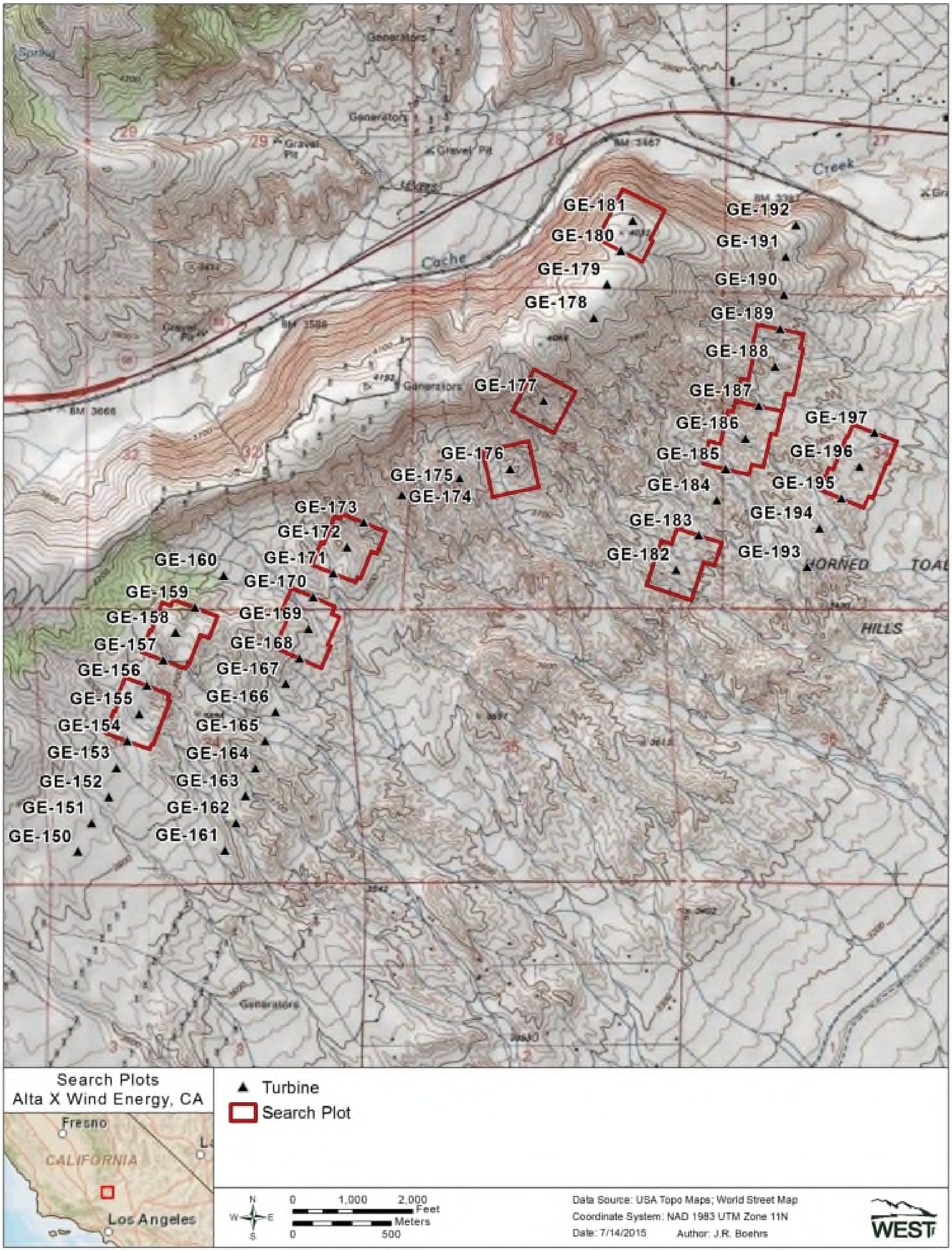

Figure 2. Location of search plots at the Alta X Wind Energy Project.

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	**633,600**	**218,762**	**852,362**
Equivalent Number of Turbines	**11**	**3.8**	**14.8**

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 photograph 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 (February 29 – June 2), summer (June 3 – September 2), fall (September 3 – November 15), and winter (November 16 – June 2) at each of the 11 search plots.

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of mortalities found by searchers. Efficiency trials were conducted between 2014 and 2016 at Alta X and other facilities throughout the larger Alta Wind Energy Center. To produce a larger sample size and more robust dataset, results of efficiency trails were pooled among the studies when there was no statistical difference. Searcher efficiency trials were conducted in the same areas as carcass surveys and searcher efficiency was estimated by the size of the carcasses and the season. Estimates of searcher efficiency were used to adjust the total number of carcasses found for those missed by searchers, correcting for detection bias.

Personnel conducting carcass surveys did not know when searcher efficiency trials were being conducted or the location of the trial carcasses. 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*]). Brown mice (*Mus musculus*) were included in searcher efficiency trials as surrogates for bats.

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. Carcass removal trials were conducted at Alta I-V and other nearby phases of the Alta Wind Energy Center. Removal trial carcasses were of similar composition to those used for searcher efficiency trials, except that 44 carcasses (12 large birds, 25 small birds, and seven bats) included in removal trials were actual mortalities found during the mortality searches or incidentally that were left in the field and monitored as trial carcasses.

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 removed by scavenging or 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

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following 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.

Mortality Surveys

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 was either unknown or attributed to the facility

n the number of search plots

k the number of turbines searched (including the turbines centered within each search plot)

$\bar{c}$ the average number of carcasses observed per turbine per monitoring year

s the number of carcasses used in removal trials

s_c the number of carcasses in removal trials that remained in the study area after 40 days

t_j the time (in days) carcass j remained in the study area before it was 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 was:

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

Estimation of Carcass Non-Removal Rates

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

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

Estimation of Searcher Efficiency Rates

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

Estimation of Facility-Related Mortality Rates

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

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

where $\hat{\pi}$ included 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 5^{th} and upper 95^{th} 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

The 11 search plots were each searched from 16 to 19 times over the course of the mortality monitoring study, for a total of 203 plot searches. Twenty-two 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, with a full list of mortalities presented in Appendix A.

Bird Mortality

Nineteen birds comprising 11 identifiable species were found during scheduled searches (Table 2, Figure 3). Three bird mortalities were found incidentally outside of search plots and were, therefore, not included in the mortality rate estimation (Table 2). The most common bird species found were northern flicker (*Colaptes auratus*; three) and mourning dove (*Zenaida macroura*; two mortalities) Unidentifiable species totaled seven casualties: four unidentified small birds (found during scheduled search), one unidentified sparrow (found incidentally off-plot), and two unidentified warblers (one incidental find and one during scheduled search; Table 2). No state or federally listed bird species or species of concern were found during the study.

The greatest number of bird mortalities found at any one search plot was seven mortalities at Plot GE-155, and four at Plot GE-182. It is worth noting that Plot GE-155 is essentially two plots that encompass areas associated with three turbines (see Figure 2 and Table 1). All other search plots had two or fewer bird mortalities during the year-long study, with five of the 11 search plots having no documented bird mortalities (Figures 2, 3, and 4). Bird mortalities were distributed throughout the search plots, with 35.7% found between 90 and 120 m (295 and 394 ft), while 21.4% were found between 50 and 60 m (164 and 196 ft) from turbines (Table 3, Figure 5). Bird mortalities were distributed throughout the year, with the highest rates occurring in spring for both large birds and small birds (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 April 10, 2015 – April 7, 2016.

Species	Mortalities during Scheduled Searches		Incidentals Found Outside Search Plots		Total	
	Total	% Comp.	Total	% Comp.	Total	% Comp.
Birds						
unidentified bird (small)	4	21.1	0	0	4	0.18
northern flicker	3	15.8	0	0	3	0.14
mourning dove	2	10.5	0	0	2	0.09
greater roadrunner	2	10.5	0	0	2	0.09
unidentified warbler	1	5.3	1	0.33	2	0.09
black-and-white warbler	1	5.3	0	0.00	1	0.05
California quail	1	5.3	0	0.00	1	0.05
cinnamon teal	1	5.3	0	0.00	1	0.05
fox sparrow	1	5.3	0	0.00	1	0.05
house wren	1	5.3	0	0.00	1	0.05
orange-crowned warbler	1	5.3	0	0.00	1	0.05
rufous-crowned sparrow	1	5.3	0	0.00	1	0.05
pine siskin	0	0	1	0.33	1	0.05
unidentified sparrow	0	0	1	0.33	1	0.05
Overall Birds	**19**	**100**	**3**	**100**	**22**	**100**
Bats						
California myotis	1	50	0	0	1	33.3
Mexican free-tailed bat	1	50	0	0	1	33.3
hoary bat	0	0	1	100	1	33.3
Overall Bats	**2**	**100**	**1**	**100**	**3**	**100**

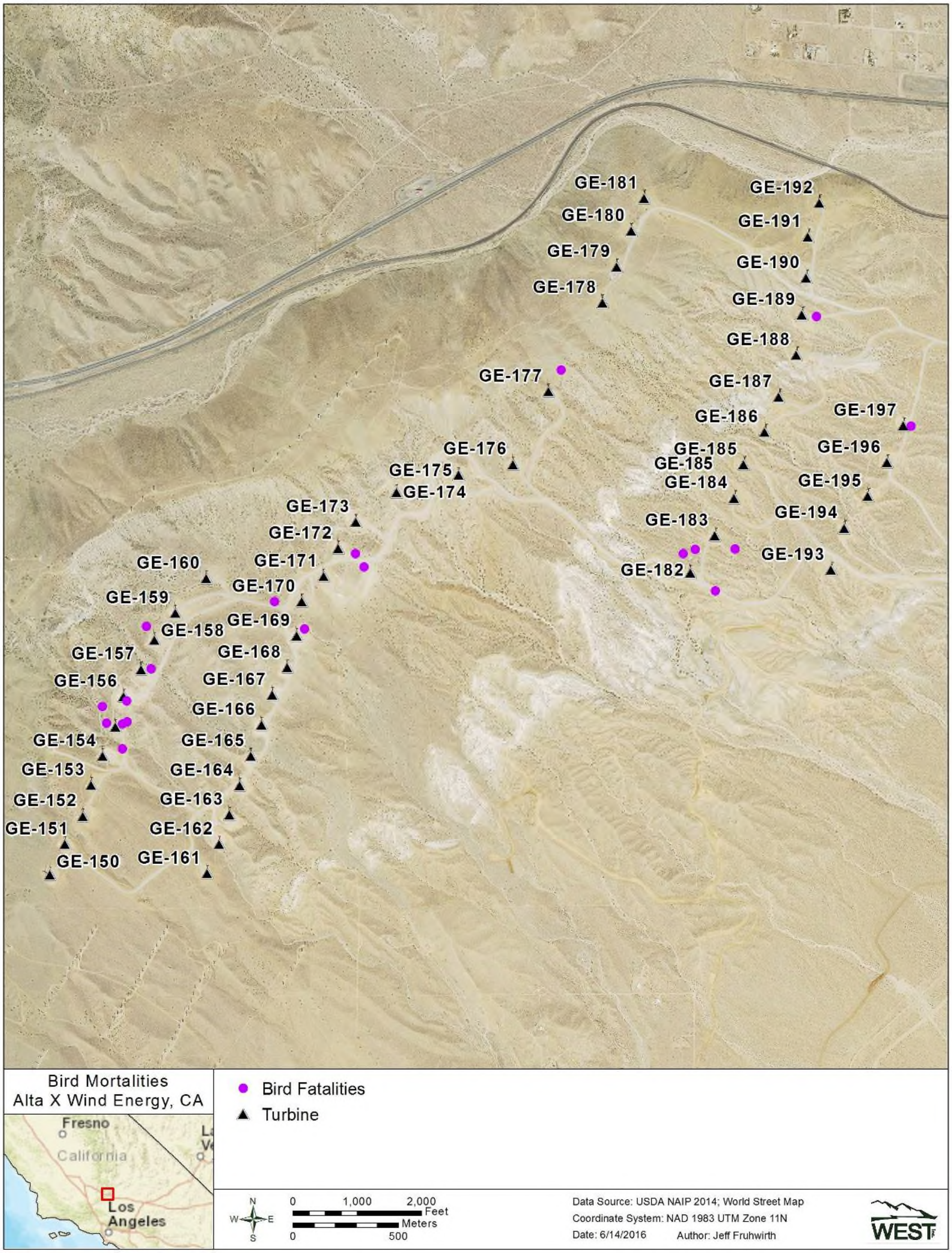

Figure 3. Location of all bird mortalities found at the Alta X Wind Energy Project.

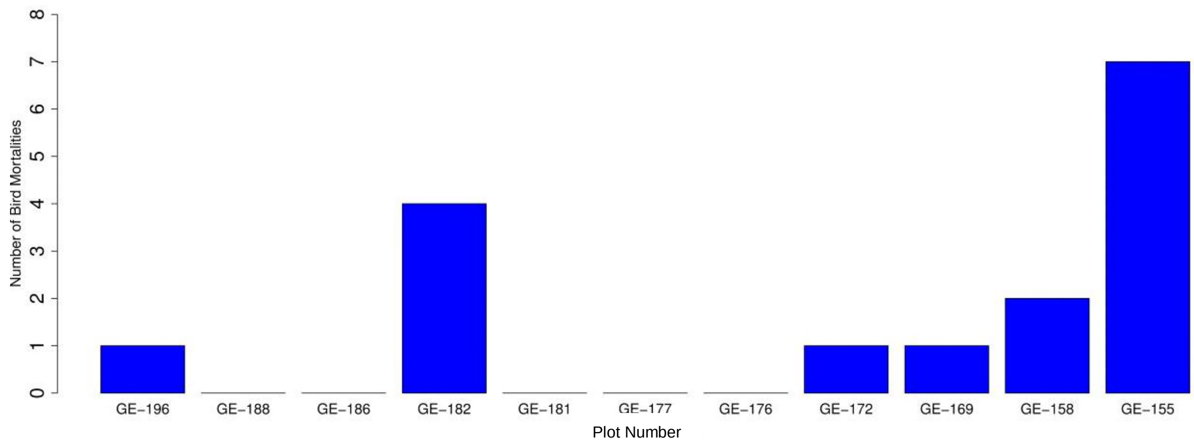

Figure 4. Number of bird mortalities found during scheduled searches within search plots at the Alta X Wind Energy Project.

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	0	0
10 to 20	0	50.0
20 to 30	7.1	0
30 to 40	7.1	0
40 to 50	7.1	0
50 to 60	21.4	50.0
60 to 70	7.1	0
70 to 80	7.1	0
80 to 90	7.1	0
>90	35.7	0

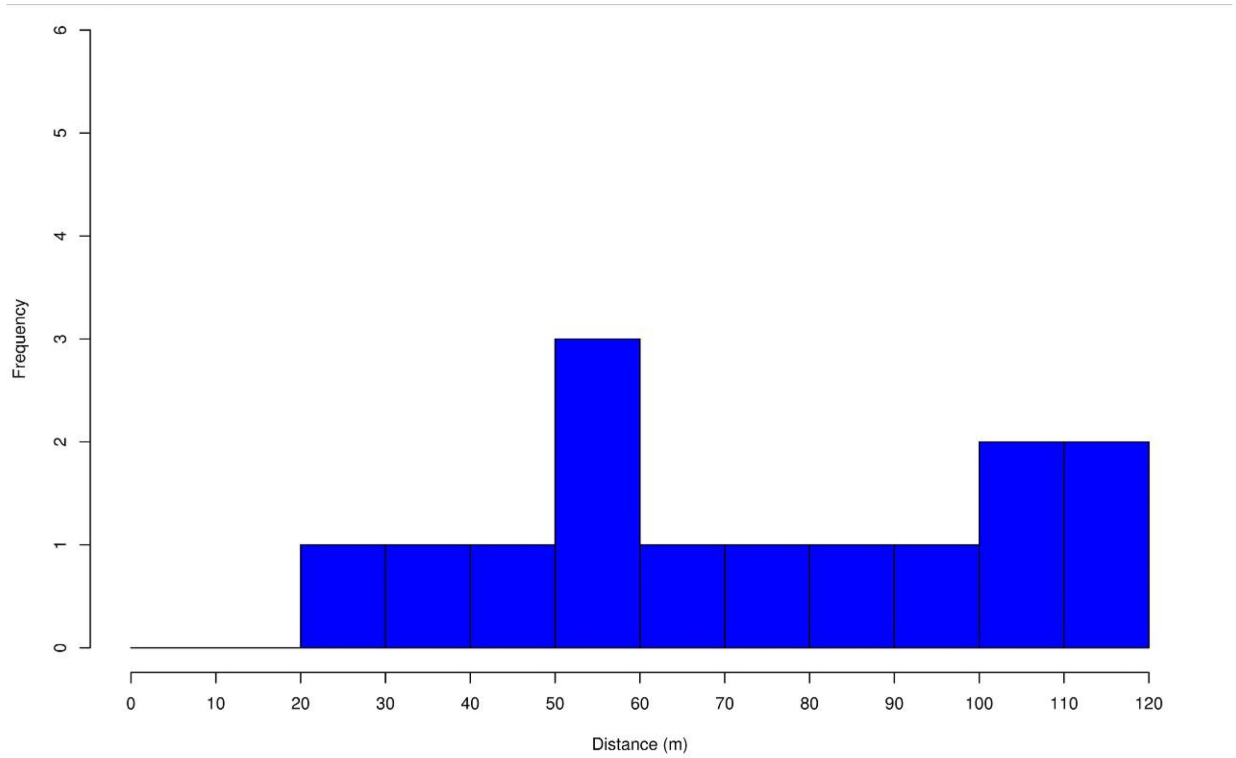

Figure 5. Distance from the turbine of bird mortalities found during scheduled searches and incidentally at the Alta X Wind Energy Project.

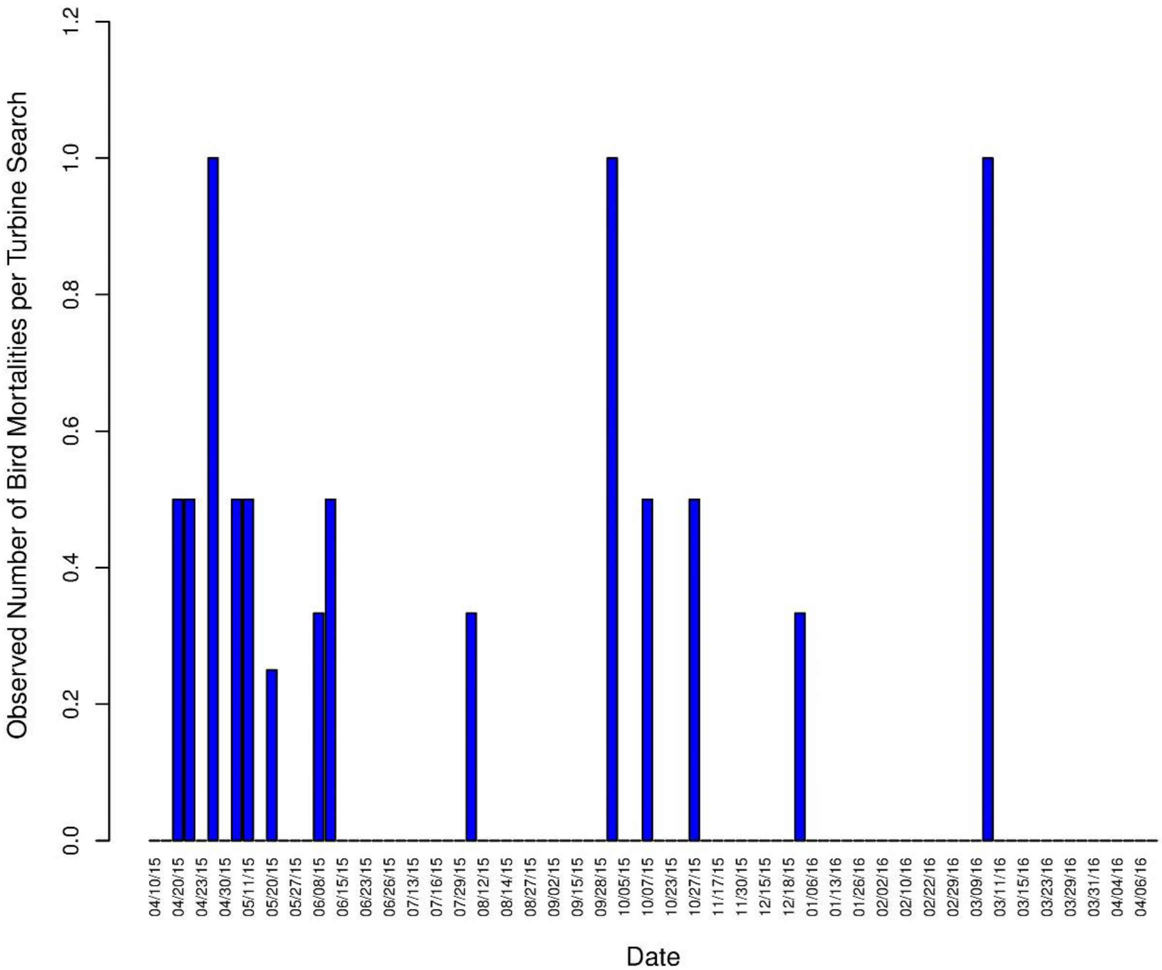

Figure 6. Timing by turbine of bird mortalities found within search plots at the Alta X Wind Energy Project.

Bat Mortality

Two bat mortalities, a Mexican free-tailed bat (*Tadarida brasiliensis*; found in the winter) and a California myotis (*Myotis californicus;* found in the summer) were found during scheduled turbine searches. These mortalities were located at Plot GE-155 and Plot GE-169, respectively (Table 2, Figure 7, Appendix A). One bat mortality, a hoary bat (*Lasiurus cinereus)*, was found incidentally near Turbine GE-191 during the fall.

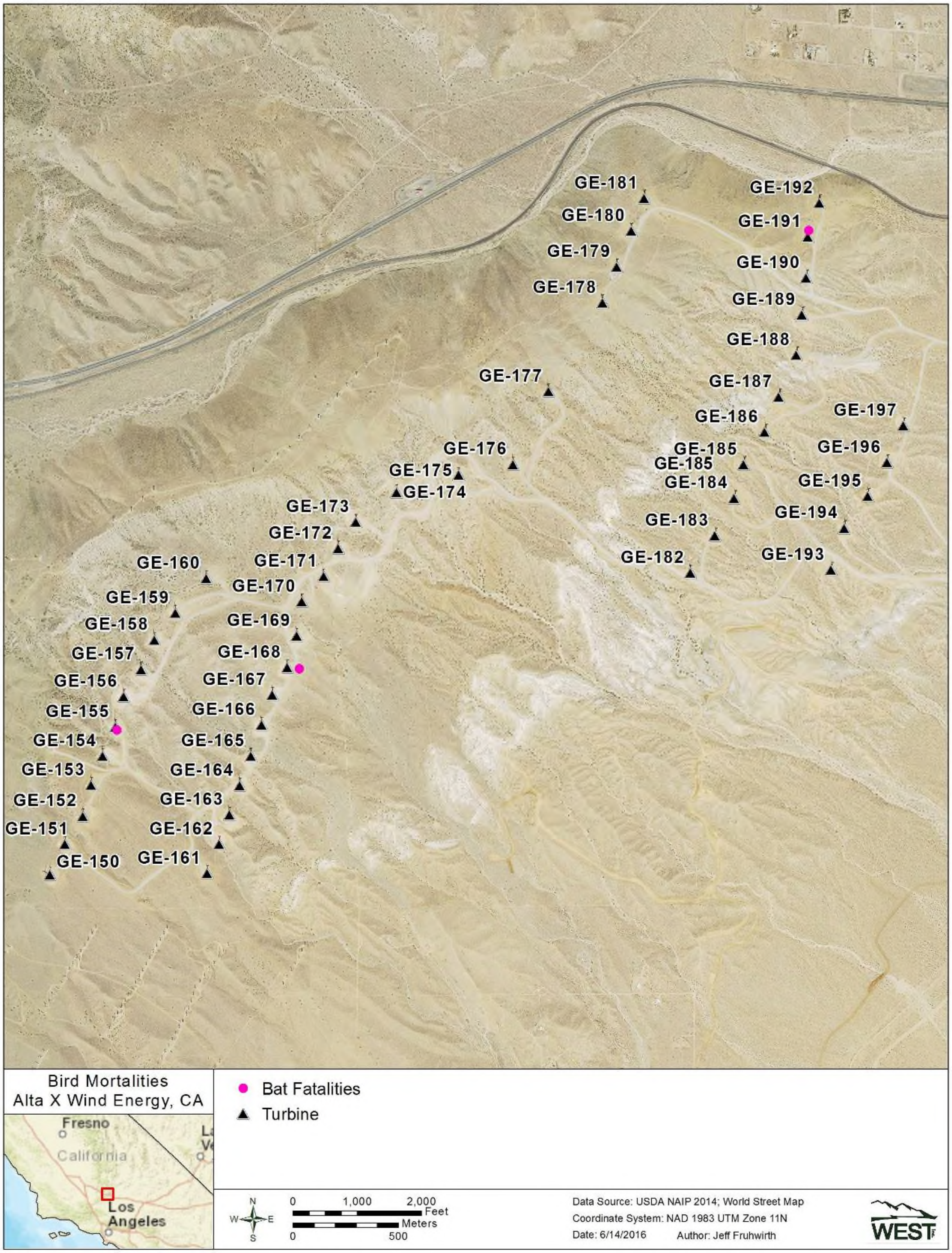

Figure 7. Location of all bat mortalities found at the Alta X Wind Energy Project.

Searcher Efficiency Trials

A total of 239 bird carcasses were used in searcher efficiency trials conducted in the Alta Wind Energy Center from May 2014 through April 2016 (Table 4). Because no bat carcasses were available for searcher efficiency trails, brown mice were used as a substitute for bat searcher efficiency trials. Forty-seven brown mice carcasses were used in searcher efficiency trials from May 2014 through April 2016. Searcher efficiency did not differ significantly across years or across season, therefore data were pooled and a single searcher efficiency estimate was calculated for each carcass size class (large bird, small bird, and bat). The overall searcher efficiency rate for large birds was 94.4%, compared to 81.2% for small birds, and 69.2% for bats (Table 4).

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
Large Birds	5/15/2014	2	2	2	100
	6/5/2014	2	2	2	100
	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
	8/26/2015	10	10	10	100
	8/31/2015	5	5	5	100
	11/11/2015	5	5	4	80.0
	12/8/2015	5	5	5	100
	2/8/2016	5	5	5	100
	2/10/2016	3	3	3	100
	3/29/2016	1	1	1	100
	3/31/2016	2	2	2	100
	4/12/2016	2	2	2	100
Large Bird Total		**72**	**72**	**68**	**94.4**

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	5/15/2014	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
	8/26/2015	20	18	16	88.9
	8/31/2015	8	8	7	87.5
	11/11/2015	12	7	7	100
	12/8/2015	10	10	8	80.0
	2/8/2016	15	13	13	100
	2/10/2016	7	3	2	66.7
	3/23/2016	5	5	2	40.0
	3/29/2016	4	4	3	75.0
	3/31/2016	11	11	10	90.9
	4/12/2016	7	6	5	83.3
Small Bird Total		**167**	**149**	**121**	**81.2**
Bats	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
	8/26/2015	8	6	4	66.7
	8/31/2015	2	2	2	100
	11/11/2015	3	1	0	0
	12/8/2015	1	1	1	100
	3/31/2016	2	1	1	100
	4/12/2016	1	0	0	-
Bat Total		**47**	**39**	**27**	**69.2**

Carcass Removal Trials

A total of 320 carcasses were used in carcass removal trials conducted at the Alta Wind Energy Center from April 2014 through April 2016, including 110 large birds, 157 small birds, and 53 bats (or bat substitutes, such as mice (*Mus musculus*) or small brown birds). Forty-four of these carcasses (12 large birds, 25 small birds, and seven bats) were actual mortalities found during the mortality searches or incidentally and left in the field and monitored for carcass removal trials.

A total of 320 carcasses were used in carcass removal trials conducted within the Alta Wind Energy Center in 2014-2016 (110 large birds, 157 small birds, 46 mice, and seven bats). By day 10, roughly 50% of large birds, 10% of small birds, and 3% of bats or bat substitutes remained in the search area. By day 30, roughly 45% of large bird carcasses, 5% of small bird carcasses, and 2% of bat or bat substitute carcasses persisted within the search area (Figure 8). The mean carcass removal time for large birds, small birds, and bats varied by season, with removal times being shortest in the fall and longest in the winter (Appendix B). Mean carcass removal times ranged from 19.03 days in fall to 30.42 days in the winter for large birds and from 2.38 days to 3.81 days for small birds (Appendix B1). For bats/bat substitutes, the mean carcass removal times ranged from 1.42 days in the fall to 2.27 days in the winter (Appendix B2).

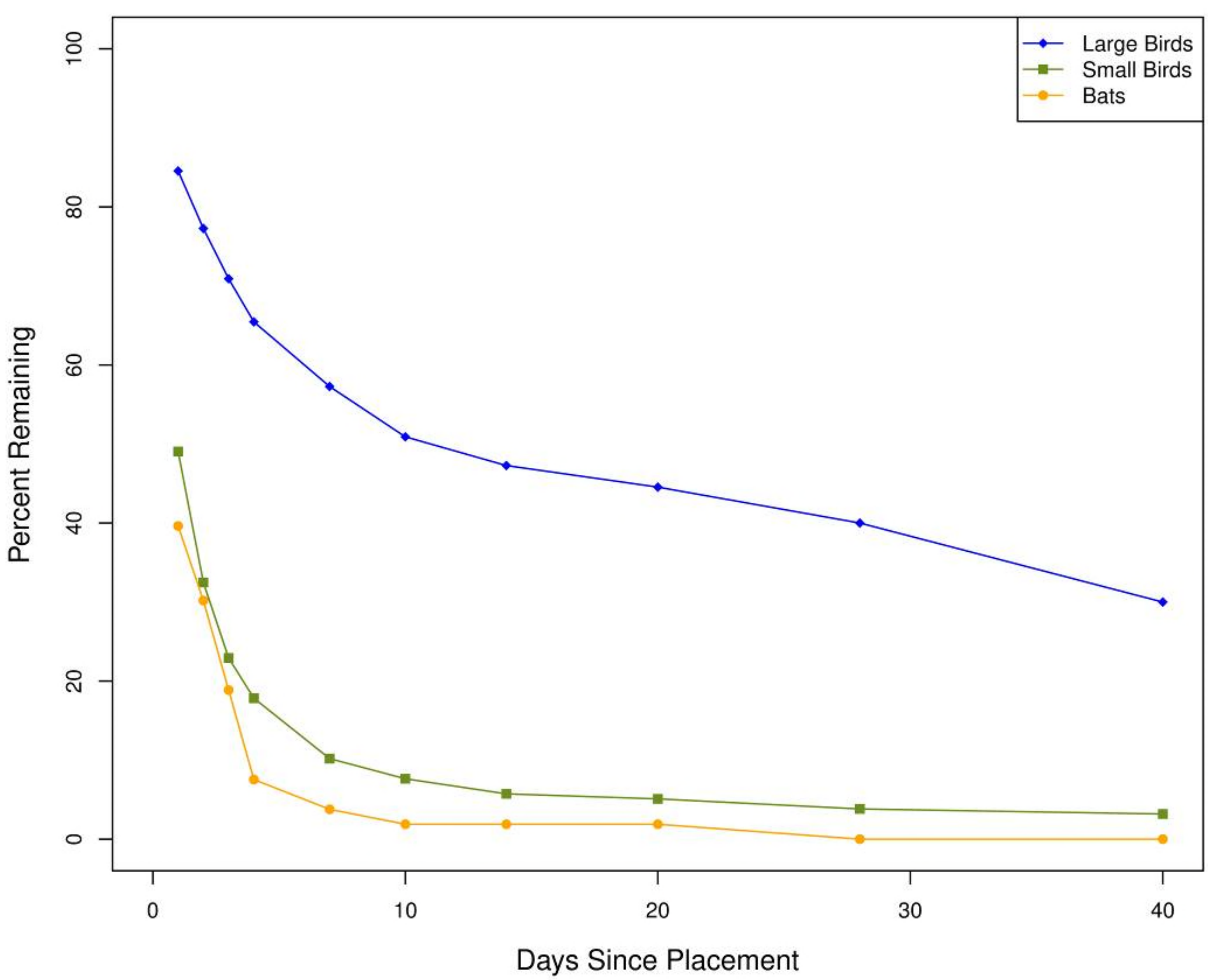

Figure 8. Carcass removal rates at the Alta Wind Energy Center.

Adjusted Mortality Estimates

Seasonal and annual mortality estimates and 90% confidence intervals were calculated on a per turbine and per MW basis for each bird or bat category (Table 5; Appendix B). The mortality estimates were adjusted based on the corrections for carcass removal and searcher efficiency bias (Appendix B). Because 100% of each search plot was surveyed, no search area correction factor was applied. Searcher efficiency rates did not differ significantly throughout the study period (Appendix B). For small birds, the probability that a carcass would remain in a search plot and be found by a searcher ranged from 0.10 during fall to 0.16 during winter (Appendix B1). For large birds, this probability ranged from 0.60 during fall to 0.72 during winter (Appendix B1). For bats/bat substitutes, the probability that a carcass would remain in the search plot and be found by a searcher remained ranged from 0.05 in summer and fall to 0.08 during winter (Appendix B2).

Table 5. Adjusted bird and bat mortality estimates for the Alta X Wind Energy Project from April 10, 2015 – April 7, 2016. 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	5.47	2.60 – 9.94
large birds	0.73	0.29 – 1.26
diurnal raptors	0	-
all birds	6.20	3.38 – 10.73
bats	2.27	-
	# mortalities/MW/year	
small birds	1.92	0.91 – 3.49
large birds	0.25	0.10 – 0.44
diurnal raptors	0	-
all birds	2.17	1.19 – 3.77
bats	0.80	-

Small Birds

Estimated mortality for small birds was highest during the spring, summer, and fall (0.72, 0.68, and 0.52 birds/MW/season, respectively), and zero during the winter (Appendix B). Combining all seasons, the overall estimated mortality for small birds within the Project was 1.92 birds/MW/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 for large birds was highest during the spring (0.14 birds/MW), followed by the fall (0.04 birds/MW) and summer (0.04 birds/MW), and winter (0.03 birds/MW; Appendix B). Combining all seasons, the overall estimated mortality rate for large birds within the Project was 0.25 birds/MW/year (Table 5). A detailed breakdown of large bird mortality rates and the associated correction factors is presented in Appendix B.

Diurnal Raptors

No raptor mortalities were found during the second year of mortality monitoring at Alta X; therefore, the estimated mortality rate for diurnal raptors was zero raptors/MW/year (Appendix B).

All Birds

Estimated mortality for all birds were highest during the spring (0.86 birds/MW), followed by summer, fall, and winter (0.71, 0.57, 0.09, respectively; Appendix B). Combining all seasons, the overall estimated mortality for all birds within the Project was 2.17 birds/MW/year (Table 5). A detailed breakdown of all bird mortality rates and the associated correction factors is presented in Appendix B.

Bats

Estimated mortality for bats was 0.44 bats/MW/season in the summer and 0.35 bats/MW/season in the spring. No bat mortalities were found during the fall and winter (Appendix B). The overall estimated mortality for bats within the Project was 0.80 bats/MW/year. A detailed breakdown of bat mortality rates and the associated correction factors is presented in Appendix B.

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. We accounted for this by conducting scavenging trials throughout the year and compared data to prior years, combining data to enhance sample sizes when there were no significant differences among seasons or years. We also estimated searcher efficiency rates throughout the year to account for any biases associated with changes in conditions and again compared data to prior years.

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. Second, it was assumed that all carcasses found during the study were due to collision with wind turbines or associated infrastructure at the facility. 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). This is particularly true for ground nesting species such as California quail and greater roadrunner (*Geococcyx californianus*), which rarely fly within the rotor swept area, but are susceptible to both avian and mammalian predators. This factor would lead to an overestimate of avian mortality. Unlike birds, it is considered unlikely that any of the three bat casualties found during the study were due to factors unrelated to interactions with wind turbines.

Another potential bias that may affect mortality estimates may occur when no adjustments are made for mortalities that possibly occurred outside of the search plot boundaries. Plot boundaries were established a minimum distance of 120 m from the selected search turbines, which was based on results of other studies (Higgins et al. 1996; Erickson et al. 2004; Johnson et al. 2002b, 2003b, 2004; Kerlinger et al. 2007; Young et al. 2003c, 2005), in which a distance equal to the approximate height of the turbine appeared to capture a very large percentage of mortalities. Based on the distribution of carcasses as a function of distance from turbines, a small percentage of bird and bat carcasses possibly fell outside the search plots and may have been missed. This factor could lead to an underestimate of mortality.

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 some 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 birds as a group. Additionally, a combination of brown mice and bats were used to estimate carcass removal and searcher rates for bats.

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 9), 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, Pacific Northwest, Rocky Mountains, and Southwest regions), bird mortality rates have ranged from 0.16 to 17.44 birds/MW/year

(Appendix C1). The estimated annual bird mortality at Alta X for the 2015-2016 monitoring year (2.17 birds/MW/year) was lower than that estimated during first year of monitoring in 2014-2015 (4.88 birds/MW/year) and would be considered moderate compared to other wind energy facilities in western North America (Appendix C1). For the 2015-2016 monitoring period, the all bird mortality at Alta X (2.17 birds/MW/year) was slightly lower but comparable to the all bird mortality at Alta I (2.57; Thompson et al. 2016), which is located in the hilly terrain to the southwest of the Project. In contrast, 2015-2016 all bird mortality at Alta X was higher than that estimated for the Alta II-V (0.51 birds/MW/year; Thompson et al. 2016), which is located to the south of the Project and on the lower elevation and less topographically diverse desert floor. The decrease in estimated bird mortality observed at Alta X in year 2 (2015-2016) was also consistent with a decrease observed at the Alta I-V projects (Thompson et al. 2016), suggesting a more region wide reduction that may be a result of climactic or other conditions that vary from year to year. The majority (30%) of avian mortalities at Alta X were passerines, with those identifiable to species composed of both common seasonal residents and common Neotropical migrants (such as orange-crowned warbler [*Vermivora celata*], black and white warbler [*Mniotilta varia*], and pine siskin [*Carduelis pinus*]).

Diurnal raptor mortality estimates at wind energy facilities in California have ranged from zero to 1.06 birds/MW/year (Figure 10), 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). No raptors were found during the 2015-2016 study year at Alta X; therefore, the diurnal raptor mortality estimate for Alta X was very low at zero raptors/MW/year. Only one unidentified diurnal raptor was found during the first year of monitoring (2014-2015) at Alta X, further indicating that raptor mortality at Alta X is low relative to other California projects (Figure 10). Low raptor mortality observed during the first and second year of mortality monitoring at Alta X is consistent with the low diurnal raptor use observed during pre-construction surveys conducted at the Project (0.04 diurnal raptors/ 800-m plot/ per 20-minute survey; Erickson and Chatfield 2009; Appendix C2).

Bat Mortality

In California, bat mortality rates have ranged from zero to 3.92 bats/MW/year (Figure 11). At the Project, only three bat mortalities (during searches and incidental) were found during the second year of monitoring, resulting in an overall bat mortality of 0.8 bats/MW/year. This estimate is relatively 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 during the second year of monitoring (2015 – 2016) was higher than that estimated during the first year of monitoring (0.42/bats/MW/year), but was generally comparable to bat mortality at the other Alta projects (Figure 11). For the 2015-2016 monitoring period specifically, the bat mortality estimate at Alta X (0.8 bats/MW/year) was very consistent with that observed during a similar monitoring period at Alta I (0.7 bats/MW/year; Thompson et al. 2016). Based on the relatively 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 the Project will result in any substantial impacts to bat populations.

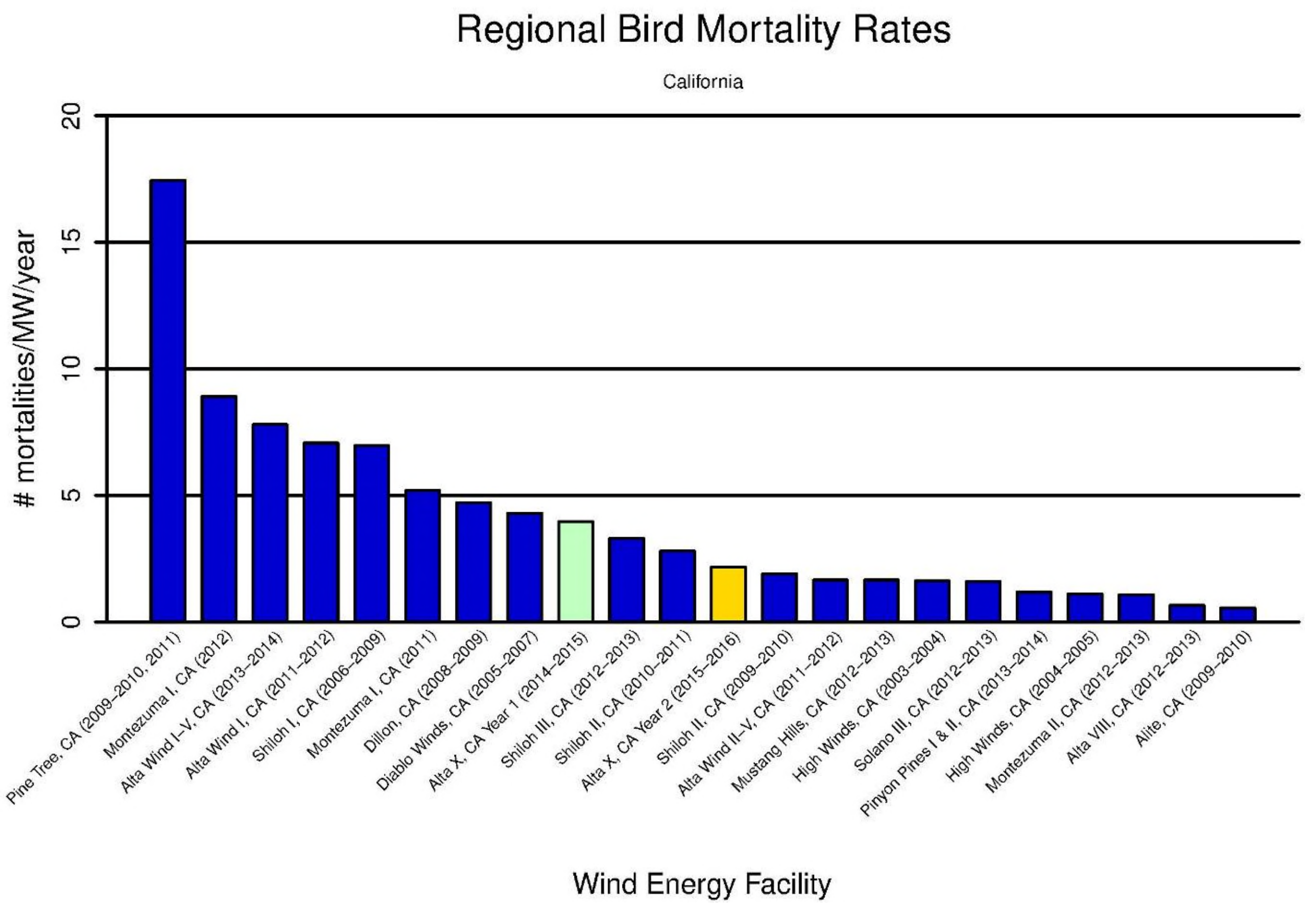

Figure 9. Mortality rates for all birds (number of birds per MW per year) at the Alta X Wind Energy Project compared with publicly-available studies at wind energy facilities in California.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Alta X, CA Year 1 (14-15)	Thompson et al. 2016				
Alta X, CA Year 2(15-16)	This study.				
Pine Tree, CA (09-10, 11)	BioResource Consultants 2012	Diablo Winds, CA (05-07)	WEST 2006, 2008	Solano III, CA (12-13)	AECOM 2013
Montezuma I, CA (12)	ICF International 2013	Shiloh III, CA (12-13)	Kerlinger et al. 2013b	Pinyon Pines I & II, CA (13-14)	Chatfield and Russo 2014
Alta Wind I-V, CA (13-14)	Chatfield et al. 2014	Shiloh II, CA (10-11)	Kerlinger et al. 2013a	High Winds, CA (04-05)	Kerlinger et al. 2006
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Shiloh II, CA (09-10)	Kerlinger et al. 2010	Montezuma II, CA (12-13)	Harvey & Associates 2013
Shiloh I, CA (06-09)	Kerlinger et al. 2009	Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Alta VIII, CA (12-13)	Chatfield and Bay 2014
Montezuma I, CA (11)	ICF International 2012	Mustang Hills, CA (12-13)	Chatfield and Bay 2014	Alite, CA (09-10)	Chatfield et al. 2010
Dillon, CA (08-09)	Chatfield et al. 2009	High Winds, CA (03-04)	Kerlinger et al. 2006		

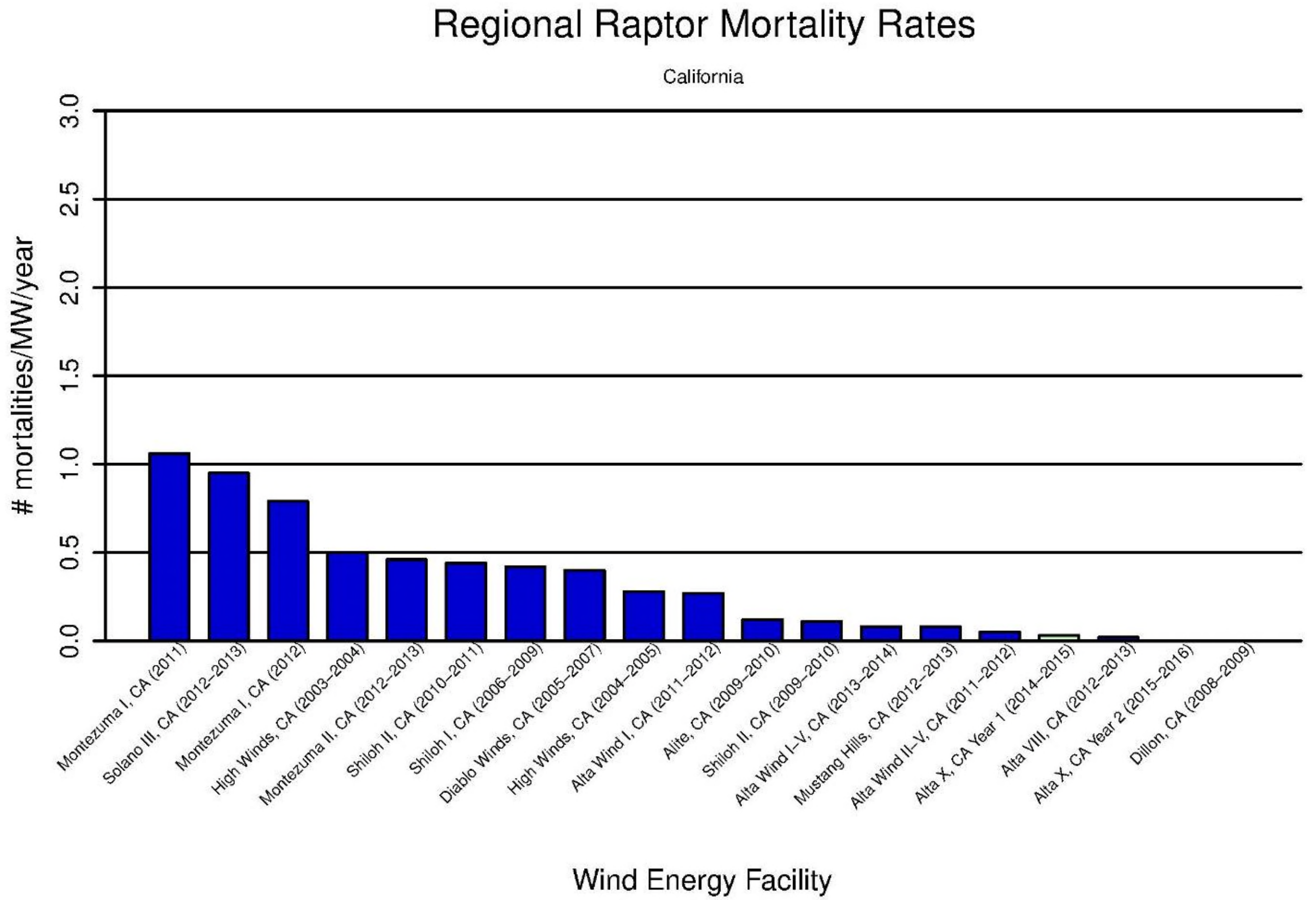

Figure 10. Mortality rates for raptors (number of raptors per MW per year) at the Alta X Wind Energy Project compared with studies from publicly-available wind energy facilities in California.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Alta X, CA Year 1 (14-15)	Thompson et al. 2016				
Alta X, CA Year 2(15-16)	This study.				
Montezuma I, CA (11)	ICF International 2012	Shiloh I, CA (06-09)	Kerlinger et al. 2009	Alta Wind I-V, CA (13-14)	Chatfield et al. 2014
Solano III, CA (12-13)	AECOM 2013	Diablo Winds, CA (05-07)	WEST 2006, 2008	Mustang Hills, CA (12-13)	Chatfield and Bay 2014
Montezuma I, CA (12)	ICF International 2013	High Winds, CA (04-05)	Kerlinger et al. 2006	Alta Wind II-V, CA (11-12)	Chatfield et al. 2012
High Winds, CA (03-04)	Kerlinger et al. 2006	Alta Wind I, CA (11-12)	Chatfield et al. 2012	Alta VIII, CA (12-13)	Chatfield and Bay 2014
Montezuma II, CA (12-13)	Harvey & Associates 2013	Alite, CA (09-10)	Chatfield et al. 2010	Dillon, CA (08-09)	Chatfield et al. 2009
Shiloh II, CA (10-11)	Kerlinger et al. 2013a	Shiloh II, CA (09-10)	Kerlinger et al. 2010		

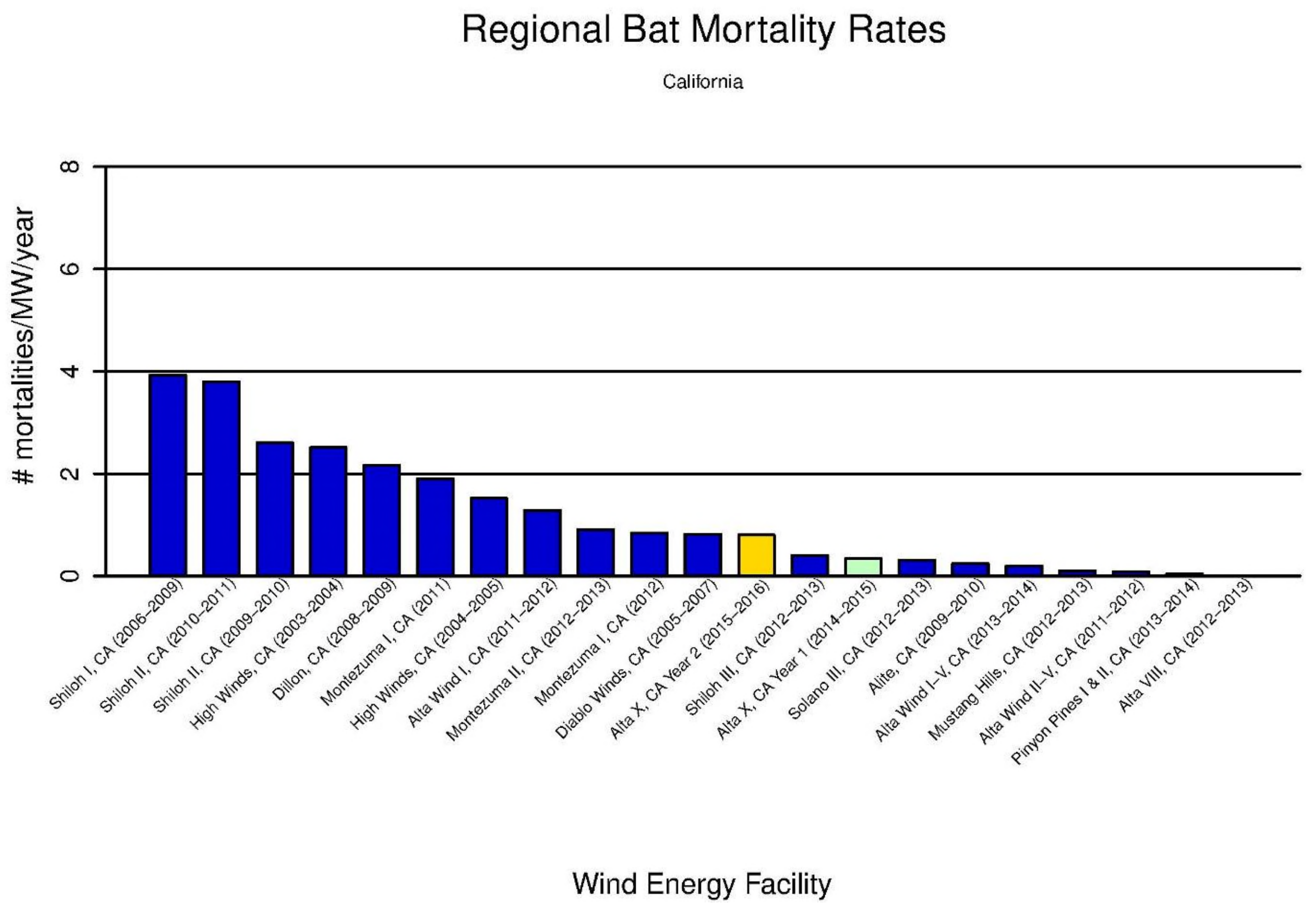

Figure 11. Mortality rates for bats (number of bats per MW per year) at the Alta X Wind Energy Project compared with studies at publicly-available wind energy facilities in California.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Alta X, CA Year 1 (14-15)	Thompson et al. 2016				
Alta X, CA Year 2(15-16)	This study.				
Shiloh I, CA (06-09)	Kerlinger et al. 2009	Alta Wind I, CA (11-12)	Chatfield et al. 2012	Alta Wind I-V, CA (13-14)	Chatfield et al. 2014
Shiloh II, CA (10-11)	Kerlinger et al. 2013a	Montezuma II, CA (12-13)	Harvey & Associates 2013	Mustang Hills, CA (12-13)	Chatfield and Bay 2014
Shiloh II, CA (09-10)	Kerlinger et al. 2010	Montezuma I, CA (12)	ICF International 2013	Alta Wind II-V, CA (11-12)	Chatfield et al. 2012
High Winds, CA (03-04)	Kerlinger et al. 2006	Diablo Winds, CA (05-07)	WEST 2006, 2008	Pinyon Pines I & II, CA (13-14)	Chatfield and Russo 2014
Dillon, CA (08-09)	Chatfield et al. 2009	Shiloh III, CA (12-13)	Kerlinger et al. 2013b	Alta VIII, CA (12-13)	Chatfield and Bay 2014
Montezuma I, CA (11)	ICF International 2012	SMUD Solano, CA (04-05)	Erickson and Sharp 2005		
High Winds, CA (04-05)	Kerlinger et al. 2006	Alite, CA (09-10)	Chatfield et al. 2010		

Yearly Comparison

An objective of the second year of monitoring was to assess annual variability in mortality rates by comparing bird mortality to the previous year of monitoring. Both monitoring years used the Shoenfeld estimator for adjusting mortalities, allowing for a fair comparison between monitoring years. Estimated overall bird mortality decreased from 4.88 birds/MW/year (Chatfield et al. 2015) in Year 1 to 2.17 birds/MW/year in Year 2. The overall reduction in small bird mortality was a result of a relatively large reduction in small bird mortality compared to a small increase in large bird mortality (Table 6). Raptor fatality rates were consistently low across years (Table 6), with only one diurnal raptor mortality found during the two years of study. Although two bat fatalities were found on search plots in each of Years 1 and 2, the fatality estimator resulted in an increase in estimated bat mortalities from Year 1 (0.42 bats/MW/year; Chatfield et al. 2012) to Year 2 (0.80 bats/MW/year).

Compared to the first year of monitoring there were a similar number of bat mortalities (two in each year) and large bird mortalities (five in Year 1 and nine in Year 2). The Year 1 studies found bat mortalities occurring in fall (Chatfield et al. 2015), whereas the Year 2 studies found bat mortalities in spring and summer; however, given the low number of fatalities found, the seasonal distribution should be interpreted with caution. Carcass persistence rates varied across seasons in the Year 2 analysis and were generally shorted, on average, across all three species groups. The shorter persistence times resulted in smaller values for $\hat{\pi}$, the estimated probability of a carcass being available and detected in Year 2. Search intervals were also a bit longer in Year 2 (a result of missed searches due primarily to severe weather events), which further contributed to $\hat{\pi}$ being smaller on average for Year 2 studies than for Year 1 studies. Lower values for $\hat{\pi}$ result in elevated mortality estimates given similar numbers of documented mortalities, which is why the estimated bat mortality was higher in Year 2 even though the same number of bat mortalities were found in both years.

Table 6. Adjusted bird and bat mortality estimates (fatalities/MW/study period) for the Alta X Project for Year 1 (March 31, 2013 – March 27, 2015), and Year 2 (April 10, 2015 – April 7, 2016) post-construction mortality monitoring studies.

	Project-Wide Mortality Estimate	
Group	**Year 1 (2014-2015)**	**Year 2 (2015-2016)**
Small Birds	4.67	1.92
Large Birds	0.21	0.25
Diurnal Raptors	0.04	0.00
All Birds	4.88	2.17
Bats	0.42	0.80

CONCLUSIONS

Results of the second year of mortality monitoring at Alta X illustrate the annual variability inherent in estimating bird and bat mortality. Although bird and bat mortality during the first and second years of monitoring did vary some, diurnal raptor and bat mortality estimates were generally low compared to other wind energy facilities in California, while all bird mortality was considered to be more moderate. Local factors, such as facility location, and physical features, such as topography and vegetation, may influence mortality estimates. However, other environmental factors, such as weather and the long-standing drought in California in particular, may affect bird abundance and behavior, which in turn may influence the potential for mortality. Results from the two years of monitoring at Alta X do not suggest that levels of bird and bat mortality will result in substantial impacts to bird and bat populations. A third year of mortality monitoring is ongoing at Alta X (2016-2017). Upon completion, the three years of mortality monitoring data will be assessed cumulatively to provide a clearer picture of the impacts of Alta X on birds and bats.

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Appendix A. List of Mortalities for the Alta X Wind Energy Project for Studies Conducted from April 10, 2015 – April 7, 2016

Appendix A. Complete listing of mortalities for the Alta X Wind Energy Project for studies conducted from April 10, 2015 – April 7, 2016.

Date	Common Name	Plot Location	Distance from Turbine (m)	Type of Find	Condition
4/20/2015	northern flicker	GE-155	103	carcass search	Feather Spot
4/22/2015	greater roadrunner	GE-158	72	carcass search	Feather Spot
4/24/2015	black-and-white warbler	GE-196	43	carcass search	Feather Spot
5/5/2015	unidentified bird (small)	GE-158	51	carcass search	Feather Spot
5/5/2015	pine siskin	GE-189	72	incidental find	Intact
5/11/2015	unidentified bird (small)	GE-172	85	carcass search	Feather Spot
5/20/2015	cinnamon teal	GE-182	118	carcass search	Feather Spot
6/8/2015	unidentified warbler	GE-182	108	carcass search	Feather Spot
6/9/2015	unidentified bird (small)	GE-155	52	carcass search	Feather Spot
6/9/2015	greater roadrunner	GE-169	62	carcass search	Feather Spot
6/23/2015	California quail	GE-169	194	carcass search	Feather Spot
6/23/2015	California bat	GE-169	60	carcass search	Intact
6/29/2015	mourning dove	GE-172	153	carcass search	Feather Spot
8/11/2015	rufous-crowned sparrow	GE-182	NA	carcass search	NA
8/27/2015	orange-crowned warbler	GE-177	119	carcass search	Feather Spot
9/9/2015	hoary bat	GE-191	30	incidental find	Intact
10/1/2015	unidentified bird (small)	GE-182	98	carcass search	Feather Spot
10/7/2015	fox sparrow	GE-155	36	carcass search	Dismembered
10/27/2015	northern flicker	GE-155	NA	carcass search	NA
11/11/2015	unidentified sparrow	VE-351	NA	incidental find	NA
12/28/2015	northern flicker	GE-155	116	carcass search	Feather Spot
2/2/2016	unidentified warbler	GE-182	146	incidental find	Intact
3/10/2016	house wren	GE-155	23	carcass search	Intact
3/10/2016	mourning dove	GE-155	55	carcass search	NA
4/6/2016	Mexican free-tailed bat	GE-155	16	carcass search	Intact

Appendix B. Complete Bird and Bat Mortality Tables for the Alta X Wind Energy Project for Studies Conducted from April 10, 2015 - April 7, 2016

Appendix B1. Complete bird adjusted mortality rates for 12 turbines at the Alta X Wind Energy Project, April 10, 2015 – April 7, 2016.

	Spring			Summer			Fall			Winter		
		90% CI			90% CI			90% CI			90% CI	
Parameter	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**
Search Area Adjustment												
A (small birds)	1.00			1.00			1.00			1.00		
A (large birds)	1.00			1.00			1.00			1.00		
Effective Number of Turbines Searched												
	14.80			14.80			13.59			14.80		
Observer Detection												
p (small birds)	0.81	0.75	0.87	0.81	0.75	0.87	0.81	0.75	0.87	0.81	0.75	0.87
p (large birds)	0.94	0.90	0.99	0.94	0.90	0.99	0.94	0.90	0.99	0.94	0.90	0.99
Mean Carcass Removal Time (days)												
$\bar{t}$ (small birds)	3.20	2.10	4.36	2.54	1.52	3.81	2.38	1.56	3.22	3.81	2.33	5.55
$\bar{t}$ (large birds)	25.54	18.42	34.96	20.34	13.19	30.76	19.03	13.60	26.46	30.42	20.22	45.75
Observed Mortality Rates (casualties/turbine/study period)												
Small birds	0.09	-	-	0.07	-	-	0.05	-	-	0.00	-	-
Large birds	0.09	-	-	0.02	-	-	0.03	-	-	0.02	-	-
Diurnal Raptors	0	-	-	0	-	-	0	-	-	0	-	-
Average Probability of Carcass Availability and Detected												
Small birds	0.13	0.09	0.18	0.11	0.06	0.15	0.10	0.06	0.13	0.16	0.10	0.22
Large birds	0.68	0.59	0.75	0.62	0.49	0.72	0.60	0.50	0.69	0.72	0.62	0.80
Adjusted Mortality Estimates (casualties/turbine/study period)												
Small birds	2.05	-	-	1.93	-	-	1.49	-	-	0.00	-	-
Large birds	0.40	-	-	0.11	-	-	0.12	-	-	0.09	-	-
All Birds	2.45	1.07	4.68	2.04	-	-	1.62	-	-	0.09	-	-
Diurnal Raptors	0	-	-	0	-	-	0	-	-	0	-	-
Adjusted Mortality Estimates (casualties/MW/study period)												
Small birds	0.72	-	-	0.68	-	-	0.52	-	-	0.00	-	-
Large birds	0.14	-	-	0.04	-	-	0.04	-	-	0.03	-	-
All Birds	0.86	0.38	1.64	0.71	-	-	0.57	-	-	0.03	-	-
Diurnal Raptors	0	-	-	0	-	-	0	-	-	0	-	-

Overall Adjusted Mortality Estimates (casualties/MW/study period)

		90 % Confidence Interval	
	Mean	**Lower Limit**	**Upper Limit**
Small Birds	1.92	0.91	3.49
Large Birds	0.25	0.10	0.44
All Birds	2.17	1.19	3.77
Diurnal Raptors	0	-	-

Appendix B2. Complete bat adjusted mortality rates for 12 turbines at the Alta X Wind Energy Project, April 10, 2015 – April 7, 2016.

	Spring			Summer			Fall			Winter		
		90% CI			90% CI			90% CI			90% CI	
Parameter	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**	**Mean**	**ll**	**ul**
Search Area Adjustment												
A (bats)	1.00			1.00			1.00			1.00		
Effective Number of Turbines Searched												
	14.80			14.80			13.59			14.80		
Observer Detection												
p (bats)	0.69	0.56	0.82	0.69	0.56	0.82	0.69	0.56	0.82	0.69	0.56	0.82
Mean Carcass Removal Time (days)												
$\bar{t}$ (bats)	1.91	1.07	2.90	1.52	0.92	2.39	1.42	0.89	2.08	2.27	1.37	3.48
Observed Mortality Rates (casualties/turbine/study period)												
Average Probability of Carcass Availability and Detected												
Bats	0.07	0.04	0.10	0.05	0.03	0.09	0.05	0.03	0.08	0.08	0.05	0.13
Adjusted Mortality Estimates (casualties/turbine/study period)												
Bats	1.01	-	-	1.26	-	-	0.00	-	-	0.00	-	-
Adjusted Mortality Estimates (casualties/MW/study period)												
Bats	0.35	-	-	0.44	-	-	0.00	-	-	0.00	-	-

Overall Adjusted Mortality Estimates (casualties/MW/study period)		90 % Confidence Interval	
	Mean	**Lower Limit**	**Upper Limit**
Bats	0.80	-	-

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 fatalities per megawatt (MW) per year.

Wind Energy Facility	Mortality Estimate	No. of Turbines	Total MW
Alta X, CA (2015-2016)	**2.17**	**48**	**136.8**
Alta X, CA (2014-2015)	**4.88**	**48**	**136.8**
California			
Pine Tree, CA (2009-2010, 2011)	17.44	90	135
Montezuma I, CA (2012)	8.91	16	36.8
Alta Wind I-V, CA (2013-2014)	7.8	290	720 (150 GE, 570 vestas)
Alta Wind I, CA (2011-2012)	7.07	100	150
Shiloh I, CA (2006-2009)	6.96	100	150
Montezuma I, CA (2011)	5.19	16	36.8
Dillon, CA (2008-2009)	4.71	45	45
Diablo Winds, CA (2005-2007)	4.29	31	20.46
Shiloh III, CA (2012-2013)	3.3	50	102.5
Shiloh II, CA (2010-2011)	2.8	75	150
Shiloh II, CA (2009-2010)	1.9	75	150
Mustang Hills, CA (2012-2013)	1.66	50	150
Alta Wind II-V, CA (2011-2012)	1.66	190	570
High Winds, CA (2003-2004)	1.62	90	162
Solano III, CA (2012-2013)	1.6	55	128
Pinyon Pines I & II, CA (2013-2014)	1.18	100	NA
High Winds, CA (2004-2005)	1.1	90	162
Montezuma II, CA (2012-2013)	1.08	34	78.2
Alta VIII, CA (2012-2013)	0.66	50	150
Alite, CA (2009-2010)	0.55	8	24
Pacific Northwest			
Windy Flats, WA (2010-2011)	8.45	114	262.2
Leaning Juniper, OR (2006-2008)	6.66	67	100.5
Linden Ranch, WA (2010-2011)	6.65	25	50
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	65	150
White Creek, WA (2007-2011)	4.05	89	204.7
Tuolumne (Windy Point I), WA (2009-2010)	3.2	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)	1.4	47	94

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 fatalities per megawatt (MW) per year.

Wind Energy Facility	Mortality Estimate	No. of Turbines	Total MW
Vantage, WA (2010-2011)	1.27	60	90
Hopkins Ridge, WA (2006)	1.23	83	150
Stateline, OR/WA (2006)	1.23	454	299
Kittitas Valley, WA (2011-2012)	1.06	48	100.8
Klondike, OR (2002-2003)	0.95	16	24
Vansycle, OR (1999)	0.95	38	24.9
Palouse Wind, WA (2012-2013)	0.72	58	104.4
Elkhorn, OR (2008)	0.64	61	101
Marengo I, WA (2009-2010)	0.27	78	140.4
Marengo II, WA (2009-2010)	0.16	39	70.2
Rocky Mountains			
Foote Creek Rim, WY (Phase I; 1999)	3.40	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.42	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	69	41.4
Summerview, Alb (2005-2006)	1.06	39	70.2
Milford I & II, UT (2011-2012)	0.73	107	160.5 (58.5 Phase I, 102 Phase II)
Milford I, UT (2010-2011)	0.56	58	145
Southwest			
Dry Lake I, AZ (2009-2010)	2.02	30	63
Dry Lake II, AZ (2011-2012)	1.57	31	65
Midwest			
Wessington Springs, SD (2009)	8.25	34	51
Blue Sky Green Field, WI (2008; 2009)	7.17	88	145
Cedar Ridge, WI (2009)	6.55	41	67.6
Buffalo Ridge, MN (Phase III; 1999)	5.93	138	103.5
Moraine II, MN (2009)	5.59	33	49.5
Barton I & II, IA (2010-2011)	5.5	80	160
Buffalo Ridge I, SD (2009-2010)	5.06	24	50.4
Buffalo Ridge, MN (Phase I; 1996)	4.14	73	25
Winnebago, IA (2009-2010)	3.88	10	20
Rugby, ND (2010-2011)	3.82	71	149
Cedar Ridge, WI (2010)	3.72	41	68
Elm Creek II, MN (2011-2012)	3.64	62	148.8
Buffalo Ridge, MN (Phase II; 1999)	3.57	143	107.25
Buffalo Ridge, MN (Phase I; 1998)	3.14	73	25
Ripley, Ont (2008)	3.09	38	76
Fowler I, IN (2009)	2.83	162	301
Buffalo Ridge, MN (Phase I; 1997)	2.51	73	25
Buffalo Ridge, MN (Phase II; 1998)	2.47	143	107.25
PrairieWinds SD1, SD (2012-2013)	2.01	108	162
Buffalo Ridge II, SD (2011-2012)	1.99	105	210
Kewaunee County, WI (1999-2001)	1.95	31	20.46
PrairieWinds SD1, SD (2013-2014)	1.66	108	162
NPPD Ainsworth, NE (2006)	1.63	36	20.5
PrairieWinds ND1 (Minot), ND (2011)	1.56	80	115.5
Elm Creek, MN (2009-2010)	1.55	67	100
PrairieWinds ND1 (Minot), ND (2010)	1.48	80	115.5
Buffalo Ridge, MN (Phase I; 1999)	1.43	73	25
PrairieWinds SD1, SD (2011-2012)	1.41	108	162

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 fatalities per megawatt (MW) per year.

Wind Energy Facility	Mortality Estimate	No. of Turbines	Total MW
Wessington Springs, SD (2010)	0.89	34	51
Rail Splitter, IL (2012-2013)	0.84	67	100.5
Top of Iowa, IA (2004)	0.81	89	80
Top Crop I & II, IL (2012-2013)	0.6	200 (68 Phase I, 132 Phase II)	300 (102 Phase I, 198 Phase II)
Big Blue, MN (2013)	0.6	18	36
Grand Ridge I, IL (2009-2010)	0.48	66	99
Top of Iowa, IA (2003)	0.42	89	80
Big Blue, MN (2014)	0.37	18	36
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	62	102.3
Southern Plains			
Buffalo Gap I, TX (2006)	1.32	67	134
Barton Chapel, TX (2009-2010)	1.15	60	120
Buffalo Gap II, TX (2007-2008)	0.15	155	233
Big Smile, OK (2012-2013)	0.09	66	132
Red Hills, OK (2012-2013)	0.08	82	123
Northeast			
Stetson Mountain I, ME (2013)	6.95	38	57
Criterion, MD (2011)	6.4	28	70
Mount Storm, WV (2011)	4.24	132	264
Pinnacle, WV (2012)	3.99	23	55.2
Mount Storm, WV (2009)	3.85	132	264
Record Hill, ME (2012)	3.7	22	50.6
Criterion, MD (2013)	3.49	28	70
Lempster, NH (2009)	3.38	12	24
Stetson Mountain II, ME (2012)	3.37	17	25.5
Rollins, ME (2012)	2.9	40	60
Casselman, PA (2009)	2.88	23	34.5
Mountaineer, WV (2003)	2.69	44	66
Stetson Mountain I, ME (2009)	2.68	38	57
Noble Ellenburg, NY (2009)	2.66	54	80
Lempster, NH (2010)	2.64	12	24
Mount Storm, WV (2010)	2.6	132	264
Maple Ridge, NY (2007)	2.34	195	321.75
Noble Bliss, NY (2009)	2.28	67	100
Criterion, MD (2012)	2.14	28	70
Maple Ridge, NY (2007-2008)	2.07	195	321.75
Record Hill, ME (2014)	1.84	22	50.6
Noble Altona, NY (2010)	1.84	65	97.5
High Sheldon, NY (2010)	1.76	75	112.5
Mars Hill, ME (2008)	1.76	28	42
Noble Wethersfield, NY (2010)	1.7	84	126
Mars Hill, ME (2007)	1.67	28	42
Noble Chateaugay, NY (2010)	1.66	71	106.5
Noble Clinton, NY (2008)	1.59	67	100
High Sheldon, NY (2011)	1.57	75	112.5
Casselman, PA (2008)	1.51	23	34.5
Beech Ridge, WV (2013)	1.48	67	100.5
Munnsville, NY (2008)	1.48	23	34.5
Stetson Mountain II, ME (2010)	1.42	17	25.5
Cohocton/Dutch Hill, NY (2009)	1.39	50	125

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 fatalities per megawatt (MW) per year.

Wind Energy Facility	Mortality Estimate	No. of Turbines	Total MW
Cohocton/Dutch Hills, NY (2010)	1.32	50	125
Noble Bliss, NY (2008)	1.3	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 (15-16)	This study.		
Alta X, CA (14-15)	Thompson et al. 2016		
Alite, CA (09-10)	Chatfield et al. 2010	Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011
Alta Wind I-V, CA (13-14)	Chatfield et al. 2014	Maple Ridge, NY (07)	Jain et al. 2009a
Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Maple Ridge, NY (07-08)	Jain et al. 2009d
Alta VIII, CA (12-13)	Chatfield and Bay 2014	Marengo I, WA (09-10)	URS Corporation 2010b
Barton I & II, IA (10-11)	Derby et al. 2011a	Marengo II, WA (09-10)	URS Corporation 2010c
Barton Chapel, TX (09-10)	WEST 2011	Mars Hill, ME (07)	Stantec 2008a
Beech Ridge, WV (12)	Tidhar et al. 2013b	Mars Hill, ME (08)	Stantec 2009a
Beech Ridge, WV (13)	Young et al. 2014b	Milford I & II, UT (11-12)	Stantec 2012b
Big Blue, MN (13)	Fagen Engineering 2014	Milford I, UT (10-11)	Stantec 2011b
Big Blue, MN (14)	Fagen Engineering 2015	Montezuma I, CA (11)	ICF International 2012
Big Horn, WA (06-07)	Kronner et al. 2008	Montezuma I, CA (12)	ICF International 2013
Big Smile, OK (12-13)	Derby et al. 2013b	Montezuma II, CA (12-13)	Harvey & Associates 2013
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Moraine II, MN (09)	Derby et al. 2010d
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Munnsville, NY (08)	Stantec 2009b
Buffalo Gap I, TX (06)	Tierney 2007	Mustang Hills, CA (12-13)	Chatfield and Bay 2014
Buffalo Gap II, TX (07-08)	Tierney 2009	Nine Canyon, WA (02-03)	Erickson et al. 2003a
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Noble Altona, NY (10)	Jain et al. 2011b
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Noble Bliss, NY (08)	Jain et al. 2009e
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000	Noble Bliss, NY (09)	Jain et al. 2010a
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000	Noble Chateaugay, NY (10)	Jain et al. 2011c
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000	Noble Clinton, NY (08)	Jain et al. 2009c
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000	Noble Clinton, NY (09)	Jain et al. 2010b
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000	Noble Ellenburg, NY (08)	Jain et al. 2009b
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	Noble Ellenburg, NY (09)	Jain et al. 2010c
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000	Noble Wethersfield, NY (10)	Jain et al. 2011a
Buffalo Ridge I, SD (09-10)	Derby et al. 2010b	NPPD Ainsworth, NE (06)	Derby et al. 2007
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Palouse Wind, WA (12-13)	Stantec 2013a
Casselman, PA (08)	Arnett et al. 2009b	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Casselman, PA (09)	Arnett et al. 2010	Pine Tree, CA (09-10, 11)	BioResource Consultants 2012
Cedar Ridge, WI (09)	BHE Environmental 2010	Pinnacle, WV (12)	Hein et al. 2013a
Cedar Ridge, WI (10)	BHE Environmental 2011	Pinyon Pines I & II, CA (13-14)	Chatfield and Russo 2014
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Cohocton/Dutch Hill, NY (10)	Stantec 2011a	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011c
Combine Hills, OR (Ph. I; 04-05)	Young et al. 2006	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Combine Hills, OR (11)	Enz et al. 2012	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
Criterion, MD (11)	Young et al. 2012a	PrairieWinds SD1 (Crow Lake), SD (12-13)	Derby et al. 2013a
Criterion, MD (12)	Young et al. 2013	PrairieWinds SD1, SD (13-14)	Derby et al. 2014
Criterion, MD (13)	Young et al. 2014a	Rail Splitter, IL (12-13)	Good et al. 2013b
Diablo Winds, CA (05-07)	WEST 2006, 2008	Record Hill, ME (12)	Stantec 2013b
Dillon, CA (08-09)	Chatfield et al. 2009	Record Hill, ME (14)	Stantec 2015
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Red 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	Rollins, ME (12)	Stantec 2013c
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. 2010
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	Shiloh II, CA (10-11)	Kerlinger et al. 2013a
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b	Shiloh III, CA (12-13)	Kerlinger et al. 2013b
Foote Creek Rim, WY (Ph. I; 01-02)	Young et al. 2003b	Solano III, CA (12-13)	AECOM 2013
Fowler I, IN (09)	Johnson et al. 2010a	Stateline, OR/WA (01-02)	Erickson et al. 2004
Goodnoe, WA (09-10)	URS Corporation 2010a	Stateline, OR/WA (03)	Erickson et al. 2004
Grand Ridge, IL (09-10)	Derby et al. 2010g	Stateline, OR/WA (06)	Erickson et al. 2007
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Stetson Mountain I, ME (09)	Stantec 2009c
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Stetson Mountain I, ME (11)	Normandeau Associates 2011
High Sheldon, NY (10)	Tidhar et al. 2012a	Stetson Mountain I, ME (13)	Stantec 2014
High Sheldon, NY (11)	Tidhar et al. 2012b	Stetson Mountain II, ME (10)	Normandeau Associates 2010
High Winds, CA (03-04)	Kerlinger et al. 2006	Stetson Mountain II, ME (12)	Stantec 2013e
High Winds, CA (04-05)	Kerlinger et al. 2006	Summerview, Alb (05-06)	Brown and Hamilton 2006b
Hopkins Ridge, WA (06)	Young et al. 2007	Top Crop I & II, IL (12-13)	Good et al. 2013a
Hopkins Ridge, WA (08)	Young et al. 2009c	Top of Iowa, IA (03)	Jain 2005
Kewaunee County, WI (99-01)	Howe et al. 2002	Top of Iowa, IA (04)	Jain 2005
Kittitas Valley, WA (11-12)	Stantec 2012	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
Klondike, OR (02-03)	Johnson et al. 2003a	Vansycle, OR (99)	Erickson et al. 2000b
Klondike II, OR (05-06)	NWC and WEST 2007	Vantage, WA (10-11)	Ventus 2012

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
Klondike III, OR (Phase I; 07-09)	Gritski et al. 2010	Wessington Springs, SD (09)	Derby et al. 2010f
Klondike IIIa, OR (Phase II; 08-10)	Gritski et al. 2011	Wessington Springs, SD (10)	Derby et al. 2011d
Leaning Juniper, OR (06-08)	Gritski et al. 2008	White Creek, WA (07-11)	Downes and Gritski 2012b
Lempster, NH (09)	Tidhar et al. 2010	Wild Horse, WA (07)	Erickson et al. 2008
Lempster, NH (10)	Tidhar et al. 2011	Windy Flats, WA (10-11)	Enz et al. 2011
Linden Ranch, WA (10-11)	Enz and Bay 2011	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 (2015-2016)	**0.04**	**0**	**48**	**136.8**
Alta X, CA (2014-2015)	**0.04**	**0.04**	**48**	**136.8**
California				
Montezuma I, CA (2011)	NA	1.06	16	36.8
Solano III, CA (2012-2013)	NA	0.95	55	128
Montezuma I, CA (2012)	NA	0.79	16	36.8
High Winds, CA (2003-2004)	2.34	0.5	90	162
Montezuma II, CA (2012-2013)	NA	0.46	34	78.2
Shiloh II, CA (2010-2011)	NA	0.44	75	150
Shiloh I, CA (2006-2009)	NA	0.42	100	150
Diablo Winds, CA (2005-2007)	2.16	0.4	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)	NA	0.12	8	24
Shiloh II, CA (2009-2010)	NA	0.11	75	150
Mustang Hills, CA (2012-2013)	NA	0.08	50	150
Alta Wind I-V, CA (2013-2014)	NA	0.08	290	720 (150 GE, 570 vestas)
Alta Wind II-V, CA (2011-2012)	0.04	0.05	190	570
Alta VIII, CA (2012-2013)	NA	0.02	50	150
Dillon, CA (2008-2009)	NA	0	45	45
Pacific Northwest				
White Creek, WA (2007-2011)	NA	0.47	89	204.7
Tuolumne (Windy Point I), WA (2009-2010)	0.77	0.29	62	136.6
Vantage, WA (2010-2011)	NA	0.29	60	90
Linden Ranch, WA (2010-2011)	NA	0.27	25	50
Harvest Wind, WA (2010-2012)	NA	0.23	43	98.9
Goodnoe, WA (2009-2010)	NA	0.17	47	94
Leaning Juniper, OR (2006-2008)	0.52	0.16	67	100.5
Klondike III (Phase I), OR (2007-2009)	NA	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)	NA	0.09	48	100.8
Wild Horse, WA (2007)	0.29	0.09	127	229
Stateline, OR/WA (2001-2002)	0.48	0.09	454	299
Stateline, OR/WA (2003)	0.48	0.09	454	299
Elkhorn, OR (2010)	1.07	0.08	61	101
Hopkins Ridge, WA (2008)	0.70	0.07	87	156.6
Elkhorn, OR (2008)	1.07	0.06	61	101
Klondike II, OR (2005-2006)	0.50	0.06	50	75
Klondike IIIa (Phase II), OR (2008-2010)	NA	0.06	51	76.5
Combine Hills, OR (2011)	0.75	0.05	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	0.32	0.05	76	174.8
Marengo II, WA (2009-2010)	NA	0.05	39	70.2
Windy Flats, WA (2010-2011)	NA	0.04	114	262.2
Pebble Springs, OR (2009-2010)	NA	0.04	47	98.7
Biglow Canyon, OR (Phase I; 2008)	0.32	0.03	76	125.4

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
Biglow Canyon, OR (Phase II; 2010-2011)	0.32	0.03	65	150
Nine Canyon, WA (2002-2003)	0.35	0.03	37	48.1
Hay Canyon, OR (2009-2010)	NA	0	48	100.8
Biglow Canyon, OR (Phase I; 2009)	0.32	0	76	125.4
Marengo I, WA (2009-2010)	NA	0	78	140.4
Klondike, OR (2002-2003)	0.50	0	16	24
Vansycle, OR (1999)	0.66	0	38	24.9
Combine Hills, OR (Phase I; 2004-2005)	0.75	0	41	41
Rocky Mountains				
Summerview, Alb (2005-2006)	NA	0.11	39	70.2
Foote Creek Rim, WY (Phase I; 1999)	0.55	0.08	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	0.55	0.05	69	41.4
Milford I & II, UT (2011-2012)	NA	0.04	107	160.5 (58.5 Phase I, 102 Phase II)
Foote Creek Rim, WY (Phase I; 2001-2002)	0.55	0	69	41.4
Southwest				
Dry Lake I, AZ (2009-2010)	0.13	0	30	63
Dry Lake II, AZ (2011-2012)	NA	0	31	65
Midwest				
Buffalo Ridge, MN (Phase I; 1999)	NA	0.47	73	25
Moraine II, MN (2009)	NA	0.37	33	49.5
Winnebago, IA (2009-2010)	NA	0.27	10	20
Buffalo Ridge I, SD (2009-2010)	NA	0.2	24	50.4
Cedar Ridge, WI (2009)	NA	0.18	41	67.6
PrairieWinds SD1, SD (2013-2014)	NA	0.17	108	162
Top of Iowa, IA (2004)	NA	0.17	89	80
Cedar Ridge, WI (2010)	NA	0.13	41	68
Ripley, Ont (2008)	NA	0.1	38	76
Wessington Springs, SD (2010)	0.23	0.07	34	51
Rugby, ND (2010-2011)	NA	0.06	71	149
NPPD Ainsworth, NE (2006)	NA	0.06	36	20.5
Wessington Springs, SD (2009)	0.23	0.06	34	51
PrairieWinds ND1 (Minot), ND (2011)	NA	0.05	80	115.5
PrairieWinds ND1 (Minot), ND (2010)	NA	0.05	80	115.5
PrairieWinds SD1, SD (2012-2013)	NA	0.03	108	162
Elm Creek, MN (2009-2010)	NA	0	67	100
Rail Splitter, IL (2012-2013)	NA	0	67	100.5
Pioneer Prairie I, IA (Phase II; 2011-2012)	NA	0	62	102.3
Buffalo Ridge, MN (Phase III; 1999)	NA	0	138	103.5
Buffalo Ridge, MN (Phase II; 1998)	NA	0	143	107.25
Buffalo Ridge, MN (Phase II; 1999)	NA	0	143	107.25
Blue Sky Green Field, WI (2008; 2009)	NA	0	88	145
Elm Creek II, MN (2011-2012)	NA	0	62	148.8
Barton I & II, IA (2010-2011)	NA	0	80	160
PrairieWinds SD1, SD (2011-2012)	NA	0	108	162
Kewaunee County, WI (1999-2001)	NA	0	31	20.46
Buffalo Ridge II, SD (2011-2012)	NA	0	105	210
Buffalo Ridge, MN (Phase I; 1996)	NA	0	73	25
Buffalo Ridge, MN (Phase I; 1997)	NA	0	73	25
Buffalo Ridge, MN (Phase I; 1998)	NA	0	73	25

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
Fowler I, IN (2009)	NA	0	162	301
Big Blue, MN (2013)	NA	0	18	36
Big Blue, MN (2014)	NA	0	18	36
Top of Iowa, IA (2003)	NA	0	89	80
Grand Ridge I, IL (2009-2010)	0.20	0	66	99
Southern Plains				
Barton Chapel, TX (2009-2010)	NA	0.25	60	120
Buffalo Gap I, TX (2006)	NA	0.1	67	134
Red Hills, OK (2012-2013)	NA	0.04	82	123
Big Smile, OK (2012-2013)	NA	0	66	132
Buffalo Gap II, TX (2007-2008)	NA	0	155	233
Northeast				
Munnsville, NY (2008)	NA	0.59	23	34.5
Noble Ellenburg, NY (2009)	NA	0.25	54	80
Noble Clinton, NY (2009)	NA	0.16	67	100
Noble Wethersfield, NY (2010)	NA	0.13	84	126
Noble Bliss, NY (2009)	NA	0.12	67	100
Noble Ellenburg, NY (2008)	NA	0.11	54	80
Noble Bliss, NY (2008)	NA	0.1	67	100
Noble Clinton, NY (2008)	NA	0.1	67	100
Mount Storm, WV (2010)	NA	0.1	132	264
Noble Chateaugay, NY (2010)	NA	0.08	71	106.5
Cohocton/Dutch Hills, NY (2010)	NA	0.08	50	125
Mountaineer, WV (2003)	NA	0.07	44	66
High Sheldon, NY (2010)	NA	0.06	75	112.5
Mount Storm, WV (2011)	NA	0.03	132	264
Maple Ridge, NY (2007-2008)	NA	0.03	195	321.75
Criterion, MD (2011)	NA	0.02	28	70
Beech Ridge, WV (2012)	NA	0.01	67	100.5
Beech Ridge, WV (2013)	NA	0.01	67	100.5
Locust Ridge, PA (Phase II; 2009)	NA	0	51	102
Locust Ridge, PA (Phase II; 2010)	NA	0	51	102
High Sheldon, NY (2011)	NA	0	75	112.5
Cohocton/Dutch Hill, NY (2009)	NA	0	50	125
Lempster, NH (2009)	NA	0	12	24
Lempster, NH (2010)	NA	0	12	24
Stetson Mountain II, ME (2010)	NA	0	17	25.5
Stetson Mountain II, ME (2012)	NA	0	17	25.5
Mount Storm, WV (2009)	NA	0	132	264
Casselman, PA (2009)	NA	0	23	34.5
Casselman, PA (2008)	NA	0	23	34.5
Mars Hill, ME (2007)	NA	0	28	42
Mars Hill, ME (2008)	NA	0	28	42
Pinnacle, WV (2012)	NA	0	23	55.2
Stetson Mountain I, ME (2011)	NA	0	38	57
Stetson Mountain I, ME (2009)	NA	0	38	57
Stetson Mountain I, ME (2013)	NA	0	38	57
Noble Altona, NY (2010)	NA	0	65	97.5

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
	Southeast			
Buffalo Mountain, TN (2000-2003)	NA	0	3	1.98
Buffalo Mountain, TN (2005)	NA	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 (15-16)	Erickson and Chatfield 2009	This study.			
Alta X, CA (14-15)	Erickson and Chatfield 2009	Thompson et al. 2016			
Alite, CA (09-10)		Chatfield et al. 2010	Leaning Juniper, OR (06-08)	Kronner et al. 2005	Gritski et al. 2008
Alta Wind I, CA (11-12)	Erickson and Chatfield 2009	Chatfield et al. 2012	Lempster, NH (09)		Tidhar et al. 2010
Alta Wind I-V, CA (13-14)		Chatfield et al. 2014	Lempster, NH (10)		Tidhar et al. 2011
Alta Wind II-V, CA (11-12)	Erickson and Chatfield 2009	Chatfield et al. 2012	Linden Ranch, WA (10-11)		Enz and Bay 2011
Alta VIII, CA (12-13)		Chatfield and Bay 2014	Locust Ridge, PA (Phase II; 09)		Arnett et al. 2011
Barton I & II, IA (10-11)		Derby et al. 2011a	Locust Ridge, PA (Phase II; 10)		Arnett et al. 2011
Barton Chapel, TX (09-10)		WEST 2011	Maple Ridge, NY (07-08)		Jain et al. 2009d
Beech Ridge, WV (12)		Tidhar et al. 2013b	Marengo I, WA (09-10)		URS Corporation 2010b
Beech Ridge, WV (13)		Young et al. 2014b	Marengo II, WA (09-10)		URS Corporation 2010c
Big Blue, MN (13)		Fagen Engineering 2014	Mars Hill, ME (07)		Stantec 2008a
Big Blue, MN (14)		Fagen Engineering 2015	Mars Hill, ME (08)		Stantec 2009a
Big Horn, WA (06-07)	Johnson and Erickson 2004	Kronner et al. 2008	Milford I & II, UT (11-12)		Stantec 2012b
Big Smile, OK (12-13)		Derby et al. 2013b	Montezuma I, CA (11)		ICF International 2012
Biglow Canyon, OR (Phase I; 08)	WEST 2005b	Jeffrey et al. 2009a	Montezuma I, CA (12)		ICF International 2013
Biglow Canyon, OR (Phase I; 09)	WEST 2005b	Enk et al. 2010	Montezuma II, CA (12-13)		Harvey & Associates 2013
Biglow Canyon, OR (Phase II; 09-10)	WEST 2005b	Enk et al. 2011a	Moraine II, MN (09)		Derby et al. 2010d
Biglow Canyon, OR (Phase II; 10-11)	WEST 2005b	Enk et al. 2012b	Mount Storm, WV (09)		Young et al. 2009a, 2010b
Biglow Canyon, OR (Phase III; 10-11)	WEST 2005b	Enk et al. 2012a	Mount Storm, WV (10)		Young et al. 2010a, 2011b
Blue Sky Green Field, WI (08; 09)		Gruver et al. 2009	Mount Storm, WV (11)		Young et al. 2011a, 2012b
Buffalo Gap I, TX (06)		Tierney 2007	Mountaineer, WV (03)		Kerns and Kerlinger 2004
Buffalo Gap II, TX (07-08)		Tierney 2009	Munnsville, NY (08)		Stantec 2009b
Buffalo Mountain, TN (00-03)		Nicholson et al. 2005	Mustang Hills, CA (12-13)		Chatfield and Bay 2014
Buffalo Mountain, TN (05)		Fiedler et al. 2007	Nine Canyon, WA (02-03)	Erickson et al. 2001	Erickson et al. 2003a
Buffalo Ridge, MN (Phase I; 96)		Johnson et al. 2000	Noble Altona, NY (10)		Jain et al. 2011b
Buffalo Ridge, MN (Phase I; 97)		Johnson et al. 2000	Noble Bliss, NY (08)		Jain et al. 2009e
Buffalo Ridge, MN (Phase I; 98)		Johnson et al. 2000	Noble Bliss, NY (09)		Jain et al. 2010a
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000	Noble Chateaugay, NY (10)		Jain et al. 2011c
Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000	Noble Clinton, NY (08)		Jain et al. 2009c
Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000	Noble Clinton, NY (09)		Jain et al. 2010b
Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000	Noble Ellenburg, NY (08)		Jain et al. 2009b
Buffalo Ridge I, SD (09-10)		Derby et al. 2010b	Noble Ellenburg, NY (09)		Jain et al. 2010c
Buffalo Ridge II, SD (11-12)		Derby et al. 2012a	Noble Wethersfield, NY (10)		Jain et al. 2011a
Casselman, PA (08)		Arnett et al. 2009b	NPPD Ainsworth, NE (06)		Derby et al. 2007
Casselman, PA (09)		Arnett et al. 2010	Pebble Springs, OR (09-10)		Gritski and Kronner 2010b
Cedar Ridge, WI (09)		BHE Environmental 2010	Pinnacle, WV (12)		Hein et al. 2013a
Cedar Ridge, WI (10)		BHE Environmental 2011	Pioneer Prairie I, IA (Phase II; 11-12)		Chodachek et al. 2012
Cohocton/Dutch Hill, NY (09)		Stantec 2010	PrairieWinds ND1 (Minot), ND (10)		Derby et al. 2011c
Cohocton/Dutch Hills, NY (10)		Stantec 2011a	PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012c
Combine Hills, OR (Phase I; 04-05)	Young et al. 2003c	Young et al. 2006	PrairieWinds SD1 (Crow Lake), SD (11-12)		Derby et al. 2012d
Combine Hills, OR (11)	Young et al. 2003c	Enz et al. 2012	PrairieWinds SD1 (Crow Lake), SD (12-13)		Derby et al. 2013a

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

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 (2015-2016)	**0.78**	**6/26/09-10/31/09**	**0.80**	**100**	**100**
Alta X, CA (2014-2015)	**0.78**	**6/26/09-10/31/09**	**0.42**	**48**	**136.8**
California					
Shiloh I, CA (2006-2009)	NA	NA	3.92	100	150
Shiloh II, CA (2010-2011)	NA	NA	3.80	75	150
Shiloh II, CA (2009-2010)	NA	NA	2.60	75	150
High Winds, CA (2003-2004)	NA	NA	2.51	90	162
Dillon, CA (2008-2009)	NA	NA	2.17	45	45
Montezuma I, CA (2011)	NA	NA	1.90	16	36.8
High Winds, CA (2004-2005)	NA	NA	1.52	90	162
Alta Wind I, CA (2011-2012)	4.42[A]	6/26/09-10/31/09	1.28	100	150
Montezuma II, CA (2012-2013)	NA	NA	0.91	34	78.2
Montezuma I, CA (2012)	NA	NA	0.84	16	36.8
Diablo Winds, CA (2005-2007)	NA	NA	0.82	31	20.46
Shiloh III, CA (2012-2013)	NA	NA	0.40	50	102.5
Solano III, CA (2012-2013)	NA	NA	0.31	55	128
Alite, CA (2009-2010)	NA	NA	0.24	8	24
Alta Wind I-V, CA (2013-2014)	NA	NA	0.20	290	720 (150 GE, 570 vestas)
Mustang Hills, CA (2012-2013)	NA	NA	0.10	50	150
Alta Wind II-V, CA (2011-2012)	0.78	6/26/09-10/31/09	0.08	190	570
Pinyon Pines I & II, CA (2013-2014)	NA	NA	0.04	100	NA
Alta VIII, CA (2012-2013)	NA	NA	0.00	50	150
Pacific Northwest					
Palouse Wind, WA (2012-2013)	NA	NA	4.23	58	104.4
Biglow Canyon, OR (Phase II; 2009-2010)	NA	NA	2.71	65	150
Nine Canyon, WA (2002-2003)	NA	NA	2.47	37	48.1
Stateline, OR/WA (2003)	NA	NA	2.29	454	299
Elkhorn, OR (2010)	NA	NA	2.14	61	101
White Creek, WA (2007-2011)	NA	NA	2.04	89	204.7
Biglow Canyon, OR (Phase I; 2008)	NA	NA	1.99	76	125.4
Leaning Juniper, OR (2006-2008)	NA	NA	1.98	67	100.5
Big Horn, WA (2006-2007)	NA	NA	1.90	133	199.5
Combine Hills, OR (Phase I; 2004-2005)	NA	NA	1.88	41	41
Linden Ranch, WA (2010-2011)	NA	NA	1.68	25	50
Pebble Springs, OR (2009-2010)	NA	NA	1.55	47	98.7
Hopkins Ridge, WA (2008)	NA	NA	1.39	87	156.6
Harvest Wind, WA (2010-2012)	NA	NA	1.27	43	98.9
Elkhorn, OR (2008)	NA	NA	1.26	61	101
Vansycle, OR (1999)	NA	NA	1.12	38	24.9
Klondike III (Phase I), OR (2007-2009)	NA	NA	1.11	125	223.6
Stateline, OR/WA (2001-2002)	NA	NA	1.09	454	299
Stateline, OR/WA (2006)	NA	NA	0.95	454	299
Tuolumne (Windy Point I), WA (2009-2010)	NA	NA	0.94	62	136.6
Klondike, OR (2002-2003)	NA	NA	0.77	16	24

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
Combine Hills, OR (2011)	NA	NA	0.73	104	104
Hopkins Ridge, WA (2006)	NA	NA	0.63	83	150
Biglow Canyon, OR (Phase I; 2009)	NA	NA	0.58	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)	NA	NA	0.57	65	150
Hay Canyon, OR (2009-2010)	NA	NA	0.53	48	100.8
Windy Flats, WA (2010-2011)	NA	NA	0.41	114	262.2
Klondike II, OR (2005-2006)	NA	NA	0.41	50	75
Vantage, WA (2010-2011)	NA	NA	0.40	60	90
Wild Horse, WA (2007)	NA	NA	0.39	127	229
Goodnoe, WA (2009-2010)	NA	NA	0.34	47	94
Marengo II, WA (2009-2010)	NA	NA	0.27	39	70.2
Biglow Canyon, OR (Phase III; 2010-2011)	NA	NA	0.22	76	174.8
Marengo I, WA (2009-2010)	NA	NA	0.17	78	140.4
Klondike IIIa (Phase II), OR (2008-2010)	NA	NA	0.14	51	76.5
Kittitas Valley, WA (2011-2012)	NA	NA	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)	NA	NA	10.27	39	70.2
Judith Gap, MT (2006-2007)	NA	NA	8.93	90	135
Foote Creek Rim, WY (Phase I; 1999)	NA	NA	3.97	69	41.4
Judith Gap, MT (2009)	NA	NA	3.20	90	135
Milford I, UT (2010-2011)	NA	NA	2.05	58	145
Milford I & II, UT (2011-2012)	NA	NA	1.67	107	160.5 (58.5 I, 102 II)
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2[B,C]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2[B,C]	6/15/00-9/1/00	1.05	69	41.4
Southwest					
Dry Lake I, AZ (2009-2010)	8.80	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
Top Crop I & II, IL (2012-2013)	NA	NA	12.5	200 (68 Phase I, 132 Phase II)	300 300 (102 Phase I, 198 Phase II)
Blue Sky Green Field, WI (2008; 2009)	7.7[D]	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	9.97[B,C,D,E]	7/16/07-9/30/07	24.12	41	68
Rail Splitter, IL (2012-2013)	NA	NA	11.21	67	100.5
Fowler I, II, III, IN (2011)	NA	NA	20.19	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
Fowler I, II, III, IN (2010)	NA	NA	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)	NA	NA	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)	NA	NA	10.06	62	102.3
Fowler I, IN (2009)	NA	NA	8.09	162	301
Crystal Lake II, IA (2009)	NA	NA	7.42	80	200
Top of Iowa, IA (2003)	NA	NA	7.16	89	80
Kewaunee County, WI (1999-2001)	NA	NA	6.45	31	20.46
Ripley, Ont (2008)	NA	NA	4.67	38	76
Winnebago, IA (2009-2010)	NA	NA	4.54	10	20
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2[B]	6/15/01-9/15/01	4.35	143	107.25
Pioneer Prairie II, IA (2013)	NA	NA	3.83	62	102.3
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2[B]	6/15/01-9/15/01	3.71	138	103.5
Crescent Ridge, IL (2005-2006)	NA	NA	3.27	33	49.5
Fowler I, II, III, IN (2012)	NA	NA	2.96	355	600
Elm Creek II, MN (2011-2012)	NA	NA	2.81	62	148.8
Buffalo Ridge II, SD (2011-2012)	NA	NA	2.81	105	210
Buffalo Ridge, MN (Phase III; 1999)	NA	NA	2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)	NA	NA	2.59	143	107.25
Moraine II, MN (2009)	NA	NA	2.42	33	49.5
Buffalo Ridge, MN (Phase II; 1998)	NA	NA	2.16	143	107.25
PrairieWinds ND1 (Minot), ND (2010)	NA	NA	2.13	80	115.5
Grand Ridge I, IL (2009-2010)	NA	NA	2.10	66	99
Big Blue, MN (2013)	NA	NA	2.04	18	36
Barton I & II, IA (2010-2011)	NA	NA	1.85	80	160
Fowler III, IN (2009)	NA	NA	1.84	60	99
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9[B]	6/15/02-9/15/02	1.81	138	103.5
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9[B]	6/15/02-9/15/02	1.64	143	107.25
Rugby, ND (2010-2011)	NA	NA	1.60	71	149
Elm Creek, MN (2009-2010)	NA	NA	1.49	67	100
Wessington Springs, SD (2009)	NA	NA	1.48	34	51
Big Blue, MN (2014)	NA	NA	1.43	18	36
PrairieWinds ND1 (Minot), ND (2011)	NA	NA	1.39	80	115.5
PrairieWinds SD1, SD (2011-2012)	NA	NA	1.23	108	162
NPPD Ainsworth, NE (2006)	NA	NA	1.16	36	20.5
PrairieWinds SD1, SD (2012-2013)	NA	NA	1.05	108	162
Buffalo Ridge, MN (Phase I; 1999)	NA	NA	0.74	73	25
PrairieWinds SD1, SD (2013-2014)	NA	NA	0.52	108	162
Wessington Springs, SD (2010)	NA	NA	0.41	34	51
Buffalo Ridge I, SD (2009-2010)	NA	NA	0.16	24	50.4

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
		Southern Plains			
Barton Chapel, TX (2009-2010)	NA	NA	3.06	60	120
Big Smile, OK (2012-2013)	NA	NA	2.90	66	132
Buffalo Gap II, TX (2007-2008)	NA	NA	0.14	155	233
Red Hills, OK (2012-2013)	NA	NA	0.11	82	123
Buffalo Gap I, TX (2006)	NA	NA	0.10	67	134
		Northeast			
Pinnacle, WV (2012)	NA	NA	40.20	23	55.2
Mountaineer, WV (2003)	NA	NA	31.69	44	66
Mount Storm, WV (2009)	30.09	7/15/09-10/7/09	17.53	132	264
Noble Wethersfield, NY (2010)	NA	NA	16.30	84	126
Criterion, MD (2011)	NA	NA	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)	NA	NA	14.38	51	102
Locust Ridge, PA (Phase II; 2009)	NA	NA	14.11	51	102
Casselman, PA (2008)	NA	NA	12.61	23	34.5
Maple Ridge, NY (2006)	NA	NA	11.21	120	198
Cohocton/Dutch Hills, NY (2010)	NA	NA	10.32	50	125
Wolfe Island, Ont (July-December 2010)	NA	NA	9.50	86	197.8
Cohocton/Dutch Hill, NY (2009)	NA	NA	8.62	50	125
Casselman, PA (2009)	NA	NA	8.60	23	34.5
Noble Bliss, NY (2008)	NA	NA	7.80	67	100
Criterion, MD (2012)	NA	NA	7.62	28	70
Mount Storm, WV (2011)	NA	NA	7.43	132	264
Maple Ridge, NY (2012)	NA	NA	7.30	195	321.75
Mount Storm, WV (Fall 2008)	35.2	7/20/08-10/12/08	6.62	82	164
Maple Ridge, NY (2007)	NA	NA	6.49	195	321.75
Wolfe Island, Ont (July-December 2009)	NA	NA	6.42	86	197.8
Criterion, MD (2013)	NA	NA	5.32	28	70
Maple Ridge, NY (2007-2008)	NA	NA	4.96	195	321.75
Noble Clinton, NY (2009)	1.9[E]	8/1/09-09/31/09	4.50	67	100
Casselman Curtailment, PA (2008)	NA	NA	4.40	23	35.4
Noble Altona, NY (2010)	NA	NA	4.34	65	97.5
Noble Ellenburg, NY (2009)	16.1[E]	8/16/09-09/15/09	3.91	54	80
Noble Bliss, NY (2009)	NA	NA	3.85	67	100
Lempster, NH (2010)	NA	NA	3.57	12	24
Noble Ellenburg, NY (2008)	NA	NA	3.46	54	80
Noble Clinton, NY (2008)	2.1[E]	8/8/08-09/31/08	3.14	67	100
Lempster, NH (2009)	NA	NA	3.11	12	24
Record Hill, ME (2012)	24.6	4/16/12-10/23/12	2.96	22	50.6
Mars Hill, ME (2007)	NA	NA	2.91	28	42
Wolfe Island, Ont (July-December 2011)	NA	NA	2.49	86	197.8
Noble Chateaugay, NY (2010)	NA	NA	2.44	71	106.5

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
High Sheldon, NY (2010)	NA	NA	2.33	75	112.5
Stetson Mountain II, ME (2012)	NA	NA	2.27	17	25.5
Beech Ridge, WV (2012)	NA	NA	2.03	67	100.5
Munnsville, NY (2008)	NA	NA	1.93	23	34.5
High Sheldon, NY (2011)	NA	NA	1.78	75	112.5
Stetson Mountain II, ME (2010)	NA	NA	1.65	17	25.5
Stetson Mountain I, ME (2009)	28.5; 0.3[G]	7/10/09-10/15/09	1.40	38	57
Beech Ridge, WV (2013)	NA	NA	0.58	67	100.5
Record Hill, ME (2014)	NA	NA	0.55	22	50.6
Mars Hill, ME (2008)	NA	NA	0.45	28	42
Stetson Mountain I, ME (2011)	NA	NA	0.28	38	57
Stetson Mountain I, ME (2013)	NA	NA	0.18	38	57
Rollins, ME (2012)	NA	NA	0.18	40	60
Kibby, ME (2011)	NA	NA	0.12	44	132
Southeast					
Buffalo Mountain, TN (2005)	NA	NA	39.70	18	28.98
Buffalo Mountain, TN (2000-2003)	23.70[C]	NA	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 mortality 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
Alta X, CA (15-16)	Solick et al. 2010	This study.
Alta X, CA (14-15)	Solick et al. 2010	Thompson et al. 2016
Alite, CA (09-10)		Chatfield et al. 2010
Alta Wind I, CA (11-12)	Solick et al. 2010	Chatfield et al. 2012
Alta Wind I-V, CA (13-14)		Chatfield et al. 2014
Alta Wind II-V, CA (11-12)	Solick et al. 2010	Chatfield et al. 2012
Alta VIII, CA (12-13)		Chatfield and Bay 2014
Barton I & II, IA (10-11)		Derby et al. 2011a
Barton Chapel, TX (09-10)		WEST 2011
Beech Ridge, WV (12)		Tidhar et al. 2013b
Beech Ridge, WV (13)		Young et al. 2014b
Big Blue, MN (13)		Fagen Engineering 2014
Big Blue, MN (14)		Fagen Engineering 2015
Big Horn, WA (06-07)		Kronner et al. 2008
Big Smile, OK (12-13)		Derby et al. 2013b
Biglow Canyon, OR (Phase I; 08)		Jeffrey et al. 2009a
Biglow Canyon, OR (Phase I; 09)		Enk et al. 2010
Biglow Canyon, OR (Phase II; 09-10)		Enk et al. 2011a
Biglow Canyon, OR (Phase II; 10-11)		Enk et al. 2012b
Biglow Canyon, OR (Phase III; 10-11)		Enk et al. 2012a
Blue Sky Green Field, WI (08; 09)	Gruver 2008	Gruver et al. 2009
Buffalo Gap I, TX (06)		Tierney 2007
Buffalo Gap II, TX (07-08)		Tierney 2009
Buffalo Mountain, TN (00-03)	Fiedler 2004	Nicholson et al. 2005
Buffalo Mountain, TN (05)		Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004
Buffalo Ridge I, SD (09-10)		Derby et al. 2010b
Buffalo Ridge II, SD (11-12)		Derby et al. 2012a
Casselman, PA (08)		Arnett et al. 2009b
Casselman, PA (09)		Arnett et al. 2010
Casselman Curtailment, PA (08)		Arnett et al. 2009a
Cedar Ridge, WI (09)	BHE Environmental 2008	BHE Environmental 2010
Cedar Ridge, WI (10)	BHE Environmental 2008	BHE Environmental 2011
Cohocton/Dutch Hill, NY (09)		Stantec 2010
Cohocton/Dutch Hills, NY (10)		Stantec 2011a
Combine Hills, OR (Phase I; 04-05)		Young et al. 2006
Combine Hills, OR (11)		Enz et al. 2012
Crescent Ridge, IL (05-06)		Kerlinger et al. 2007
Criterion, MD (11)		Young et al. 2012a
Criterion, MD (12)		Young et al. 2013
Lempster, NH (09)		Tidhar et al. 2010
Lempster, NH (10)		Tidhar et al. 2011
Linden Ranch, WA (10-11)		Enz and Bay 2011
Locust Ridge, PA (Phase II; 09)		Arnett et al. 2011
Locust Ridge, PA (Phase II; 10)		Arnett et al. 2011
Maple Ridge, NY (06)		Jain et al. 2007
Maple Ridge, NY (07)		Jain et al. 2009a
Maple Ridge, NY (07-08)		Jain et al. 2009d
Maple Ridge, NY (12)		Tidhar et al. 2013a
Marengo I, WA (09-10)		URS Corporation 2010b
Marengo II, WA (09-10)		URS Corporation 2010c
Mars Hill, ME (07)		Stantec 2008a
Mars Hill, ME (08)		Stantec 2009a
Milford I, UT (10-11)		Stantec 2011b
Milford I & II, UT (11-12)		Stantec 2012b
Montezuma I, CA (11)		ICF International 2012
Montezuma I, CA (12)		ICF International 2013
Montezuma II, CA (12-13)		Harvey & Associates 2013
Moraine II, MN (09)		Derby et al. 2010d
Mount Storm, WV (Fall 08)	Young et al. 2009b	Young et al. 2009b
Mount Storm, WV (09)	Young et al. 2009a, 2010b	Young et al. 2009a, 2010b
Mount Storm, WV (10)	Young et al. 2010a, 2011b	Young et al. 2010a, 2011b
Mount Storm, WV (11)		Young et al. 2011a, 2012b
Mountaineer, WV (03)		Kerns and Kerlinger 2004
Munnsville, NY (08)		Stantec 2009b
Mustang Hills, CA (12-13)		Chatfield and Bay 2014
Nine Canyon, WA (02-03)		Erickson et al. 2003a
Noble Altona, NY (10)		Jain et al. 2011b
Noble Bliss, NY (08)		Jain et al.2009e
Noble Bliss, NY (09)		Jain et al. 2010a
Noble Chateaugay, NY (10)		Jain et al. 2011c
Noble Clinton, NY (08)	Reynolds 2010a	Jain et al. 2009c
Noble Clinton, NY (09)	Reynolds 2010a	Jain et al. 2010b
Noble Ellenburg, NY (08)		Jain et al. 2009b
Noble Ellenburg, NY (09)	Reynolds 2010b	Jain et al. 2010c
Noble Wethersfield, NY (10)		Jain et al. 2011a
NPPD Ainsworth, NE (06)		Derby et al. 2007
Palouse Wind, WA (12-13)		Stantec 2013a
Pebble Springs, OR (09-10)		Gritski and Kronner 2010b
Pinnacle, WV (12)		Hein et al. 2013a
Pinyon Pines I&II, CA (13-14)		Chatfield and Russo 2014
Pioneer Prairie I, IA (Phase II; 11-12)		Chodachek et al. 2012
Pioneer Prairie II, IA (13)		Chodachek et al. 2014
PrairieWinds ND1 (Minot), ND (10)		Derby et al. 2011c
PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012c

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

Appendix C4. Mortality estimates for North American wind energy facilities.

Project	Bird Mortality (birds/MW/ year)	Raptor Mortality (raptors/MW/ year)	Bat Mortality (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 I-V, CA (2013-2014)	7.80	0.08	0.20	NA	Chatfield et al. 2014
Alta Wind II-V, CA (2011-2012)	1.66	0.05	0.08	Desert scrub	Chatfield et al. 2012
Alta VIII, CA (2012-2013)	0.66	0.02	0.00	Grassland and riparian	Chatfield and Bay 2014
Alta X, CA Year 1 (2014-2015)	4.88	0.00	0.80	Grassland and riparian	Thompson et al. 2016
Alta X, CA Year 2 (2015-2016)	2.17	0.00	0.80	NA	This study.
Barton I & II, IA (2010-2011)	5.50	0.00	1.85	Agriculture	Derby et al. 2011a
Barton Chapel, TX (2009-2010)	1.15	0.25	3.06	Agriculture/forest	WEST 2011
Beech Ridge, WV (2012)	1.19	0.01	2.03	Forest	Tidhar et al. 2013b
Beech Ridge, WV (2013)	1.48	0.01	0.58	Forest	Young et al. 2014b
Big Blue, MN (2013)	0.60	0.00	2.04	Agriculture	Fagen Engineering 2014
Big Blue, MN (2014)	0.37	0.00	1.43	Agriculture	Fagen Engineering 2015
Big Horn, WA (2006-2007)	2.54	0.11	1.90	Agriculture/grassland	Kronner et al. 2008
Big Smile, OK (2012-2013)	0.09	0.00	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	0.00	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	0.00	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	0.00	0.14	Forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	11.02	0.00	31.54	Forest	Nicholson et al. 2005
Buffalo Mountain, TN (2005)	1.10	0.00	39.70	Forest	Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 1996)	4.14	0.00	NA	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1997)	2.51	0.00	NA	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1998)	3.14	0.00	NA	Agriculture	Johnson et al. 2000

Appendix C4. Mortality estimates for North American wind energy facilities.

Project	Bird Mortality (birds/MW/ year)	Raptor Mortality (raptors/MW/ year)	Bat Mortality (bats/MW/ year)	Predominant Habitat Type	Citation
Buffalo Ridge, MN (Phase I; 1999)	1.43	0.47	0.74	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1998)	2.47	0.00	2.16	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1999)	3.57	0.00	2.59	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	NA	NA	4.35	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	NA	NA	1.64	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 1999)	5.93	0.00	2.72	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	NA	NA	3.71	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	NA	NA	1.81	Agriculture	Johnson et al. 2004
Buffalo Ridge I, SD (2009-2010)	5.06	0.20	0.16	Agriculture/grassland	Derby et al. 2010b
Buffalo Ridge II, SD (2011-2012)	1.99	0.00	2.81	Agriculture, grassland	Derby et al. 2012a
Casselman, PA (2008)	1.51	0.00	12.61	Forest	Arnett et al. 2009b
Casselman, PA (2009)	2.88	0.00	8.60	Forest, pasture, grassland	Arnett et al. 2010
Casselman Curtailment, PA (2008)	NA	NA	4.40	Forest	Arnett et al. 2009a
Cedar Ridge, WI (2009)	6.55	0.18	30.61	Agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	3.72	0.13	24.12	Agriculture	BHE Environmental 2011
Cohocton/Dutch Hill, NY (2009)	1.39	0.00	8.62	Agriculture/forest	Stantec 2010
Cohocton/Dutch Hills, NY (2010)	1.32	0.08	10.32	Agriculture, forest	Stantec 2011a
Combine Hills, OR (Phase I; 2004-2005)	2.56	0.00	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
Criterion, MD (2013)	3.49	NA	5.32	Forest, agriculture	Young et al.2014a
Crystal Lake II, IA (2009)	NA	NA	7.42	Agriculture	Derby et al. 2010a
Diablo Winds, CA (2005-2007)	4.29	0.40	0.82	NA	WEST 2006, 2008
Dillon, CA (2008-2009)	4.71	0.00	2.17	Desert	Chatfield et al. 2009
Dry Lake I, AZ (2009-2010)	2.02	0.00	3.43	Desert grassland/forested	Thompson et al. 2011

Appendix C4. Mortality estimates for North American wind energy facilities.

Project	Bird Mortality (birds/MW/ year)	Raptor Mortality (raptors/MW/ year)	Bat Mortality (bats/MW/ year)	Predominant Habitat Type	Citation
Dry Lake II, AZ (2011-2012)	1.57	0.00	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	0.00	1.49	Agriculture	Derby et al. 2010c
Elm Creek II, MN (2011-2012)	3.64	0.00	2.81	Agriculture, grassland	Derby et al. 2012b
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	0.00	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	0.00	8.09	Agriculture	Johnson et al. 2010a
Fowler I, II, III, IN (2010)	NA	NA	18.96	Agriculture	Good et al. 2011
Fowler I, II, III, IN (2011)	NA	NA	20.19	Agriculture	Good et al. 2012
Fowler I, II, III, IN (2012)	NA	NA	2.96	Agriculture	Good et al. 2013c
Fowler III, IN (2009)	NA	NA	1.84	Agriculture	Johnson et al. 2010b
Goodnoe, WA (2009-2010)	1.40	0.17	0.34	Grassland and shrub-steppe	URS Corporation 2010a
Grand Ridge I, IL (2009-2010)	0.48	0.00	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	0.00	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	0.00	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

Appendix C4. Mortality estimates for North American wind energy facilities.

Project	Bird Mortality (birds/MW/ year)	Raptor Mortality (raptors/MW/ year)	Bat Mortality (bats/MW/ year)	Predominant Habitat Type	Citation
Kewaunee County, WI (1999-2001)	1.95	0.00	6.45	Agriculture	Howe et al. 2002
Kibby, ME (2011)	NA	NA	0.12	Forest; commercial forest	Stantec 2012a
Kittitas Valley, WA (2011-2012)	1.06	0.09	0.12	Sagebrush-steppe, grassland	Stantec Consulting Services 2012
Klondike, OR (2002-2003)	0.95	0.00	0.77	Agriculture/grassland	Johnson et al. 2003b
Klondike II, OR (2005-2006)	3.14	0.06	0.41	Agriculture/grassland	NWC and WEST 2007
Klondike III (Phase I), OR (2007-2009)	3.02	0.15	1.11	Agriculture/grassland	Gritski et al. 2010
Klondike IIIa (Phase II), OR (2008-2010)	2.61	0.06	0.14	Grassland/shrub-steppe and agriculture	Gritski et al. 2011
Leaning Juniper, OR (2006-2008)	6.66	0.16	1.98	Agriculture	Gritski et al. 2008
Lempster, NH (2009)	3.38	0.00	3.11	Grasslands/forest/rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	2.64	0.00	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	0.00	14.11	Grassland	Arnett et al. 2011
Locust Ridge, PA (Phase II; 2010)	0.76	0.00	14.38	Grassland	Arnett et al. 2011
Maple Ridge, NY (2006)	NA	NA	11.21	Agriculture/forested	Jain et al. 2007
Maple Ridge, NY (2007)	2.34	NA	6.49	Agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007-2008)	2.07	0.03	4.96	Agriculture/forested	Jain et al. 2009d
Maple Ridge, NY (2012)	NA	NA	7.30	Agriculture/forested	Tidhar et al. 2013a
Marengo I, WA (2009-2010)	0.27	0.00	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	0.00	2.91	Forest	Stantec 2008a
Mars Hill, ME (2008)	1.76	0.00	0.45	Forest	Stantec 2009a
Milford I, UT (2010-2011)	0.56	NA	2.05	Desert shrub	Stantec 2011b
Milford I & II, UT (2011-2012)	0.73	0.04	1.67	Desert shrub	Stantec 2012b
Montezuma I, CA (2011)	5.19	1.06	1.90	Agriculture and grasslands	ICF International 2012
Montezuma I, CA (2012)	8.91	0.79	0.84	Agriculture and grasslands	ICF International 2013
Montezuma II, CA (2012-2013)	1.08	0.46	0.91	Agriculture	Harvey & Associates 2013

Appendix C4. Mortality estimates for North American wind energy facilities.

Project	Bird Mortality (birds/MW/ year)	Raptor Mortality (raptors/MW/ year)	Bat Mortality (bats/MW/ year)	Predominant Habitat Type	Citation
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	0.00	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
Mustang Hills, CA (2012-2013)	1.66	0.08	0.10	Grasslands and Riparian	Chatfield and Bay 2014
Nine Canyon, WA (2002-2003)	2.76	0.03	2.47	Agriculture/grassland	Erickson et al. 2003a
Noble Altona, NY (2010)	1.84	0.00	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
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
Palouse Wind, WA (2012-2013)	0.72	NA	4.23	Agriculture and grasslands	Stantec 2013a
Pebble Springs, OR (2009-2010)	1.93	0.04	1.55	Grassland	Gritski and Kronner 2010b
Pine Tree, CA (2009-2010, 2011)	17.44	NA	NA	Grassland	BioResource Consultants 2012
Pinnacle, WV (2012)	3.99	0.00	40.20	Forest	Hein et al. 2013a
Pinyon Pines I & II, CA (2013-2014)	1.18	NA	0.04	NA	Chatfield and Russo 2014
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	0.00	10.06	Agriculture, grassland	Chodachek et al. 2012
Pioneer Prairie II, IA (2013)	NA	NA	3.83	Agriculture	Chodachek et al. 2014
PrairieWinds ND1 (Minot), ND (2010)	1.48	0.05	2.13	Agriculture	Derby et al. 2011c
PrairieWinds ND1 (Minot), ND (2011)	1.56	0.05	1.39	Agriculture, grassland	Derby et al. 2012c
PrairieWinds SD1, SD (2011-2012)	1.41	0.00	1.23	Grassland	Derby et al. 2012d
PrairieWinds SD1, SD (2012-2013)	2.01	0.03	1.05	Grassland	Derby et al. 2013a
PrairieWinds SD1, SD (2013-2014)	1.66	0.17	0.52	Grassland	Derby et al. 2014

Appendix C4. Mortality estimates for North American wind energy facilities.

Project	Bird Mortality (birds/MW/ year)	Raptor Mortality (raptors/MW/ year)	Bat Mortality (bats/MW/ year)	Predominant Habitat Type	Citation
Rail Splitter, IL (2012-2013)	0.84	0.00	11.21	Agriculture	Good et al. 2013b
Record Hill, ME (2012)	3.70	NA	2.96	Forest	Stantec 2013b
Record Hill, ME (2014)	1.84	NA	0.55	Forest	Stantec 2015
Red Hills, OK (2012-2013)	0.08	0.04	0.11	Grassland	Derby et al. 2013c
Ripley, Ont (2008)	3.09	0.10	4.67	Agriculture	Jacques Whitford 2009
Rollins, ME (2012)	2.90	NA	0.18	Forest	Stantec 2013c
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. 2009
Shiloh II, CA (2009-2010)	1.90	0.11	2.60	Agriculture	Kerlinger et al. 2010, 2013a
Shiloh II, CA (2010-2011)	2.80	0.44	3.80	Agriculture	Kerlinger et al. 2013a
Shiloh III, CA (2012-2013)	3.30	NA	0.40	NA	Kerlinger et al. 2013b
Solano III, CA (2012-2013)	1.60	0.95	0.31	NA	AECOM 2013
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	0.00	1.40	Forest	Stantec 2009c
Stetson Mountain I, ME (2011)	1.18	0.00	0.28	Forest	Normandeau Associates 2011
Stetson Mountain I, ME (2013)	6.95	0.00	0.18	Forest	Stantec 2014
Stetson Mountain II, ME (2010)	1.42	0.00	1.65	Forest	Normandeau Associates 2010
Stetson Mountain II, ME (2012)	3.37	0.00	2.27	Forest	Stantec 2013e
Summerview, Alb (2005-2006)	1.06	0.11	10.27	Agriculture	Brown and Hamilton 2006b
Summerview, Alb (2006; 2007)	NA	NA	11.42	Agriculture/grassland	Baerwald 2008
Top Crop I & II, IL (2012-2013)	0.60	NA	12.5	Agriculture	Good et al. 2013a
Top of Iowa, IA (2003)	0.42	0.00	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	0.00	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
Wessington Springs, SD (2009)	8.25	0.06	1.48	Grassland	Derby et al. 2010f

Appendix C4. Mortality estimates for North American wind energy facilities.

Project	Bird Mortality (birds/MW/ year)	Raptor Mortality (raptors/MW/ year)	Bat Mortality (bats/MW/ year)	Predominant Habitat Type	Citation
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 VIII, CA (2012-2013)	50	150	90	12 plots (equivalent to 15 turbines)	240 x 240 m	1 year	Bi-weekly
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	80	41	120-m radius circle	14.5 months	Every two weeks
Alta Wind I-V, CA (2013-2014)	290	720 (150 GE, 570 vestas)	80	55 (25 at Alta I, 30 at Alta II-V)	120 m radius circles	NA	Monthly or bi-weekly
Barton I & II, IA (2010-2011)	80	160	100	35 (9 turbines were dropped in June 2010 due to landowner issues) 26 turbines were searched for the remainder of the study	200 m x 200 m	1 year	Weekly (spring, fall; migratory turbines), monthly (summer, winter; non-migratory turbines)
Barton Chapel, TX (2009-2010)	60	120	78	30	200 m x 200 m	1 year	10 turbines weekly, 20 monthly
Beech Ridge, WV (2012)	67	100.5	80	67	40 m radius	7 months	Every two days
Beech Ridge, WV (2013)	67	100.5	80	67	40 m radius	7.5 months	Every two days
Big Blue, MN (2013)	18	36	78 or 90 (according to Gamesa website)	18	200m diameter	NA	Weekly, monthly (Nov and Dec)
Big Blue, MN (2014)	18	36	78 or 90 (according to Gamesa website)	18	200m diameter	NA	Weekly, monthly (Nov and Dec)

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
Big Horn, WA (2006-2007)	133	199.5	80	133	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Big Smile, OK (2012-2013)	66	132	78	17 (plus one met tower)	100 x 100	1 year	Weekly (spring, summer, fall), monthly (winter)
Biglow Canyon, OR (Phase I; 2008)	76	125.4	80	50	110 m x 110 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase I; 2009)	76	125.4	80	50	110 m x 110 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2009-2010)	65	150	80	50	250 m x 250 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2010-2011)	65	150	80	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Biglow Canyon, OR (Phase III; 2010-2011)	76	174.8	80	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Blue Sky Green Field, WI (2008; 2009)	88	145	80	30	160 m x 160 m	Fall, spring	Daily(10 turbines), weekly (20 turbines)
Buena Vista, CA (2008-2009)	38	38	45-55	38	75-m radius	1 year	Monthly to bi-monthly starting in September 2008
Buffalo Gap I, TX (2006)	67	134	78	21	215 m x 215 m	10 months	Every 3 weeks
Buffalo Gap II, TX (2007-2008)	155	233	80	36	215 m x 215 m	14 months	Every 21 days
Buffalo Mountain, TN (2000-2003)	3	1.98	65	3	50-m radius	3 years	Bi-weekly, weekly, bi-monthly
Buffalo Mountain, TN (2005)	18	28.98	V47 = 65; V80 = 78	18	50-m radius	1 year	Bi-weekly, weekly, bi-monthly, and 2 to 5 day intervals

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

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

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
Crescent Ridge, IL (2005-2006)	33	49.5	80	33	70-m radius	1 year	Weekly (fall, spring)
Criterion, MD (2011)	28	70	80	28	40-50m radius	7.3 months	Daily
Criterion, MD (2012)	28	70	80	14	40-50m radius	7.5 months	Weekly
Criterion, MD (2013)	28	70	80	14	40-50m radius	7.5 months	Weekly
Crystal Lake II, IA (2009)	80	200	80	16 turbines through week 6, and then 15 for duration of study	100 m x 100 m	Spring, summer, fall	3 times per week for 26 weeks
Diablo Winds, CA (2005-2007)	31	20.46	50 and 55	31	75 m x 75 m	2 years	Monthly
Dillon, CA (2008-2009)	45	45	69	15	200 m x 200 m	1 year	Weekly, bi-monthly in winter
Dry Lake I, AZ (2009-2010)	30	63	78	15	160 m x 160 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Dry Lake II, AZ (2011-2012)	31	65	78	31: 5 (full plot), 26 (road & pad)	160 m x 160 m	1 year	Twice weekly (spring, summer, fall), weekly (winter)
Elkhorn, OR (2008)	61	101	80	61	220 m x 220 m	1 year	Monthly
Elkhorn, OR (2010)	61	101	80	31	220 m x 220 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Elm Creek, MN (2009-2010)	67	100	80	29	200 m x 200 m	1 year	Weekly, monthly
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

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
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
Harrow, Ont (2010)	24 (four 6-turb facilities)	39.6	NA	12 in July, 24 Aug-Oct	50-m radius from turbine base	4 months	Twice-weekly
Harvest Wind, WA (2010-2012)	43	98.9	80	32	180 m x 180 m & 240 m x 240 m	2 years	Twice a week, weekly and monthly
Hay Canyon, OR (2009-2010)	48	100.8	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Heritage Garden I, MI (2012-2014)	14	28	90	14	120x120 m except one plot that was 280x280 m	2 years	Weekly (spring, summer, and fall) and bi-weekly (winter)

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
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
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)

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 IIIa (Phase II), OR (2008-2010)	51	76.5	GE = 80	34	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (summer, winter)
Lakefield Wind, MN (2012)	137	205.5	80	26	100 m x 100 m	7.5 months	3 times per week
Leaning Juniper, OR (2006-2008)	67	100.5	80	17	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (winter, summer)
Lempster, NH (2009)	12	24	78	4	120 m x 130 m	6 months	Daily
Lempster, NH (2010)	12	24	78	12	120 m x 130 m	6 months	Weekly
Linden Ranch, WA (2010-2011)	25	50	80	25	110 m x 110 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Locust Ridge, PA (Phase II; 2009)	51	102	80	15	120m x 126m	6.5 months	Daily
Locust Ridge, PA (Phase II; 2010)	51	102	80	15	120m x 126m	6.5 months	Daily
Madison, NY (2001-2002)	7	11.55	67	7	60-m radius	1 year	Weekly (spring, fall), monthly (summer)
Maple Ridge, NY (2006)	120	198	80	50	130 m x 120 m	5 months	Daily (10 turbines), every 3 days (10 turbines), weekly (30 turbines)
Maple Ridge, NY (2007)	195	321.75	80	64	130 m x 120 m	7 months	Weekly
Maple Ridge, NY (2007-2008)	195	321.75	80	64	130 m x 120 m	7 months	Weekly
Maple Ridge, NY (2012)	195	321.75	80	105 (5 turbines, 100 roads/pads)	100 m x 100 m	3 months	Weekly
Marengo I, WA (2009-2010)	78	140.4	67	39	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Marengo II, WA (2009-2010)	39	70.2	67	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Mars Hill, ME (2007)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	Spring, summer, fall	Daily (2 random turbines), weekly (all turbines): extended plot searched once per season
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

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
McBride, Alb (2004)	114	75	50	114	4 parallel transects 120-m wide	1 year	Weekly, bi-weekly
Melancthon, Ont (Phase I; 2007)	45	NA	NA	45	35m radius	5 months	Weekly, twice weekly
Meyersdale, PA (2004)	20	30	80	20	130 m x 120 m	6 weeks	Daily (half turbines), weekly (half turbines)
Milford I, UT (2010-2011)	58	145	80	24	120x120	Na	Weekly
Milford I & II, UT (2011-2012)	107	160.5 (58.5 Phase I, 102 Phase II)	80	43	120x120	Na	Every 10.5 days
Montezuma I, CA (2011)	16	36.8	80	16	105 m radius	1 year	Weekly and bi-Weekly
Montezuma I, CA (2012)	16	36.8	80	16	105 m radius	1 year	Weekly and bi-Weekly
Montezuma II, CA (2012-2013)	34	78.2	80	17	105 m radius	1 year	Weekly
Moraine II, MN (2009)	33	49.5	82.5	30	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Mount Storm, WV (Fall 2008)	82	164	78	27	varied	3 months	Weekly (18 turbines), daily (9 turbines)
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
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

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

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
NPPD Ainsworth, NE (2006)	36	20.5	70	36	220 m x 220 m	Spring, summer, fall	Bi-monthly
Oklahoma Wind Energy Center, OK (2004; 2005)	68	102	70	68	20m radius	3 months (2 years)	Bi-monthly
Pacific, CA (2012-2013)	70	140	78.5	20	126 m radius	NA	Twice weekly (fall), and biweekly
Palouse Wind, WA (2012-2013)	58	104.4	80, 90, or 105 M (according to the Vestas website)	19	120m x 120m	1 year	Monthly (winter) and weekly (spring-fall)
Pebble Springs, OR (2009-2010)	47	98.7	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Pine Tree, CA (2009-2010, 2011)	90	135	65	40	100 m radius	1.5 year	Bi-weekly, weekly
Pinnacle, WV (2012)	23	55.2	80	11	126 m x 120m	9 months	Weekly
Pinnacle Operational Mitigation Study (2012)	23	55.2	80	12	126m x 120m	2.5 months	Daily
Pinyon Pines I & II, CA (2013-2014)	100	NA	90	25 plots (approx. 31 turbines)	240x240 m	NA	Bi-weekly
Pioneer Prairie II, IA (2013)	62	102.3	80	62	80x80 m (5 turbines), road and pad within 100 m of turbine (57 turbines)	Na	Weekly
Pioneer Prairie I, IA (Phase II; 2011-2012)	62	102.3	80	62 (57 road/pad) 5 full search plots	80 x 80m	1 year	Weekly (spring and fall), every two weeks (summer), monthly (winter)
Pioneer Trail, IL (2012-2013)	94	150.5	NA	50	80x80m	Fall, spring	Weekly
Prairie Rose, MN (2014)	119	200	80	10	100x100m	6 months	Weekly
PrairieWinds SD1, SD (2012-2013)	108	162	80	50	200 x 200m	1 year	Bi-weekly

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 SD1, SD (2013-2014)	108	162	80	45	200 x 200m	1 year	Twice monthly (spring, summer, fall), monthly (winter)
PrairieWinds ND1 (Minot), ND (2010)	80	115.5	89	35	minimum of 100 m x 100 m	3 seasons	Bi-monthly
PrairieWinds ND1 (Minot), ND (2011)	80	115.5	80	35	minimum 100 x 100m	3 season	Twice monthly
PrairieWinds SD1, SD (2011-2012)	108	162	80	50	200 x 200m	1 year	Twice monthly (spring, summer, fall), monthly (winter)
Rail Splitter, IL (2012-2013)	67	100.5	80	34	60 m radius	1 year	Weekly (spring, summer, and fall) and bi-weekly (winter)
Record Hill, ME (2012)	22	50.6	80	22	126.5x126.5	5 months	Three times every two weeks
Record Hill, ME (2014)	22	50.6	80	10	varied due to steep terrain and heavily vegetated areas	4.5 months	Daily for 5 days a week
Red Canyon, TX (2006-2007)	56	84	70	28	200 m x 200 m in fall and winter; 160 m x 160 m in spring and summer	1 year	Every 14 days in fall and winter; 7 days in spring, 3 days in summer
Red Hills, OK (2012-2013)	82	123	80	20 (plus one met tower)	100 x 100	1 year	Weekly (spring, summer, fall), monthly (winter)
Ripley, Ont (2008)	38	76	64	38	80 m x 80 m	Spring, fall	Twice weekly for odd turbines; weekly for even turbines.
Ripley, Ont (2008-2009)	38	76	64	38	80 m x 80 m	6 weeks	Twice weekly for odd turbines; weekly for even turbines.
Rollins, ME (2012)	40	60	80	20	varied; turbine laydown area and gravel access roads out to 60m	6 months	Weekly
Roth Rock, MD (2011)	20	50	80	10	80m x 80m	3 months	Daily

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
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	n/a	24.4-42.7		50-m radius	2 years	Quarterly
Searsburg, VT (1997)	11	7	65	11	20- to 55-m radius	Spring, fall	Weekly (fall migration)
Sheffield, VT (2012)	16	40	80	8	126m x 120m	3 months	Daily
Sheffield Operational Mitigation Study (2012)	16	40	80	16	126m x 120m	4 months	Daily
Shiloh I, CA (2006-2009)	100	150	65	100	105-m radius	3 years	Weekly
Shiloh II, CA (2009-2010)	75	150	80	25	100m radius	1 year	Weekly
Shiloh II, CA (2010-2011)	75	150	80	25	100 m radius	1 year	Weekly
Shiloh III, CA (2012-2013)	50	102.5	78.5	25	100 m radius	Na	Weekly
SMUD Solano, CA (2004-2005)	22	15	65	22	60-m radius	1 year	Bi-monthly
Solano III, CA (2012-2013)	55	128	80	19	100 m radius	Na	Bi-Weekly
Spruce Mountain, ME (2012)	10	20	78	10	100 m x 100 m	7 months	Weekly
Stateline, OR/WA (2001-2002)	454	299	50	124	minimum 126 m x 126 m	17 months	Bi-weekly, monthly
Stateline, OR/WA (2003)	454	299	50	153	minimum 126 m x 126 m	1 year	Bi-weekly, monthly
Stateline, OR/WA (2006)	454	299	50	39	variable turbine strings	1 year	Bi-weekly
Steel Winds I, NY (2007)	8	20	80	8	176m x 176m	6.5 months	Every 10 days (spring, fall) every 21 days (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
Steel Winds I & II, NY (2012)	14	35	80	8 (1 was just gravel pad)	120m x 120m	6 months	Weekly, bi-weekly (November only)
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	79.45x79.45m	6 months	Weekly
Stetson Mountain I, ME (2013)	38	57	80	19	76 m diameter	6 months	Weekly
Stetson Mountain II, ME (2010)	17	25.5	80	17	74.5x74.5m	6 months	Weekly (3 turbines twice a week)
Stetson Mountain II, ME (2012)	17	25.5	80	17	laydown area and road up to 60m	6 months	Weekly
Summerview, Alb (2005-2006)	39	70.2	67	39	140 m x 140 m	1 year	Weekly, bi-weekly (May to July, September)
Summerview, Alb (2006; 2007)	39	70.2	65	39	52-m radius; 2 spiral transects 7 m apart	Summer, fall (2 years)	Daily (10 turbines), weekly (29 turbines)
Tehachapi, CA (1996-1998)	3300	n/a	14.7 to 57.6	201	50-m radius	20 months	Quarterly
Top Crop I & II, IL (2012-2013)	200 (68 Phase I, 132 Phase II)	300 (102 Phase I, 198 Phase II)	65 (Phase I), 80 (Phase II)	100	61 m radius	1 year	Weekly (spring, summer, and fall) and bi-weekly (winter)
Top of Iowa, IA (2003)	89	80	71.6	26	76 m x 76 m	Spring, summer, fall	Once every 2 to 3 days
Top of Iowa, IA (2004)	89	80	71.6	26	76 m x 76 m	Spring, summer, fall	Once every 2 to 3 days
Tuolumne (Windy Point I), WA (2009-2010)	62	136.6	80	21	180 m x 180 m	1 year	Monthly throughout the year, a sub-set of 10 turbines were also searched weekly during the spring, summer, and fall
Vansycle, OR (1999)	38	24.9	50	38	126 m x 126 m	1 year	Monthly

Appendix 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
Vantage, WA (2010-2011)	60	90	80	30	240 m x 240 m	1 year	Monthly, a subset of 10 searched weekly during migration
Vasco, CA (2012-2013)	34	78.2	80	34	105 m radius	1 year	Weekly, monthly
Wessington Springs, SD (2009)	34	51	80	20	200 m x 200 m	Spring, summer, fall	Bi-monthly
Wessington Springs, SD (2010)	34	51	80	20	200 m x 200 m	8 months	Bi-weekly (spring, summer, fall)
White Creek, WA (2007-2011)	89	204.7	80	89	180 m x 180 m & 240 m x 240 m	4 years	Twice a week, weekly and monthly
Wild Horse, WA (2007)	127	229	67	64	110 m from two turbines in plot	1 year	Monthly, weekly (fall, spring migration at 16 turbines)
Windy Flats, WA (2010-2011)	114	262.2	80	36 (plus 1 MET tower)	180 m x 180 m (120m at MET tower)	1 year	Monthly (spring, summer, fall, and winter), weekly (spring and fall migration)
Winnebago, IA (2009-2010)	10	20	78	10	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Wolfe Island, Ont (May-June 2009)	86	197.8	80	86	60-m radius	Spring	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2009)	86	197.8	80	86	60-m radius	Summer, fall	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2010)	86	197.8	80	86	60-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2010)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2011)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2011)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2012)	86	197.8	NA	86	50-m radius	NA	1/2 searched twice weekly, 1/2 searched 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	Marengo I, WA (09-10)	URS Corporation 2010b
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Marengo II, WA (09-10)	URS Corporation 2010c
Alta Wind I-V, CA (13-14)	Chatfield et al. 2014	Mars Hill, ME (07)	Stantec 2008a
Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Mars Hill, ME (08)	Stantec 2009a
Alta VIII, CA (12-13)	Chatfield and Bay 2014	McBride, Alb (04)	Brown and Hamilton 2004
Barton I & II, IA (10-11)	Derby et al. 2011a	Melancthon, Ont (Phase I; 07)	Stantec Ltd. 2008
Barton Chapel, TX (09-10)	WEST 2011	Meyersdale, PA (04)	Arnett et al. 2005
Beech Ridge, WV (12)	Tidhar et al. 2013b	Milford I, UT (10-11)	Stantec 2011b
Beech Ridge, WV (13)	Young et al. 2014b	Milford I & II, UT (11-12)	Stantec 2012b
Big Blue, MN (13)	Fagen Engineering 2014	Montezuma I, CA (11)	ICF International 2012
Big Blue, MN (14)	Fagen Engineering 2015	Montezuma I, CA (12)	ICF International 2013
Big Horn, WA (06-07)	Kronner et al. 2008	Montezuma II, CA (12-13)	Harvey & Associates 2013
Big Smile, OK (12-13)	Derby et al. 2013b	Moraine II, MN (09)	Derby et al. 2010d
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Mount Storm, WV (Fall 08)	Young et al. 2009b
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Mountaineer, WV (04)	Arnett et al. 2005
Buena Vista, CA (08-09)	Insignia Environmental 2009	Munnsville, NY (08)	Stantec 2009b
Buffalo Gap I, TX (06)	Tierney 2007	Mustang Hills, CA (12-13)	Chatfield and Bay 2014
Buffalo Gap II, TX (07-08)	Tierney 2009	Nine Canyon, WA (02-03)	Erickson et al. 2003a
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Nine Canyon II, WA (04)	Erickson et al. 2005
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Noble Altona, NY (10)	Jain et al. 2011b
Buffalo Ridge, MN (94-95)	Osborn et al. 1996, 2000	Noble Altona, NY (11)	Kerlinger et al. 2011b
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000	Noble Bliss, NY (08)	Jain et al.2009e
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000	Noble Bliss, NY (09)	Jain et al. 2010a
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000	Noble Bliss/Wethersfield, NY (11)	Kerlinger et al. 2011a
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000	Noble Chateaugay, NY (10)	Jain et al. 2011c
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000	Noble Clinton, NY (08)	Jain et al. 2009c
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	Noble Clinton, NY (09)	Jain et al. 2010b
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Noble Ellenburg, NY (08)	Jain et al. 2009b
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Noble Ellenburg, NY (09)	Jain et al. 2010c
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000	Noble Wethersfield, NY (10)	Jain et al. 2011a
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	NPPD Ainsworth, NE (06)	Derby et al. 2007
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Oklahoma Wind Energy Center, OK (04; 05)	Piorkowski and O'Connell 2010
Buffalo Ridge I, SD (09-10)	Derby et al. 2010b	Pacific, CA (12-13)	Sapphos 2014
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Palouse Wind, WA (12-13)	Stantec 2013a
Casselman, PA (08)	Arnett et al. 2009b	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Casselman, PA (09)	Arnett et al. 2010	Pine Tree, CA (09-10, 11)	BioResource Consultants 2012
Casselman Curtailment, PA (08)	Arnett et al. 2009a	Pinnacle, WV (12)	Hein et al. 2013a
Castle River, Alb. (01)	Brown and Hamilton 2006a	Pinnacle Operational Mitigation Study (12)	Hein et al. 2013b
Castle River, Alb. (02)	Brown and Hamilton 2006a	Pinyon Pines I & II, CA (13-14)	Chatfield and Russo 2014
Cedar Ridge, WI (09)	BHE Environmental 2010	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Cedar Ridge, WI (10)	BHE Environmental 2011	Pioneer Prairie II, IA (13)	Chodachek et al. 2014
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Pioneer Trail, IL (12-13)	ARCADIS 2013
Cohocton/Dutch Hills, NY (10)	Stantec 2011a	Prairie Rose, MN (14)	Chodachek et al. 2015
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)	Derby et al. 2014
Criterion, MD (12)	Young et al. 2013	Rail Splitter, IL (12-13)	Good et al. 2013b
Criterion, MD (13)	Young et al. 2014a	Record Hill, ME (12)	Stantec 2013b
Crystal Lake II, IA (09)	Derby et al. 2010a	Record Hill, ME (14)	Stantec 2015
Diablo Winds, CA (05-07)	WEST 2006, 2008	Red Canyon, TX (06-07)	Miller 2008
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	Ripley, Ont (08)	Jacques Whitford 2009
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Ripley, Ont (08-09)	Golder Associates 2010
Elkhorn, OR (08)	Jeffrey et a. 2009b	Rollins, ME (12)	Stantec 2013c
Elkhorn, OR (10)	Enk et al. 2011b	Roth Rock, MD (11)	Atwell 2012
Elm Creek, MN (09-10)	Derby et al. 2010c	Rugby, ND (10-11)	Derby et al. 2011b
Elm Creek II, MN (11-12)	Derby et al. 2012b	San Gorgonio, CA (97-98; 99-00)	Anderson et al. 2005
Erie Shores, Ont. (06)	James 2008	Searsburg, VT (97)	Kerlinger 2002a
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	Sheffield, VT (12)	Martin et al. 2013

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
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b	Sheffield Operational Mitigation Study (12)	Martin et al. 2013
Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003b	Shiloh I, CA (06-09)	Kerlinger et al. 2009
Forward Energy Center, WI (08-10)	Grodsky and Drake 2011	Shiloh II, CA (09-10)	Kerlinger et al. 2010
Fowler I, IN (09)	Johnson et al. 2010a	Shiloh II, CA (10-11)	Kerlinger et al. 2013a
Fowler I, II, III, IN (10)	Good et al. 2011	Shiloh III, CA (12-13)	Kerlinger et al. 2013b
Fowler I, II, III, IN (11)	Good et al. 2012	SMUD Solano, CA (04-05)	Erickson and Sharp 2005
Fowler I, II, III, IN (12)	Good et al. 2013c	Solano III, CA (12-13)	AECOM 2013
Fowler III, IN (09)	Johnson et al. 2010b	Spruce Mountain, ME (12)	Tetra Tech 2013
Goodnoe, WA (09-10)	URS Corporation 2010a	Stateline, OR/WA (01-02)	Erickson et al. 2004
Grand Ridge I, IL (09-10)	Derby et al. 2010g	Stateline, OR/WA (03)	Erickson et al. 2004
Harrow, Ont (10)	Natural Resource Solutions 2011	Stateline, OR/WA (06)	Erickson et al. 2007
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Steel Winds I, NY (07)	Grehan 2008
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Steel Winds I & II, NY (12)	Stantec 2013d
Heritage Garden I, MI (12-14)	Kerlinger et al. 2014	Stetson Mountain I, ME (09)	Stantec 2009c
High Sheldon, NY (10)	Tidhar et al. 2012a	Stetson Mountain I, ME (11)	Normandeau Associates 2011
High Sheldon, NY (11)	Tidhar et al. 2012b	Stetson Mountain I, ME (13)	Stantec 2014
High Winds, CA (03-04)	Kerlinger et al. 2006	Stetson Mountain II, ME (10)	Normandeau Associates 2010
High Winds, CA (04-05)	Kerlinger et al. 2006	Stetson Mountain II, ME (12)	Stantec 2013e
Hopkins Ridge, WA (06)	Young et al. 2007	Summerview, Alb (05-06)	Brown and Hamilton 2006b
Hopkins Ridge, WA (08)	Young et al. 2009c	Summerview, Alb (06; 07)	Baerwald 2008
Jersey Atlantic, NJ (08)	NJAS 2008a, 2008b, 2009	Tehachapi, CA (96-98)	Anderson et al. 2004
Judith Gap, MT (06-07)	TRC 2008	Top Crop I & II, IL (12-13)	Good et al. 2013a
Judith Gap, MT (09)	Poulton and Erickson 2010	Top of Iowa, IA (03)	Jain 2005
Kewaunee County, WI (99-01)	Howe et al. 2002	Top of Iowa, IA (04)	Jain 2005
Kibby, ME (11)	Stantec 2012a	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
Kittitas Valley, WA (11-12)	Stantec Consulting 2012	Vansycle, OR (99)	Erickson et al. 2000a
Klondike, OR (02-03)	Johnson et al. 2003b	Vantage, WA (10-11)	Ventus Environmental Solutions 2012
Klondike II, OR (05-06)	NWC and WEST 2007	Vasco, CA (12-13)	Brown et al. 2013
Klondike III (Phase I), OR (07-09)	Gritski et al. 2010	Wessington Springs, SD (09)	Derby et al. 2010f
Klondike IIIa (Phase II), OR (08-10)	Gritski et al. 2011	Wessington Springs, SD (10)	Derby et al. 2011d
Lakefield Wind, MN (12)	MPUC 2012	White Creek, WA (07-11)	Downes and Gritski 2012b
Leaning Juniper, OR (06-08)	Gritski et al. 2008	Wild Horse, WA (07)	Erickson et al. 2008
Lempster, NH (09)	Tidhar et al. 2010	Windy Flats, WA (10-11)	Enz et al. 2011
Lempster, NH (10)	Tidhar et al. 2011	Winnebago, IA (09-10)	Derby et al. 2010e
Linden Ranch, WA (10-11)	Enz and Bay 2011	Wolfe Island, Ont (May-June 09)	Stantec Ltd. 2010a
Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011	Wolfe Island, Ont (July-December 09)	Stantec Ltd. 2010b
Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011	Wolfe Island, Ont (January-June 10)	Stantec Ltd. 2011a
Madison, NY (01-02)	Kerlinger 2002b	Wolfe Island, Ont (July-December 10)	Stantec Ltd. 2011b
Maple Ridge, NY (06)	Jain et al. 2007	Wolfe Island, Ont (January-June 11)	Stantec Ltd. 2011c
Maple Ridge, NY (07)	Jain et al. 2009a	Wolfe Island, Ont (July-December 11)	Stantec Ltd. 2012
Maple Ridge, NY (07-08)	Jain et al. 2009d	Wolfe Island, Ont (January-June 12)	Stantec Ltd. 2014
Maple Ridge, NY (12)	Tidhar et al. 2013a		