

Post-Construction Avian and Bat Mortality Monitoring At the Rising Tree and Addison Wind Energy Projects Kern County, California

**Year 1 – Final Report
September 2015 – September 2016**



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EXECUTIVE SUMMARY

Rising Tree Wind Farm LLC, Rising Tree Wind Farm II LLC, and Rising Tree Wind Farm III LLC (collectively referred to as Rising Tree), each wholly owned subsidiaries of EDP Renewables North America LLC (EDPR), own and operate the Rising Tree I, II, and III Wind Energy Projects (Projects) in Kern County, California. During the development phase, the Projects were known as the Homestead Wind Energy Project and Bent Tree Wind Energy Project, with a portion that was also referred to as the Addison Energy Wind Project. Environmental Impact Reports (EIRs) were developed for the Rising Tree and Addison Wind Projects as a part of the California Environmental Quality Act review process. Although the Projects were referred to by various names (e.g., Homestead, Bent Tree, Addison, and Rising Tree) throughout the development and permitting processes, the Projects are referred to throughout this report as the Projects or the Rising Tree Projects. As specified in Mitigation Measures (MM) 4.4-22 and 4.4-23 of the EIRs, EDPR is committed to conducting post-construction avian and bat mortality and raptor nest monitoring at the Projects for at least three years of operation. Western EcoSystems Technology, Inc. (WEST), was contracted by EDPR 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 stipulated in the Rising Tree Bird and Bat Conservation Strategy and Eagle Conservation Plan, and 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 (USFWS) Service Wind Turbine Advisory Committee Guidelines, the California Wind Energy Guidelines, and are based on WEST's experience studying wildlife at wind energy projects throughout the US. In mid-2016, the USFWS inquired about potentially revising the monitoring protocol for the remainder of the survey period, and in coordination with Kern County, EDPR has suspended the monitoring effort until the first years' results can be reviewed, and any agreed upon revisions discussed with interested parties. This report presents the results of the first year of avian and bat fatality and raptor nest monitoring conducted at the Projects, from September 2015 through September 2016.

As stated in MM 4.4-22 of the Rising Tree and Addison EIRs, the objective of the mortality monitoring study was to demonstrate the level of incidental injury and mortality to populations of avian and bat species in the vicinity of the Project. To this end, WEST designed 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 five components: 1) standardized carcass surveys of selected turbines, 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers, 3) carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection, 4) calculation of adjusted fatality estimates for birds and bats, and 5) raptor nest monitoring within the Project.

The Projects are located approximately three miles (4.8 kilometers) west of the unincorporated community of Mojave in south-central Kern County, California and consists of 60 3.3-megawatt (MW) wind turbines sited on privately owned lands. The turbines have a hub height of

approximately 84 meters (m; 275 feet [ft]) and a rotor radius of approximately 56 m (184 ft), for a maximum turbine height of 140 m (459 ft).

Standardized carcass searches were conducted to systematically search the ground beneath 19 of the Project's 60 turbines (31%) every two weeks during the first year of monitoring. Searches were conducted within square plots measuring 280 m (918 ft) on a side and centered on each of the sample turbines. Sixty bird fatalities, representing 25 identifiable species, were found during standardized carcass searches or incidentally within the Projects. No bat fatalities were found. The bird species most commonly found as fatalities during the study, including incidentally, were horned lark (nine fatalities) and mourning dove (seven fatalities). Three diurnal raptor fatalities, two red-tailed hawks and one merlin, were found during the study. No state or federally listed bird species were found; however, one yellow-headed blackbird, a state species of concern, was found. Although bird fatalities were distributed throughout the Projects, higher numbers of bird fatalities were documented at Turbine 34 and Turbine 36 (eight and 12 fatalities, respectively). The increased number of fatalities at Turbine 36 may have been influenced by the presence of a successful common raven nest that was located within the search plot associated with Turbine 36. Bird fatalities were documented more regularly during the spring (April through June) compared to summer, fall, and winter.

A total of 181 trial carcasses (49 large birds, 100 small birds, and 32 bats/bat surrogates) were placed throughout the Projects to estimate searcher efficiency rates. The overall searcher efficiency rate for large birds was 87.0%, compared to 75.0% for small birds and 73.3% for bats/bat surrogates. A total of 163 trial carcasses (28 large birds, 92 small birds, and 43 bats/bat surrogates) were placed within the Projects during the study period to estimate carcass persistence. At day 14 (equal to the search interval), roughly 93% of large birds remained in the search area, while about 55% of small birds and about 42% of bats/bat surrogates remained. Carcass persistence times were modeled and the top models indicated that the probability of a carcass persisting through the search interval was 0.66 for large birds across all seasons, while for small birds the probability that a carcass would persist through the search interval varied by season, and was 0.34 in spring, 0.29 in summer, 0.26 in fall, and 0.17 in winter.

Fatality estimates were adjusted based on the corrections for carcass removal and observer detection bias. The probability that a small bird carcass would remain in the search plot and be found by a searcher was 0.25 in the spring, 0.22 in the summer, 0.19 in the fall, and 0.13 in the winter. For large birds, the probability was 0.58 and consistent across seasons. Based on the 3.3-MW capacity of the turbines at the Projects, the estimated fatality rate for all birds was 3.13 birds per MW per year, with an estimated fatality rate of 0.06 diurnal raptors per MW per year. No bat fatalities were found, therefore the bat fatality rate was assumed to be zero based on the available data.

Raptor nest monitoring was conducted in accordance with MM 4.4-23 of the Rising Tree and Addison EIRs with the goal of demonstrating whether raptor nesting was compatible with operation of the Projects. No raptor nests were documented during nest surveys conducted monthly from March through June. Three larger stick nests were identified, although all three

were occupied by common ravens. One common raven nest was located within the search plot associated with Turbine 36 and successfully fledged young. The presence of this active common raven nest appeared to influence the density of bird fatalities documented at Turbine 36.

While the raptor and bat fatality rates estimated during the first year of monitoring at the Projects were low and consistent with other nearby facilities in the Tehachapi Wind Resource Area, the overall bird fatality rate was slightly higher than reported at some nearby facilities (e.g., Mustang Hills, Alta II-V, Alta VIII). Although the influence of the above noted common raven nest is not clear, if it were assumed that some of the fatalities at Turbine 36 (which accounted for 23.5% of the fatalities used to estimate fatality rates) were brought in by the common ravens and not caused with Turbine 36, this would result in a an overestimate of true turbine-related fatality rates. As such, the actual fatality rate for the Projects might be slightly lower and more consistent with the lower fatality rates observed at the other nearby facilities (e.g., Alta II-V, Alta VIII, and Mustang Hills). Two additional years of mortality monitoring are scheduled to be conducted at the Projects in Year 2 and Year 3 of operations, the results of which will help to clarify the long term impacts of the Projects on birds and bats. It is recommended that the inclusion of search plots at Turbine 34 and Turbine 36 be reconsidered for Year 2 and Year 3 to minimize the potential influence of nesting common ravens on the mortality estimates at the Projects.

STUDY PARTICIPANTS

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A number of individuals were instrumental in the completion of the post-construction studies at the Rising Tree and Rising Tree III (a.k.a. Addison) Wind Energy Projects. EDP Renewables provided funding for the monitoring study. From WEST, Landy Figueroa, Elizabeth Ashby, Eman Jabali, Spencer Lejins, and Lindsey Dernovsek conducted fatality surveys and carcass removal trials beneath turbines. Ashley Albert conducted searcher efficiency trials.

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INTRODUCTION

Rising Tree Wind Farm LLC, Rising Tree Wind Farm II LLC, and Rising Tree Wind Farm III LLC (collectively referred to as Rising Tree), each wholly owned subsidiaries of EDP Renewables North America LLC (EDPR), own and operate the Rising Tree I, II, and III Wind Energy Projects (Projects) in Kern County, California. During the development phase, the Projects were known as the Homestead Wind Energy Project and Bent Tree Wind Energy Project, with a portion that was also referred to as the Addison Energy Wind Project. Environmental Impact Reports (EIRs) were developed for the Rising Tree Wind Project and Addison Wind Project as a part of the California Environmental Quality Act review process, and as specified in Mitigation Measures (MM) 4.4-22 and 4.4-23 of the EIRs (Kern County Planning and Community Development Department [Kern County] 2013b, 2013a), EDPR is committed to conducting post-construction avian and bat mortality and raptor nest monitoring at the Projects for at least three years of operation.

Although the Projects were referred to by various names (e.g., Homestead, Bent Tree, Addison, and Rising Tree) throughout the development and permitting processes, the Projects are referenced throughout this report as the Projects or Rising Tree Projects. Western EcoSystems Technology, Inc. (WEST), was contracted by EDPR 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 were stipulated in the Rising Tree Bird and Bat Conservation Strategy and Eagle Conservation Plan, and are similar to those used at other wind energy facilities throughout California and the US. Data collection and analysis follows the recommendations presented in the US Fish and Wildlife Service (USFWS) Wind Turbine Advisory Committee Guidelines (USFWS 2012), the California Wind Energy Guidelines (California Energy Commission [CEC] and California Department of Fish and Game [CDFG] 2007), and are based on WEST's experience studying wildlife at wind energy projects throughout the US. In mid-2016, the USFWS inquired about potentially revising the monitoring protocol for the remainder of the survey period, and in coordination with Kern County, EDPR has suspended the monitoring effort until the first years' results can be reviewed, and any agreed upon revisions discussed with interested parties. This report presents the results of the first year of avian and bat fatality and raptor nest monitoring conducted at the Projects.

As stated in MM 4.4-22 of the EIRs, the objective of the mortality monitoring study was to demonstrate the level of incidental injury and mortality to populations of avian and bat species in the vicinity of the Projects. 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 Projects on an annual basis. In addition to the mortality monitoring, raptor nest monitoring was conducted in accordance with MM 4.4-23 of the EIRs, with the goal of demonstrating whether raptor nesting was compatible with operation of the Projects. If, after three years of post-construction fatality and raptor nest monitoring, the Kern County Planning Department, in consultation with the California Department of Fish and Wildlife (CDFW [formerly the CDFG]) and USFWS, determines that the Projects are causing unanticipated significant adverse impacts to

populations of avian or bat species, the Projects' proponents will provide supplemental mitigation as described in MM 4.4-24 of the EIRs (Kern County 2013b, 2013a).

Post-construction monitoring at the Projects was conducted from September 8, 2015, through September 2, 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 Projects are located approximately three miles (4.8 kilometers) west of the unincorporated community of Mojave in south-central Kern County, California (Figure 1). The Projects consist of 60 Vestas V112 wind turbine generators sited on private lands covering an area of approximately 2,826 acres (1,144 hectares). The turbines have a hub height of approximately 84 meters (m; 275 feet [ft]) and a rotor radius of approximately 56 m (184 ft), for a maximum turbine height of 140 m (459 ft).

Topography within the Projects is varied, with the southern and eastern portions being relatively flat, while the northwestern portion is more topographically diverse, with a number of ridges oriented northwest-southeast (Figures 1 and 2). Vegetation consists primarily of creosote bush (*Larrea tridentata*) scrub, Mojave mixed scrub, and scattered patches of Joshua tree (*Yucca brevifolia*) woodland. There is also a significant amount of disturbed habitat. No permanent water exists in the Projects; however, a number of washes with intermittent water flow are present. The Projects are bordered to the south by Oak Creek Road, which runs east to west, and by an underground portion of the Los Angeles Aqueduct that runs along the eastern boundary of the Projects (Figures 1 and 2). Existing wind energy facilities are also present to the north, west, south, and southeast of the Projects.

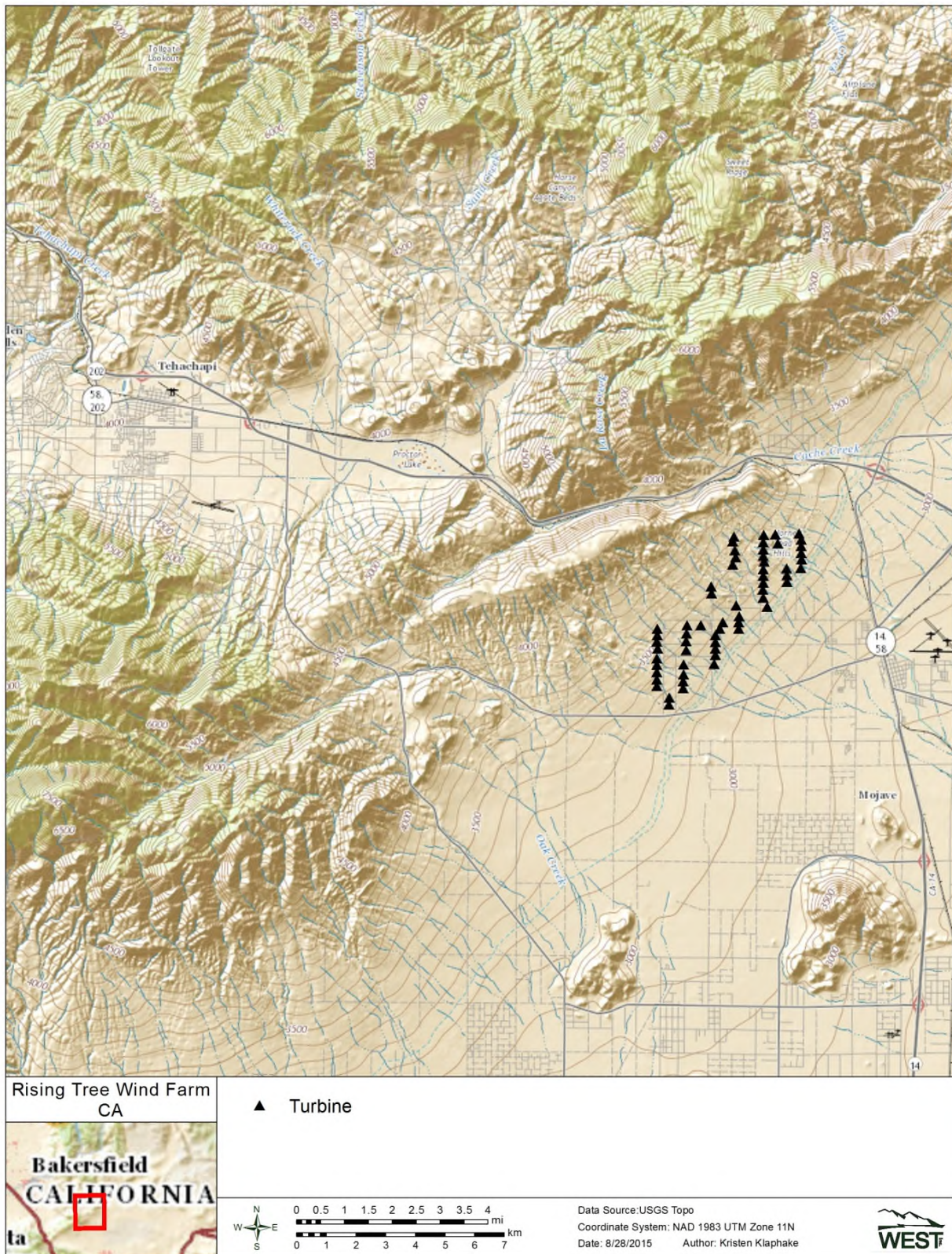


Figure 1. Location of the Rising Tree Projects.

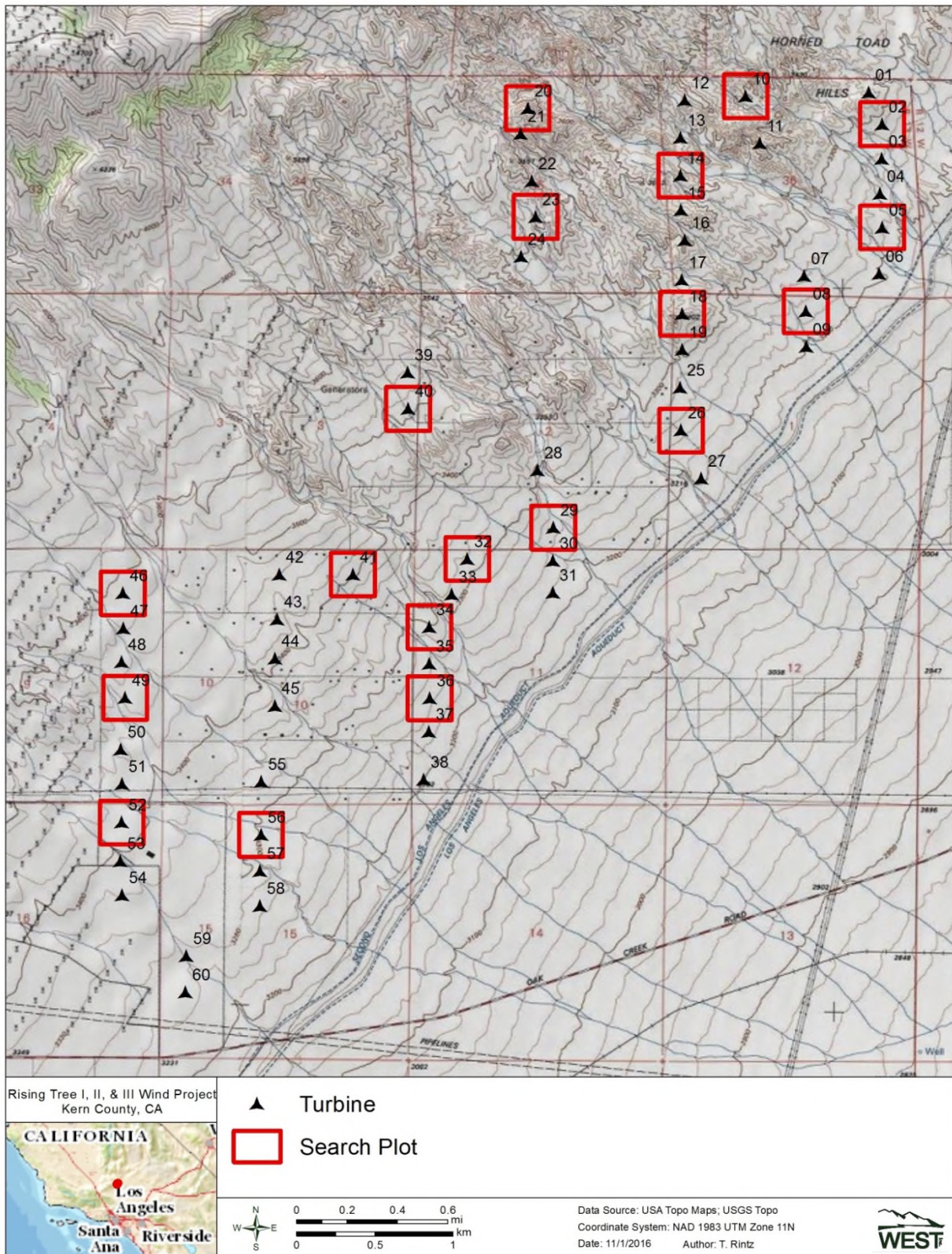


Figure 2. Location of carcass search plots at the Rising Tree Projects.

MORTALITY MONITORING STUDY

The primary objective of the mortality monitoring study was to estimate the level of bird and bat mortality attributable to collisions with wind turbines at the facility on an annual basis. Additionally, estimated mortality at the Projects was compared to average mortality observed at other wind energy facilities, both regionally and nationally, to determine if mortality at the Projects was lower, similar to, or higher than that observed at other facilities, with an emphasis on other facilities in the Tehachapi wind resource area. The methods for the fatality study were broken into four primary components: 1) standardized carcass surveys of selected turbines, 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers, 3) carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection, and 4) calculation of adjusted mortality estimates for bird and bat species within the Projects.

Study Components and Field Methodology

Standardized Carcass Searches

Standardized carcass searches were conducted to systematically search the ground beneath turbines for avian and bat fatalities. Nineteen of the Project's 60 turbines (31%) were searched during the first year of monitoring (Figure 2). Searches were conducted within square plots measuring 280 m (918 ft) on a side and centered on each of the sample turbines (Figure 2). Search plots were selected using a constrained random sample, such that the search effort was distributed throughout the Projects and all habitats and topographies were represented. Plots were searched along parallel transects spaced six to 10 m (20 to 33 ft) apart (depending on visibility), with the orientation of transects based on the orientation of the topography within the plots.

Data recorded for all documented fatalities 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 fatalities were photographed as found, including detailed close-up photos of the carcass for identification purposes, as well as photos showing location of the carcass in relation to the closest wind turbine or other Project facilities, such as overhead power lines.

Incidental fatalities found within search plots but outside of the standardized search times were documented in the same manner as those found during scheduled searches and were included in the overall dataset under the assumption that these fatalities would have been found during the next scheduled search. Incidental fatalities found outside the formal search area (e.g., near a turbine or other portion of the Projects' infrastructure not included in the study) were also recorded following the above protocol as closely as possible; however, these fatalities were not included in the overall dataset used for estimating mortality rates. Fatalities found by maintenance personnel and others not conducting the formal searches were similarly documented.

Standardized carcass surveys were conducted every two weeks during the spring (March 10 – May 27), summer (May 28 – September 2), fall (September 3 – November 11), and winter (November 12 – March 9) at each of the sampled turbines.

Searcher Efficiency Trials

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

Personnel conducting carcass surveys did not know when searcher efficiency trials were being conducted or the location of the trial carcasses. Carcasses used for searcher efficiency trials were non-native/non-protected or commercially available species (e.g., *Coturnix* quail [*Coturnix* spp.], mallard [*Anas platyrhynchos*], and house sparrows [*Passer domesticus*]). Due to a lack of bat carcasses available for the study, dark-colored mice (*Mus musculus*) were used 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 and environmental conditions, and scavenger densities. Trial carcasses were of similar composition to those used for searcher efficiency trials.

Turbines, including searched and non-searched turbines, were randomly selected for inclusion in the removal trials. Trial carcasses were randomly placed at selected turbines within a plot of similar size to the actual search plots. Personnel conducting carcass searches monitored the trial carcasses 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, 20, 30, and 40. This schedule varied somewhat depending on weather and coordination with the other survey work. Removal trial carcasses were discreetly marked (e.g., with dark electrical tape around one or both legs) for recognition

by searchers and other personnel, and left at the location until the end of the carcass removal trial. Any remaining evidence of the carcass was removed at the end of the trial period.

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® SQL Server 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.

Fatality Estimates

Overall fatality estimates are provided for five categories: 1) small birds, 2) large birds, 3) diurnal raptors, 4) all birds, and 5) bats. Estimates of facility-related fatalities were based on:

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

Fatality rates were estimated using the Huso estimator (Huso 2010, Huso et al. 2015). The following variables were used in the equations presented below for the Huso estimator:

c_i total number of carcasses in category i (e.g., season)

n_i number of turbines sampled in category i

k number of carcass categories

I_i time interval between the previous search and discovery for category i

$\hat{I}_i$ effective search interval for carcasses in category i

$\hat{r}_i$ average probability of persistence for carcasses in category i

$\hat{p}_i$ probability of detection for carcasses in category i

$\hat{\pi}_i$ the estimated probability that a carcass in category i was both available to be found during a search and was found, as determined by carcass removal and searcher efficiency trials

$\hat{f}_i$ per turbine mortality for category i

$\hat{f}$ total per turbine mortality

$\hat{m}$ total per turbine mortality

Estimation of Carcass Persistence

Estimates of carcass persistence are used to adjust carcass counts for removal bias. Carcass persistence can be modeled as a function of a variety of variables including ground visibility, size, season, and the interactions between these variables. The average probability of persistence of a carcass, $\hat{p}_i$, is estimated from an interval censored carcass persistence model. Exponential, log-logistic, lognormal, and Weibull distributions are fit along with other covariates appropriate for the study. For this study, season was investigated as a potential covariate in the model. Models were selecting using the Akaike Information Criteria (AIC; Burnham and Anderson 2002) statistic, with the final model selected being the most parsimonious model within two AIC values of the top model.

Estimation of Searcher Efficiency Rates

Searcher efficiency rates, $\hat{p}_i$, were estimated as the proportion of trial carcasses found in a search category. Searcher efficiency was assumed to be a binomial process, and was pooled across seasons and visibility classes as appropriate (i.e., if the data indicated no statistical difference).

Estimation of Adjusted Facility-Related Fatality Rates

The estimated probability that a carcass in category i was available and detected was:

$$\hat{\pi}_i = \hat{p}_i \cdot \hat{r}_i \cdot \hat{v}_i$$

where $\hat{v}_i = \min(1, \hat{I}_i/I_i)$. The model assumes that searchers have a single opportunity to find each carcass, even though some carcasses may persist through multiple searches before being detected. Therefore, a carcass was only included in calculation of adjusted fatality estimates if it had been become available since the last search, and no longer. The estimated time since death, recorded in the field and based on carcass condition, was used to evaluate each carcass for inclusion in the final fatality estimate calculations.

The per-turbine fatality rate ($\hat{f}_i$) in category i , based on the number of carcasses found in category i is given by

$$\hat{f}_i = \frac{c_i}{\hat{\pi}_i}.$$

The standard errors and 90% confidence intervals on this estimate 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 and the standard deviation of the bootstrap estimates was the estimated standard error. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates are estimates of the lower and upper limits of 90% confidence intervals.

RAPTOR NEST MONITORING

Raptor nest surveys were conducted throughout the Projects between February 15 and August 15 (or before if fledged) during Year 1 of post-construction monitoring. Surveys for nesting raptors were conducted during the breeding season by vehicle and on foot to determine the presence or absence of raptor nests within suitable habitats. Biologists recorded nest location coordinates of each identified nest with a hand-held GPS device. Nest status information was recorded as: 1) Unoccupied - a nest with no evidence of recent use, or attendance by adults or young; or 2) Occupied - a nest site exhibiting recent refurbishing (greenery, recent egg cup), and/or was attended by one or more adults on or immediately adjacent to the nest structure(s). Biologists recorded species present (if any), condition of the nest, presence of eggs or young (if present and visible), substrate of the nest (e.g., tree, power pole, rock outcrop), and height and aspect of the nest.

RESULTS

Avian and Bat Mortality Monitoring

Twenty-six rounds of searches were conducted over the course of the fatality monitoring study, for a total of 492 plot searches. Sixty birds comprising 25 identifiable species were found during standardized carcass surveys or incidentally (Table 1). No bats were found during scheduled searches or incidentally. The number, species, location, other characteristics of the bird fatalities, and the bird fatality estimates adjusted for searcher efficiency and carcass removal biases, are discussed below. A full listing of fatalities is presented in Appendix A.

Table 1. Total number of bird fatalities and the composition of fatalities discovered at the Rising Tree Projects from September 8, 2015 – September 2, 2016. No bat fatalities were documented during the study period.

Species	On-Plot Casualties Included in Analysis		Casualties Off Plot Not Included in Analysis		On-Plot Casualties Censored and Not Included in Analysis		Total	
	Total	% Comp.	Total	% Comp.	Total	% Comp.	Total	% Comp.
horned lark	4	7.84	2	40.00	3	75.00	9	15.00
mourning dove	7	13.73	0	0	0	0	7	11.67
unidentified bird (small)	7	13.72	0	0	0	0	7	11.67
rock pigeon	4	7.84	0	0	0	0	4	6.67
black-headed grosbeak	2	3.92	1	20.00	0	0	3	5.00
dark-eyed junco	2	3.92	0	0	0	0	2	3.33
greater roadrunner	2	3.92	0	0	0	0	2	3.33
Swainson's thrush	2	3.92	0	0	0	0	2	3.33
white-crowned sparrow	2	3.92	0	0	0	0	2	3.33
western meadowlark	2	3.92	0	0	0	0	2	3.33
western tanager	2	3.92	0	0	0	0	2	3.33
red-tailed hawk	1	1.96	1	20.00	0	0	2	3.33
blue-winged teal	1	1.96	0	0	0	0	1	1.67
cactus wren	1	1.96	0	0	0	0	1	1.67
chipping sparrow	1	1.96	0	0	0	0	1	1.67
European starling	1	1.96	0	0	0	0	1	1.67
fox sparrow	1	1.96	0	0	0	0	1	1.67
gray flycatcher	1	1.96	0	0	0	0	1	1.67
merlin	1	1.96	0	0	0	0	1	1.67
MacGillivray's warbler	1	1.96	0	0	0	0	1	1.67
Savannah sparrow	1	1.96	0	0	0	0	1	1.67
song sparrow	1	1.96	0	0	0	0	1	1.67
unidentified sparrow	1	1.96	0	0	0	0	1	1.67
unidentified warbler	1	1.96	0	0	0	0	1	1.67
Wilson's warbler	1	1.96	0	0	0	0	1	1.67
yellow-rumped warbler	1	1.96	0	0	0	0	1	1.67
ruby-crowned kinglet	0	0	1	20.00	0	0	1	1.67
yellow-headed blackbird	0	0	0	0	1	25.00	1	1.67
Overall	51	100	5	100	4	100	60	100

Bird Fatalities

Fifty-five bird fatalities were found on search plots during scheduled searches or incidentally (Appendix A, Figure 3). Of the 55 birds found on search plots, 51 were included in analyses and four were censored because their estimated time of death was prior to the previous search (Table 1). Five additional fatalities were found incidentally outside of search plots and were also not included in analyses (Table 1). The bird species most commonly found as fatalities during the study, including incidentally, were horned lark (*Eremophila alpestris*; nine fatalities) and mourning dove (*Zenaida macroura*; seven fatalities). All other identified bird species found during the study were represented by four or fewer carcasses (Table 1). Three diurnal raptor fatalities, two red-tailed hawks (*Buteo jamaicensis*) and one merlin (*Falco columbarius*), were found during the study. No state or federally listed bird species were found. One state species of concern was found, one yellow-headed blackbird (*Xanthocephalus xanthocephalus*).

Although bird fatalities were distributed throughout the Projects; higher numbers of bird fatalities were documented at Turbine 34 (eight fatalities) and Turbine 36 (12 fatalities; Figures 3 and 4). Five or fewer bird fatalities were documented at all other search plots (Figures 3 and 4). The increased number of fatalities at Turbine 36 may have been influenced by the presence of a successful common raven (*Corvus corax*) nest that was located approximately 100 m (328 ft) northeast of Turbine 36. Bird fatalities were found throughout the search plots, with roughly one third (31.4%) found between 90 and 110 m (295 and 360 ft) from search turbines (Table 2, Figure 5). Bird fatalities were documented more regularly during the spring (April through June) compared to summer, fall, and winter (Figure 6).

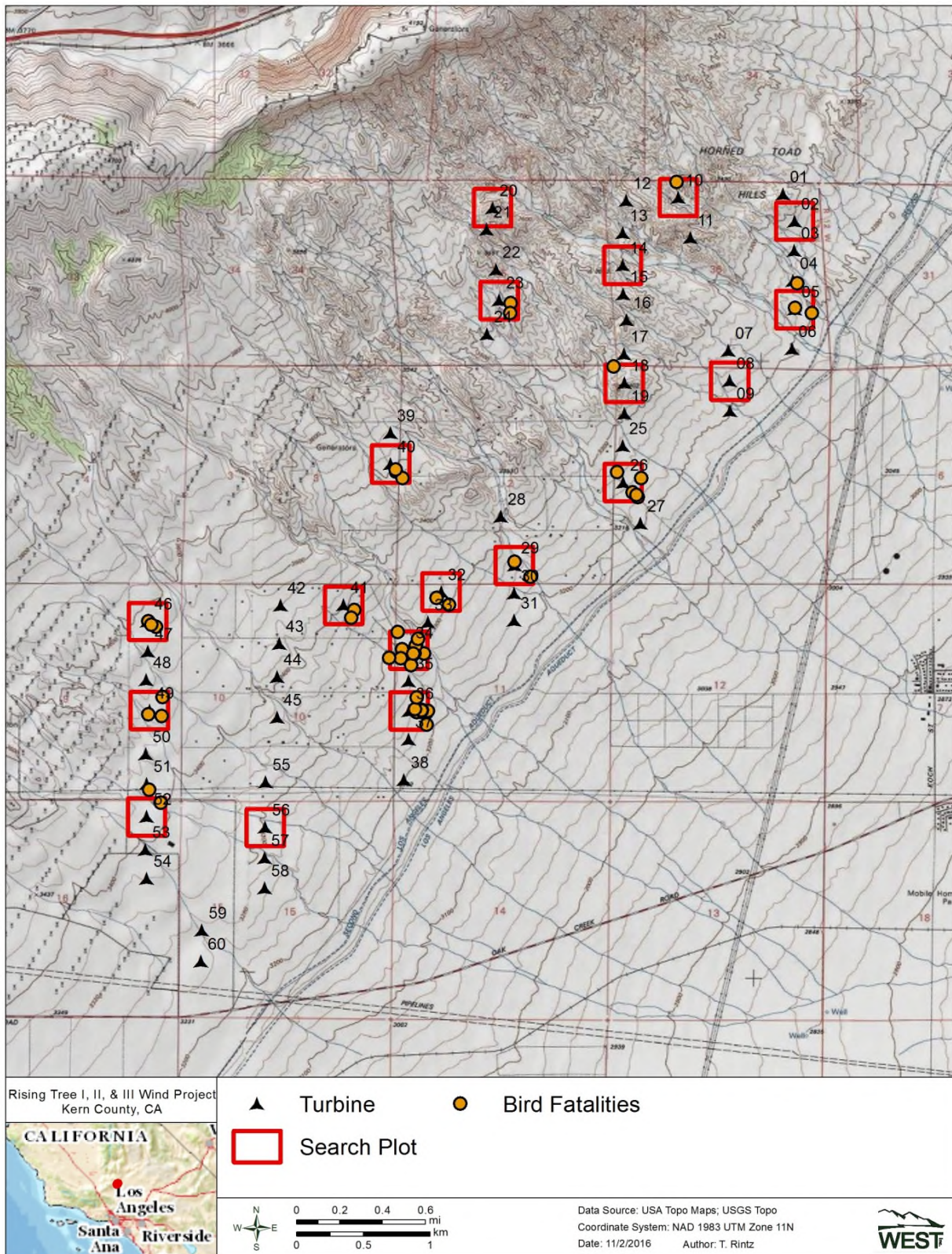


Figure 3. Location of all bird fatalities found at the Rising Tree Projects. No bat fatalities were documented.

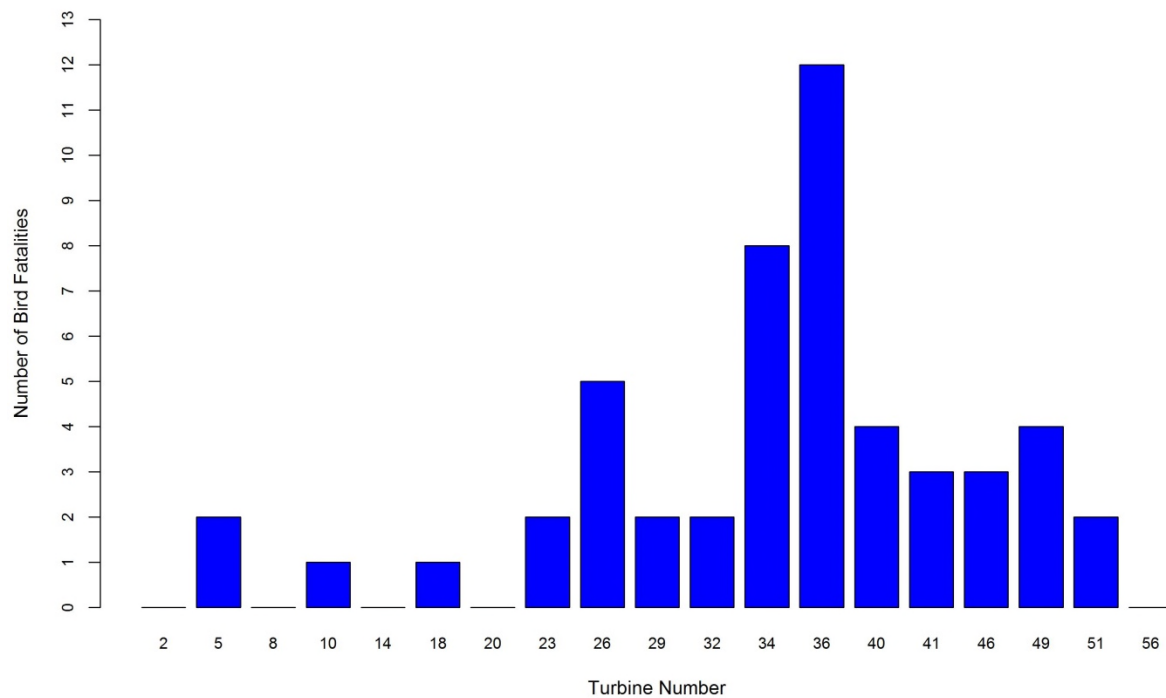


Figure 4. Number of bird fatalities by search plot at the Rising Tree Projects.

Table 2. Distribution of distances from turbines of bird fatalities found during scheduled searches or incidentally on turbine search plots at the Rising Tree Projects.

Distance to Turbine (m)	% Bird Casualties	% Bat Casualties
0 to 10	0	0
10 to 20	1.9	0
20 to 30	1.9	0
30 to 40	1.9	0
40 to 50	9.8	0
50 to 60	9.8	0
60 to 70	1.9	0
70 to 80	3.9	0
80 to 90	7.8	0
90 to 100	13.8	0
100 to 110	17.6	0
110 to 120	5.9	0
120 to 130	3.9	0
130 to 140	7.8	0
140 to 150	5.9	0
150 to 160	5.9	0

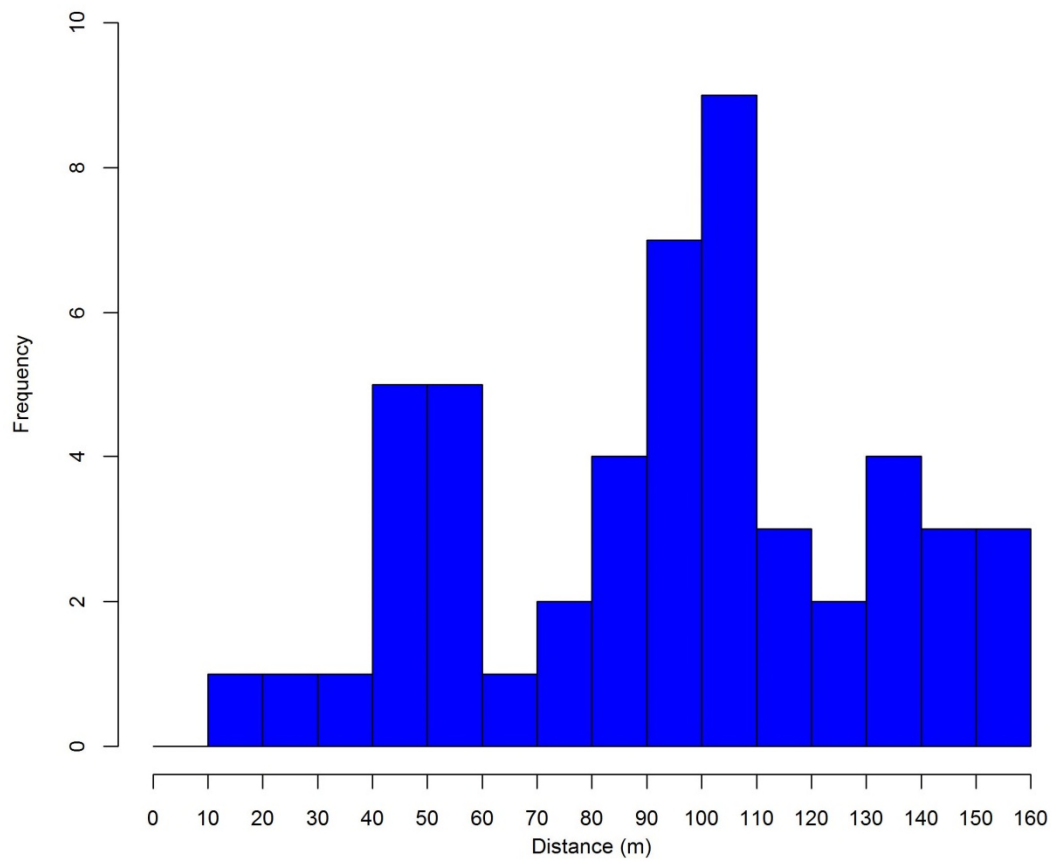


Figure 5. Distance from turbine of bird fatalities found during scheduled searches and incidentally at the Rising Tree Projects.

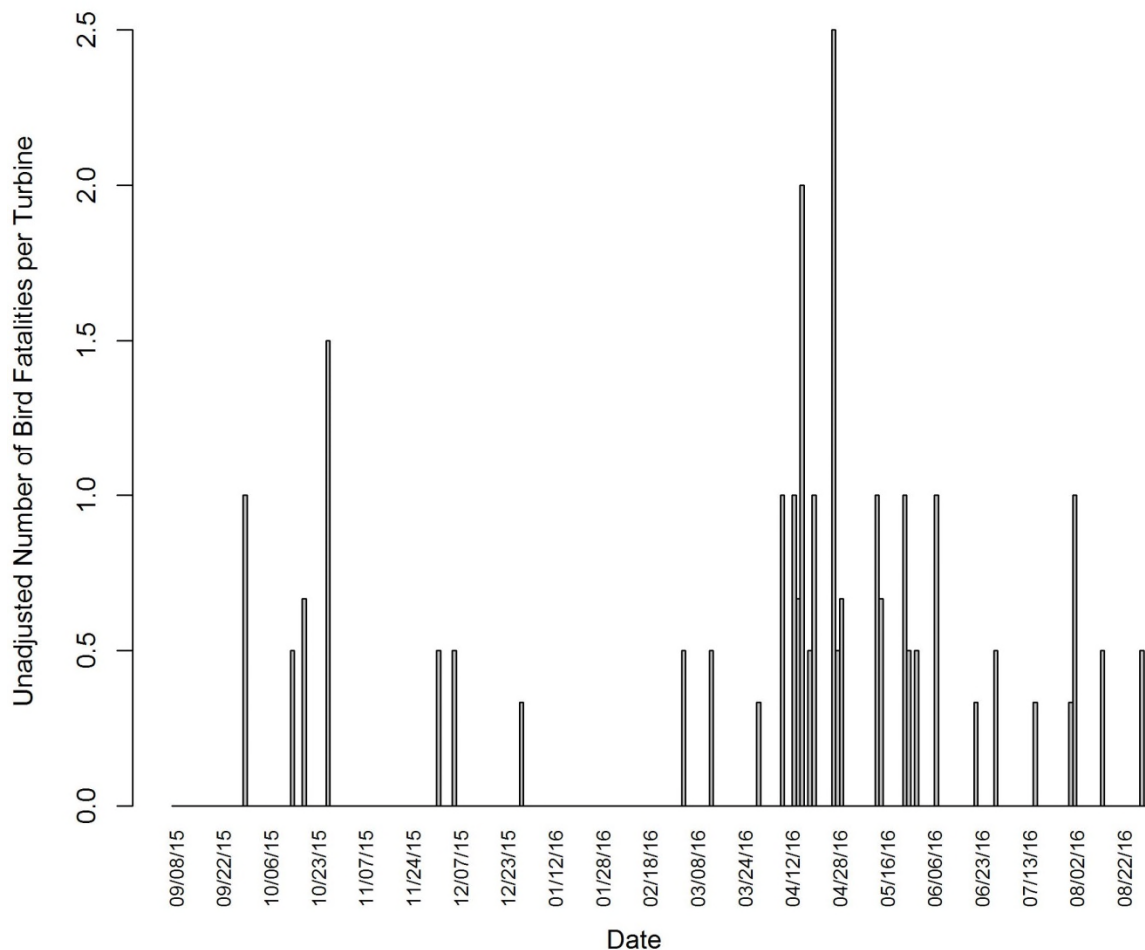


Figure 6. Timing by turbine of bird fatalities found within search plots at the Rising Projects.

Searcher Efficiency Trials

A total of 181 trial carcasses (49 large birds, 100 small birds, and 32 bats/bat surrogates) were placed throughout the Projects to estimate searcher efficiency rates (Table 3). Searcher efficiency did not vary significantly by season; therefore, a single overall estimate of searcher efficiency was used for each size class. The overall searcher efficiency rate for large birds was 87.0%, compared to 75.0% for small birds and 73.3% for bats/bat surrogates (Table 3).

Table 3. Searcher efficiency results at the Rising Tree Projects as a function of season and carcass size.

Size Class	Season	# Placed	# Available	# Found	% Found
Bat	Spring	1	1	0	0
	Summer	29	29	22	75.9
	Fall	2	0	0	N/A
	Overall	32	30	22	73.3
Small Bird	Spring	30	25	18	72.0
	Summer	30	30	23	76.7
	Fall	11	6	3	50.0
	Winter	29	19	16	84.2
	Overall	100	80	60	75.0
Large Bird	Spring	12	12	12	100
	Summer	13	13	12	92.3
	Fall	5	4	3	75.0
	Winter	18	17	13	76.5
	Overall	48	46	40	87.0

Carcass Removal Trials

A total of 163 trial carcasses (28 large birds, 92 small birds, and 43 bats/bat surrogates) were placed within the Projects during the study period to estimate carcass persistence. At day 14 (equal to the search interval), roughly 93% of large birds remained in the search area, while about 55% of small birds and about 42% of bats/bat surrogates remained (Figure 7). Carcass persistence models for bats were best fit by the lognormal model with no covariates, models for small birds were best fit by the loglogistic model with a season covariate, and models for large birds were best fit by the Weibull model with no additional covariates (Appendix B). The probability a carcass persisted through the search interval was 0.66 for large birds and raptors and was consistent across seasons (Appendix C). For small birds the probability that a carcass persisted through the search interval varied by season, and was 0.34 in spring, 0.29 in summer, 0.26 in fall, and 0.17 in winter (Appendix C). For bats/bat surrogates, the probability a carcass persisted through the search interval was 0.14 and was consistent among seasons.

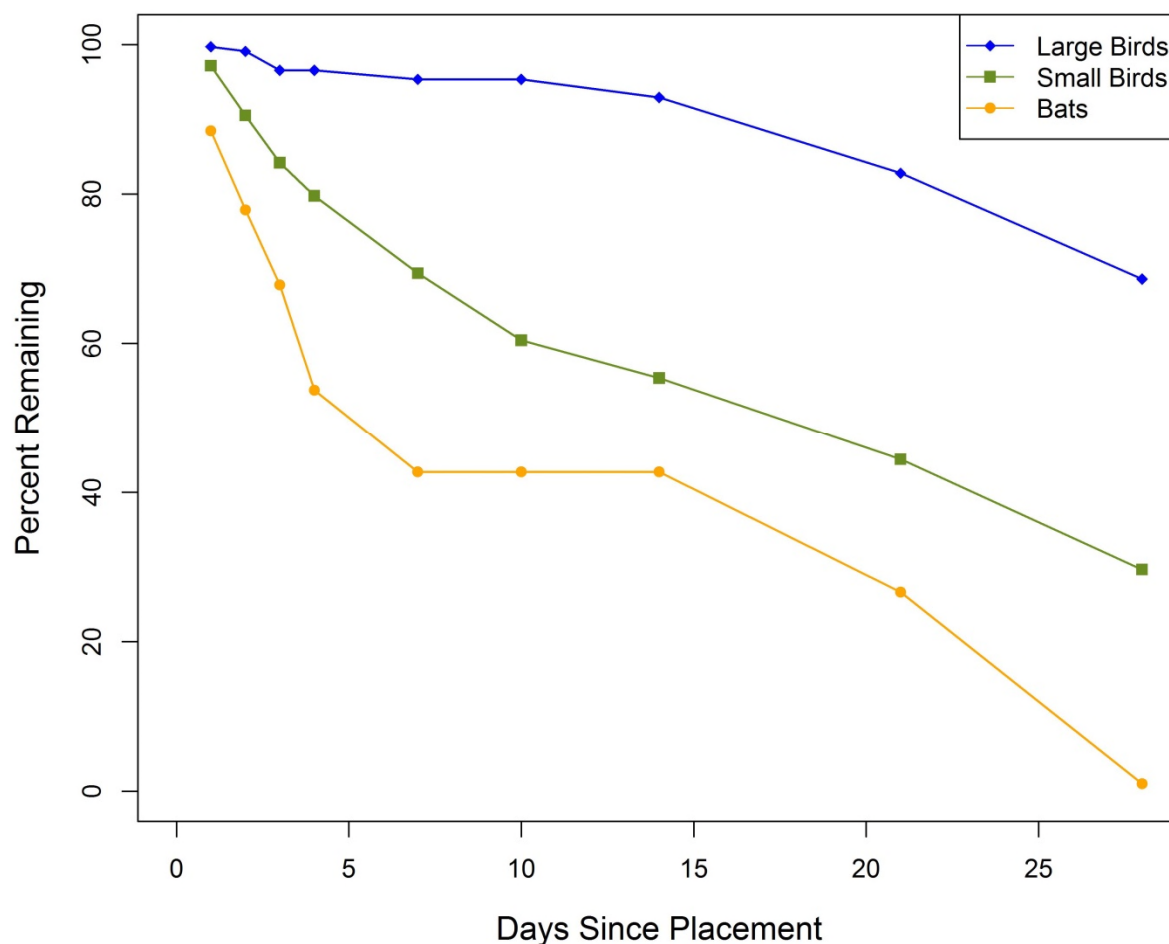


Figure 7. Carcass persistence times at the Rising Tree Projects.

Carcasses Excluded from Fatality Estimation

The Huso estimator assumes that searchers have a single opportunity to find a carcass. As a result, bird carcasses with an estimated time-since-death that was longer than the search interval had to be excluded from the data used for fatality estimation. Table 4 provides the estimated time-since-death for the 51 fatalities included in the analysis. Four small birds were censored from the fatality estimate calculations because the estimated time-since-death indicated they had occurred prior to the previous search and had been missed by searchers.

Table 4. Estimated time of death for fatalities found at the Rising Tree Projects from September 8, 2015 – September 2, 2016, and included in fatality analyses.

Size Class	Estimate Time of Death	# of Carcasses	% Composition
Large Bird	last night	1	6.25
	2-3 days	2	12.50
	4-7 days	1	6.25
	7-14 days	12	75.0
Small Bird	last night	8	22.86
	2-3 days	5	14.29
	4-7 days	4	11.43
	7-14 days	18	51.43

Adjusted Fatality Estimates

Seasonal fatality estimates and 90% confidence intervals were calculated on a per turbine basis for each bird category (Appendix C), and overall project-wide fatality estimates and 90% confidence intervals were calculated on a per turbine and per megawatt (MW) basis for each bird category (Table 5). No bat fatalities were documented during the study period; therefore, bat fatality rates were assumed to be zero and an estimate was not calculated. Although some bat fatalities may have occurred and been missed, given the lack of documented fatalities it is assumed that the bat fatality rate was very low, if not zero. The fatality estimates are adjusted based on the corrections for carcass removal and observer detection bias. Because 100% of each search plot was surveyed, no search area correction factor was applied. Given the search interval and estimates of searcher efficiency and carcass persistence, the probability that a small bird carcass would remain in a search plot and be found by a searcher was 0.25 in the spring, 0.22 in the summer, 0.19 in the fall, and 0.13 in the winter. For large birds the probability that a carcass would remain in a search plot and be found by a searcher was 0.58, which was consistent across seasons (Appendix C).

Table 5. Adjusted bird fatality estimates for the Rising Tree Projects from September 8, 2015 – September 2, 2016. For more details concerning correction factors and confidence intervals for bird fatality estimates, refer to Appendix C. No bats were found during the study period; therefore, fatality rates for bats were not calculated.

Adjusted Overall Fatality Estimate and 90% Confidence Intervals		
	Mean	Confidence Interval
# fatalities/turbine/year		
small birds	8.62	4.98-13.97
large birds	1.71	0.84-2.32
diurnal raptors	0.21	0.00-0.40
all birds	10.32	6.24-15.82
# fatalities/MW/year		
small birds	2.61	1.51-4.23
large birds	0.52	0.26-0.70
diurnal raptors	0.06	0.0-0.12
all birds	3.13	1.89-4.79

Small Birds

Estimated fatality rates for small birds were highest during the spring (4.28 birds per turbine per season), and lowest during the winter (1.05; Appendix C). Combining all seasons, the overall estimated fatality rate for small birds within the Projects was 8.62 birds per turbine per year (Table 5). A detailed breakdown of small bird fatality rates and the associated correction factors is presented in Appendix C.

Large Birds

Estimated fatality rates for large birds were also highest during the spring (0.96 birds per turbine per season), and lowest during the winter (0.11 birds; Appendix C). Combining all seasons, the overall estimated fatality rate for large birds within the Projects was 1.71 birds per turbine per year (Table 5). A detailed breakdown of large bird fatality rates and the associated correction factors is presented in Appendix C.

Diurnal Raptors

Estimated fatality rates for diurnal raptor were highest during the summer and fall (0.10 and 0.11 birds per turbine per season, respectively), with no diurnal raptors found during spring or winter (Appendix C). Combining all seasons, the overall estimated fatality rate for raptors within the Projects was 0.21 raptors per turbine per year (Table 5). A detailed breakdown of raptor fatality rates and the associated correction factors is presented in Appendix C.

All Birds

Estimated fatality rates for all birds were highest during the spring (5.24 birds per turbine per season), and lowest during the winter (1.17; Appendix C). Combining all seasons, the overall estimated fatality rate for all birds within the Projects was 10.32 birds per turbine per year (Table 5). A detailed breakdown of all bird fatality rates and the associated correction factors is presented in Appendix C.

Bats

There were no bat fatalities documented at the Projects so no fatality estimates were calculated.

Overall Fatality Estimates

Overall fatality rate estimates were calculated across all study seasons on a per MW basis (Table 5). Based on the 3.3-MW capacity of the turbines at the Projects, the estimated fatality rate for all birds was 3.13 birds per MW per year, with an estimated fatality rate of 0.06 diurnal raptors per MW per year (Table 5). Because no bat fatalities were documented, bat fatality rates were not calculated.

Raptor Nest Monitoring

Ground-based surveys for raptor nests were conducted in February, March, April, May, and June within the Projects. Three nests were identified which were considered suitable for supporting nesting raptors; however, all three nests were occupied by common ravens (Table 6, Figure 8). At least one of the common raven nests successfully fledged young. No occupied raptor nests were found within the Projects in 2016.

Table 6. Raptor nest survey results at the Rising Tree Projects, February – June 2016.

Substrate	Species	Nearest Turbine	Distance to Turbine (m)	Final Status
Radio tower	common raven	20	200	Occupied, reproductive status unknown
Radio tower	common raven	19	300	Occupied, reproductive status unknown
Joshua tree	common raven	36	120	Occupied, fledged young

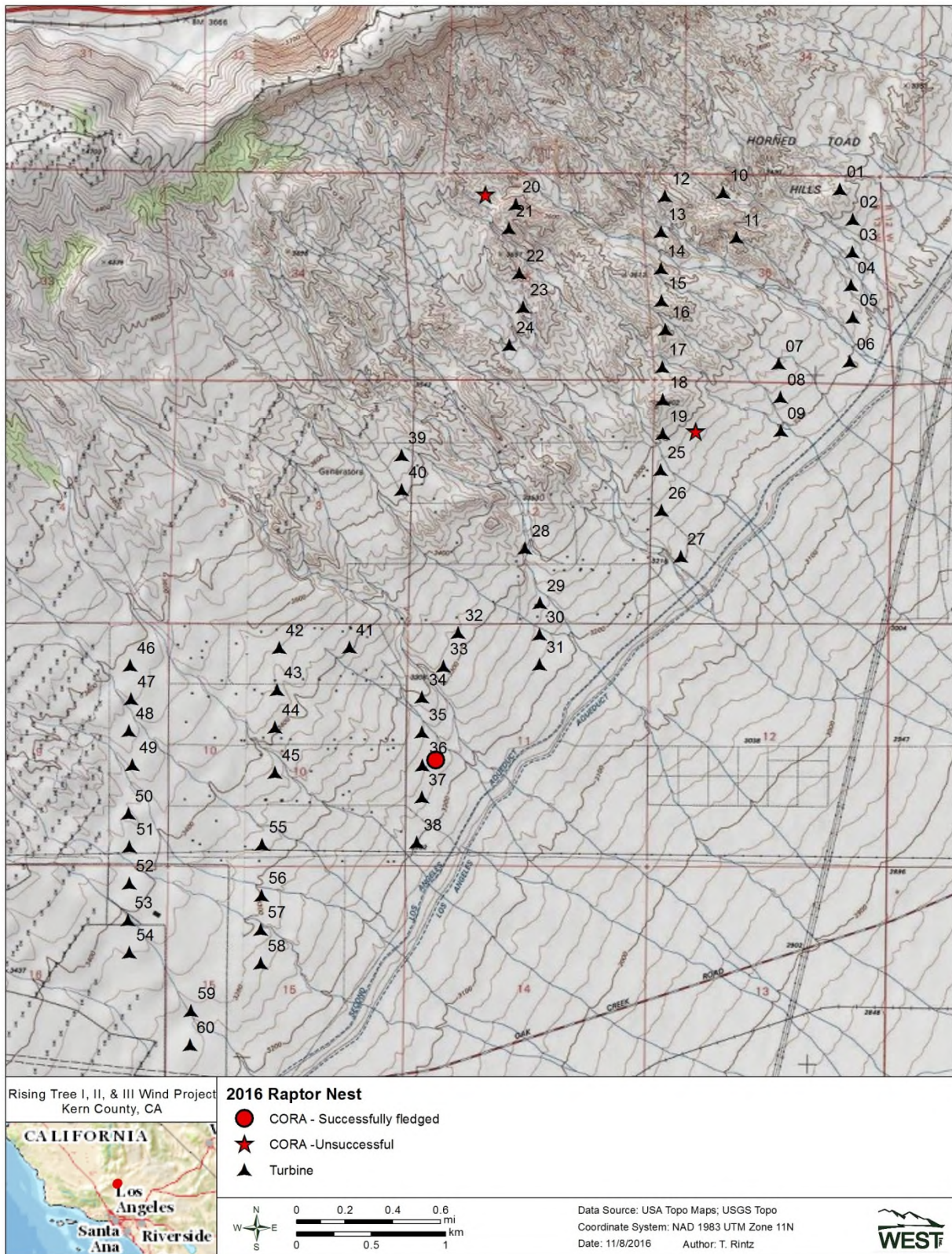


Figure 8. Common raven nest locations at the Rising Tree Projects.

DISCUSSION

The Huso estimator (Huso 2010, Huso et al. 2015) was used for calculating adjusted fatality estimates and accounted for search interval, searcher efficiency, 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 fatality rates. We accounted for this by conducting scavenging trials throughout the year. We also estimated searcher efficiency rates throughout the year to account for any biases associated with changes in environmental conditions.

Potential Biases

There are numerous factors that could contribute to both positive and negative biases in estimating fatality rates (Erickson 2006). The overall design of this study incorporated several assumptions or factors that could affect fatality estimates. First, all bird fatalities found within the standardized search plots during the study were included in the analysis. This included carcasses found during a scheduled survey as well as those found incidentally within a search plot during other activities on-site, under the conservative assumption that the incidentally found carcasses would have been found during the next scheduled search (which may or may not be true). Second, it was assumed that all carcasses found during the study were due to collision with wind turbines, while true cause of death is unknown for most of the fatalities. It is possible that some of the bird fatalities were caused by predators, and some of the fatalities included in the data were potentially due to natural causes (background mortality; see Johnson et al. 2000, Althouse and Meade 2014, Harvey & Associates 2014).

While the above are considered positive biases (i.e., potentially leading to overestimates), there are also some potential negative biases. For example, no adjustments were made for fatalities possibly occurring outside of the square plot boundaries. Plot boundaries were established a minimum distance of 140 m (459 ft) from the turbine, which was equivalent to the maximum turbine height. The search plot distance for this study was selected based on results of other studies (Higgins et al. 1996; Erickson et al. 2004; Johnson et al. 2002b, 2003b, 2004; Kerlinger et al. 2007; Young et al. 2003c, 2006), in which a distance equal to the approximate height of the turbine appeared to capture a very large percentage of fatalities. Based on the distribution of fatalities as a function of distance from turbines (Figure 5, Appendix A), a small percentage of bird fatalities possibly fell outside the search plots and may have been missed. This factor would lead to an underestimate of fatality rates.

Other potential biases are associated with the experimental carcasses used in searcher efficiency and carcass removal trials and whether or not they are representative of naturally occurring carcasses. This may occur if the types of birds used are larger or smaller than the carcasses of fatalities or more or less cryptic in color than the actual fatalities. Mallards, *Coturnix* quail, house sparrows, and dark-colored mice were used to represent the range of bird and bat fatalities possibly occurring. It is believed that this range captures the range of sizes and other characteristics of actual fatalities and should be a reasonable representation of

scavenging rates of the birds as a whole. It is generally not practical or feasible to obtain large numbers of native bird and bat species in fresh condition for use in these trials.

Concern has also been raised regarding how the number of carcasses placed in the field for carcass removal trials on a given day could lead to biased estimates of scavenging rates (e.g., Smallwood 2007, Smallwood et al. 2010). Hypothetically, this would lead to underestimating true scavenging rates if the scavenger densities were low enough such that scavenging rates for trial carcasses were lower than for turbine related fatalities. 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 turbine caused fatalities. If this were the case, and the trial carcass density was much greater than actual turbine related fatality density, the trials would underestimate true scavenging rates. The contrary is also possible where placing carcasses may draw in more scavengers and carcasses could be removed more quickly than normal.

Bird Fatalities

The majority (72%) of avian fatalities at the Projects were passerines, with the most commonly documented fatalities being common residents of the region, such as mourning dove and horned lark. Overall bird fatality rates at wind energy facilities across North America have ranged from 0.08 to 17.44 birds/MW/year (Appendix D1). In the far western US (comprised of California and the Pacific Northwest), bird fatality rates have ranged from 0.16 to 17.44 birds/MW/year (Appendix D1). The estimated annual bird fatality rates at the Projects (3.13 birds/MW/year) would be considered moderate compared to other wind energy facilities in California and the Pacific Northwest (Figure 9). Compared to more local facilities, the 3.13 birds/MW/year estimated at the Projects was well below the 17.44 and 7.88 birds/MW/year reported in studies of the Pine Tree (BioResource Consultants 2012) and Alta I-V (Chatfield et al. 2014) facilities, but higher than estimates for studies at the nearby Mustang Hills (Chatfield and Bay 2014), Alta VIII (Chatfield and Bay 2014), and Alta II-V (Chatfield et al. 2012) facilities (Appendix D1). While the Pine Tree facility is located several miles to the northeast of the Projects in a more mountainous region with different vegetation types, the Alta I-V, Mustang Hills, and Alta VIII facilities are all located a few miles to the south and west of the Projects and are more generally similar in terms of topography and vegetation types, which likely accounts for the more similar fatality rate between the Projects and these facilities.

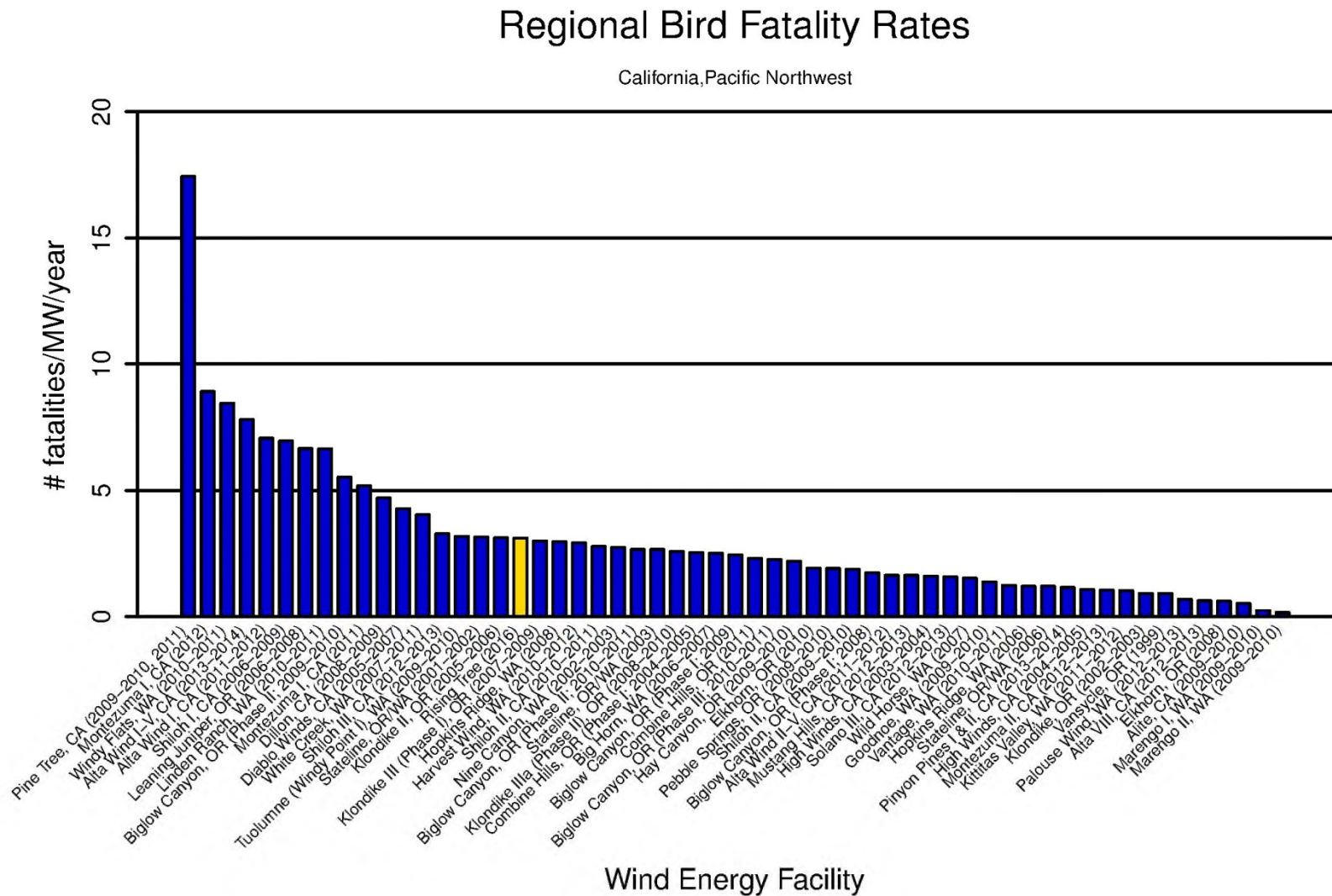


Figure 9. Fatality rates for all birds (number of birds per megawatt [MW] per year) at the Rising Tree Projects compared with publicly available studies at wind energy facilities in California and the Pacific Northwest. Results of this study are shown in yellow.

Figure 9 (continued). Fatality rates for all birds (number of birds per megawatt [MW] per year) at the Rising Tree Projects compared with publicly available studies at wind energy facilities in California and the Pacific Northwest.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Rising Tree I, II & III, CA (15-16)	This study.				
Pine Tree, CA (09-10, 11)	BioResource Consultants 2012	Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Solano III, CA (12-13)	AECOM 2013
Montezuma I, CA (12)	ICF International 2013	Shiloh II, CA (10-11)	Kerlinger et al. 2013a	Wild Horse, WA (07)	Erickson et al. 2008
Windy Flats, WA (10-11)	Enz et al. 2011	Nine Canyon, WA (02-03)	Erickson et al. 2003b	Goodhoe, WA (09-10)	URS Corporation 2010a
Alta Wind I-V, CA (13-14)	Chatfield et al. 2014	Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012a	Vantage, WA (10-11)	Ventus Environmental Solutions 2012
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Stateline, OR/WA (03)	Erickson et al. 2004	Hopkins Ridge, WA (06)	Young et al. 2007
Shiloh I, CA (06-09)	Kerlinger et al. 2009	Klondike IIIa (Phase II), OR (08-10)	Gritski et al. 2011	Stateline, OR/WA (06)	Erickson et al. 2007
Leaning Juniper, OR (06-08)	Gritski et al. 2008	Combine Hills, OR (Phase I; 04-05)	Young et al. 2006	Pinyon Pines I & II, CA (13-14)	Chodachek et al. 2012
Linden Ranch, WA (10-11)	Enz and Bay 2011	Big Horn, WA (06-07)	Kronner et al. 2008	High Winds, CA (04-05)	Kerlinger et al. 2006
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Montezuma II, CA (12-13)	Harvey & Associates 2013
Montezuma I, CA (11)	ICF International 2012	Combine Hills, OR (11)	Enz et al. 2012	Kittitas Valley, WA (11-12)	Stantec Consulting Services 2012
Dillon, CA (08-09)	Chatfield et al. 2009	Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012b	Klondike, OR (02-03)	Johnson et al. 2003a
Diablo Winds, CA (05-07)	WEST 2006, 2008	Hay Canyon, OR (09-10)	Gritski and Kronner 2010b	Vansycle, OR (99)	Erickson et al. 2000b
White Creek, WA (07-11)	Downes and Gritski 2012b	Elkhorn, OR (10)	Enk et al. 2011b	Palouse Wind, WA (12-13)	Stantec 2013d
Shiloh III, CA (12-13)	Kerlinger et al. 2013b	Pebble Springs, OR (09-10)	Gritski and Kronner 2010a	Alta VIII, CA (12-13)	Chatfield and Bay 2014
Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010	Shiloh II, CA (09-10)	Kerlinger et al. 2010, 2013a	Elkhorn, OR (08)	Jeffrey et al. 2009b
Stateline, OR/WA (01-02)	Erickson et al. 2004	Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Alite, CA (09-10)	Chatfield et al. 2010
Klondike II, OR (05-06)	NWC and WEST 2007	Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Marengo I, WA (09-10)	URS Corporation 2010b
Klondike III (Phase I), OR (07-09)	Gritski et al. 2010	Mustang Hills, CA (12-13)	Chatfield and Bay 2014	Marengo II, WA (09-10)	URS Corporation 2010c
Hopkins Ridge, WA (08)	Young et al. 2009c	High Winds, CA (03-04)	Kerlinger et al. 2006		

Diurnal raptor mortality estimates at wind energy facilities in California and the Pacific Northwest have ranged from zero to 1.06 birds/MW/year (Figure 10), with the highest raptor fatality estimates reported at facilities in California (Appendix D2). Two red-tailed hawk fatalities and one merlin fatality were found during this study and resulted in a diurnal raptor mortality estimate of 0.06 raptors/MW/year for the Projects, which would be considered low compared to other facilities in California and the Pacific Northwest. The low raptor mortality rate at the Projects was consistent with that reported at nearby Alta II-V (0.05 raptors/MW/year in 2011-2012) and Mustang Hills (0.08 raptors/MW/year in 2012-2013) facilities (see Appendix D2). Low raptor mortality at the Projects and nearby facilities was consistent with the relatively low diurnal raptor use observed during pre-construction surveys conducted at nearby sites (Appendix D2).

It is worth noting again that there was an active common raven nest located in the vicinity of Turbine 35 and Turbine 36. The nest was located within the northeastern corner of the search plot associated with Turbine 36 and was less than 200 m (656 ft) from Turbine 35. In total, 17 of the 60 (28%) bird fatalities found during the study, either during scheduled searches or incidentally, were located at these two turbines. Given the clustering of documented fatalities around the active common raven nest and a lack of other defining landscape features in the vicinity of these turbines, there appears a high likelihood that the presence of the active nest may have been responsible for the high density of carcasses and feather spots documented in this location. Furthermore, 16 of the 17 fatalities (94%) found near Turbine 35 and Turbine 36 were found from April 13 through June 7, a time when the common ravens were actively feeding nestlings and fledged young. Although it cannot be said with certainty that the fatalities were not associated Turbine 36, the clustering of fatalities in the immediate vicinity of the nest seems a good indication that some carcasses were brought in by common ravens (see Figure 11). Although Turbine 34 also had a higher density of fatalities relative to other turbines and was the next closest search plot to the active common raven nest (less than 400 m [1,312 ft] away), there was no clear indication that the common ravens had a significant influence on the number of fatalities found at Turbine 34, as the fatalities were more dispersed in space (i.e., no obvious plucking areas) and time (half of fatalities were in fall and half in spring).

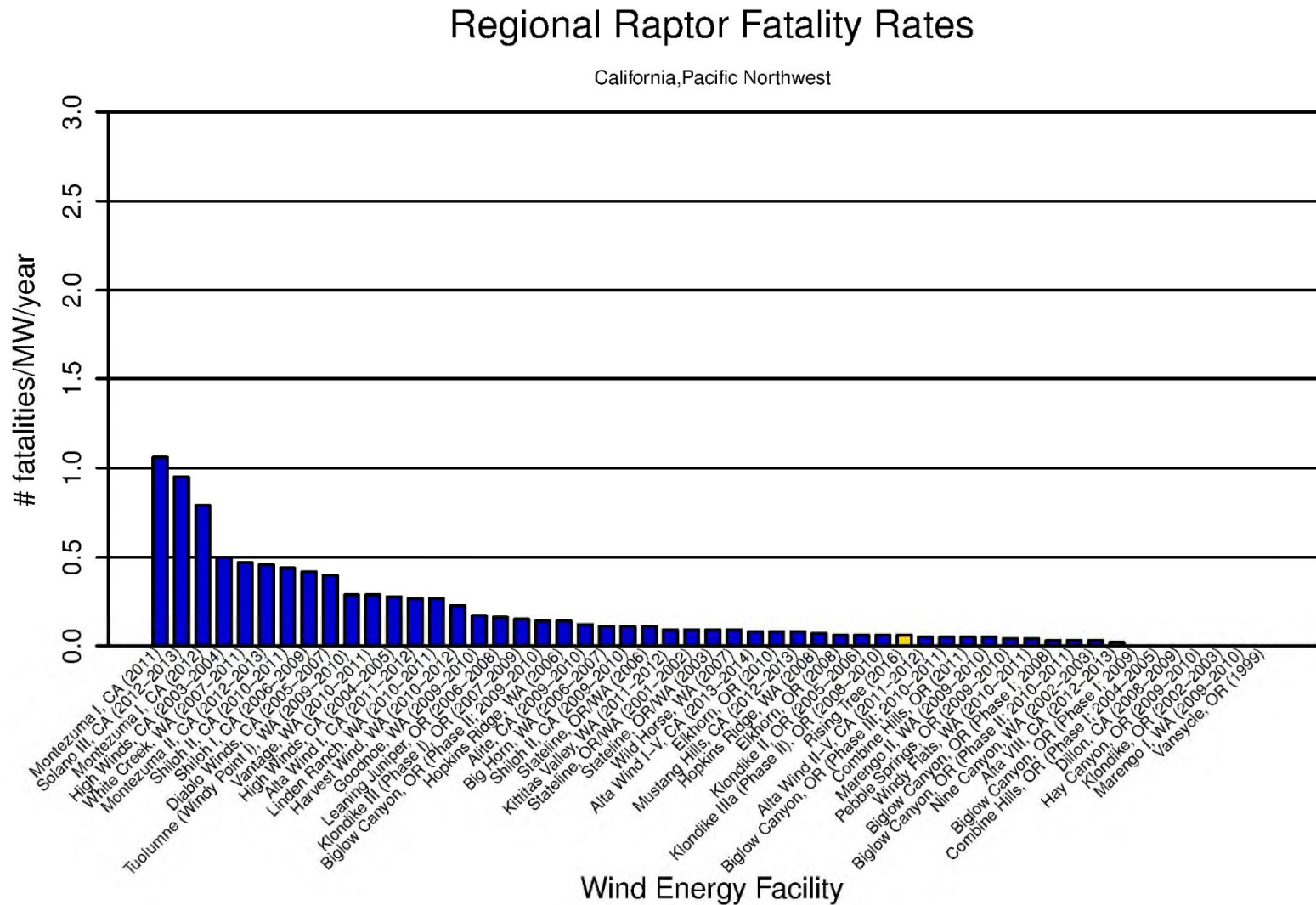


Figure 10. Fatality rates for raptors (number of raptors per megawatt [MW] per year) at the Rising Tree Projects compared with publicly available studies at wind energy facilities in California and the Pacific Northwest. Results of this study are shown in yellow.

Figure 10 (continued). Fatality rates for raptors (number of raptors per megawatt [MW] per year) at the Rising Tree Projects compared with publicly available studies at wind energy facilities in California and the Pacific Northwest.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Rising Tree I, II & III, CA (15-16)	This study.				
Montezuma I, CA (11)	ICF International 2012	Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012b
Solano III, CA (12-13)	AECOM 2013	Hopkins Ridge, WA (06)	Young et al. 2007	Combine Hills, OR (11)	Enz et al. 2012
Montezuma I, CA (12)	ICF International 2013	Alite, CA (09-10)	Chatfield et al. 2010	Marengo II, WA (09-10)	URS Corporation 2010c
High Winds, CA (03-04)	Kerlinger et al. 2006	Big Horn, WA (06-07)	Kronner et al. 2008	Pebble Springs, OR (09-10)	Gritski and Kronner 2010a
White Creek, WA (07-11)	Downes and Gritski 2012b	Shiloh II, CA (09-10)	Kerlinger et al. 2010, 2013a	Windy Flats, WA (10-11)	Enz et al. 2011
Montezuma II, CA (12-13)	Harvey & Associates 2013	Stateline, OR/WA (06)	Erickson et al. 2007	Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a
Shiloh II, CA (10-11)	Kerlinger et al. 2013a	Kittitas Valley, WA (11-12)	Stantec Consulting Services 2012	Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012a
Shiloh I, CA (06-09)	Kerlinger et al. 2009	Stateline, OR/WA (01-02)	Erickson et al. 2004	Nine Canyon, WA (02-03)	Erickson et al. 2003b
Diablo Winds, CA (05-07)	WEST 2006, 2008	Stateline, OR/WA (03)	Erickson et al. 2004	Alta VIII, CA (12-13)	Chatfield and Bay 2014
Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010	Wild Horse, WA (07)	Erickson et al. 2008	Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010
Vantage, WA (10-11)	Ventus Environmental Solutions 2012	Alta Wind I-V, CA (13-14)	Chatfield et al. 2014	Combine Hills, OR (Phase I; 04-05)	Young et al. 2006
High Winds, CA (04-05)	Kerlinger et al. 2006	Elkhorn, OR (10)	Enk et al. 2011b	Dillon, CA (08-09)	Chatfield et al. 2009
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Mustang Hills, CA (12-13)	Chatfield and Bay 2014	Hay Canyon, OR (09-10)	Gritski and Kronner 2010b
Linden Ranch, WA (10-11)	Enz and Bay 2011	Hopkins Ridge, WA (08)	Young et al. 2009c	Klondike, OR (02-03)	Johnson et al. 2003a
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Elkhorn, OR (08)	Jeffrey et al. 2009b	Marengo I, WA (09-10)	URS Corporation 2010b
Goodnoe, WA (09-10)	URS Corporation 2010a	Klondike II, OR (05-06)	NWC and WEST 2007	Vansycle, OR (99)	Erickson et al. 2000b
Leaning Juniper, OR (06-08)	Gritski et al. 2008	Klondike IIIa (Phase II), OR (08-10)	Gritski et al. 2011		
Klondike III (Phase I), OR (07-09)	Gritski et al. 2010	Alta Wind II-V, CA (11-12)	Chatfield et al. 2012		

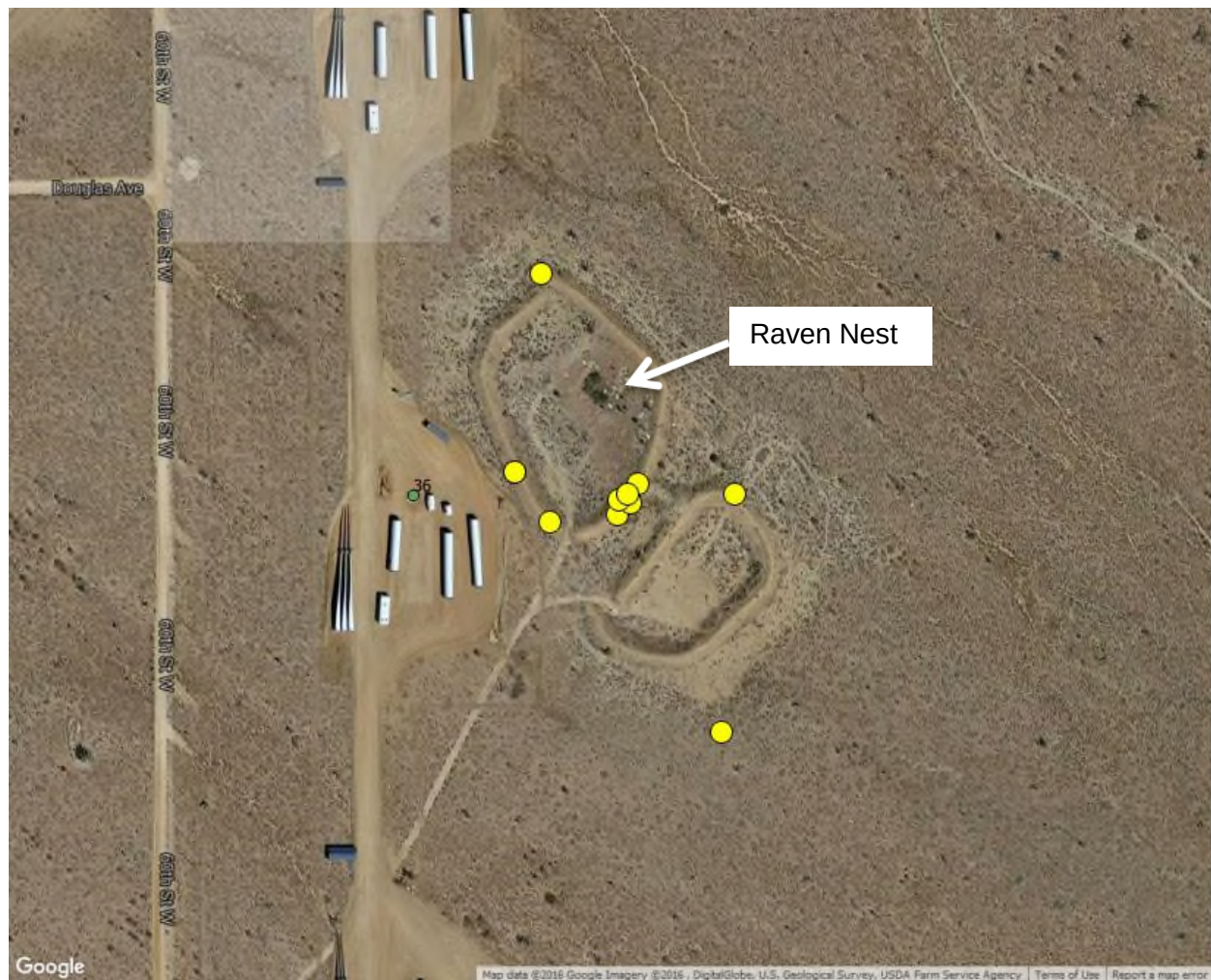


Figure 11. Location of active common raven nest near Turbine 36 and the clustering of the 12 bird fatalities (yellow dots) found in the vicinity of the nest and included in the calculation of fatality estimates

Bat Fatalities

In California, bat mortality rates have ranged from zero to 3.92 bats/MW/year (Figure 12). No bat fatalities were found during this first year of monitoring at the Projects, resulting in an assumed bat mortality rate of zero based on the study results. While some bat fatalities may have occurred and gone undetected by searchers, the lack of documented fatalities is a clear indication that the true fatality rate would be considered very low compared to other sites within California and the Pacific Northwest, where bat mortality rates have ranged from zero to 4.23 bats/MW/year (Figure 12; Appendix D3). The low bat mortality rate at the Projects was consistent with the relatively low bat activity levels (0.10 bat passes/night) reported during pre-construction studies and similar to results from other projects in the Tehachapi area (e.g., Alta I-V, Mustang Hills, Alta VIII; Appendix D3).

Regional Bat Fatality Rates

California, Pacific Northwest

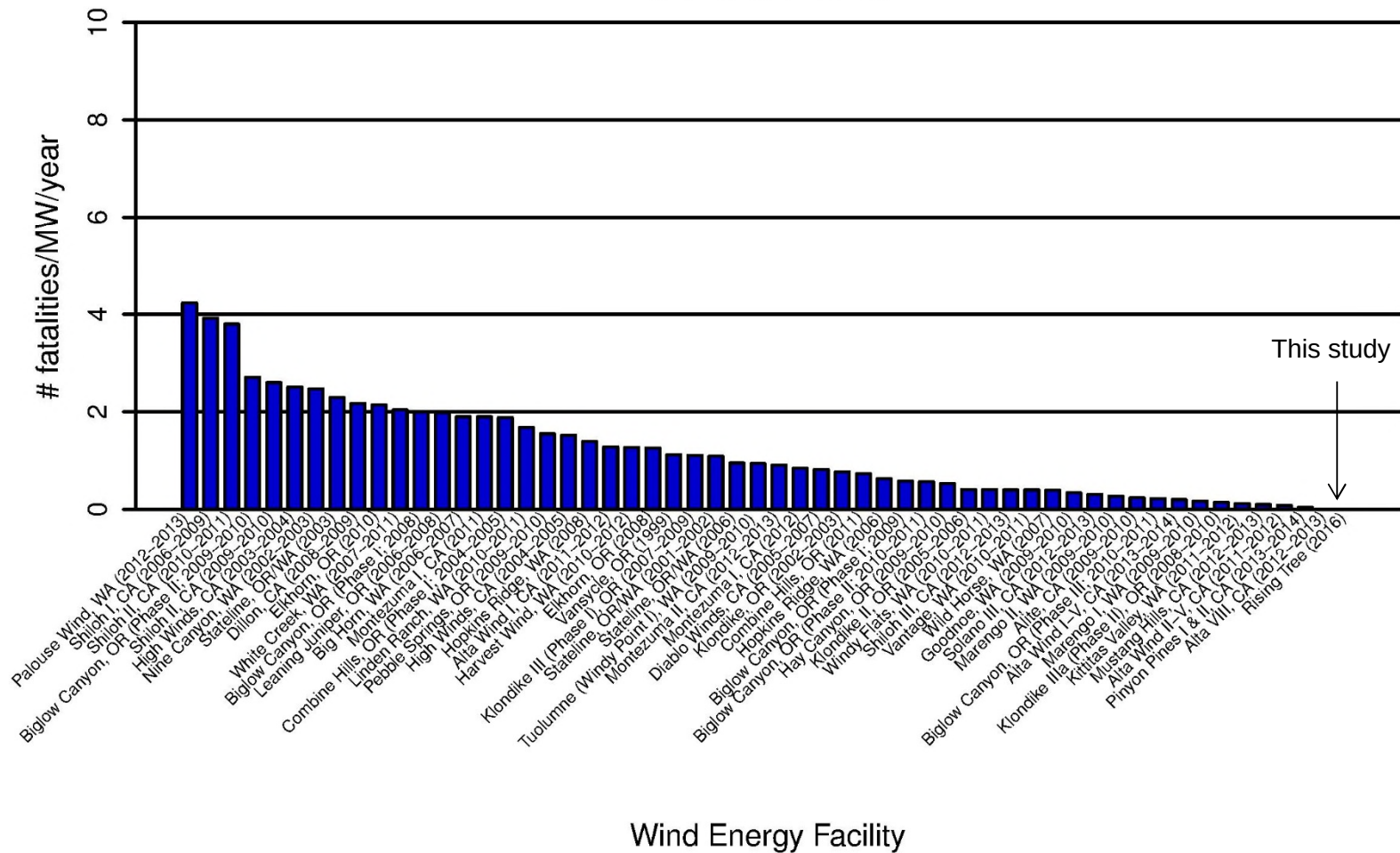


Figure 12. Fatality rates for bats (number of bats per megawatt [MW] per year) at the Rising Tree Projects compared with publicly available studies at wind energy facilities in California and the Pacific Northwest. Results of this study are indicated with a black arrow.

Figure 12 (continued). Fatality rates for bats (number of bats per megawatt [MW] per year) at the Rising Tree Projects compared with publicly available studies at wind energy facilities in California and the Pacific Northwest.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Rising Tree I, II & III, CA (15-16)	This study.				
Palouse Wind, WA (12-13)	Stantec 2013d	Hopkins Ridge, WA (08)	Young et al. 2009c	Windy Flats, WA (10-11)	Enz et al. 2011
Shiloh I, CA (06-09)	Kerlinger et al. 2009	Alta Wind I, CA (11-12)	Chatfield et al. 2012	Shiloh III, CA (12-13)	Kerlinger et al. 2013b
Shiloh II, CA (10-11)	Kerlinger et al. 2013a	Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Vantage, WA (10-11)	Ventus Environmental Solutions 2012
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Elkhorn, OR (08)	Jeffrey et al. 2009b	Wild Horse, WA (07)	Erickson et al. 2008
Shiloh II, CA (09-10)	Kerlinger et al. 2010, 2013a	Vansycle, OR (99)	Erickson et al. 2000b	Goodnoe, WA (09-10)	URS Corporation 2010a
High Winds, CA (03-04)	Kerlinger et al. 2006	Klondike III (Phase I), OR (07-09)	Gritski et al. 2010	Solano III, CA (12-13)	AECOM 2013
Nine Canyon, WA (02-03)	Erickson et al. 2003b	Stateline, OR/WA (01-02)	Erickson et al. 2004	Marengo II, WA (09-10)	URS Corporation 2010c
Stateline, OR/WA (03)	Erickson et al. 2004	Stateline, OR/WA (06)	Erickson et al. 2007	Alite, CA (09-10)	Chatfield et al. 2010
Dillon, CA (08-09)	Chatfield et al. 2009	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010	Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012b
Elkhorn, OR (10)	Enk et al. 2011b	Montezuma II, CA (12-13)	Harvey & Associates 2013	Alta Wind I-V, CA (13-14)	Chatfield et al. 2014
White Creek, WA (07-11)	Downes and Gritski 2012b	Montezuma I, CA (12)	ICF International 2013	Marengo I, WA (09-10)	URS Corporation 2010b
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Diablo Winds, CA (05-07)	WEST 2006, 2008	Klondike IIIa (Phase II), OR (08-10)	Gritski et al. 2011
Leaning Juniper, OR (06-08)	Gritski et al. 2008	Klondike, OR (02-03)	Johnson et al. 2003a	Kittitas Valley, WA (11-12)	Stantec Consulting Services 2012
Big Horn, WA (06-07)	Kronner et al. 2008	Combine Hills, OR (11)	Enz et al. 2012	Mustang Hills, CA (12-13)	Chatfield and Bay 2014
Montezuma I, CA (11)	ICF International 2012	Hopkins Ridge, WA (06)	Young et al. 2007	Alta Wind II-V, CA (11-12)	Chatfield et al. 2012
Combine Hills, OR (Phase I; 04-05)	Young et al. 2006	Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Pinyon Pines I & II, CA (13-14)	Chodachek et al. 2012
Linden Ranch, WA (10-11)	Enz and Bay 2011	Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012a	Alta VIII, CA (12-13)	Chatfield and Bay 2014
Pebble Springs, OR (09-10)	Gritski and Kronner 2010a	Hay Canyon, OR (09-10)	Gritski and Kronner 2010b		
High Winds, CA (04-05)	Kerlinger et al. 2006	Klondike II, OR (05-06)	NWC and WEST 2007		

CONCLUSIONS AND RECOMMENDATIONS

While the raptor and bat fatality rates estimated during the first year of monitoring at the Projects were low and consistent with other nearby facilities in the Tehachapi Wind Resource Area, the overall bird fatality rate was slightly higher than nearby facilities (e.g., Mustang Hills, Alta II-V, Alta VIII). However, if it were assumed that some of the fatalities at Turbine 36 were brought in from other areas by the common ravens nesting nearby, including other nearby turbines not searched during the study, this would result in an overestimate of true turbine-caused fatality rates. As such, the actual fatality rate for the Projects might be more consistent with the slightly lower fatality rates observed at the other most proximal facilities (e.g., Alta II-V, Alta VIII, and Mustang Hills). Two additional years of mortality monitoring are planned to be conducted at the Projects, the results of which will help to clarify the long-term impacts of the Projects on birds and bats. It is recommended that the inclusion of search plots at Turbine 34 and Turbine 36 be reconsidered for Year 2 and Year 3 to avoid any potential influence of nesting common ravens on overall fatality rate calculations.

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**Appendix A. Complete Listing of Bird and Bat Fatalities for Studies Conducted at the
Rising Tree Projects from September 8, 2015 – September 2, 2016**

Appendix A. Complete listing of fatalities for the Rising Tree Projects.

Date	Common Name	Turbine	Distance from Turbine (m)	Type of Find	Search Type	Condition
2015-09-30	greater roadrunner	40	65	Scheduled Carcass Search	Bi-monthly	Feather spot
2015-10-13	dark-eyed junco	34	107	Scheduled Carcass Search	Bi-monthly	Feather spot
2015-10-20	yellow-rumped warbler	51	149	Scheduled Carcass Search	Bi-monthly	Scavenged
2015-10-20	white-crowned sparrow	49	109	Scheduled Carcass Search	Bi-monthly	Scavenged
2015-10-27	red-tailed hawk	34	152	Scheduled Carcass Search	Bi-monthly	Feather spot
2015-10-27	western meadowlark	34	113	Scheduled Carcass Search	Bi-monthly	Feather spot
2015-10-27	dark-eyed junco	34	49	Scheduled Carcass Search	Bi-monthly	Feather spot
2015-11-05	red-tailed hawk	23	128	Incidental	Bi-monthly	Feather spot
2015-11-05	ruby crowned kinglet	44	112	Incidental	Bi-monthly	Intact
2015-12-02	western meadowlark	18	123	Scheduled Carcass Search	Bi-monthly	Feather spot
2015-12-06	unidentified bird (small)	40	143	Scheduled Carcass Search	Bi-monthly	Feather spot
2015-12-21	horned lark	36	97	Scheduled Carcass Search	Bi-monthly	Feather spot
2015-12-29	unidentified bird (small)	26	75	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-02-15	horned lark	32	158	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-03-03	blue-winged teal	32	57	Scheduled Carcass Search	Bi-monthly	Dismembered
2016-03-14	song sparrow	40	72	Scheduled Carcass Search	Bi-monthly	Intact
2016-03-31	rock pigeon	46	110	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-04-08	fox sparrow	23	87	Scheduled Carcass Search	Bi-monthly	Intact
2016-04-13	horned lark	35	40	Incidental	Bi-monthly	Feather spot
2016-04-13	chipping sparrow	41	86	Scheduled Carcass Search	Bi-monthly	Intact
2016-04-14	mourning dove	29	148	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-04-14	black-headed grosbeak	35	166	Incidental	Bi-monthly	Scavenged
2016-04-14	Western tanager	32	115	Scheduled Carcass Search	Bi-monthly	Intact
2016-04-15	black-headed grosbeak	36	95	Scheduled Carcass Search	Bi-monthly	Dismembered
2016-04-15	Swainson's thrush	36	95	Scheduled Carcass Search	Bi-monthly	Dismembered
2016-04-15	mourning dove	36	94	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-04-15	Savannah sparrow	34	108	Scheduled Carcass Search	Bi-monthly	Intact
2016-04-16	yellow-headed blackbird	40	71	Scheduled Carcass Search	Bi-monthly	Dismembered
2016-04-18	horned lark	5	13	Scheduled Carcass Search	Bi-monthly	Intact
2016-04-19	unidentified warbler	26	138	Scheduled Carcass Search	Bi-monthly	Dismembered
2016-04-19	rock pigeon	26	158	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-04-27	black-headed grosbeak	36	139	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-04-27	rock pigeon	36	93	Scheduled Carcass Search	Bi-monthly	Dismembered
2016-04-27	unidentified bird (small)	36	46	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-04-27	mourning dove	36	59	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-04-27	cactus wren	36	46	Scheduled Carcass Search	Bi-monthly	Feather spot

Appendix A. Complete listing of fatalities for the Rising Tree Projects.

Date	Common Name	Turbine	Distance from Turbine (m)	Type of Find	Search Type	Condition
2016-04-27	horned lark	36	55	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-04-27	horned lark	35	48	Incidental	Bi-monthly	Dismembered
2016-04-28	white-crowned sparrow	41	57	Scheduled Carcass Search	Bi-monthly	Scavenged
2016-04-29	mourning dove	49	99	Scheduled Carcass Search	Bi-monthly	Intact
2016-04-29	rock pigeon	46	40	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-05-11	horned lark	36	90	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-05-11	unidentified bird (small)	36	110	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-05-12	western tanager	29	41	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-05-12	mourning dove	46	43	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-05-25	horned lark	34	157	Scheduled Carcass Search	Bi-monthly	Intact
2016-05-25	Wilson's warbler	34	51	Scheduled Carcass Search	Bi-monthly	Intact
2016-05-26	Swainson's thrush	40	110	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-05-26	MacGillivray's warbler	49	90	Scheduled Carcass Search	Bi-monthly	Intact
2016-05-31	unidentified bird (small)	10	110	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-06-07	mourning dove	36	95	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-06-07	unidentified sparrow	36	93	Scheduled Carcass Search	Bi-monthly	Dismembered
2016-06-22	horned lark	34	104	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-06-30	unidentified bird (small)	26	117	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-07-15	greater roadrunner	23	138	Incidental	Bi-monthly	Feather spot
2016-07-29	mourning dove	5	130	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-08-02	merlin	51	51	Scheduled Carcass Search	Bi-monthly	Scavenged
2016-08-02	European starling	49	30	Scheduled Carcass Search	Bi-monthly	Injured
2016-08-11	unidentified bird (small)	26	137	Scheduled Carcass Search	Bi-monthly	Feather spot
2016-08-29	gray flycatcher	41	105	Scheduled Carcass Search	Bi-monthly	Intact

**Appendix B. Final Models for Carcass Persistence Based on Carcass Removal Trials
Conducted at the Rising Tree Projects from
September 2015 – September 2016**

Appendix B. Final carcass persistence models and parameters for each size class at the Rising Tree Projects.

Size	null	Season	Distribution	Predicted Values	Scale
Bat	1		Lognormal	0.88	1.38
Small Bird		Spring	Loglogistic	2.91	0.76
		Summer	Loglogistic	2.37	0.76
		Fall	Loglogistic	2.01	0.76
		Winter	Loglogistic	1.18	0.76
Large Bird	1		Weibull	24.83	1.60

**Appendix C. Complete Bird Fatality Table (Based on Huso Estimates) for the
Rising Tree Projects for Studies Conducted from
September 2015 – September 2016**

Appendix C. Complete bird fatality table (based on Huso estimates) for the Rising Tree Projects for studies conducted from September 2015 – September 2016.

Parameter	Spring		Summer		Fall		Winter	
	Estimate	90 % CI	Estimate	90 % CI	Estimate	90 % CI	Estimate	90 % CI
Observer Detection Rate								
P (Small Bird)	0.75	0.67 - 0.82	0.75	0.67 - 0.82	0.75	0.67 - 0.82	0.75	0.67 - 0.82
P (Large Bird)	0.87	0.79 - 0.94	0.87	0.79 - 0.94	0.87	0.79 - 0.94	0.87	0.79 - 0.94
P (Raptor)	0.87	0.79 - 0.94	0.87	0.79 - 0.94	0.87	0.79 - 0.94	0.87	0.79 - 0.94
Probability of a Carcass Persisting Through the Search Interval								
$\bar{f}$ (Small Bird)	0.34	0.24 - 0.42	0.29	0.19 - 0.44	0.26	0.17 - 0.39	0.17	0.12 - 0.24
$\bar{f}$ (Large Bird)	0.66	0.54 - 0.78	0.66	0.54 - 0.78	0.66	0.54 - 0.78	0.66	0.54 - 0.78
$\bar{f}$ (Raptor)	0.66	0.54 - 0.78	0.66	0.54 - 0.78	0.66	0.54 - 0.78	0.66	0.54 - 0.78
Probability of Available and Detected								
Small Bird	0.25	0.18 - 0.32	0.22	0.14 - 0.33	0.19	0.13 - 0.29	0.13	0.09 - 0.18
Large Bird	0.58	0.46 - 0.70	0.58	0.46 - 0.70	0.58	0.46 - 0.70	0.58	0.46 - 0.70
Raptor	0.58	0.46 - 0.70	0.58	0.46 - 0.70	0.58	0.46 - 0.70	0.58	0.46 - 0.70
Unadjusted Number of Fatalities								
Small Bird	20.0	9.95 - 33.0	7.0	3.0 - 12.0	5.0	1.0 - 10.0	3.0	1.0 - 6.0
Large Bird	9.0	3.0 - 16.0	4.0	1.0 - 7.0	2.0	0.0 - 4.0	1.0	0.0 - 3.0
Raptor	0		1.0	0.0 - 3.0	1.0	0.0 - 3.0	0	
Observed Fatality Rates (Fatalities/Turbine/Season)								
Small Bird	1.05	0.52 - 1.74	0.37	0.16 - 0.63	0.26	0.05 - 0.53	0.16	0.05 - 0.32
Large Bird	0.47	0.16 - 0.84	0.21	0.05 - 0.37	0.11	0.0 - 0.21	0.05	0.0 - 0.16
Raptor	0		0.05	0.0 - 0.16	0.05	0.0 - 0.16	0	
Adjusted Fatality Rates (Fatalities/Turbine/Season)								
Small Bird	4.28	2.16 - 7.73	1.81	0.68 - 3.70	1.48	0.20 - 3.39	1.05	0.27 - 2.39
Large Bird	0.96	0.28 - 1.54	0.43	0.10 - 0.65	0.21	0.0 - 0.40	0.11	0.0 - 0.28
All Birds	5.24	2.68 - 9.01	2.23	1.04 - 4.08	1.69	0.28 - 3.68	1.17	0.33 - 2.41
Raptor	0		0.10	0.0 - 0.26	0.11	0.0 - 0.25	0	
Adjusted Fatality Rates (Fatalities/MW/Season)								
Small Bird	1.30	0.65 - 2.34	0.55	0.20 - 1.12	0.45	0.06 - 1.03	0.32	0.08 - 0.73
Large Bird	0.29	0.09 - 0.47	0.13	0.03 - 0.20	0.06	0.0 - 0.12	0.03	0.0 - 0.09
All Birds	1.59	0.81 - 2.73	0.68	0.32 - 1.24	0.51	0.08 - 1.11	0.35	0.10 - 0.73
Raptor	0		0.03	0.0 - 0.08	0.03	0.0 - 0.08	0	

Appendix D. North American Fatality Summary Tables

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

Wind Energy Facility	Fatality Estimate	No. of Turbines	Total MW
Rising Tree Projects, CA (2015-2016)	3.13	60	200
<i>California</i>			
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	300
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
<i>Pacific Northwest</i>			
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 D1. Wind energy facilities in North America with fatality data for all bird species, by geographic region. Fatality estimate presented as number of bird fatalities per megawatt (MW) per year.

Wind Energy Facility	Fatality Estimate	No. of Turbines	Total MW
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			
Foot Creek Rim, WY (Phase I; 1999)	3.4	69	41.4
Foot Creek Rim, WY (Phase I; 2000)	2.42	69	41.4
Foot 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

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

Wind Energy Facility	Fatality Estimate	No. of Turbines	Total MW
PrairieWinds SD1, SD (2011-2012)	1.41	108	162
Top Crop I & II (2012-2013)	1.35	200 (68 Phase I, 132 Phase II)	300 (102 Phase I, 198 Phase II)
Heritage Garden I, MI (2012-2014)	1.3	14	28
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
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
<i>Southern Plains</i>			
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
<i>Northeast</i>			
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

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

Wind Energy Facility	Fatality Estimate	No. of Turbines	Total MW
Stetson Mountain II, ME (2010)	1.42	17	25.5
Cohocton/Dutch Hill, NY (2009)	1.39	50	125
Cohocton/Dutch Hills, NY (2010)	1.32	50	125
Noble Bliss, NY (2008)	1.3	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
<i>Southeast</i>			
Buffalo Mountain, TN (2000-2003)	11.02	3	1.98
Buffalo Mountain, TN (2005)	1.1	18	28.98

Appendix D1 (continued). Wind energy facilities in North America with fatality data for all bird species. Data from the following sources

Wind Energy Facility	Estimate Reference	Wind Energy Facility	Estimate Reference
Rising Tree I, II & III,, CA (15-16)	This study		
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 2008b
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. 2012a	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012b	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Munnsville, NY (08)	Stantec 2009c
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. 2003b
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. 2010c
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. 2010b
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. 2010c	NPPD Ainsworth, NE (06)	Derby et al. 2007
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Palouse Wind, WA (12-13)	Stantec 2013d
Casselman, PA (08)	Arnett et al. 2009b	Pebble Springs, OR (09-10)	Gritski and Kronner 2010a
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. 2013b
Cedar Ridge, WI (10)	BHE Environmental 2011	Pinyon Pines I & II, CA (13-14)	Chatfield and Russo 2014
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Cohocton/Dutch 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 2013e
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 2013a
Elkhorn, OR (10)	Enk et al. 2011b	Rugby, ND (10-11)	Derby et al. 2011b
Elm Creek, MN (09-10)	Derby et al. 2010b	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
Foot Creek Rim, WY (Phase I; 99)	Young et al. 2003b	Shiloh II, CA (10-11)	Kerlinger et al. 2013a
Foot Creek Rim, WY (Phase I; 00)	Young et al. 2003b	Shiloh III, CA (12-13)	Kerlinger et al. 2013b
Foot 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 2009b
Hay Canyon, OR (09-10)	Gritski and Kronner 2010b	Stetson Mountain I, ME (11)	Normandeau Associates 2011
Heritage Garden I, MI (12-14)	Kerlinger et al. 2014	Stetson Mountain I, ME (13)	Stantec 2014
High Sheldon, NY (10)	Tidhar et al. 2012a	Stetson Mountain II, ME (10)	Normandeau Associates 2010
High Sheldon, NY (11)	Tidhar et al. 2012b	Stetson Mountain II, ME (12)	Stantec 2013c
High Winds, CA (03-04)	Kerlinger et al. 2006	Summerview, Alb (05-06)	Brown and Hamilton 2006b
High Winds, CA (04-05)	Kerlinger et al. 2006	Top Crop I & II, IL (12-13)	Good et al. 2013a
Hopkins Ridge, WA (06)	Young et al. 2007	Top of Iowa, IA (03)	Jain 2005
Hopkins Ridge, WA (08)	Young et al. 2009c	Top of Iowa, IA (04)	Jain 2005
Kewaunee County, WI (99-01)	Howe et al. 2002	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
Kittitas Valley, WA (11-12)	Stantec 2012	Vansycle, OR (99)	Erickson et al. 2000a
Klondike, OR (02-03)	Johnson et al. 2003a	Vantage, WA (10-11)	Ventus 2012
Klondike II, OR (05-06)	NWC and WEST 2007	Wessington Springs, SD (09)	Derby et al. 2010f
Klondike III, OR (Phase I; 07-09)	Gritski et al. 2010	Wessington Springs, SD (10)	Derby et al. 2011d
Klondike IIIa, OR (Phase II; 08-10)	Gritski et al. 2011	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		

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

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	No. of Turbines	Total MW
Rising Tree Projects, CA (2015 -2016)	0.12	0.06	60	200
<i>California</i>				
Montezuma I, CA (2011)		1.06	16	36.8
Solano III, CA (2012-2013)		0.95	55	128
Montezuma I, CA (2012)		0.79	16	36.8
High Winds, CA (2003-2004)	2.337	0.5	90	162
Montezuma II, CA (2012-2013)		0.46	34	78.2
Shiloh II, CA (2010-2011)		0.44	75	150
Shiloh I, CA (2006-2009)		0.42	100	150
Diablo Winds, CA (2005-2007)	2.161	0.4	31	20.46
High Winds, CA (2004-2005)	2.337	0.28	90	162
Alta Wind I, CA (2011-2012)	0.19	0.27	100	150
Alite, CA (2009-2010)		0.12	8	24
Shiloh II, CA (2009-2010)		0.11	75	150
Mustang Hills, CA (2012-2013)		0.08	50	150
Alta Wind I-V, CA (2013-2014)		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)		0.02	50	150
Dillon, CA (2008-2009)		0	45	45
<i>Pacific Northwest</i>				
White Creek, WA (2007-2011)		0.47	89	204.7
Tuolumne (Windy Point I), WA (2009-2010)	0.77	0.29	62	136.6
Vantage, WA (2010-2011)		0.29	60	90
Linden Ranch, WA (2010-2011)		0.27	25	50
Harvest Wind, WA (2010-2012)		0.23	43	98.9
Goodnoe, WA (2009-2010)		0.17	47	94
Leaning Juniper, OR (2006-2008)	0.522	0.16	67	100.5
Klondike III (Phase I), OR (2007-2009)		0.15	125	223.6
Hopkins Ridge, WA (2006)	0.698	0.14	83	150
Biglow Canyon, OR (Phase II; 2009-2010)	0.318	0.14	65	150
Big Horn, WA (2006-2007)	0.511	0.11	133	199.5
Stateline, OR/WA (2006)	0.478	0.11	454	299
Kittitas Valley, WA (2011-2012)		0.09	48	100.8
Wild Horse, WA (2007)	0.291	0.09	127	229
Stateline, OR/WA (2001-2002)	0.478	0.09	454	299
Stateline, OR/WA (2003)	0.478	0.09	454	299
Elkhorn, OR (2010)	1.07	0.08	61	101
Hopkins Ridge, WA (2008)	0.698	0.07	87	156.6
Elkhorn, OR (2008)	1.07	0.06	61	101
Klondike II, OR (2005-2006)	0.504	0.06	50	75
Klondike IIIa (Phase II), OR (2008-2010)		0.06	51	76.5
Combine Hills, OR (2011)	0.746	0.05	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	0.318	0.05	76	174.8
Marengo II, WA (2009-2010)		0.05	39	70.2
Windy Flats, WA (2010-2011)		0.04	114	262.2
Pebble Springs, OR (2009-2010)		0.04	47	98.7
Biglow Canyon, OR (Phase I; 2008)	0.318	0.03	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)	0.318	0.03	65	150
Nine Canyon, WA (2002-2003)	0.35	0.03	37	48.1
Hay Canyon, OR (2009-2010)		0	48	100.8

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

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	No. of Turbines	Total MW
Biglow Canyon, OR (Phase I; 2009)	0.318	0	76	125.4
Marengo I, WA (2009-2010)		0	78	140.4
Klondike, OR (2002-2003)	0.504	0	16	24
Vansycle, OR (1999)	0.66	0	38	24.9
Combine Hills, OR (Phase I; 2004-2005)	0.746	0	41	41
Southwest				
Dry Lake I, AZ (2009-2010)	0.13	0	30	63
Dry Lake II, AZ (2011-2012)		0	31	65
Rocky Mountains				
Summerview, Alb (2005-2006)		0.11	39	70.2
Foote Creek Rim, WY (Phase I; 1999)	0.554	0.08	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	0.554	0.05	69	41.4
Milford I & II, UT (2011-2012)		0.04	107	160.5 (58.5 Phase I, 102 Phase II)
Foote Creek Rim, WY (Phase I; 2001-2002)	0.554	0	69	41.4
Midwest				
Buffalo Ridge, MN (Phase I; 1999)		0.47	73	25
Moraine II, MN (2009)		0.37	33	49.5
Winnebago, IA (2009-2010)		0.27	10	20
Buffalo Ridge I, SD (2009-2010)		0.2	24	50.4
Cedar Ridge, WI (2009)		0.18	41	67.6
PrairieWinds SD1, SD (2013-2014)		0.17	108	162
Top of Iowa, IA (2004)		0.17	89	80
Cedar Ridge, WI (2010)		0.13	41	68
Ripley, Ont (2008)		0.1	38	76
Wessington Springs, SD (2010)	0.232	0.07	34	51
Rugby, ND (2010-2011)		0.06	71	149
NPPD Ainsworth, NE (2006)		0.06	36	20.5
Wessington Springs, SD (2009)	0.232	0.06	34	51
PrairieWinds ND1 (Minot), ND (2011)		0.05	80	115.5
PrairieWinds ND1 (Minot), ND (2010)		0.05	80	115.5
PrairieWinds SD1, SD (2012-2013)		0.03	108	162
Elm Creek, MN (2009-2010)		0	67	100
Rail Splitter, IL (2012-2013)		0	67	100.5
Pioneer Prairie I, IA (Phase II; 2011-2012)		0	62	102.3
Buffalo Ridge, MN (Phase III; 1999)		0	138	103.5
Buffalo Ridge, MN (Phase II; 1998)		0	143	107.25
Buffalo Ridge, MN (Phase II; 1999)		0	143	107.25
Blue Sky Green Field, WI (2008; 2009)		0	88	145
Elm Creek II, MN (2011-2012)		0	62	148.8
Barton I & II, IA (2010-2011)		0	80	160
PrairieWinds SD1, SD (2011-2012)		0	108	162
Kewaunee County, WI (1999-2001)		0	31	20.46
Buffalo Ridge II, SD (2011-2012)		0	105	210
Buffalo Ridge, MN (Phase I; 1996)		0	73	25
Buffalo Ridge, MN (Phase I; 1997)		0	73	25
Buffalo Ridge, MN (Phase I; 1998)		0	73	25
Fowler I, IN (2009)		0	162	301
Big Blue, MN (2013)		0	18	36
Big Blue, MN (2014)		0	18	36

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

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	No. of Turbines	Total MW
Top of Iowa, IA (2003)		0	89	80
Grand Ridge I, IL (2009-2010)	0.195	0	66	99
<i>Southern Plains</i>				
Barton Chapel, TX (2009-2010)		0.25	60	120
Buffalo Gap I, TX (2006)		0.1	67	134
Red Hills, OK (2012-2013)		0.04	82	123
Big Smile, OK (2012-2013)		0	66	132
Buffalo Gap II, TX (2007-2008)		0	155	233
<i>Northeast</i>				
Munnsville, NY (2008)		0.59	23	34.5
Noble Ellenburg, NY (2009)		0.25	54	80
Noble Clinton, NY (2009)		0.16	67	100
Noble Wethersfield, NY (2010)		0.13	84	126
Noble Bliss, NY (2009)		0.12	67	100
Noble Ellenburg, NY (2008)		0.11	54	80
Noble Bliss, NY (2008)		0.1	67	100
Noble Clinton, NY (2008)		0.1	67	100
Mount Storm, WV (2010)		0.1	132	264
Noble Chateaugay, NY (2010)		0.08	71	106.5
Cohocton/Dutch Hills, NY (2010)		0.08	50	125
Mountaineer, WV (2003)		0.07	44	66
High Sheldon, NY (2010)		0.06	75	112.5
Mount Storm, WV (2011)		0.03	132	264
Maple Ridge, NY (2007-2008)		0.03	195	321.75
Criterion, MD (2011)		0.02	28	70
Beech Ridge, WV (2012)		0.01	67	100.5
Beech Ridge, WV (2013)		0.01	67	100.5
Locust Ridge, PA (Phase II; 2009)		0	51	102
Locust Ridge, PA (Phase II; 2010)		0	51	102
High Sheldon, NY (2011)		0	75	112.5
Cohocton/Dutch Hill, NY (2009)		0	50	125
Lempster, NH (2009)		0	12	24
Lempster, NH (2010)		0	12	24
Stetson Mountain II, ME (2010)		0	17	25.5
Stetson Mountain II, ME (2012)		0	17	25.5
Mount Storm, WV (2009)		0	132	264
Casselman, PA (2009)		0	23	34.5
Casselman, PA (2008)		0	23	34.5
Mars Hill, ME (2007)		0	28	42
Mars Hill, ME (2008)		0	28	42
Pinnacle, WV (2012)		0	23	55.2
Stetson Mountain I, ME (2011)		0	38	57
Stetson Mountain I, ME (2009)		0	38	57
Stetson Mountain I, ME (2013)		0	38	57
Noble Altona, NY (2010)		0	65	97.5
<i>Southeast</i>				
Buffalo Mountain, TN (2000-2003)		0	3	1.98
Buffalo Mountain, TN (2005)		0	18	28.98

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

Data from the following sources:

Facility	Use Estimate	Mortality Estimate	Facility	Use Estimate	Mortality Estimate
Rising Tree I, II, & III, CA (15-16)		This study.			
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 2008b
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 2005a	Jeffrey et al. 2009a	Montezuma I, CA (12)		ICF International 2013
Biglow Canyon, OR (Phase I; 09)	WEST 2005a	Enk et al. 2010	Montezuma II, CA (12-13)		Harvey & Associates 2013
Biglow Canyon, OR (Phase II; 09-10)	WEST 2005a	Enk et al. 2011a	Moraine II, MN (09)		Derby et al. 2010d
Biglow Canyon, OR (Phase II; 10-11)	WEST 2005a	Enk et al. 2012a	Mount Storm, WV (09)		Young et al. 2009a, 2010b
Biglow Canyon, OR (Phase III; 10-11)	WEST 2005a	Enk et al. 2012b	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 2009c
Buffalo Mountain, TN (00-03)	Fiedler 2004	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. 2003b
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. 2010c
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. 2010c	Noble Ellenburg, NY (09)		Jain et al. 2010b
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 2010a
Cedar Ridge, WI (09)		BHE Environmental 2010	Pinnacle, WV (12)		Hein et al. 2013b
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
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

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

Data from the following sources:

Facility	Use Estimate	Mortality Estimate	Facility	Use Estimate	Mortality Estimate
Dry Lake II, AZ (11-12)		Thompson and Bay 2012	Rugby, ND (10-11)		Derby et al. 2011b
Elkhorn, OR (08)	WEST 2005b	Jeffrey et al. 2009b	Shiloh I, CA (06-09)		Kerlinger et al. 2009
Elkhorn, OR (10)	WEST 2005b	Enk et al. 2011b	Shiloh II, CA (09-10)		Kerlinger et al. 2010
Elm Creek, MN (09-10)		Derby et al. 2010b	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. 2003a	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. 2003a	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. 2003a	Erickson et al. 2007
Fowler I, IN (09)		Johnson et al. 2010a	Stetson Mountain I, ME (09)		Stantec 2009b
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 2010b	Stetson Mountain II, ME (12)		Stantec 2013c
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. 2000a
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. 2003c	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 D3. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Bat activity presented as number of bat passes per detector-night. Fatality estimate given as number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Rising Tree Projects, CA (2015-2016)	0.10	7/1/08-8/13/09	0	60	200
California					
Shiloh I, CA (2006-2009)	NA	NA	3.92	100	150
Shiloh II, CA (2010-2011)	NA	NA	3.8	75	150
Shiloh II, CA (2009-2010)	NA	NA	2.6	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	1.9	16	36.8
High Winds, CA (2004-2005)	NA	NA	1.52	90	162
Alta Wind I, CA (2011-2012)	4.42 ^A	6/26/2009 - 10/31/2009	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	0.4	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	0.2	290	720 (150 GE, 570 vestas)
Mustang Hills, CA (2012-2013)	NA	NA	0.1	50	150
Alta Wind II-V, CA (2011-2012)	0.78	6/26/2009 - 10/31/2009	0.08	190	570
Pinyon Pines I & II, CA (2013-2014)	NA	NA	0.04	100	300
Alta VIII, CA (2012-2013)	NA	NA	0	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	1.9	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

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

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Klondike, OR (2002-2003)	NA	NA	0.77	16	24
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
Klondike II, OR (2005-2006)	NA	NA	0.41	50	75
Windy Flats, WA (2010-2011)	NA	NA	0.41	114	262.2
Vantage, WA (2010-2011)	NA	NA	0.4	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
Southwest					
Dry Lake I, AZ (2009-2010)	8.8	4/29/10-11/10/10	3.43	30	63
Dry Lake II, AZ (2011-2012)	11.5	5/11/11-10/26/11	1.66	31	65
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	3.2	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 Phase I, 102 Phase II)
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2 ^{B,C}	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2 ^{B,C}	6/15/00-9/1/00	1.05	69	41.4
Midwest					
Cedar Ridge, WI (2009)	9.97 ^{B,C,D,E}	7/16/07-9/30/07	30.61	41	67.6
Blue Sky Green Field, WI (2008; 2009)	7.7	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	9.97 ^{B,C,D,E}	7/16/07-9/30/07	24.12	41	68
Fowler I, II, III, IN (2011)	NA	NA	20.19	355	600
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
Top Crop I & II (2012-2013)	NA	NA	12.55	200 (68 Phase I, 132 Phase II)	300 (102 Phase I, 198 Phase II)

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

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Rail Splitter, IL (2012-2013)	NA	NA	11.21	67	100.5
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
Heritage Garden I, MI (2012-2014)	NA	NA	5.9	14	28
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 ^D	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 ^D	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
Buffalo Ridge II, SD (2011-2012)	NA	NA	2.81	105	210
Elm Creek II, MN (2011-2012)	NA	NA	2.81	62	148.8
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	2.1	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 ^D	6/15/02-9/15/02	1.81	138	103.5
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9 ^D	6/15/02-9/15/02	1.64	143	107.25
Rugby, ND (2010-2011)	NA	NA	1.6	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 D3. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Bat activity presented as number of bat passes per detector-night. Fatality estimate given as number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
<i>Southern Plains</i>					
Barton Chapel, TX (2009-2010)	NA	NA	3.06	60	120
Big Smile, OK (2012-2013)	NA	NA	2.9	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	0.1	67	134
<i>Northeast</i>					
Pinnacle, WV (2012)	NA	NA	40.2	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	16.3	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	9.5	86	197.8
Cohocton/Dutch Hill, NY (2009)	NA	NA	8.62	50	125
Casselman, PA (2009)	NA	NA	8.6	23	34.5
Noble Bliss, NY (2008)	NA	NA	7.8	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	7.3	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 ^D	8/1/09-09/31/09	4.5	67	100
Casselman Curtailment, PA (2008)	NA	NA	4.4	23	35.4
Noble Altona, NY (2010)	NA	NA	4.34	65	97.5
Noble Ellenburg, NY (2009)	16.1 ^D	8/16/09-09/15/09	3.91	54	80
Noble Bliss, NY (2009)	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 ^D	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
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

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

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
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	1.4	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
Rollins, ME (2012)	NA	NA	0.18	40	60
Stetson Mountain I, ME (2013)	NA	NA	0.18	38	57
Kibby, ME (2011)	NA	NA	0.12	44	132
<i>Southeast</i>					
Buffalo Mountain, TN (2005)	NA	NA	39.7	18	28.98
Buffalo Mountain, TN (2000-2003)	23.7 ^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 pre-construction monitoring; data for all other activity and fatality rates were collected concurrently

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

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

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

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

Data from the following sources:

Facility	Activity Estimate	Mortality Estimate	Facility	Activity Estimate	Mortality Estimate
Rising Tree I, II & III, CA (15-16)			This study		
Alite, CA (09-10)		Chatfield et al. 2010	Lempster, NH (09)		Tidhar et al. 2010
Alta Wind I, CA (11-12)	Solick et al. 2010	Chatfield et al. 2012	Lempster, NH (10)		Tidhar et al. 2011
Alta Wind I-V, CA (13-14)		Chatfield et al. 2014	Linden Ranch, WA (10-11)		Enz and Bay 2011
Alta Wind II-V, CA (11-12)	Solick et al. 2010	Chatfield et al. 2012	Locust Ridge, PA (Phase II; 09)		Arnett et al.
Alta VIII, CA (12-13)		Chatfield and Bay 2014	Locust Ridge, PA (Phase II; 10)		Arnett et al.
Barton I & II, IA (10-11)		Derby et al. 2011a	Maple Ridge, NY (06)		Jain et al. 2007
Barton Chapel, TX (09-10)		WEST 2011	Maple Ridge, NY (07)		Jain et al. 2009a
Beech Ridge, WV (12)		Tidhar et al. 2013b	Maple Ridge, NY (07-08)		Jain et al. 2009d
Beech Ridge, WV (13)		Young et al. 2014b	Maple Ridge, NY (12)		Tidhar et al. 2013a
Big Blue, MN (13)		Fagen Engineering 2014	Marengo I, WA (09-10)		URS Corporation 2010b
Big Blue, MN (14)		Fagen Engineering 2015	Marengo II, WA (09-10)		URS Corporation 2010c
Big Horn, WA (06-07)		Kronner et al. 2008	Mars Hill, ME (07)		Stantec 2008b
Big Smile, OK (12-13)		Derby et al. 2013b	Mars Hill, ME (08)		Stantec 2009a
Biglow Canyon, OR (Phase I; 08)		Jeffrey et al. 2009a	Milford I, UT (10-11)		Stantec 2011b
Biglow Canyon, OR (Phase I; 09)		Enk et al. 2010	Milford I & II, UT (11-12)		Stantec 2012b
Biglow Canyon, OR (Phase II; 09-10)		Enk et al. 2011a	Montezuma I, CA (11)		ICF International 2012
Biglow Canyon, OR (Phase II; 10-11)		Enk et al. 2012a	Montezuma I, CA (12)		ICF International 2013
Biglow Canyon, OR (Phase III; 10-11)		Enk et al. 2012b	Montezuma II, CA (12-13)		Harvey & Associates 2013
Blue Sky Green Field, WI (08; 09)	Gruver 2008	Gruver et al. 2009	Moraine II, MN (09)		Derby et al. 2010d
Buffalo Gap I, TX (06)		Tierney 2007	Mount Storm, WV (Fall 08)	Young et al. 2009b	Young et al. 2009b
Buffalo Gap II, TX (07-08)		Tierney 2009	Mount Storm, WV (09)	Young et al. 2009a, 2010b	Young et al. 2009a, 2010b
Buffalo Mountain, TN (00-03)	Fiedler 2004	Nicholson et al. 2005	Mount Storm, WV (10)	Young et al. 2010a, 2011b	Young et al. 2010a, 2011b
Buffalo Mountain, TN (05)		Fiedler et al. 2007	Mount Storm, WV (11)		Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000	Mountaineer, WV (03)		Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000	Munnsville, NY (08)		Stantec 2009c
Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000	Mustang Hills, CA (12-13)		Chatfield and Bay 2014
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Nine Canyon, WA (02-03)		Erickson et al. 2003b
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Noble Altona, NY (10)		Jain et al. 2011b
Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000	Noble Bliss, NY (08)		Jain et al. 2009e
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Noble Bliss, NY (09)		Jain et al. 2010a
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Noble Chateaugay, NY (10)		Jain et al. 2011c
Buffalo Ridge I, SD (09-10)		Derby et al. 2010c	Noble Clinton, NY (08)	Reynolds 2010a	Jain et al. 2009c
Buffalo Ridge II, SD (11-12)		Derby et al. 2012a	Noble Clinton, NY (09)	Reynolds 2010a	Jain et al. 2010c
Casselman, PA (08)		Arnett et al. 2009b	Noble Ellenburg, NY (08)		Jain et al. 2009b
Casselman, PA (09)		Arnett et al. 2010	Noble Ellenburg, NY (09)	Reynolds 2010b	Jain et al. 2010b
Casselman Curtailment, PA (08)		Arnett et al. 2009a	Noble Wethersfield, NY (10)		Jain et al. 2011a
Cedar Ridge, WI (09)	BHE Environmental 2008	BHE Environmental 2010	NPPD Ainsworth, NE (06)		Derby et al. 2007
Cedar Ridge, WI (10)	BHE Environmental 2008	BHE Environmental 2011	Palouse Wind, WA (12-13)		Stantec 2013d
Cohocton/Dutch Hill, NY (09)		Stantec 2010	Pebble Springs, OR (09-10)		Gritski and Kronner 2010a
Cohocton/Dutch Hills, NY (10)		Stantec 2011a	Pinnacle, WV (12)		Hein et al. 2013b
Combine Hills, OR (Phase I; 04-05)		Young et al. 2006	Pinyon Pines I&II, CA (13-14)		Chatfield and Russo 2014
Combine Hills, OR (11)		Enz et al. 2012	Pioneer Prairie I, IA (Phase II; 11-12)		Chodachek et al. 2012
Crescent Ridge, IL (05-06)		Kerlinger et al. 2007	Pioneer Prairie II, IA (13)		Chodachek et al. 2014
Criterion, MD (11)		Young et al. 2012a	PrairieWinds ND1 (Minot), ND (10)		Derby et al. 2011c
Criterion, MD (12)		Young et al. 2013	PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012c
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

Appendix D3 (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
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 2008a	Stantec 2013e
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. 2010b	Rollins, ME (12)		Stantec 2013a
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 2009b	Stantec 2009b
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 2013c
Hay Canyon, OR (09-10)		Gritski and Kronner 2010b	Summerview, Alb (05-06)		Brown and Hamilton 2006b
Heritage Garden, MI (12-14)		Kerlinger et al. 2014	Summerview, Alb (06; 07)	Baerwald 2008	Baerwald 2008
High Sheldon, NY (10)		Tidhar et al. 2012a	Top Crop I & II, IL (12-13)		Good et al. 2013a
High Sheldon, NY (11)		Tidhar et al. 2012b	Top of Iowa, IA (03)		Jain 2005
High Winds, CA (03-04)		Kerlinger et al. 2006	Top of Iowa, IA (04)	Jain 2005	Jain 2005
High Winds, CA (04-05)		Kerlinger et al. 2006	Tuolumne (Windy Point I), WA (09-10)		Enz and Bay 2010
Hopkins Ridge, WA (06)		Young et al. 2007	Vansycle, OR (99)		Erickson et al. 2000b
Hopkins Ridge, WA (08)		Young et al. 2009c	Vantage, WA (10-11)		Ventus 2012
Judith Gap, MT (06-07)		TRC 2008	Wessington Springs, SD (09)		Derby et al. 2010f
Judith Gap, MT (09)		Poulton and Erickson 2010	Wessington Springs, SD (10)		Derby et al. 2011d
Kewaunee County, WI (99-01)		Howe et al. 2002	White Creek, WA (07-11)		Downes and Gritski 2012b
Kibby, ME (11)		Stantec 2012a	Wild Horse, WA (07)		Erickson et al. 2008
Kittitas Valley, WA (11-12)		Stantec Consulting Services 2012	Windy Flats, WA (10-11)		Enz et al. 2011
Klondike, OR (02-03)		Johnson et al. 2003a	Winnebago, IA (09-10)		Derby et al. 2010e
Klondike II, OR (05-06)		NWC and WEST 2007	Wolfe Island, Ont (July-December 09)		Stantec Ltd. 2010a
Klondike III (Phase I), OR (07-09)		Gritski et al. 2010	Wolfe Island, Ont (July-December 10)		Stantec Ltd. 2011a
Klondike IIIa (Phase II), OR (08-10)		Gritski et al. 2011	Wolfe Island, Ont (July-December 11)		Stantec Ltd. 2012
Leaning Juniper, OR (06-08)		Gritski et al. 2008			

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

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Alite, CA (2009-2010)	0.55	0.12	0.24	Shrub/scrub & grassland	Chatfield et al. 2010
Alta Wind I, CA (2011-2012)	7.07	0.27	1.28	Woodland, grassland, shrubland	Chatfield et al. 2012
Alta Wind I-V, CA (2013-2014)	7.8	0.08	0.2	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	Grassland and riparian	Chatfield and Bay 2014
Barton I & II, IA (2010-2011)	5.5	0	1.85	Agriculture	Derby et al. 2011a
Barton Chapel, TX (2009-2010)	1.15	0.25	3.06	Agriculture/forest	WEST 2011
Beech Ridge, WV (2012)	1.19	0.01	2.03	Forest	Tidhar et al. 2013b
Beech Ridge, WV (2013)	1.48	0.01	0.58	Forest	Young et al. 2014b
Big Blue, MN (2013)	0.6	0	2.04	Agriculture	Fagen Engineering 2014
Big Blue, MN (2014)	0.37	0	1.43	Agriculture	Fagen Engineering 2015
Big Horn, WA (2006-2007)	2.54	0.11	1.9	Agriculture/grassland	Kronner et al. 2008
Big Smile, OK (2012-2013)	0.09	0	2.9	Grassland, agriculture	Derby et al. 2013b
Biglow Canyon, OR (Phase I; 2008)	1.76	0.03	1.99	Agriculture/grassland	Jeffrey et al. 2009a
Biglow Canyon, OR (Phase I; 2009)	2.47	0	0.58	Agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	0.14	2.71	Agriculture	Enk et al. 2011a
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	0.03	0.57	Grassland/shrub-steppe, agriculture	Enk et al. 2012a
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	0.05	0.22	Grassland/shrub-steppe, agriculture	Enk et al. 2012b
Blue Sky Green Field, WI (2008; 2009)	7.17	0	24.57	Agriculture	Gruver et al. 2009
Buffalo Gap I, TX (2006)	1.32	0.1	0.1	Grassland	Tierney 2007
Buffalo Gap II, TX (2007-2008)	0.15	0	0.14	Forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	11.02	0	31.54	Forest	Nicholson et al. 2005
Buffalo Mountain, TN (2005)	1.1	0	39.7	Forest	Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 1996)	4.14	0	NA	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1997)	2.51	0	NA	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1998)	3.14	0	NA	Agriculture	Johnson et al. 2000

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

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Buffalo Ridge, MN (Phase I; 1999)	1.43	0.47	0.74	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1998)	2.47	0	2.16	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1999)	3.57	0	2.59	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	NA	NA	4.35	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	NA	NA	1.64	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 1999)	5.93	0	2.72	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	NA	NA	3.71	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	NA	NA	1.81	Agriculture	Johnson et al. 2004
Buffalo Ridge I, SD (2009-2010)	5.06	0.2	0.16	Agriculture/grassland	Derby et al. 2010c
Buffalo Ridge II, SD (2011-2012)	1.99	0	2.81	Agriculture, grassland	Derby et al. 2012a
Casselman, PA (2008)	1.51	0	12.61	Forest	Arnett et al. 2009b
Casselman, PA (2009)	2.88	0	8.6	Forest, pasture, grassland	Arnett et al. 2010
Casselman Curtailment, PA (2008)	NA	NA	4.4	Forest	Arnett et al. 2009a
Cedar Ridge, WI (2009)	6.55	0.18	30.61	Agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	3.72	0.13	24.12	Agriculture	BHE Environmental 2011
Cohocton/Dutch Hill, NY (2009)	1.39	0	8.62	Agriculture/forest	Stantec 2010
Cohocton/Dutch Hills, NY (2010)	1.32	0.08	10.32	Agriculture, forest	Stantec 2011a
Combine Hills, OR (Phase I; 2004- 2005)	2.56	0	1.88	Agriculture/grassland	Young et al. 2006
Combine Hills, OR (2011)	2.33	0.05	0.73	Grassland/shrub- steppe, agriculture	Enz et al. 2012
Crescent Ridge, IL (2005-2006)	NA	NA	3.27	Agriculture	Kerlinger et al. 2007
Criterion, MD (2011)	6.4	0.02	15.61	Forest, agriculture	Young et al. 2012a
Criterion, MD (2012)	2.14	NA	7.62	Forest, agriculture	Young et al. 2013
Criterion, MD (2013)	3.49	NA	5.32	Forest, agriculture	Young et al. 2014a
Crystal Lake II, IA (2009)	NA	NA	7.42	Agriculture	Derby et al. 2010a
Diablo Winds, CA (2005-2007)	4.29	0.4	0.82	NA	WEST 2006, 2008
Dillon, CA (2008-2009)	4.71	0	2.17	Desert	Chatfield et al. 2009

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

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Dry Lake I, AZ (2009-2010)	2.02	0	3.43	Desert grassland/forested	Thompson et al. 2011
Dry Lake II, AZ (2011-2012)	1.57	0	1.66	Desert grassland/forested	Thompson and Bay 2012
Elkhorn, OR (2008)	0.64	0.06	1.26	Shrub/scrub & agriculture	Jeffrey et al. 2009b
Elkhorn, OR (2010)	1.95	0.08	2.14	Shrub/scrub & agriculture	Enk et al. 2011b
Elm Creek, MN (2009-2010)	1.55	0	1.49	Agriculture	Derby et al. 2010b
Elm Creek II, MN (2011-2012)	3.64	0	2.81	Agriculture, grassland	Derby et al. 2012b
Foote Creek Rim, WY (Phase I; 1999)	3.4	0.08	3.97	Grassland	Young et al. 2003b
Foote Creek Rim, WY (Phase I; 2000)	2.42	0.05	1.05	Grassland	Young et al. 2003b
Foote Creek Rim, WY (Phase I; 2001- 2002)	1.93	0	1.57	Grassland	Young et al. 2003b
Forward Energy Center, WI (2008- 2010)	NA	NA	18.17	Agriculture	Grodsky and Drake 2011
Fowler I, IN (2009)	2.83	0	8.09	Agriculture	Johnson et al. 2010a
Fowler I, II, III, IN (2010)	NA	NA	18.96	Agriculture	Good et al. 2011
Fowler I, II, III, IN (2011)	NA	NA	20.19	Agriculture	Good et al. 2012
Fowler I, II, III, IN (2012)	NA	NA	2.96	Agriculture	Good et al. 2013c
Fowler III, IN (2009)	NA	NA	1.84	Agriculture	Johnson et al. 2010b
Goodhoe, WA (2009-2010)	1.4	0.17	0.34	Grassland and shrub- steppe	URS Corporation 2010a
Grand Ridge I, IL (2009-2010)	0.48	0	2.1	Agriculture	Derby et al. 2010g
Harrow, Ont (2010)	NA	NA	11.13	Agriculture	Natural Resource Solutions Inc. (NRSI) 2011
Harvest Wind, WA (2010-2012)	2.94	0.23	1.27	Grassland/shrub- steppe	Downes and Gritski 2012a
Hay Canyon, OR (2009-2010)	2.21	0	0.53	Agriculture	Gritski and Kronner 2010b
Heritage Garden I, MI (2012-2014)	1.3	NA	5.9	agriculture	Kerlinger et al. 2014
High Sheldon, NY (2010)	1.76	0.06	2.33	Agriculture	Tidhar et al. 2012a
High Sheldon, NY (2011)	1.57	0	1.78	Agriculture	Tidhar et al. 2012b
High Winds, CA (2003-2004)	1.62	0.5	2.51	Agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2004-2005)	1.1	0.28	1.52	Agriculture/grassland	Kerlinger et al. 2006

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

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Hopkins Ridge, WA (2006)	1.23	0.14	0.63	Agriculture/grassland	Young et al. 2007
Hopkins Ridge, WA (2008)	2.99	0.07	1.39	Agriculture/grassland	Young et al. 2009c
Judith Gap, MT (2006-2007)	NA	NA	8.93	Agriculture/grassland	TRC 2008
Judith Gap, MT (2009)	NA	NA	3.2	Agriculture/grassland	Poulton and Erickson 2010
Kewaunee County, WI (1999-2001)	1.95	0	6.45	Agriculture	Howe et al. 2002
Kibby, ME (2011)	NA	NA	0.12	Forest; commercial forest	Stantec 2012a
Kittitas Valley, WA (2011-2012)	1.06	0.09	0.12	Sagebrush-steppe, grassland	Stantec Consulting Services 2012
Klondike, OR (2002-2003)	0.95	0	0.77	Agriculture/grassland	Johnson et al. 2003a
Klondike II, OR (2005-2006)	3.14	0.06	0.41	Agriculture/grassland	NWC and WEST 2007
Klondike III (Phase I), OR (2007-2009)	3.02	0.15	1.11	Agriculture/grassland	Gritski et al. 2010
Klondike IIIa (Phase II), OR (2008-2010)	2.61	0.06	0.14	Grassland/shrub-steppe and agriculture	Gritski et al. 2011
Leaning Juniper, OR (2006-2008)	6.66	0.16	1.98	Agriculture	Gritski et al. 2008
Lempster, NH (2009)	3.38	0	3.11	Grasslands/forest/rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	2.64	0	3.57	Grasslands/forest/rocky embankments	Tidhar et al. 2011
Linden Ranch, WA (2010-2011)	6.65	0.27	1.68	Grassland/shrub-steppe, agriculture	Enz and Bay 2011
Locust Ridge, PA (Phase II; 2009)	0.84	0	14.11	Grassland	Arnett et al. 2011
Locust Ridge, PA (Phase II; 2010)	0.76	0	14.38	Grassland	Arnett et al. 2011
Maple Ridge, NY (2006)	NA	NA	11.21	Agriculture/forested	Jain et al. 2007
Maple Ridge, NY (2007)	2.34	NA	6.49	Agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007-2008)	2.07	0.03	4.96	Agriculture/forested	Jain et al. 2009d
Maple Ridge, NY (2012)	NA	NA	7.3	Agriculture/forested	Tidhar et al. 2013a
Marengo I, WA (2009-2010)	0.27	0	0.17	Agriculture	URS Corporation 2010b
Marengo II, WA (2009-2010)	0.16	0.05	0.27	Agriculture	URS Corporation 2010c
Mars Hill, ME (2007)	1.67	0	2.91	Forest	Stantec 2008b
Mars Hill, ME (2008)	1.76	0	0.45	Forest	Stantec 2009a
Milford I, UT (2010-2011)	0.56	NA	2.05	Desert shrub	Stantec 2011b
Milford I & II, UT (2011-2012)	0.73	0.04	1.67	Desert shrub	Stantec 2012b

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

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Montezuma I, CA (2011)	5.19	1.06	1.9	Agriculture and grasslands	ICF International 2012
Montezuma I, CA (2012)	8.91	0.79	0.84	Agriculture and grasslands	ICF International 2013
Montezuma II, CA (2012-2013)	1.08	0.46	0.91	Agriculture	Harvey & Associates 2013
Moraine II, MN (2009)	5.59	0.37	2.42	Agriculture/grassland	Derby et al. 2010d
Mount Storm, WV (Fall 2008)	NA	NA	6.62	Forest	Young et al. 2009b
Mount Storm, WV (2009)	3.85	0	17.53	Forest	Young et al. 2009a, 2010b
Mount Storm, WV (2010)	2.6	0.1	15.18	Forest	Young et al. 2010a, 2011b
Mount Storm, WV (2011)	4.24	0.03	7.43	Forest	Young et al. 2011a, 2012b
Mountaineer, WV (2003)	2.69	0.07	31.69	Forest	Kerns and Kerlinger 2004
Munnsville, NY (2008)	1.48	0.59	1.93	Agriculture/forest	Stantec 2009c
Mustang Hills, CA (2012-2013)	1.66	0.08	0.1	Grasslands and Riparian	Chatfield and Bay 2014
Nine Canyon, WA (2002-2003)	2.76	0.03	2.47	Agriculture/grassland	Erickson et al. 2003b
Noble Altona, NY (2010)	1.84	0	4.34	Forest	Jain et al. 2011b
Noble Bliss, NY (2008)	1.3	0.1	7.8	Agriculture/forest	Jain et al. 2009e
Noble Bliss, NY (2009)	2.28	0.12	3.85	Agriculture/forest	Jain et al. 2010a
Noble Chateaugay, NY (2010)	1.66	0.08	2.44	Agriculture	Jain et al. 2011c
Noble Clinton, NY (2008)	1.59	0.1	3.14	Agriculture/forest	Jain et al. 2009c
Noble Clinton, NY (2009)	1.11	0.16	4.5	Agriculture/forest	Jain et al. 2010c
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. 2010b
Noble Wethersfield, NY (2010)	1.7	0.13	16.3	Agriculture	Jain et al. 2011a
NPPD Ainsworth, NE (2006)	1.63	0.06	1.16	Agriculture/grassland	Derby et al. 2007
Palouse Wind, WA (2012-2013)	0.72	NA	4.23	Agriculture and grasslands	Stantec 2013d
Pebble Springs, OR (2009-2010)	1.93	0.04	1.55	Grassland	Gritski and Kronner 2010a
Pine Tree, CA (2009-2010, 2011)	17.44	NA	NA	Grassland	BioResource Consultants 2012
Pinnacle, WV (2012)	3.99	0	40.2	Forest	Hein et al. 2013b
Pinyon Pines I & II, CA (2013-2014)	1.18	NA	0.04	Creosote scrub/Joshua tree woodland	Chodachek et al. 2012

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

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	0	10.06	Agriculture, grassland	Chodachek et al. 2014
Pioneer Prairie II, IA (2013)	NA	NA	3.83	Agriculture	Stantec 2013d
PrairieWinds ND1 (Minot), ND (2010)	1.48	0.05	2.13	Agriculture	Derby et al. 2011c
PrairieWinds ND1 (Minot), ND (2011)	1.56	0.05	1.39	Agriculture, grassland	Derby et al. 2012c
PrairieWinds SD1, SD (2011-2012)	1.41	0	1.23	Grassland	Derby et al. 2012d
PrairieWinds SD1, SD (2012-2013)	2.01	0.03	1.05	Grassland	Derby et al. 2013a
PrairieWinds SD1, SD (2013-2014)	1.66	0.17	0.52	Grassland	Derby et al. 2014
Rail Splitter, IL (2012-2013)	0.84	0	11.21	Agriculture	Good et al. 2013b
Record Hill, ME (2012)	3.7	NA	2.96	Forest	Stantec 2013e
Record Hill, ME (2014)	1.84	NA	0.55	Forest	Stantec 2015
Red Hills, OK (2012-2013)	0.08	0.04	0.11	Grassland	Derby et al. 2013c
Ripley, Ont (2008)	3.09	0.1	4.67	Agriculture	Jacques Whitford 2009
Rising Tree Projects, CA (2015-2016)	3.13	0.06	0	Shrub/scrub and Joshua tree woodland	This study
Rollins, ME (2012)	2.9	NA	0.18	Forest	Stantec 2013a
Rugby, ND (2010-2011)	3.82	0.06	1.6	Agriculture	Derby et al. 2011b
Shiloh I, CA (2006-2009)	6.96	0.42	3.92	Agriculture/grassland	Kerlinger et al. 2009
Shiloh II, CA (2009-2010)	1.9	0.11	2.6	Agriculture	Kerlinger et al. 2010, 2013a
Shiloh II, CA (2010-2011)	2.8	0.44	3.8	Agriculture	Kerlinger et al. 2013a
Shiloh III, CA (2012-2013)	3.3	NA	0.4	NA	Kerlinger et al. 2013b
Solano III, CA (2012-2013)	1.6	0.95	0.31	NA	AECOM 2013
Stateline, OR/WA (2001-2002)	3.17	0.09	1.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.68	0.09	2.29	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2006)	1.23	0.11	0.95	Agriculture/grassland	Erickson et al. 2007
Stetson Mountain I, ME (2009)	2.68	0	1.4	Forest	Stantec 2009b
Stetson Mountain I, ME (2011)	1.18	0	0.28	Forest	Normandeau Associates 2011
Stetson Mountain I, ME (2013)	6.95	0	0.18	Forest	Stantec 2014
Stetson Mountain II, ME (2010)	1.42	0	1.65	Forest	Normandeau Associates 2010
Stetson Mountain II, ME (2012)	3.37	0	2.27	Forest	Stantec 2013c
Summerview, Alb (2005-2006)	1.06	0.11	10.27	Agriculture	Brown and Hamilton 2006b

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

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Summerview, Alb (2006; 2007)	NA	NA	11.42	Agriculture/grassland	Baerwald 2008
Top Crop I & II (2012-2013)	1.35	NA	12.55	Agriculture	Good et al. 2013a
Top of Iowa, IA (2003)	0.42	0	7.16	Agriculture	Jain 2005
Top of Iowa, IA (2004)	0.81	0.17	10.27	Agriculture	Jain 2005
Tuolumne (Windy Point I), WA (2009-2010)	3.2	0.29	0.94	Grassland/shrub-steppe, agriculture and forest	Enz and Bay 2010
Vansycle, OR (1999)	0.95	0	1.12	Agriculture/grassland	Erickson et al. 2000b
Vantage, WA (2010-2011)	1.27	0.29	0.4	Shrub-steppe, grassland	Ventus Environmental Solutions 2012
Wessington Springs, SD (2009)	8.25	0.06	1.48	Grassland	Derby et al. 2010f
Wessington Springs, SD (2010)	0.89	0.07	0.41	Grassland	Derby et al. 2011d
White Creek, WA (2007-2011)	4.05	0.47	2.04	Grassland/shrub-steppe, agriculture	Downes and Gritski 2012b
Wild Horse, WA (2007)	1.55	0.09	0.39	Grassland	Erickson et al. 2008
Windy Flats, WA (2010-2011)	8.45	0.04	0.41	Grassland/shrub-steppe, agriculture	Enz et al. 2011
Winnebago, IA (2009-2010)	3.88	0.27	4.54	Agriculture/grassland	Derby et al. 2010e
Wolfe Island, Ont (July-December 2009)	NA	NA	6.42	Grassland	Stantec Ltd. 2010a
Wolfe Island, Ont (July-December 2010)	NA	NA	9.5	Grassland	Stantec Ltd. 2011a
Wolfe Island, Ont (July-December 2011)	NA	NA	2.49	Grassland	Stantec Ltd. 2012

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Alite, CA (2009-2010)	8	24	80	8	200 m x 200 m	1 year	Weekly (spring, fall), bi-monthly (summer, winter)
Alta Wind I, CA (2011-2012)	100	150	80	25	120-m radius circle	12.5 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
Alta Wind II-V, CA (2011-2012)	190	570	80	41	120-m radius circle	14.5 months	Every two weeks
Alta VIII, CA (2012-2013)	50	150	90	12 plots (equivalent to 15 turbines)	240 x 240 m	1 year	Bi-weekly
Barton I & II, IA (2010-2011)	80	160	100	35 (9 turbines were dropped in June 2010 due to landowner issues) 26 turbines were searched for the remainder of the study	200 m x 200 m	1 year	Weekly (spring, fall; migratory turbines), monthly (summer, winter; non-migratory turbines)
Barton Chapel, TX (2009-2010)	60	120	78	30	200 m x 200 m	1 year	10 turbines weekly, 20 monthly
Beech Ridge, WV (2012)	67	100.5	80	67	40 m radius	7 months	Every two days
Beech Ridge, WV (2013)	67	100.5	80	67	40 m radius	7.5 months	Every two days

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Big Blue, MN (2013)	18	36	78 or 90 (according to Gamesa website)	18	200m diameter	NA	Weekly, monthly (Nov and Dec)
Big Blue, MN (2014)	18	36	78 or 90 (according to Gamesa website)	18	200m diameter	NA	Weekly, monthly (Nov and Dec)
Big Horn, WA (2006-2007)	133	199.5	80	133	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Big Smile, OK (2012-2013)	66	132	78	17 (plus one met tower)	100 x 100	1 year	Weekly (spring, summer, fall), monthly (winter)
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

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Buffalo Mountain, TN (2000-2003)	3	1.98	65	3	50-m radius	3 years	Bi-weekly, weekly, bi-monthly
Buffalo Mountain, TN (2005)	18	28.98	V47 = 65; V80 = 78	18	50-m radius	1 year	Bi-weekly, weekly, bi-monthly, and 2 to 5 day intervals
Buffalo Ridge, MN (1994-1995)	73	25	37	1994:10 plots (3 turbines/plot), 20 addition plots in Sept & Oct 1994, 1995: 30 turbines search every other week (Jan-Mar), 60 searched weekly (Apr, July, Aug) 73 searched weekly (May-June and Sept-Oct), 30 searched weekly (Nov-Dec)	100 x 100m	20 months	Varies. See number turbines searched or page 44 of report
Buffalo Ridge, MN (Phase I; 1996)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1997)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1998)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1999)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1998)	143	107.25	50	40	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1999)	143	107.25	50	40	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	143	107.25	50	83	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	143	107.25	50	103	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase III; 1999)	138	103.5	50	30	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	138	103.5	50	83	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	138	103.5	50	103	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge I, SD (2009-2010)	24	50.4	79	24	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Buffalo Ridge II, SD (2011-2012)	105	210	78	65 (60 road and pad, 5 turbine plots)	100 x 100m	1 year	Weekly (spring, summer, fall), monthly (winter)
Casselman, PA (2008)	23	34.5	80	10	126 m x 120 m	7 months	Daily
Casselman, PA (2009)	23	34.5	80	10	126 m x 120 m	7.5 months	Daily searches
Casselman Curtailment, PA (2008)	23	35.4	80	12 experimental; 10 control	126 m x 120 m	2.5 months	Daily
Castle River, Alb (2001)	60	39.6	50	60	50-m radius	2 years	Weekly, bi-weekly
Castle River, Alb (2002)	60	39.6	50	60	50-m radius	2 years	Weekly, bi-weekly
Cedar Ridge, WI (2009)	41	67.6	80	20	160 m x 160 m	Spring, summer, fall	Daily, every 4 days; late fall searched every 3 days

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Cedar Ridge, WI (2010)	41	68	80	20	160 m x 160 m	1 year	Five turbines were surveyed daily, 15 turbines surveyed every 4 days in rotating groups each day. All 20 surveyed every three days during late fall
Cohocton/Dutch Hill, NY (2009)	50	125	80	17	130 m x 130 m	Spring, summer, fall	Daily (5 turbines), weekly (12 turbines)
Cohocton/Dutch Hills, NY (2010)	50	125	80	17	120 m x 120 m	Spring, summer, fall	Daily, weekly
Combine Hills, OR (Phase I; 2004-2005)	41	41	53	41	90-m radius	1 year	Monthly
Combine Hills, OR (2011)	104	104	53	52 (plus 1 MET tower)	180 m x 180 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Condon, OR	84	NA	NA	NA	NA	NA	NA
Crescent Ridge, IL (2005-2006)	33	49.5	80	33	70-m radius	1 year	Weekly (fall, spring)
Criterion, MD (2011)	28	70	80	28	40-50m radius	7.3 months	Daily
Criterion, MD (2012)	28	70	80	14	40-50m radius	7.5 months	Weekly
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

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
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
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

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
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)
High Sheldon, NY (2010)	75	112.5	80	25	115 m x 115 m	7 months	Daily (8 turbines), weekly (17 turbines)

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
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)

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Klondike III (Phase I), OR (2007-2009)	125	223.6	GE = 80; Siemens= 80, Mitsubishi = 80	46	240 m x 240 m (1.5MW) 252 m x 252 m (2.3MW)	2 year	Bi-monthly (spring, fall migration), monthly (summer, winter)
Klondike IIIa (Phase II), OR (2008-2010)	51	76.5	GE = 80	34	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (summer, winter)
Lakefield Wind, MN (2012)	137	205.5	80	26	100 m x 100 m	7.5 months	3 times per week
Leaning Juniper, OR (2006-2008)	67	100.5	80	17	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (winter, summer)
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)

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
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
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 I, 102 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)

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
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
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)

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Noble Clinton, NY (2009)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Daily (8 turbines), weekly (15 turbines), all turbines weekly from July 1 to August 15
Noble Ellenburg, NY (2008)	54	80	80	18	120 m x 120 m	Spring, summer, fall	Daily (6 turbines), 3-day (6 turbines), weekly (6 turbines)
Noble Ellenburg, NY (2009)	54	80	80	18	120 m x 120 m	Spring, summer, fall	Daily (6 turbines), weekly (12 turbines), all turbines weekly from July 1 to August 15
Noble Wethersfield, NY (2010)	84	126	80	28	120 m x 120 m	Spring, summer, fall	Weekly
NPPD Ainsworth, NE (2006)	36	20.5	70	36	220 m x 220 m	Spring, summer, fall	Bi-monthly
Oklahoma Wind Energy Center, OK (2004; 2005)	68	102	70	68	20m radius	3 months (2 years)	Bi-monthly
Pacific, CA (2012-2013)	70	140	78.5	20	126 m radius	NA	Twice weekly (fall), and biweekly
Palouse Wind, WA (2012-2013)	58	104.4	80, 90, or 105 M (according to the Vestas website)	19	120m x 120m	1 year	Monthly (Winter) and Weekly (Spring-Fall)
Pebble Springs, OR (2009-2010)	47	98.7	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Pine Tree, CA (2009-2010, 2011)	90	135	65	40	100 m radius	1.5 year	Bi-weekly, weekly
Pinnacle, WV (2012)	23	55.2	80	11	126 m x 120m	9 months	Weekly
Pinnacle Operational Mitigation Study (2012)	23	55.2	80	12	126m x 120m	2.5 months	Daily

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

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

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Red Canyon, TX (2006-2007)	56	84	70	28	200 m x 200 m in fall and winter; 160 m x 160 m in spring and summer	1 year	Every 14 days in fall and winter; 7 days in spring, 3 days in summer
Red Hills, OK (2012-2013)	82	123	80	20 (plus one met tower)	100 x 100	1 year	Weekly (spring, summer, fall), monthly (winter)
Ripley, Ont (2008)	38	76	64	38	80 m x 80 m	Spring, fall	Twice weekly for odd turbines; weekly for even turbines.
Ripley, Ont (2008-2009)	38	76	64	38	80 m x 80 m	6 weeks	Twice weekly for odd turbines; weekly for even turbines.
Rollins, ME (2012)	40	60	80	20	varied; turbine laydown area and gravel access roads out to 60m	6 months	Weekly
Roth Rock, MD (2011)	20	50	80	10	80m x 80m	3 months	Daily
Rugby, ND (2010-2011)	71	149	78	32	200 m x 200 m	1 year	Weekly (spring, fall; migratory turbines), monthly (non-migratory turbines)
San Geronio, CA (1997-1998; 1999-2000)	3000	NA	24.4-42.7	NA	50-m radius	2 years	Quarterly
Searsburg, VT (1997)	11	7	65	11	20- to 55-m radius	Spring, fall	Weekly (fall migration)
Sheffield, VT (2012)	16	40	80	8	126m x 120m	3 months	Daily
Sheffield Operational Mitigation Study (2012)	16	40	80	16	126m x 120m	4 months	Daily
Shiloh I, CA (2006-2009)	100	150	65	100	105-m radius	3 years	Weekly

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

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

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Stetson Mountain II, ME (2012)	17	25.5	80	17	laydown area and road up to 60m	6 months	Weekly
Summerview, Alb (2005-2006)	39	70.2	67	39	140 m x 140 m	1 year	Weekly, bi-weekly (May to July, September)
Summerview, Alb (2006; 2007)	39	70.2	65	39	52-m radius; 2 spiral transects 7 m apart	Summer, fall (2 years)	Daily (10 turbines), weekly (29 turbines)
Tehachapi, CA (1996-1998)	3300	NA	14.7 to 57.6	201	50-m radius	20 months	Quarterly
Top Crop I & II (2012-2013)	68 (phase I) 132 (phase II)	300 (102 (phase I) 198 (phase II))	65 (phase I) 80 (phase II)	100	61 m radius	1 year	Weekly (spring, summer, and fall) and bi-weekly (winter)
Top of Iowa, IA (2003)	89	80	71.6	26	76 m x 76 m	Spring, summer, fall	Once every 2 to 3 days
Top of Iowa, IA (2004)	89	80	71.6	26	76 m x 76 m	Spring, summer, fall	Once every 2 to 3 days
Tuolumne (Windy Point I), WA (2009-2010)	62	136.6	80	21	180 m x 180 m	1 year	Monthly throughout the year, a subset of 10 turbines were also searched weekly during the spring, summer, and fall
Vansycle, OR (1999)	38	24.9	50	38	126 m x 126 m	1 year	Monthly
Vantage, WA (2010-2011)	60	90	80	30	240 m x 240 m	1 year	Monthly, a subset of 10 searched weekly during migration
Vasco, CA (2012-2013)	34	78.2	80	34	105 m radius	1 year	Weekly, monthly
Wessington Springs, SD (2009)	34	51	80	20	200 m x 200 m	Spring, summer, fall	Bi-monthly

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
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	50m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2011)	86	197.8	80	86	50m 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 D5 (continued). All post-construction monitoring studies, project characteristics, and select study methodology.

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Alite, CA (09-10)	Chatfield et al. 2010	Marengo 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 2008b
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. 2012a	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012b	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 2009c
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. 2003b
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. 2010c
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. 2010b
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. 2010c	Pacific, CA (12-13)	Sapphos 2014
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Palouse Wind, WA (12-13)	Stantec 2013d
Casselman, PA (08)	Arnett et al. 2009b	Pebble Springs, OR (09-10)	Gritski and Kronner 2010a
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. 2013b
Castle River, Alb. (01)	Brown and Hamilton 2006a	Pinnacle Operational Mitigation Study (12)	Hein et al. 2013a
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 2013e
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 al. 2009b	Rollins, ME (12)	Stantec 2013a
Elkhorn, OR (10)	Enk et al. 2011b	Roth Rock, MD (11)	Atwell 2012
Elm Creek, MN (09-10)	Derby et al. 2010b	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
Foot Creek Rim, WY (Phase I; 99)	Young et al. 2003b	Sheffield, VT (12)	Martin et al. 2013

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

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
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 2010b	Steel Winds I & II, NY (12)	Stantec 2013b
Heritage Garden I, MI (12-14)	Kerlinger et al. 2014	Stetson Mountain I, ME (09)	Stantec 2009b
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 2013c
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 2008b, 2008a, 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. 2000b
Klondike, OR (02-03)	Johnson et al. 2003a	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. 2010b
Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011	Wolfe Island, Ont (July-December 09)	Stantec Ltd. 2010a
Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011	Wolfe Island, Ont (January-June 10)	Stantec Ltd. 2011b
Madison, NY (01-02)	Kerlinger 2002b	Wolfe Island, Ont (July-December 10)	Stantec Ltd. 2011a
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		