Post-Construction Studies for the North Sky River Wind Energy Facility Kern County, California

Final Report for the First Year of Operation

January 2013 – January 2014

Prepared for:

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WEST Inc.

EXECUTIVE SUMMARY

North Sky River Energy LLC (NSRE LLC), a subsidiary of NextEra Energy Resources (NextEra), has constructed a wind energy facility in Kern County, California, referred to as the North Sky River Wind Energy Facility (NSR). Western EcoSystems Technology, Inc. (WEST) was contracted by NSRE LLC to develop and implement study protocols for post-construction monitoring at NSR for the purpose of estimating the impacts of the wind energy facility on birds and bats. Consistent with mitigation measures under the North Sky River Wind Energy Project and Jawbone Wind Energy Project Environmental Impact Report (EIR), WEST conducted fatality monitoring (MM 4.4-17) and breeding raptor monitoring (MM 4.4-16) during the initial year of operation of NSR, January 2013 to January 2014.

As stated in MM 4.4-17 of the EIR, the ultimate goal of the fatality monitoring study is to demonstrate that the level of incidental mortality does not result in an unanticipated long-term decline in populations of avian or bat species in the vicinity of NSR. To this end, WEST designed and implemented a study to determine the level of bird and bat mortality attributable to collisions with wind turbines at the facility on an annual basis. The monitoring study consisted of four components: 1) standardized carcass surveys of selected turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and 4) adjusted fatality estimates for birds and bats, calculated using the results from searcher efficiency trials and carcass removal trials to estimate the approximate level of bird and bat mortality within the NSR facility.

A sample of 30 turbines (30% of 100 total turbines), was searched bi-weekly during standardized carcass searches from January 14, 2013, to January 13, 2014, for a total of 745 turbines searches. Additionally, due to concerns over potential impacts to nocturnal migrants at turbines in the northeast portion of NSR, intensive searches (twice per week) were conducted at seven turbine in this part of the facility during spring migration for a total of 158 turbines searches. Over the course of the fatality monitoring study, 22 bird fatalities, representing nine identifiable species, were found during carcass surveys or incidentally. The bird species most commonly found as fatalities were red-tailed hawk (five fatalities) and chukar (four fatalities). Aside from the five red-tailed hawk fatalities (four within search plots and one outside), the only other diurnal raptor fatality was a single golden eagle found as an incidental fatality outside of the standardized search plots. Only four of the 22 bird fatalities documented during the study were found during the intensive spring searches. These included two of the red-tailed hawk fatalities and two of the chukar fatalities. Bird fatalities were found during each season, but were more concentrated during late winter and spring. No state or federally listed bird species were found during the study; however, a single yellow warbler, a state species of special concern, was found. Additionally, the golden eagle is protected under the federal Bald and Golden Eagle Protection Act.

During the study a total of 18 bats, representing six identifiable species, were found during carcass surveys or incidentally. The bat species most commonly found as fatalities during the study were Mexican free-tailed bat (10 fatalities) and hoary bat (three fatalities). Two of the 18 bat fatalities documented during the study were found during the intensive spring searches (one Mexican free-tailed and one unidentified *Myotis* spp.). No state or federally listed bat species were found during the study; however, a single western mastiff bat, a state species of special concern, was found. All bat fatalities occurred between mid-May and late October, peaking in late August/early September.

A total of 105 bird carcasses were placed for searcher efficiency trials: 53 large birds and 52 small birds. Due to the unavailability of bat carcasses, house sparrows were used as surrogates for bats (n=51). Overall searcher efficiency rates were 98.0% for large birds, 80.4% for small birds, and 83.0% for bats. A total of 175 carcasses were placed during carcass removal trials. By day 10, just over half of the large birds remained, while only less than 5% of small birds, and no bats remained. Mean carcass removal time was 1.57 days for small birds and 2.09 days for bats. The mean carcass removal time for large birds varied by season: 18.59 days in summer, 34.83 days in fall, 48.00 days in winter, and 67.68 days in spring.

Fatality estimates were adjusted based on the corrections for carcass removal and observer detection bias. The probability that a carcass would remain in the search plot and be found by a searcher was 0.09 for small birds and 0.12 for bats during all seasons. For large birds, this probability was considerably higher, ranging from 0.69 in the summer to 0.90 in the spring.

Based on the 1.6-megawatt (MW) capacity of the turbines at NSR, the estimated fatality rate for all birds was 2.05 birds per MW per year, with an estimated fatality rate of 0.05 diurnal raptors per MW per year. The estimated fatality rate for bats was 2.59 bats per MW per year.

As stated in MM 4.4-16 of the EIR, the purpose of the breeding monitoring is to demonstrate that sensitive resident raptors are compatible with the operation of wind turbines and that the level of mortality does not result in long-term declines in sensitive raptor species in the region. Consistent with this mitigation measure, WEST conducted raptor nest surveys to determine the presence or absence of raptor nests, particularly mid-sized to large raptor nests, within areas of suitable habitat (e.g., oak and Joshua tree woodlands, utility poles, and transmission towers) within the NSR project area. Three complete surveys of the project area were conducted, with the first occurring on March 20-21, the second on April 4, 5, and 11, and the third on May 2, 10, and 17. Active raptor nests documented during the survey included two active great horned owl nests, one active red-tailed hawk nest, one active long-eared owl nest, and two active raptor nest of an unknown species. Additionally, several inactive nest structures were recorded.

STUDY PARTICIPANTS

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REPORT REFERENCE

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

North Sky River Energy LLC (NSRE LLC), a subsidiary of NextEra Energy Resources (NextEra), has constructed a wind energy facility in Kern County, California, referred to as the North Sky River Wind Energy Facility (NSR). Following construction of NSR in the fall of 2012, As described in Mitigation Measures 4.4-17 and 4.4-16 of the *North Sky River Wind Energy Project and Jawbone Wind Energy Project Environmental Impact Report* (EIR; Kern County Planning Department 2011), NSRE LLC is committed to conducting post-construction avian and bat mortality monitoring at the NSR facility during the first, second, third, and fourth years of operation and raptor breeding monitoring during the first, second, and third years of operation. Following construction of NSR in the fall of 2012, Western EcoSystems Technology, Inc. (WEST), was contracted by NSRE LLC, to develop and implement a standardized protocol for post-construction monitoring at NSR for the purpose of estimating the impacts of facility operation on birds and bats. The monitoring protocols are similar to those used at other wind energy facilities throughout California and the US and are consistent with or exceed current industry standards. Data collection and analysis follows the recommendations presented in the US Fish and Wildlife Service (USFWS) Wind Turbine Advisory Committee Guidelines (WTGAC; USFWS 2012) the California Wind Energy Guidelines (California Energy Commission [CEC] and California Department of Fish and Game [CDFG] 2007), and is based on WEST's experience studying wildlife at wind energy projects throughout the US. This report presents the results of avian and bat fatality monitoring and raptor breeding monitoring conducted at NSR during the first year of operation, from January 2013 to January 2014.

As stated in MM 4.4-17 of the EIR, the ultimate goal of the fatality monitoring study is to demonstrate that the level of incidental mortality does not result in an unanticipated long-term decline in populations of avian or bat species in the vicinity of the projects. To this end, WEST conducted a fatality study to determine the level of bird and bat mortality attributable to collisions with wind turbines at NSR on an annual basis. If, after three years of post-construction mortality monitoring, the Kern County Planning Department, in consultation with the California Department of Fish and Wildlife (CDFW) and the USFWS, determines that NSR is causing unanticipated significant adverse impacts to populations of avian or bat species, NSRE LLC is required to provide supplemental mitigation as described in Mitigation Measure 4.4-20 (Kern County Planning Department 2011). Consistent with MM 4.4-15 of the EIR, surveys for nesting raptors were conducted throughout the NSR facility during the 2013 breeding season.

Post-construction monitoring at NSR was conducted from January 14, 2013, through January 13, 2014. 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 local studies were made.

STUDY AREA

The NSR project area is located approximately nine miles (14 kilometers [km]) west of the Bureau of Land Management (BLM) Jawbone Off-Highway Vehicle Station, Highway 14 at Jawbone Canyon Road, Cantil, California (Figure 1). The NSR facility consists of 100 turbines (GE 1.6-megawatt [MW] turbines for a total of 160 MW) on approximately 12,904 acres (20 square miles [mi^2]) of private and BLM-managed land. The turbine towers are approximately 80 meters (m; 262 feet [ft]) tall and the rotor blades are approximately 100 to 113 m (328 to 371 ft) in diameter, for a maximum height of approximately 130 to 136.5 m (427 to 448 ft) from turbine base to the fully extended blade tip.

North Sky River falls near the intersection of two ecological subsections: the High Desert Plains and Hills Subsection of the Mojave Desert to the south and east, and the Eastern Slopes Subsection of the Sierra Nevada to the north and west (US Department of Agriculture [USDA] Forest Service 1997). Topography within the project area is characterized by gently rolling hills to relatively steep, low mountains. Elevations range from approximately 3,120 ft (950 m) in the southeastern portion of the project area to just over 5,580 ft (1,700 m) in the southwest. The dominant vegetation community is Mojavean juniper (*Juniperus* spp.) woodland and scrub characterized by widely spaced California junipers (*J. californica*) interspersed with smaller woody shrubs, forbs, and grasses. Desert scrub vegetation with small areas of Joshua tree (*Yucca brevifolia*) woodland are present within the lower elevations of the study area, while juniper-pinyon pine (*Pinus monophylla*) and oak (*Quercus* spp.) woodlands are found at the higher elevations.

Several natural springs occur throughout the project area, as well as a number of small intermittent drainages, which contain riparian vegetation such as willow (*Salix* spp) and tamarisk (*Tamarix* spp). The largest of these is Cottonwood Creek, which runs through the center of the project area from the northwest to the southeast and contains areas of more substantial riparian woodlands with an overstory comprised primarily of Fremont cottonwood *(Populus fremontii*).

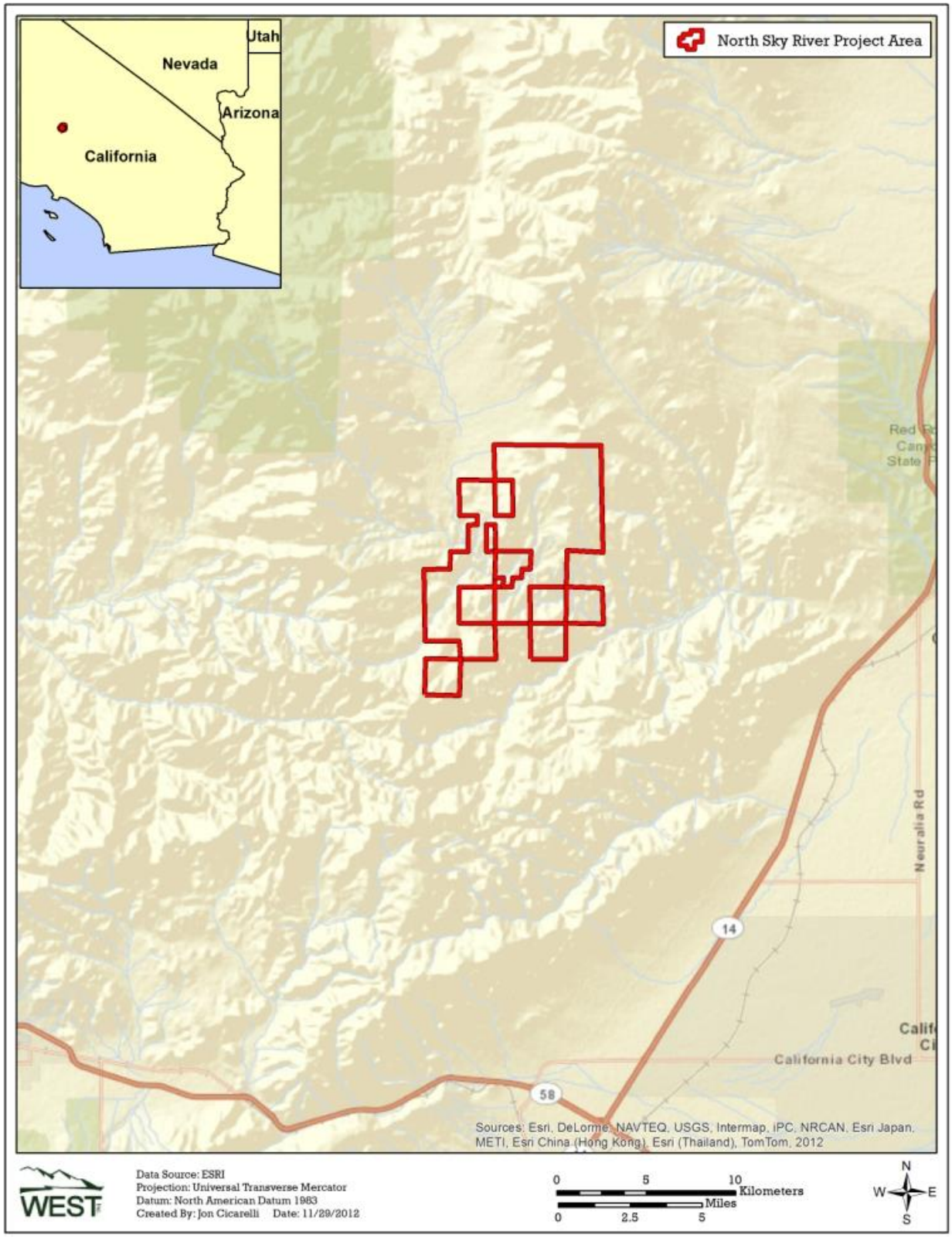

Figure 1. Location of the North Sky River Wind Energy Facility.

METHODS

Avian and Bat Fatality Monitoring

The primary objective of the fatality monitoring study is to estimate the level of bird and bat mortality attributable to collisions with wind turbines for each facility on an annual basis. The methods for the fatality study are broken into four primary components: 1) standardized carcass surveys of selected turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remains in the field for possible detection; and 4) adjusted mortality estimates for bird and bat species, calculated using the results from searcher efficiency trials and carcass removal trials to estimate the total number of bird and bat casualties within the NSR facility.

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

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

Study Components and Field Methodology

Standardized Carcass Searches

The objective of the standardized carcass searches is to systematically search the ground beneath turbines for avian and bat casualties that are attributable to collision with project facilities. During the first year of the study, in accordance with the CEC and USFWS Guidelines (CDFG and CEC 2007, USFWS 2012), carcass searches were conducted at a sample of 30 turbines (30% of NSR's 100 turbines). The turbine sample was chosen by dividing the NSR project map into grid cells approximately 1.25 miles by 1.25 miles (2.01 km by 2.01 km). Cells were numbered from left to right, top to bottom. Turbines were then listed from top to bottom and left to right by grid cell. A systematic sample was taken with a random starting value of 53; therefore, turbine 1 in the selection process was the 53rd turbine in the list. Starting with the 53rd turbine on the list, turbines were selected by taking the third turbine counting forward, then the third turbine counting forward, then the fourth turbine counting forward. This process yielded

a list of 30 turbines to be searched during the fatality monitoring study (Figure 2). Turbine selections were viewed on a map to verify adequate spatial distribution and coverage (Figure 2).

Searches at each sampled turbine were conducted within 160-m (197-ft) diameter circular plots centered on the turbine (Figure 3). Each plot was searched along parallel transects spaced six to 10 m (20 to 33 ft) apart (depending on detection ability), with the orientation of the transects based on the orientation of the topography surrounding the turbines. In order to identify features that may impact carcass visibility, the visibility class was mapped for each plot based on the ground cover and overall vegetation characteristics.

For all casualties found, data recorded included: species, sex and age when possible, date and time encountered, Global Positioning System (GPS) location, condition of carcass, and any comments that indicated possible cause of death. All casualties 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. The condition of each carcass found was recorded using the following categories:

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

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

Standardized carcass surveys were conducted every two weeks during the fall (September 7 to October 31), winter (November 1 to March 10), spring (March 11 to June 11), and summer (June 12 to September 6) at each of the 30 sampled turbines.

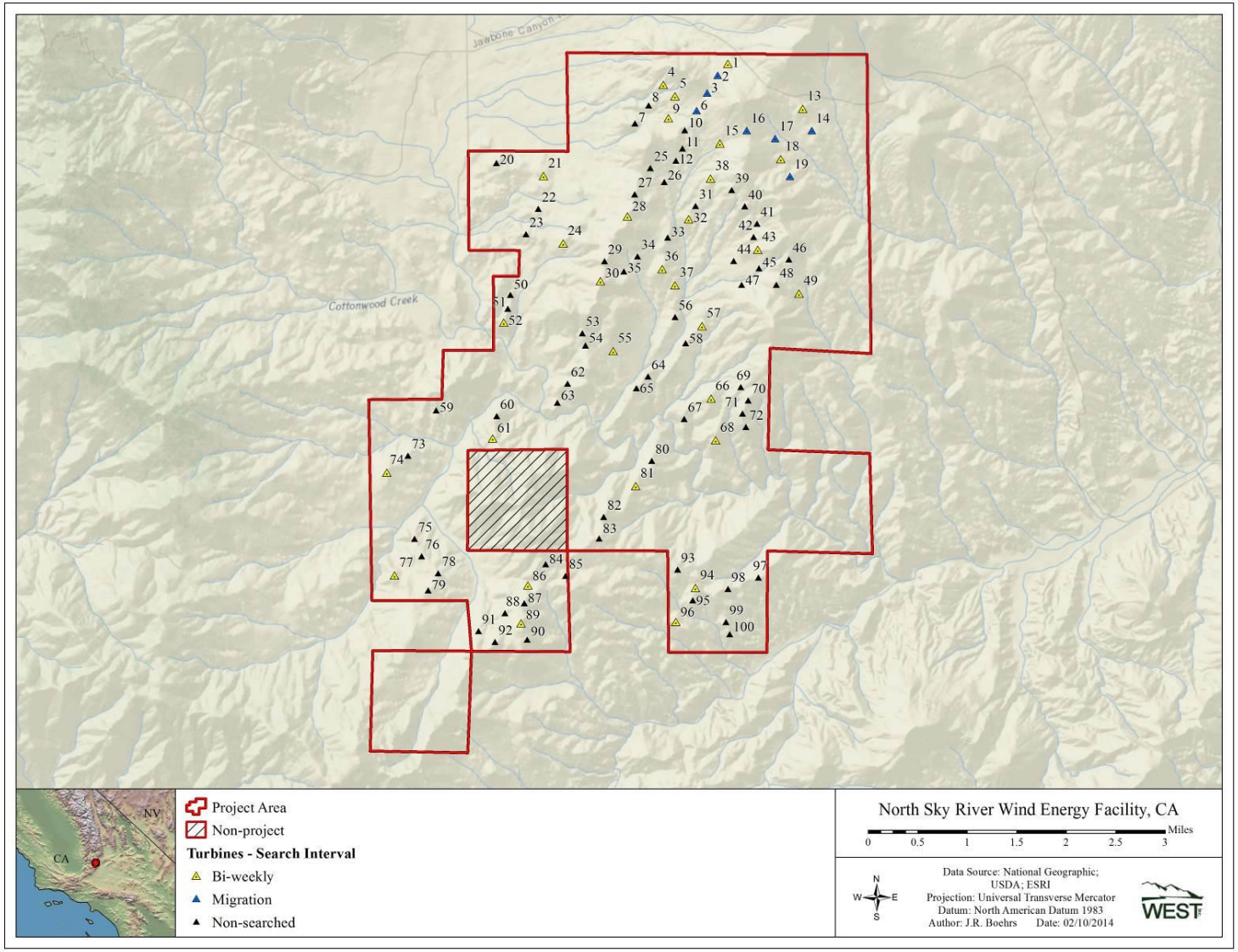

Figure 2. Turbine layout at the North Sky River Wind Energy Facility showing turbines selected for fatality monitoring.

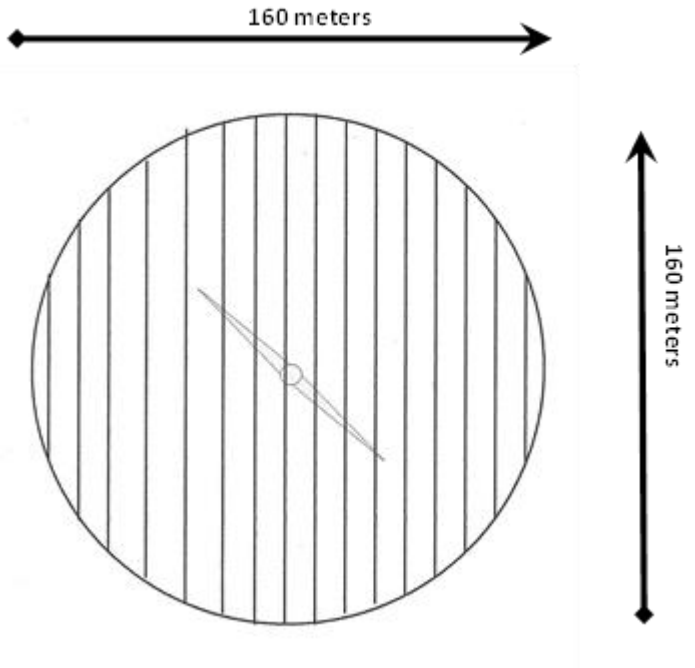

Figure 3. Schematic of turbine search plot and transects.

Intensive Spring Migration Carcass Searches

During pre-construction bird use surveys conducted at NSR during the spring migration period (April and May) of 2010 and 2011, relatively high numbers of migrating songbirds (and some migrating shorebirds) were observed passing over the northeastern portion of the project area. To investigate the potential for collision of nocturnal migrants with turbines in this portion of the NSR facility, an intensive carcass search effort was conducted during the spring of 2013 at seven turbines located in the northeast corner of NSR (Figure 2). For approximately eight weeks during the peak of migration (April 10 – June 10, 2013), each of these seven turbines was searched twice per week. Plot size and methodology for the intensive spring migration carcass searches was identical to that described above for the standardized (year-round) carcass searches.

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of casualties 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 (large or small bird) and season. Estimates of searcher efficiency were used to adjust the total number of carcasses found for those missed by searchers, correcting for detection bias.

Seven searcher efficiency trials were conducted throughout the year to encompass variable field conditions that may affect surveyor carcass detection, and approximately six to nine large bird and eight to 18 small bird carcasses were used for each trial. Carcasses used for trials consisted of non-native or commercially-available species. Large birds were represented by mallards (*Anas platyrhynchos*), while small birds included house sparrows (*Passer domesticus*),

Coturnix quail (*Coturnix* spp.), and rock pigeons (*Columba livia*). Due to the unavailability of bat carcasses, small brown birds (i.e., house sparrows) were used in lieu of bat carcasses.

All searcher efficiency trial carcasses were placed at random locations within the search area prior to that day's scheduled carcass survey. Personnel conducting carcass surveys did not know when searcher efficiency trials were being conducted or the location of the trial carcasses. Each trial carcass was discreetly marked with electrical tape so that it could be identified as a study carcass after it was found. The number and location of the searcher efficiency carcasses found during the carcass survey were recorded. The number of carcasses available for detection during each trial was determined immediately after the trial by the person responsible for distributing the carcasses.

Carcass Removal Trials

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

Trials were spread throughout the year to incorporate the effects of varying weather, climatic conditions, and scavenger densities. Carcasses were placed on two dates during each season for a total of eight trial initiation dates. For each trial, five to 11 large bird carcasses and 10 to 15 small bird carcasses were discreetly marked and placed in the field. All trial carcasses were handled with disposable gloves to minimize human scent on the carcasses. Trial carcasses were of similar composition to those used for searcher efficiency trials.

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

Statistical Analysis

Quality Assurance and Quality Control

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

identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

Data Compilation and Storage

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

Fatality Surveys

Estimates of facility-related fatalities are based on:

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

(2) Non-removal rates, expressed as the estimated average probability a carcass is expected to remain in the study area and be available for detection by the searchers during removal trials; and

(3) Searcher efficiency, expressed as the proportion of planted carcasses found by searchers during searcher efficiency trials.

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

Definition of Variables

The following variables are used in the equations below:

c_i the number of carcasses detected at plot *i* for the study period of interest (e.g., one monitoring year), for which the cause of death is either unknown or is attributed to the facility

n the number of search plots

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

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

s the number of carcasses used in removal trials

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

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

- $\bar{t}$ the average time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials
- *p* the estimated proportion of detectable carcasses found by searchers, as determined by the searcher efficiency trials
- *I* the average interval between standardized carcass searches, in days
- A proportion of the search area of a turbine actually searched
- $\hat{\pi}$ the estimated probability that a carcass is both available to be found during a search and is found, as determined by the removal trials and the searcher efficiency trials
- *m* the estimated annual average number of fatalities per turbine per year, adjusted for removal and searcher efficiency bias

Observed Number of Carcasses

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

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

Estimation of Carcass Non-Removal Rates

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

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

Estimation of Searcher Efficiency Rates

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

Estimation of Facility-Related Fatality Rates

The estimated per turbine annual fatality rate (*m*) is calculated by:

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

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

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

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

This formula has been independently verified by Shoenfeld (2004). The reported estimates standard errors and 90% confidence intervals were calculated using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. For each bootstrap sample, $\bar{c}$, $\bar{t}$, p, $\hat{\pi}$, and *m* were calculated. A total of 1,000 bootstrap samples were used. The standard deviation of the bootstrap estimates is the estimated standard error. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates are estimates of the lower limit and upper limit of 90% confidence intervals.

Raptor Nest Surveys

The primary objective of the raptor nest surveys was to determine the presence or absence of raptor nests, particularly mid-sized to large raptor nests, within areas of suitable habitat in the NSR project area. Following guidance of mitigation measure 4.4-16 of the EIR (Kern County Planning Department 2011), ground-based raptor nest surveys were conducted within the project boundary during the spring/summer 2013 breeding season. The surveys consisted of driving and/or walking throughout the study area searching for raptor nest structures within areas of suitable nesting habitat (e.g., pine and oak woodland, Joshua tree woodland, utility poles, and transmission towers). Three complete surveys of the project area were conducted, with the first occurring on March 20-21; the second on April 4, 5, and 11; and the third on May 2, 10, and 17.

The Global Positioning System (GPS) coordinates were recorded for all nests of raptors or other large bird species (e.g., ravens) identified during the survey and mapped on a geographic information system (GIS) ArcView project utilizing US Geological Survey (USGS) topographic maps (1:24000 scale) as the base. Additionally, information was collected on species, habitat,

nest substrate, nest condition, and status. The locations of all inactive nests were also recorded as they may become active during subsequent years.

RESULTS

Avian and Bat Fatality Monitoring

Thirty search plots, representing 30% of all turbines within NSR, were searched bi-weekly during the year-round standardized carcass searches, for a total of 745 plot searches. Additionally, searches were conducted at seven turbines twice per week during spring migration for a total of 158 plot searches. Over the course of the fatality monitoring study, 22 birds and 18 bats were found during carcass surveys or incidentally (Table 1). The number, species, location, other characteristics of the bird and bat fatalities, and the fatality estimates adjusted for searcher efficiency and carcass removal biases are discussed below, and a full listing of carcasses is presented in Appendix A.

Bird Fatalities

During the study, 16 birds comprising nine identifiable species were found during scheduled searches (Table 1, Figure 4). Additionally, two bird fatalities were found incidentally on search plots and four were found incidentally outside of search plots (and, therefore, not included in the overall fatality estimates). The bird species most commonly found as fatalities during the study were red-tailed hawk (*Buteo jamaicensis*; five carcasses), chukar (*Alectoris chukar*; four carcasses), and California quail (*Callipepla californica*; two carcasses; Table 1). All other identifiable bird species found during the study were represented by individual carcasses. Aside from the five red-tailed hawk fatalities (four within search plots and one outside), the only other diurnal raptor fatality was a single golden eagle (*Aquila chrysaetos*) found as an incidental fatality outside of the standardized search plots (Table 1). Only four of the 22 bird fatalities documented during the study were found during the intensive spring searches at the seven turbines in the northeast portion of the NSR. These included two of the red-tailed hawk fatalities and two of the chukar fatalities (Appendix A). No state or federally listed bird species were found during the study; however, a single yellow warbler (*Setophaga petechia*), a state species of special concern (CDFW 2013) was found on April 10, 2013. Additionally, the golden eagle is protected under the federal Bald and Golden Eagle Protection Act (BGEPA 1940).

Table 1. Total number of bird and bat casualties and the composition of casualties discovered at the North Sky River Wind Energy Facility from January 14, 2013, to January 13, 2014.

	Fatalities during Scheduled Searches		Incidental Fatalities at Search Plots*		Other Incidentals		Total	
Species	**Total**	**% Comp.**	**Total**	**% Comp.**	**Total**	**% Comp.**	**Total**	**% Comp.**
Birds								
chukar	4	25	0	0	0	0	4	18.2
unidentified small bird	4	25	0	0	0	0	4	18.2
red-tailed hawk	2	12.5	2	100	1	25	5	22.7
California quail	1	6.3	0	0	1	25	2	9.1
black-throated gray warbler	1	6.3	0	0	0	0	1	4.5
fox sparrow	1	6.3	0	0	0	0	1	4.5
unidentified large bird	1	6.3	0	0	0	0	1	4.5
western kingbird	1	6.3	0	0	0	0	1	4.5
yellow warbler[1]	1	6.3	0	0	0	0	1	4.5
golden eagle	0	0	0	0	1	25	1	4.5
greater roadrunner	0	0	0	0	1	25	1	4.5
Overall Birds	**16**	**100**	**2**	**100**	**4**	**100**	**22**	**100**
Bats								
Mexican free-tailed bat	9	52.9	0	0	1	100	10	55.6
hoary bat	3	17.6	0	0	0	0	3	16.7
unidentified myotis	2	11.8	0	0	0	0	2	11.1
big brown bat	1	5.9	0	0	0	0	1	5.6
western mastiff bat[1]	1	5.9	0	0	0	0	1	5.6
canyon bat	1	5.9	0	0	0	0	1	5.6
Overall Bats	**17**	**100**	**0**	**0**	**1**	**100**	**18**	**100**

*Fatalities found incidentally on turbine search plots were included in analyses.
[1] State species of special concern (CDFG 2008)

In general, fatalities were more commonly found at turbines located in the northern half of the NSR project area. The greatest number of bird fatalities found at any one search plot was three at turbine 49 and two at turbines 15, 37, and 52; all other search plots had one or no bird fatalities (Figures 4 and 5). Of the bird fatalities, most (77.8%) were found between 30 and 80 m (98 and 262 ft) from the turbine (Table 2, Figure 6). Bird fatalities were found during each season, but were more concentrated during late winter and spring (Figure 7). There was a spike in the number of bird carcasses found per turbine in mid-March, when two chukar and an unidentified small bird were found on March 18 (Figure 7, Appendix A).

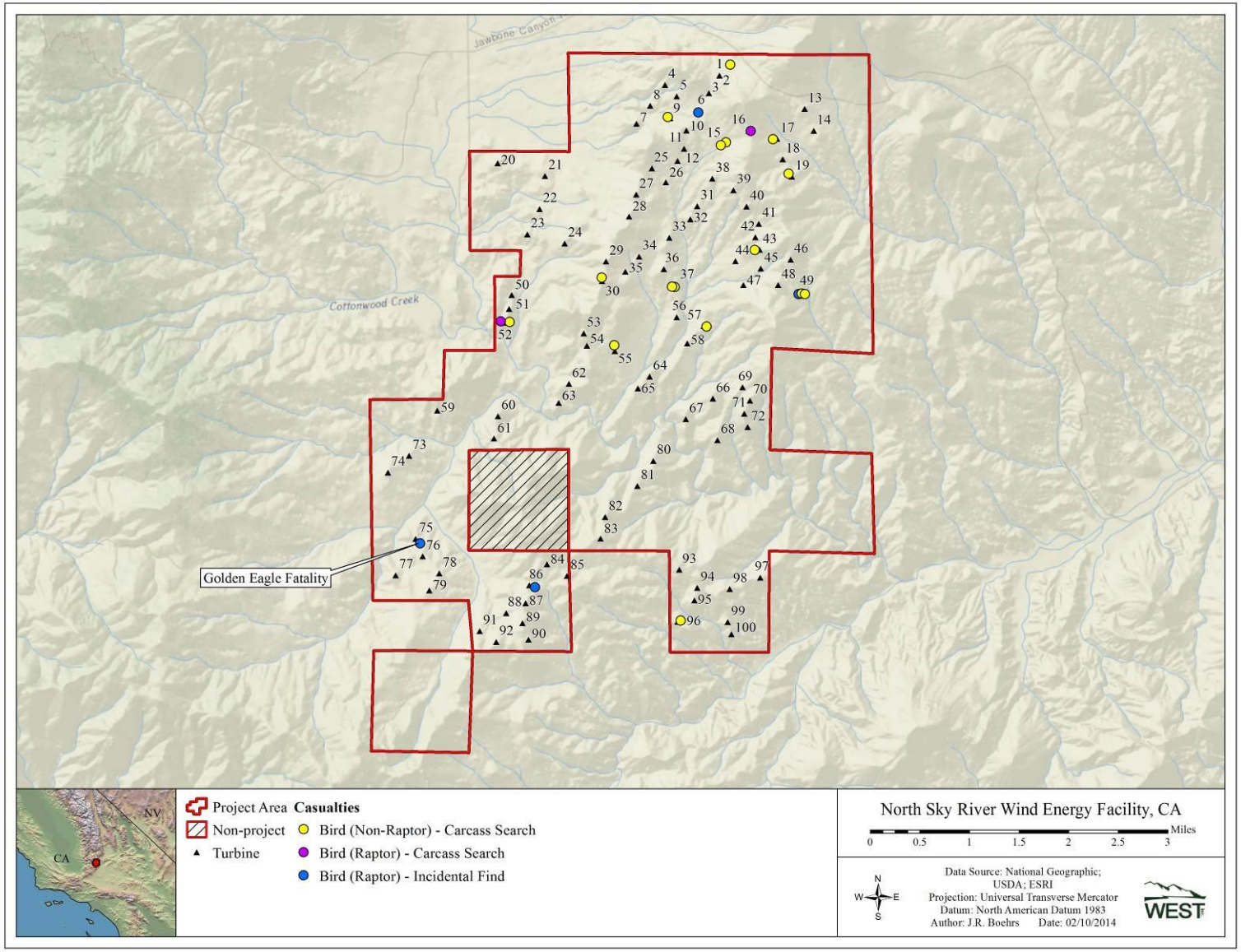

Figure 4. Location of all bird casualties found at the North Sky River Wind Energy Facility.

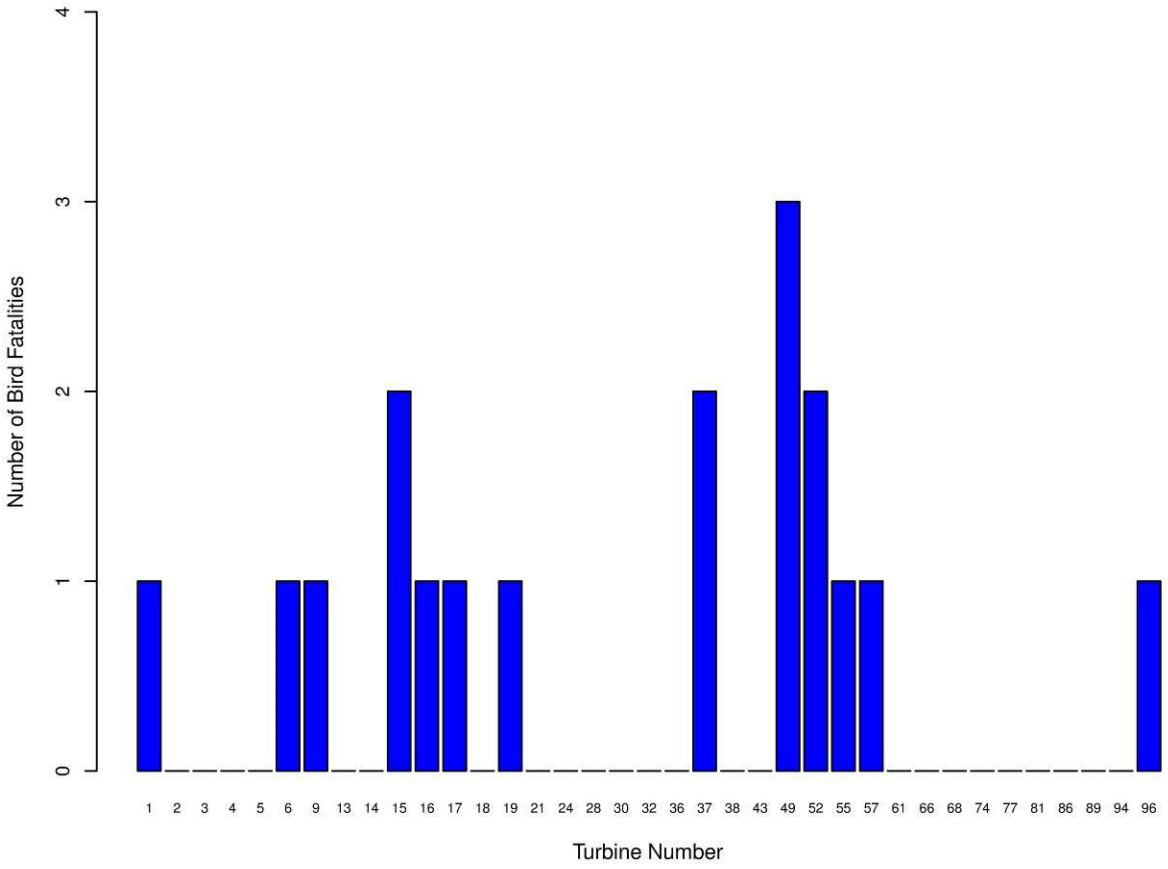

Figure 5. Number of bird fatalities by turbine found during scheduled searches or incidentally on search plots at the North Sky River Wind Energy Facility.

Table 2. Distribution of distances from turbines of bird and bat casualties found during scheduled searches or incidentally on search plots at the North Sky River Wind Energy Facility.

Distance to Turbine (m)	% Bird Casualties	% Bat Casualties
0 to 10	0	11.8
10 to 20	11.1	17.6
20 to 30	5.6	23.5
30 to 40	11.1	11.8
40 to 50	22.2	23.5
50 to 60	11.1	0
60 to 70	16.7	5.9
70 to 80	16.7	5.9
80 to 90	5.6	0
>90	0	0

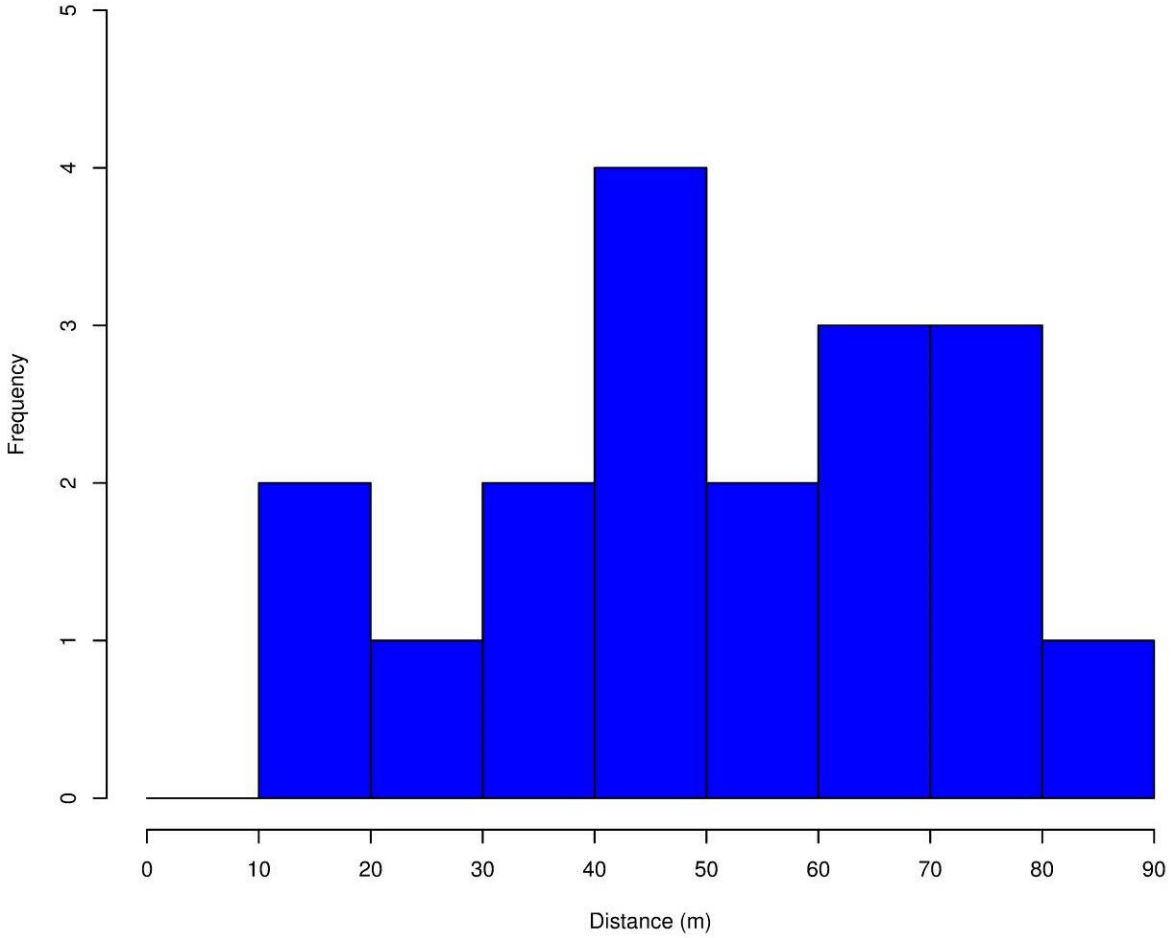

Figure 6. Distance of bird fatalities from the turbine found during scheduled searches or incidentally on search plots at the North Sky River Wind Energy Facility.

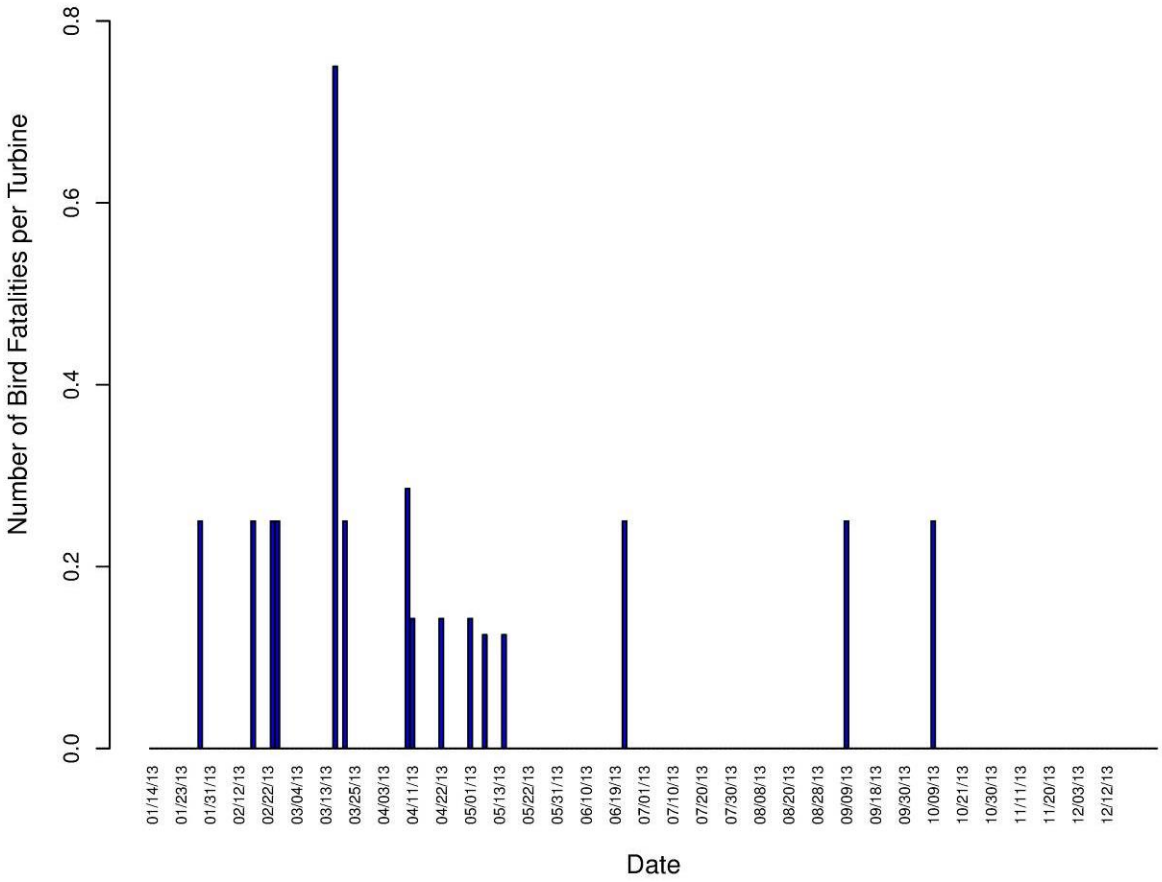

Figure 7. Timing of bird fatalities by turbine found during scheduled searches or incidentally at search plots at the North Sky River Wind Energy Facility.

Bat Fatalities

During the study, 17 bats comprising at least six species were found during scheduled searches, and one additional bat fatality was found incidentally outside of search plots (Table 1, Figure 8). The bat species most commonly found as fatalities during the study were Mexican free-tailed bat (*Tadarida brasiliensis*; 10 carcasses), hoary bat (*Lasiurus cinereus;* three carcasses), and unidentified myotis (two carcasses). Single carcasses of big brown bat (*Eptesicus fuscus*), western mastiff bat (*Eumops perotis*), and canyon bat (*Parastrellus hesperus*) also were found (Table 1). Two of the 18 bat fatalities documented during the study were found during the intensive spring searches at the seven turbines in the northeast portion of the NSR. These included one Mexican free-tailed bat and one unidentified *Myotis* spp. (Appendix A). No state or federally listed bat species were found during the study; however, the western mastiff bat is a species of special concern in California (CDFW 2013).

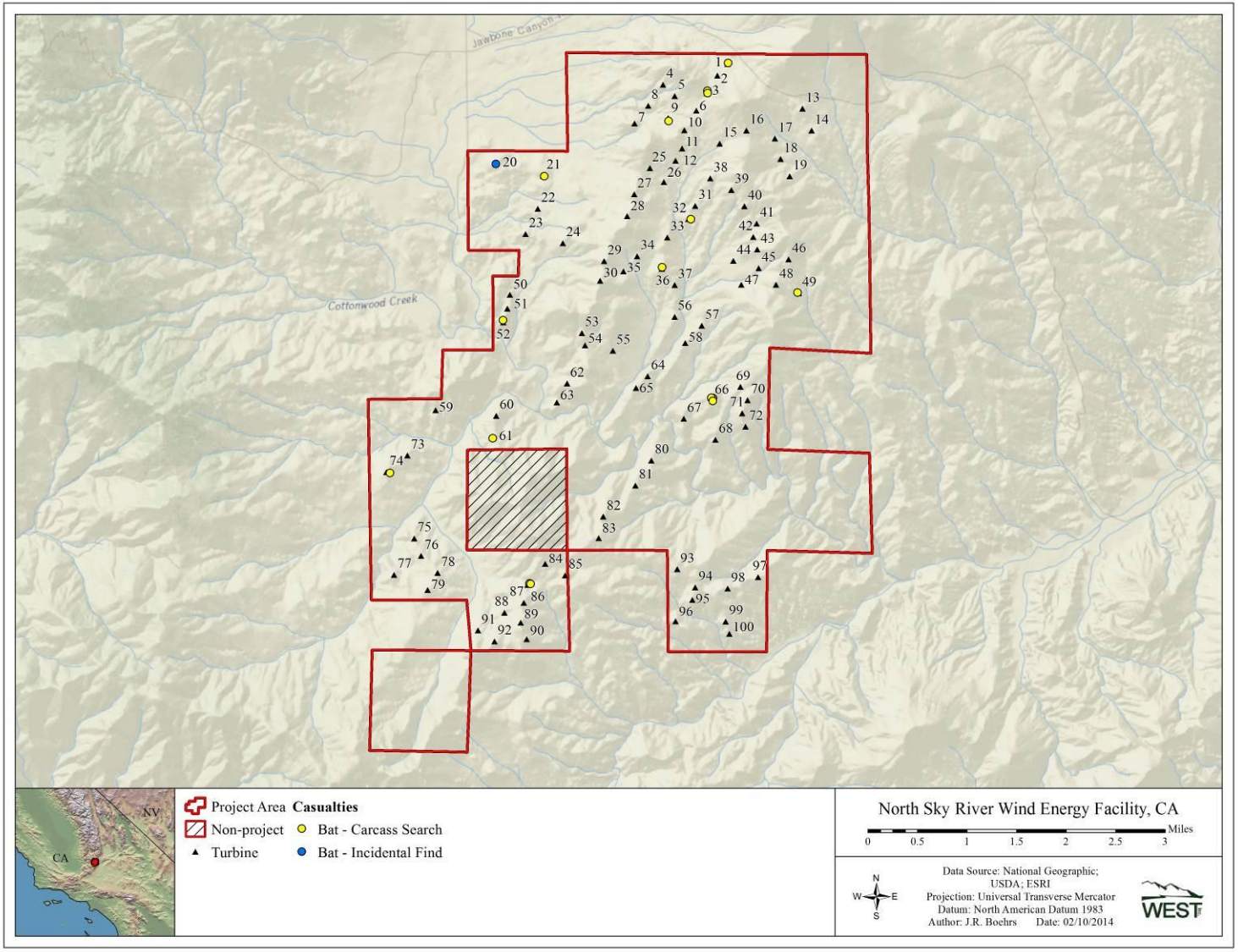

Figure 8. Location of all bat casualties found at the North Sky River Wind Energy Facility.

Bat fatalities were distributed throughout the NSR project area, with no obvious areas concentrated mortality. The greatest number of bat fatalities found at any one search plot was four at turbine 66; all other search plots had two or fewer bat fatalities (Figures 8 and 9). Among bat fatalities, 88.2% were found within 50 m (164 ft) of the turbine (Table 2, Figure 10). All bat fatalities were found between mid-May and late October, with the number of bat carcasses/turbine peaking in late August/early September (Figure 11).

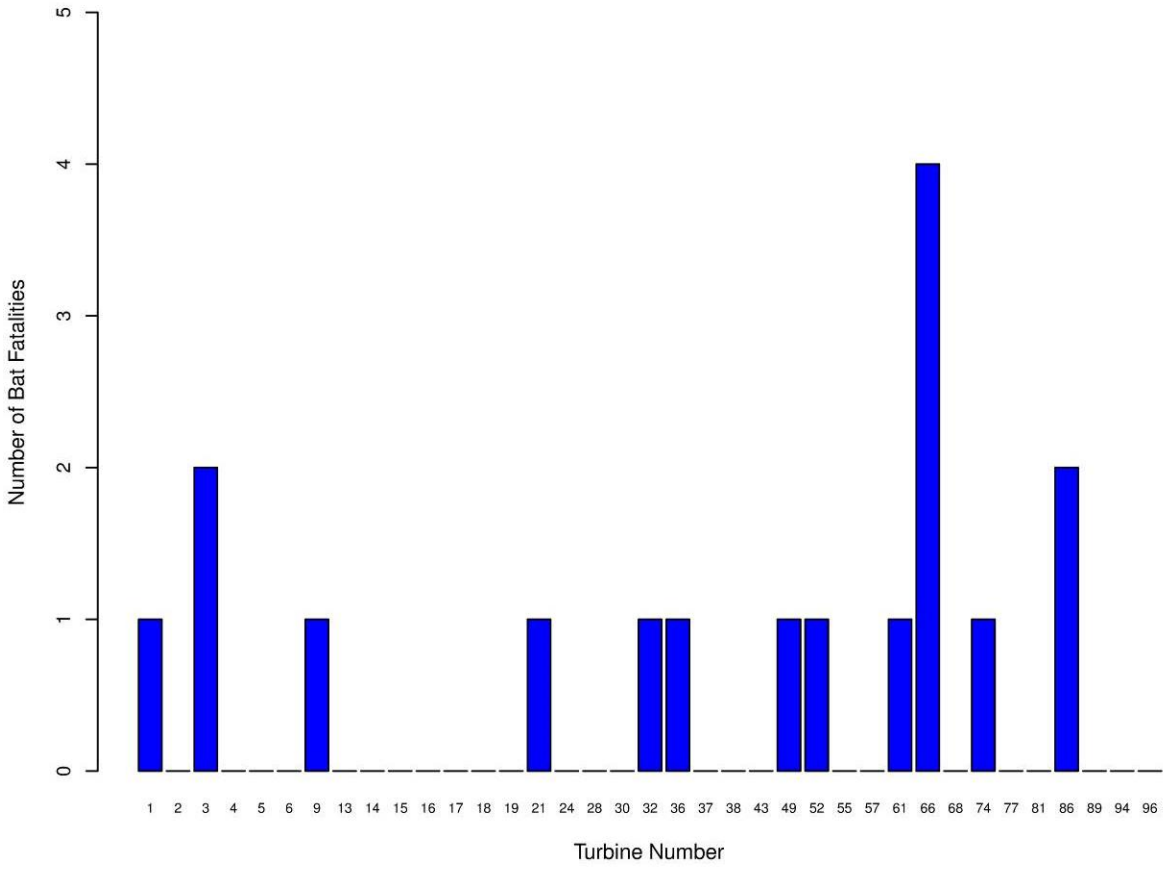

Figure 9. Number of bat fatalities by turbine found during scheduled searches or incidentally on search plots at the North Sky River Wind Energy Facility.

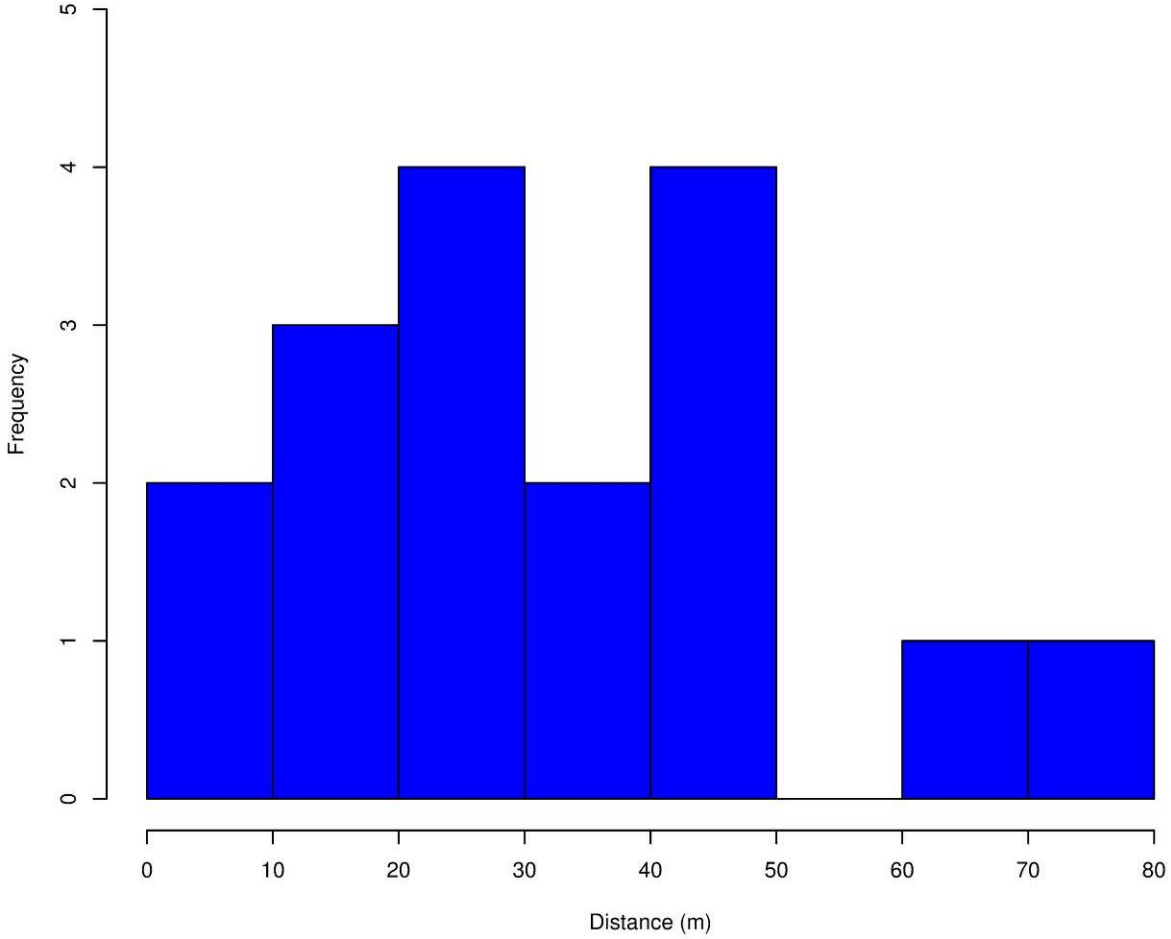

Figure 10. Distance of bat fatalities from the turbine found during scheduled searches or incidentally on search plots at the North Sky River Wind Energy Facility.

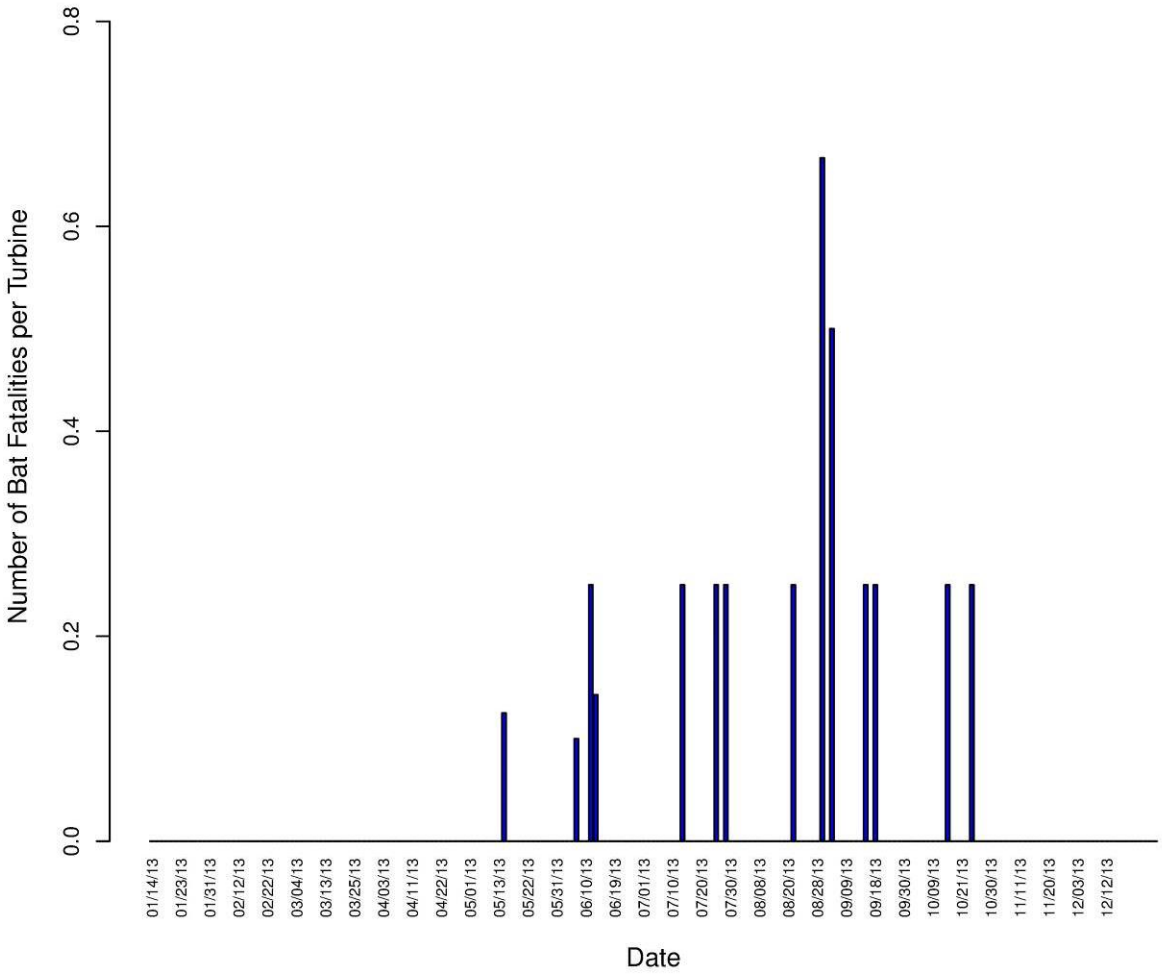

Figure 11. Timing of bat fatalities by turbine found during scheduled searches or incidentally on search plots at the North Sky River Wind Energy Facility.

Searcher Efficiency Trials

During searcher efficiency trials, a total of 105 bird carcasses (53 large birds and 52 small birds) were placed within search plots on seven separate dates (Table 3). The overall searcher efficiency rate was 98.0% for large birds and 80.4% for small birds (Table 3). House sparrows were used as a surrogate for bats, resulting in a searcher efficiency rate of 83.0% (Table 3).

Table 3. Searcher efficiency results at the North Sky River Wind Energy Facility as a function of season and carcass size. House sparrows were used as a surrogate for bats.

Size	Date	# Placed	# Available	# Found	% Found
Small Birds	2/19/2013	7	4	1	25
	5/7/2013	4	3	3	100
	6/27/2013	6	6	6	100
	8/14/2013	7	7	5	71.4
	10/1/2013	8	8	7	87.5
	11/14/2013	10	10	8	80
	1/10/2014	10	8	7	87.5
Small Bird Total		**52**	**46**	**37**	**80.4**

Table 3. Searcher efficiency results at the North Sky River Wind Energy Facility as a function of season and carcass size. House sparrows were used as a surrogate for bats.

Size	Date	# Placed	# Available	# Found	% Found
Large Birds	2/19/2013	6	5	5	100
	5/7/2013	7	6	5	83.3
	6/27/2013	8	8	8	100
	8/14/2013	7	7	7	100
	10/1/2013	9	9	9	100
	11/14/2013	9	9	9	100
	1/10/2014	7	7	7	100
Large Bird Total		**53**	**51**	**50**	**98.0**
Bats	2/19/2013	10	10	7	70
	5/7/2013	4	2	1	50
	6/27/2013	6	6	4	66.7
	8/14/2013	8	8	8	100
	10/1/2013	8	8	7	87.5
	11/14/2013	8	8	7	87.5
	1/10/2014	7	5	5	100
Bat Total		**51**	**47**	**39**	**83.0**

Carcass Removal Trials

During carcass removal trials, a total of 175 carcasses (61 large birds and 141 small birds) were placed within the NSR project area. House sparrows (71 carcasses) were used to estimate carcass removal rates for bats. By day 10, more than half of large birds remained in the search area, while less than 5% of house sparrows (bats) and no small birds remained. By day 30, half of large bird carcasses remained, while no house sparrows persisted within the study area (Figure 12).The carcass removal times for small birds and bats did not differ significantly among seasons; therefore, small bird and bat carcass removal times were averaged across season for the year. Mean carcass removal time was 2.09 days for bats and 1.57 days for small birds. The mean carcass removal time for large birds varied by season: 18.59 days in summer, 34.83 days in fall, 48.00 days in winter, and 67.68 days in spring (Appendix B).

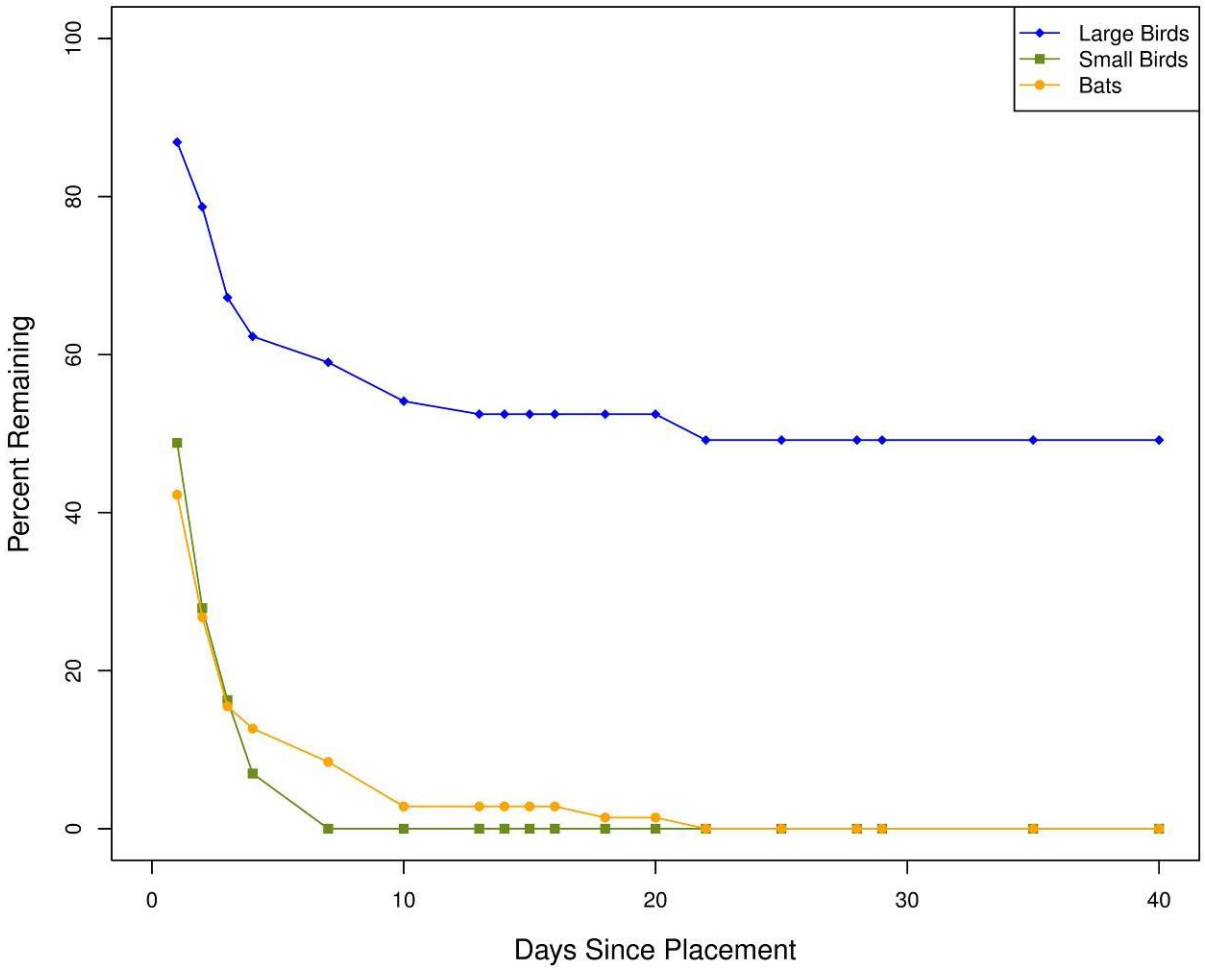

Figure 12. Carcass removal rates at the North Sky River Wind Energy Facility. House sparrows were used as surrogates for bats.

Adjusted Fatality Estimates

Overall project-wide fatality estimates and 90% confidence intervals were calculated on a per turbine and per MW basis for each bird/bat category based on the bi-weekly carcass searches conducted at 30 turbines throughout the monitoring year (Table 4a), as well as a seasonal project-wide fatality estimate based on the intensive searches conducted at seven turbines during spring migration (Table 4b). All fatality estimates are adjusted based on the corrections for carcass removal, and observer detection bias (Appendix B). Because 100% of each search plot was surveyed, no search area correction factor was applied. Searcher efficiency rates were constant throughout the entire study period. The probability that a carcass would remain in the search plot and be found by a searcher was 0.09 for small birds and 0.12 for bats during all seasons. For large birds, this probability was considerably higher, ranging from 0.69 in the summer to 0.90 in the spring (Appendix B1). At the seven turbines searched intensively in the spring, the average probability a carcass would remain in the search plot and be found by a searcher was 0.97 for large birds, 0.26 for small birds, and 0.34 for bats (Appendix B2).

Small Birds

The annual estimated fatality rate for small birds was 3.04 birds per turbine per year (Table 4a). No small birds were found at the seven turbines searched intensively during spring migration (Table 4b). A detailed breakdown of small bird fatality rates and the associated correction factors is presented in Appendix B.

Large Birds

Estimated fatality rates for large birds were highest during the spring (0.11 birds per turbine per season), followed by fall and winter (0.08 birds per turbine per season, each), and lowest during the summer (0.05; Appendix B). Combining all seasons, the overall estimated fatality rate for large birds was 0.24 birds per turbine per year (Table 4a). The large bird fatality rate at the seven turbines searched during spring migration was 0.59 fatalities per turbine per season (Table 4b). A detailed breakdown of large bird fatality rates and the associated correction factors is presented in Appendix B.

Diurnal Raptors

Estimated fatality rates for diurnal raptors were highest during the summer (0.05 birds per turbine per season), followed by fall and winter (0.04 each season); no raptor fatalities were found during spring (Appendix B). Combining all seasons, the overall estimated fatality rate for diurnal raptors was 0.09 birds per turbine per year (Table 4a). The diurnal raptor fatality rate at the seven turbines searched intensively during spring migration was 0.30 fatalities per turbine per season (Table 4b). A detailed breakdown of diurnal raptor fatality rates and the associated correction factors is presented in Appendix B.

All Birds

The estimated annual fatality rate for all bird species was 3.27 birds per turbine per year (Table 4a; Appendix B). As no small birds were found at turbines searched intensely in spring, the estimated fatality rate at those turbines was equal to the large bird estimate presented above, 0.59 fatalities per turbine per season (Table 4b). A detailed breakdown of all bird fatality rates and the associated correction factors is presented in Appendix B.

Bats

The estimated annual fatality rate for bats was 4.14 bats per turbine per year (Table 4a). The bat fatality rate at the seven turbines searched intensively during spring migration was 0.83 fatalities per turbine per season (Table 4b). A detailed breakdown of bat fatality rates and the associated correction factors is presented in Appendix B.

Table 4a. Adjusted annual bird and bat fatality estimates for the North Sky River Wind Energy Facility from bi-weekly searches at 30 turbines from January 14, 2013 to January 13, 2014. For more details concerning correction factors and confidence intervals for both bird and bat fatality estimates, refer to Appendix B1.

	Adjusted Overall Fatality Estimate and 90% Confidence Intervals	
	Mean	CI
	# fatalities/turbine/year	
small birds	3.04	1.11 – 5.51
large birds	0.24	0.09 – 0.42
diurnal raptors	0.09	0 – 0.21
all birds	3.27	1.36 – 5.75
bats	4.14	2.05 – 7.16
	# fatalities/MW/year	
small birds	1.90	0.69 – 3.45
large birds	0.15	0.06 – 0.26
diurnal raptors	0.05	0 – 0.13
all birds	2.05	0.85 – 3.6
bats	2.59	1.28 – 4.47

Table 4b. Adjusted seasonal bird and bat fatality estimates for the North Sky River Wind Energy Facility from an intensive search of seven turbines during the spring migration period (April 2 - June 11, 2013). For more details concerning correction factors and confidence intervals for both bird and bat fatality estimates, refer to Appendix B2.

	Adjusted Overall Fatality Estimate and 90% Confidence Intervals	
	Mean	CI
	# fatalities/turbine/season	
small birds	0	–
large birds	0.59	0.29 – 0.89
diurnal raptors	0.30	0 – 0.6
all birds	0.59	0.29 – 0.89
bats	0.83	0 – 2.52
	# fatalities/MW/season	
small birds	0	–
large birds	0.37	0.18 – 0.56
diurnal raptors	0.18	0 – 0.37
all birds	0.37	0.18 – 0.56
bats	0.52	0 – 1.58

Overall Fatality Estimates

Using the data collected during standardized bi-weekly searches conducted at 30 of the NSR's 100 turbines, an overall annual fatality rate estimate was calculated across all study seasons (Table 4a). Based on the 1.6-MW capacity of each of the turbines at NSR, the estimated fatality rate for all birds was 2.05 birds per MW per year, with an estimated fatality rate of 1.90 small birds per MW per year and 0.05 diurnal raptors per MW per year. The estimated fatality rate for bats was 2.59 bats per MW per year (Table 4a).

Using the data collected during the twice weekly searches at the seven turbines in the northeast corner of the NSR facility during spring migration, a seasonal (spring) fatality estimate for these turbines was calculated (Table 4b). Based on the 1.6-MW capacity of each of the turbines, the

estimated spring fatality rate for all birds at these seven turbines was 0.37 birds per MW per season, with an estimated 0.18 diurnal raptors per MW per season. The estimated spring fatality rate for bats at these seven turbines was 0.52 bats per MW per season (Table 4b).

Raptor Nest Surveys

Raptor nest surveys were conducted throughout the NSR project area on March 20-21; April 4, 5, and 11; and on May 2, 10, and 17. A total of six active nests were located during surveys including two great horned owl (*Bubo virginianus*) nests, one long-eared owl (*Asio otus*) nest, one red-tailed hawk nest, and two nests of an unknown raptor species (Figure 13). A total of 21 inactive raptor/raven nests were also located within the NSR project area during surveys. Follow-up visits were made to active nests on June 1, and 14, and July 5.

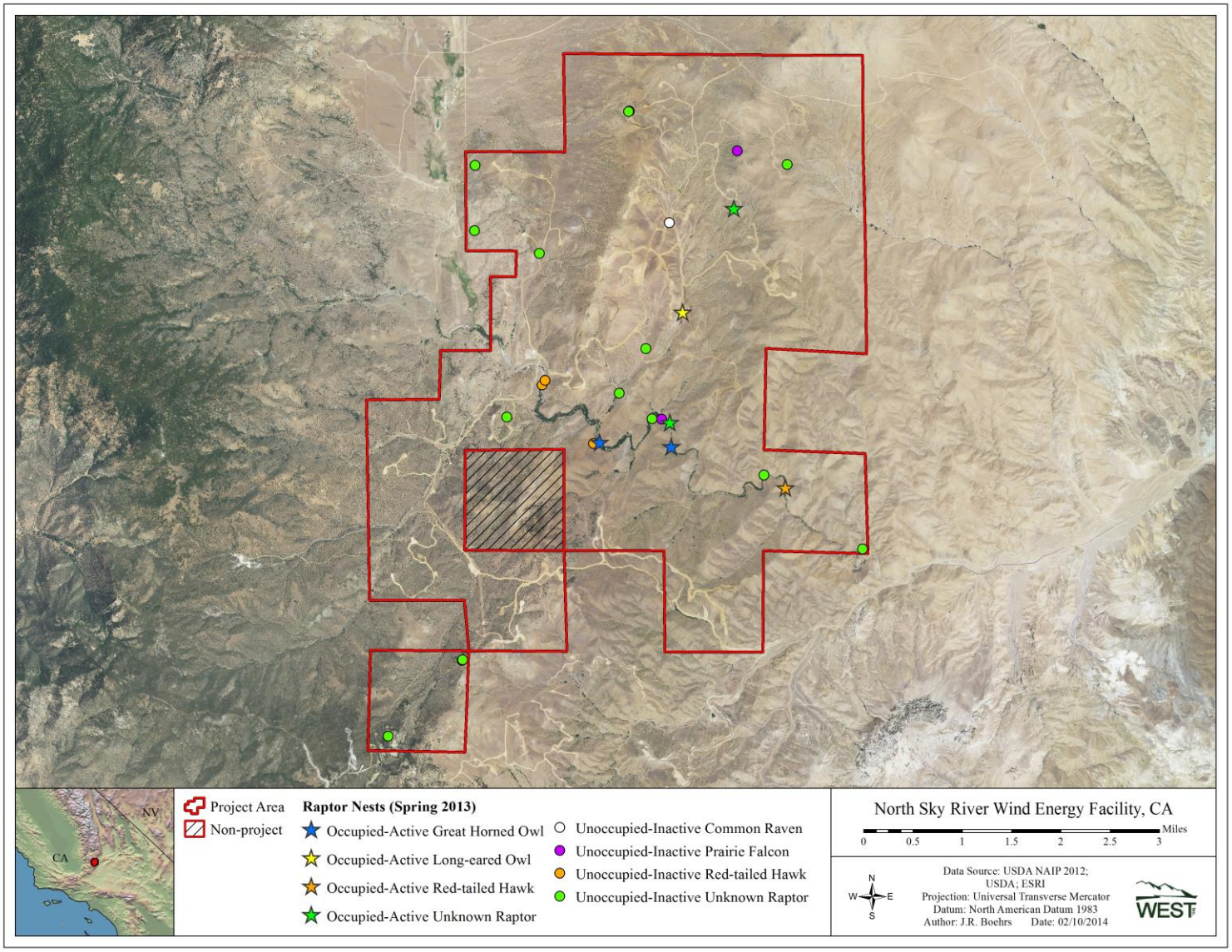

Figure 13. Raptor nests identified at the North Sky River Project in 2013.

DISCUSSION AND IMPACT ASSESSMENT

The approach used for calculating adjusted fatality estimates is consistent with the approach outlined by Shoenfeld (2004) and Erickson (2006), and accounted for search interval, searcher efficiency rates, and carcass removal rates. It is hypothesized that scavenging could change through time at a given site and must be accounted for when attempting to estimate 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 conditions.

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 incorporates several assumptions or factors that affect the results of the fatality estimates. First, all bird casualties found within the standardized search plots during the study were included in the analysis., including those found within search plots outside of a scheduled survey (incidentally). Second, it was assumed that all carcasses found during the study were due to collision with wind turbines. True cause of death is unknown for most of the fatalities. It is possible that some of the bird fatalities were caused by predators, and some of the casualties included in the data pool were potentially due to natural causes (background mortality). It is unlikely that any bat fatalities were due to factors not related to interaction wind turbines.

There are some other potential negative biases. For example, no adjustments were made for fatalities possibly occurring outside of the circular plot boundaries. Plot boundaries were established a distance of 80 m from the turbines. The search plot distance for this study was selected based on results of other studies (Higgins et al. 1996; Erickson et al. 2004; Johnson et al. 2002b, 2003a, 2004; Kerlinger et al. 2007; Young et al. 2003b, 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 6 and Figure 10), a small percentage of bird and bat 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 actual carcasses. This may occur if the types of birds used are larger or smaller than the carcasses of fatalities, more or less cryptic in color than the actual fatalities, etc. Rock pigeons, mallards, Coturnix quail, and house sparrows were used to represent the range of bird fatalities expected. 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 group. Additionally, house sparrows were used to estimate searcher efficiency and carcass removal rates for bats. It is generally not practical or feasible to obtain many of the native bird and bat species in fresh condition for these trials.

Concern has also been raised regarding how the number of carcasses placed in the field for carcass removal trials on a given day could lead to biased estimates of scavenging rates (e.g., Smallwood 2007, Smallwood et al. 2010). Hypothetically, this would lead to underestimating true scavenging rates if the scavenger densities are low enough such that scavenging rates for these placed carcasses are lower than for actual 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 wind turbine collisions. If this is the case, and the trial carcass density is much greater than actual turbine fatality density, the trials would underestimate scavenging rates compared to rates on actual fatalities.

Bird Fatalities

Overall bird fatality estimates at wind energy facilities across North America have ranged from 0.08 to 11.02 birds/MW/year (Appendix C1). In western North America (comprised of California, the Pacific Northwest, the Rocky Mountains, and the Southwest regions), bird fatality rates have ranged from 0.16 to 8.45 birds/MW/year (Appendix C1). Within the Tehachapi Wind Resource Area (TWRA), mortality data are currently available from only two modern facilities: the Pine Tree Wind Farm, located immediately to the south of NSR and Alta Wind, located approximately 20 miles (32 km) to the southwest of NSR. During an 18-month study at the Pine Tree Wind Farm in 2009-2011, the estimated avian fatality rate was 3.76 birds/MW/year (BRC 2012). During the initial year of monitoring Alta Wind in 2011-2012, Phase I (Alta I) had an estimated fatality rate of 7.07 birds/MW/year, while the adjacent Phases II-V (Alta II-V) had an estimated fatality rate of 1.66 birds/MW/year (Chatfield et al. 2012). The estimated annual bird fatality rate at NSR (2.05 birds/MW/year) is low compared to other wind energy facilities in western North America, as well other facilities within the TWRA (Figure 14). During the study at NSR Large birds composed the majority (61%) of bird fatalities found within search plots during the study, with passerines composing 29%, and diurnal raptors composing 22%. This is consistent with the results from both Pine Tree and Alta Wind (Chatfield et al. 2012, BRC 2012).

In general, fatalities were more commonly found at turbines located in the northern half of the NSR project area; however, no obvious areas concentrated mortality were observed during the study. At the seven turbines in the northeast corner of NSR that were searched intensively during spring due to concerns regarding impacts to nocturnally migrating passerines, only four bird fatalities were found: two chukar and two red-tailed hawks. Neither of these species is a nocturnal migrant. The spring fatality rate calculated for these seven turbines was 0.37 birds/MW/season. While bird fatalities were found during each season of the study, mortality was more concentrated during the late winter and spring.

Diurnal raptor mortality estimates at wind energy facilities in California have ranged from zero to 0.42 birds/MW/year, while estimates throughout North America have ranged from zero to 0.59 birds/MW/year (Appendix C2). At the nearby Alta Wind facility in the TWRA, Alta I had a diurnal raptor fatality estimate of 0.27 birds/MW/year, while Alta II-V had an estimate of 0.05 raptors/MW/year (Chatfield et al. 2012). While a raptor fatality estimate was not calculated at the Pine Tree facility, out of a total of 171 bird fatalities documented during the 17-month study, four were diurnal raptors (one American kestrel [*Falco sparverius*] and three golden eagles; BRC

2012). The overall raptor mortality estimate at NSR (0.05 raptors/MW/year) was low compared to other wind energy facilities in western North America (i.e., California, Pacific Northwest, Rocky Mountain, and Southwest regions; Figure 15; Appendix C2), which is consistent with the relatively low raptor use recorded during pre-construction avian use surveys conducted at NSR (Erickson et al. 2011). The diurnal raptor fatalities found during the study consisted of five red-tailed hawks and one golden eagle; however, one of the red-tailed hawks and the golden eagle were found incidentally outside of a search plot and were therefore not included in the fatality estimates.

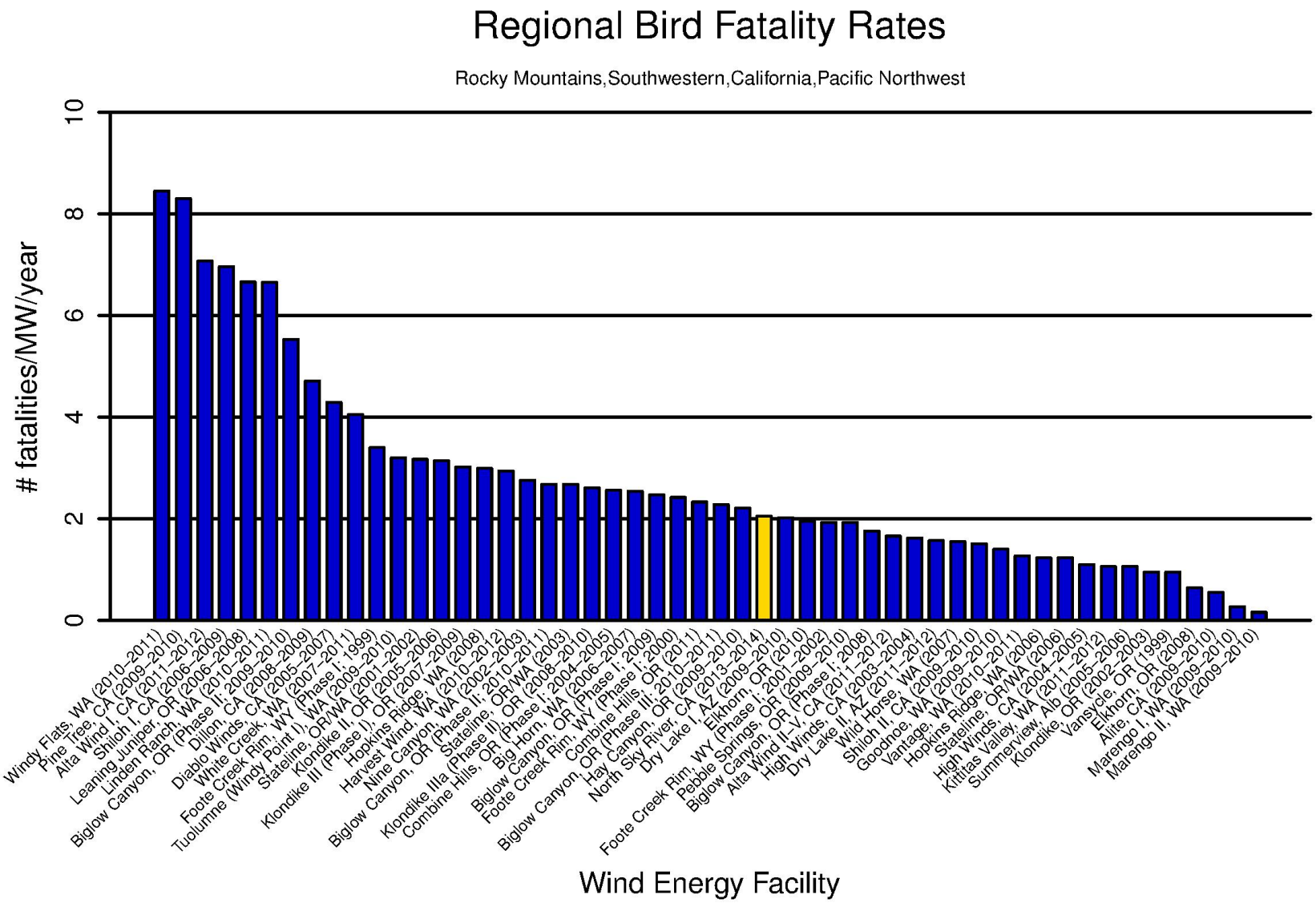

Figure 14. Fatality rates for all birds (number of birds per MW per year) at the North Sky River Wind Energy Facility compared with publicly-available wind energy facilities in western North America.

Figure 14 (*continued*). Fatality rates for all birds (number of birds per MW per year) at the North Sky River Wind Energy Facility compared with publicly-available wind energy facilities in western North America.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
North Sky River, CA	This study				
Windy Flats, WA (10-11)	Enz et al. 2011	Nine Canyon, WA (02-03)	Erickson et al. 2003b	High Winds, CA (03-04)	Kerlinger et al. 2006
Pine Tree, CA (09-10)	BioResource Consultants 2010	Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Dry Lake II, AZ (11-12)	Thompson and Bay 2012
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Stateline, OR/WA (03)	Erickson et al. 2004	Wild Horse, WA (07)	Erickson et al. 2008
Shiloh I, CA (06-09)	Kerlinger et al. 2009	Klondike IIIa, OR (Phase II; 08-10)	Gritski et al. 2011	Shiloh II, CA (09-10)	Kerlinger et al. 2010b
Leaning Juniper, OR (06-08)	Gritski et al. 2008	Combine Hills, OR (Ph. I; 04-05)	Young et al. 2006	Goodnoe, WA (09-10)	URS Corporation 2010a
Linden Ranch, WA (10-11)	Enz and Bay 2011	Big Horn, WA (06-07)	Kronner et al. 2008	Vantage, WA (10-11)	Ventus 2012
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Hopkins Ridge, WA (06)	Young et al. 2007
Dillon, CA (08-09)	Chatfield et al. 2009	Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b	Stateline, OR/WA (06)	Erickson et al. 2007
Diablo Winds, CA (05-07)	WEST 2006, 2008	Combine Hills, OR (11)	Enz et al. 2012	High Winds, CA (04-05)	Kerlinger et al. 2006
White Creek, WA (07-11)	Downes and Gritski 2012b	Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Kittitas Valley, WA (11-12)	Stantec 2012
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Summerview, Alb (05-06)	Brown and Hamilton 2006b
Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010	Dry Lake I, AZ (09-10)	Thompson et al. 2011	Klondike, OR (02-03)	Johnson et al. 2003b
Stateline, OR/WA (01-02)	Erickson et al. 2004	Elkhorn, OR (10)	Enk et al. 2011b	Vansycle, OR (99)	Erickson et al. 2000b
Klondike II, OR (05-06)	NWC and WEST 2007	Foote Creek Rim, WY (Ph. I; 01-02)	Young et al. 2003b	Elkhorn, OR (08)	Jeffrey et al. 2009b
Klondike III, OR (Phase I; 07-09)	Gritski et al. 2010	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b	Alite, CA (09-10)	Chatfield et al. 2010
Hopkins Ridge, WA (08)	Young et al. 2009c	Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Marengo I, WA (09-10)	URS Corporation 2010b
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Marengo II, WA (09-10)	URS Corporation 2010c

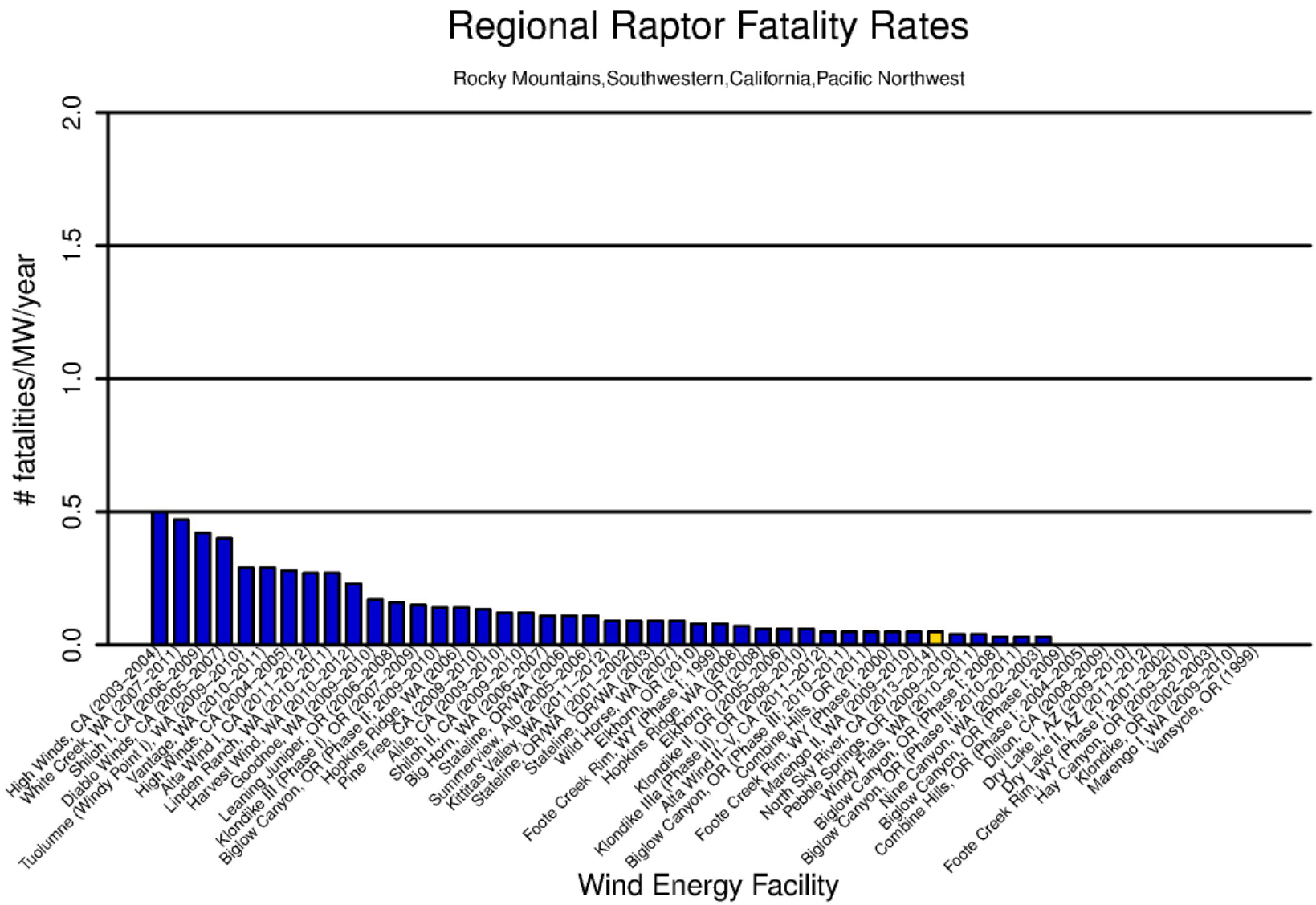

Figure 15. Fatality rates for raptors (number of raptors per MW per year) at the North Sky River Wind Energy Facility compared with publicly-available wind energy facilities in western North America.

Figure 15 (*continued*). Fatality rates for raptors (number of raptors per MW per year) at the North Sky River Wind Energy Facility compared with publicly-available wind energy facilities in western North America.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
North Sky River, CA	This study				
High Winds, CA (03-04)	Kerlinger et al. 2006	Shiloh II, CA (09-10)	Kerlinger et al. 2010b	Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b
White Creek, WA (07-11)	Downes and Gritski 2012b	Big Horn, WA (06-07)	Kronner et al. 2008	Marengo II, WA (09-10)	URS Corporation 2010c
Shiloh I, CA (06-09)	Kerlinger et al. 2009	Stateline, OR/WA (06)	Erickson et al. 2007	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Diablo Winds, CA (05-07)	WEST 2006, 2008	Summerview, Alb (05-06)	Brown and Hamilton 2006b	Windy Flats, WA (10-11)	Enz et al. 2011
Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010	Kittitas Valley, WA (11-12)	Stantec 2012	Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a
Vantage, WA (10-11)	Ventus 2012	Stateline, OR/WA (01-02)	Erickson et al. 2004	Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b
High Winds, CA (04-05)	Kerlinger et al. 2006	Stateline, OR/WA (03)	Erickson et al. 2004	Nine Canyon, WA (02-03)	Erickson et al. 2003b
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Wild Horse, WA (07)	Erickson et al. 2008	Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010
Linden Ranch, WA (10-11)	Enz and Bay 2011	Elkhorn, OR (10)	Enk et al. 2011b	Combine Hills, OR (Ph. I; 04-05)	Young et al. 2006
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	Dillon, CA (08-09)	Chatfield et al. 2009
Goodnoe, WA (09-10)	URS Corporation 2010a	Hopkins Ridge, WA (08)	Young et al. 2009c	Dry Lake I, AZ (09-10)	Thompson et al. 2011
Leaning Juniper, OR (06-08)	Gritski et al. 2008	Elkhorn, OR (08)	Jeffrey et al. 2009b	Dry Lake II, AZ (11-12)	Thompson and Bay 2012
Klondike III, OR (Phase I; 07-09)	Gritski et al. 2010	Klondike II, OR (05-06)	NWC and WEST 2007	Foote Creek Rim, WY (Ph. I; 01-02)	Young et al. 2003b
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Klondike IIIa, OR (Phase II; 08-10)	Gritski et al. 2011	Hay Canyon, OR (09-10)	Gritski and Kronner 2010a
Hopkins Ridge, WA (06)	Young et al. 2007	Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Klondike, OR (02-03)	Johnson et al. 2003b
Pine Tree, CA (09-10)	BioResource Consultants 2010	Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Marengo I, WA (09-10)	URS Corporation 2010b
Alite, CA (09-10)	Chatfield et al. 2011	Combine Hills, OR (11)	Enz et al. 2012	Vansycle, OR (99)	Erickson et al. 2000b

Bat Fatalities

A total of 18 bats, representing at least six identifiable species, were documented during the study. In California, bat mortality rates have ranged from 0.08 to 3.92 bats/MW/year. The estimated bat fatality rate at NSR (2.59 bats/MW/year) is on the higher end of this range; however, bat fatalities in California are generally low compared to other sites within western North America (i.e., California, Pacific Northwest, Rocky Mountain, and Southwest regions), which have ranged from 0.08 to 11.42 bats/MW/year (Figure 16; Appendix C3). During the intensive searches of the seven turbines in the northeast corner of NSR, only two bat fatalities were found (one Mexican free-tailed bat and one unidentified *Myotis* spp.). The spring bat fatality rate at these seven turbines was 0.52 bats/MW/season.

While still relatively low, the bat fatality rate calculated at NSR is somewhat higher than that documented at several other facilities in the TWRA. At the adjacent Pine Tree facility, only four bats were found during the 17-month study. Due to the small sample size, no bat fatality rates were calculated for Pine Tree. At the nearby Alta I and Alta II-V, the bat fatality rates were 1.28 and 0.08 bats/MW/year, respectively; Chatfield et al. 2012). During pre-construction acoustic monitoring conducted at NSR, bat activity rates were found to be moderate, particular compared to the very low rates of bat activity recorded at other wind energy projects in the Tehachapi region (Chatfield et al 2011). This suggested that more moderate levels of bat mortality might be expected to occur at NSR.

Virtually all (96.5%) of identified bat mortality at wind energy facilities have been composed of the three migratory tree bats: hoary bat, silver-haired bat (*Lasionycteris noctivagans*), and eastern red bat (*Lasiurus cinereus*; Gruver et al. 2011). Additionally, several post-construction studies at facilities within the range of the Mexican free-tailed bat have reported comparatively high levels of mortality for this species as well (Arnett et al. 2008). Species composition of mortality at NSR was consistent with this, in that hoary and Mexican free-tailed bats composed 72% of overall bat fatalities found during the study. Based on the timing of bat mortality at the NSR and the limited amount of roosting habitat for resident hoary or Mexican free-tailed bats, most of the casualties were likely spring and fall migrants through the site, as is the case at virtually all other wind energy facilities in North America (Johnson 2005, Arnett et al. 2008).

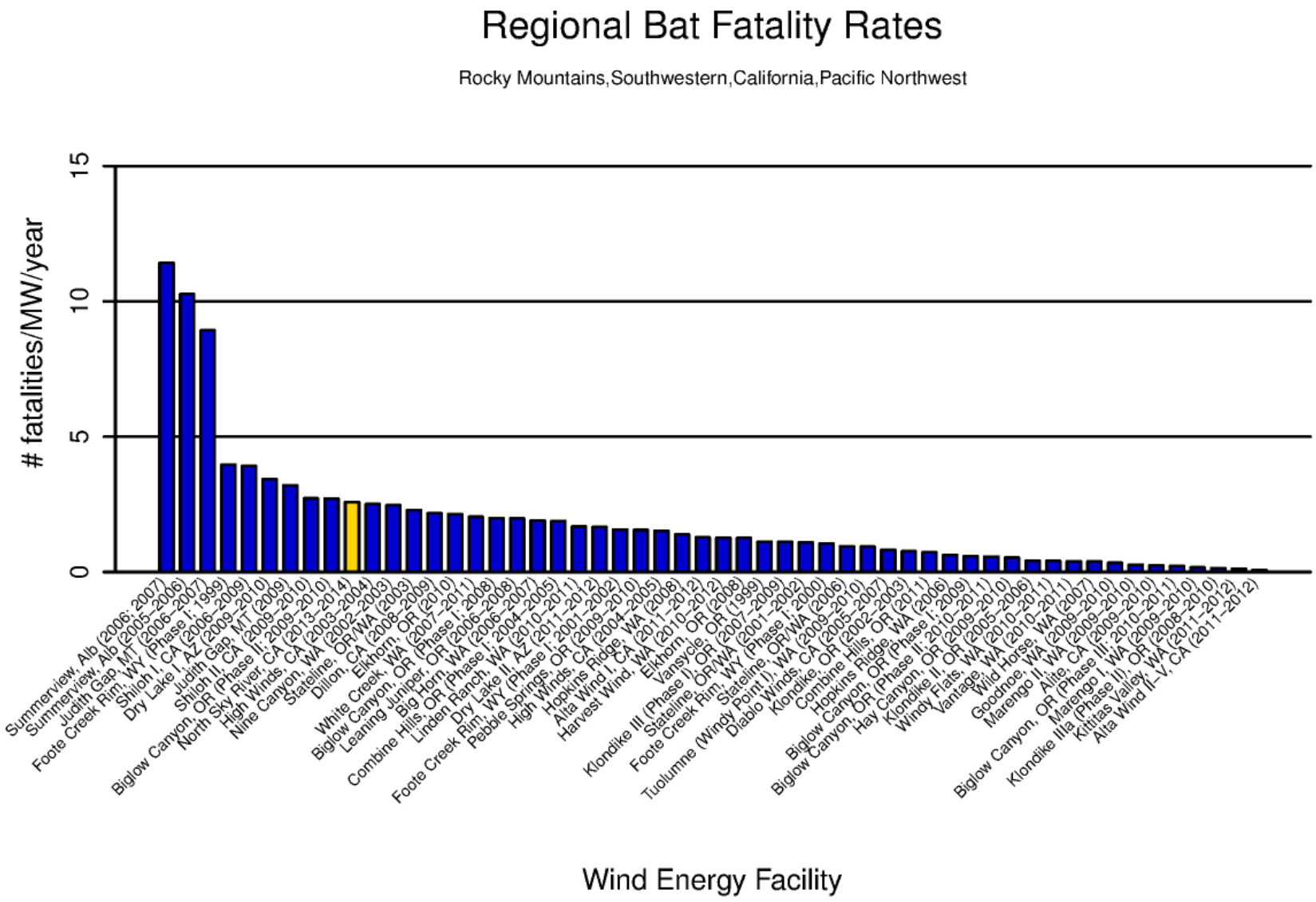

Figure 16. Fatality rates for bats (number of bats per MW per year) at the North Sky River Wind Energy Facility compared with publicly-available wind energy facilities in western North America.

Figure 16 (*continued*). Fatality rates for bats (number of bats per MW per year) at the North Sky River Wind Energy Facility compared with publicly-available wind energy facilities in western North America.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
North Sky River, CA	This study				
Summerview, Alb (06; 07)	Baerwald 2008	Combine Hills, OR (Phase I; 04-05)	Young et al. 2006	Combine Hills, OR (11)	Enz et al. 2012
Summerview, Alb (05-06)	Brown and Hamilton 2006b	Linden Ranch, WA (10-11)	Enz and Bay 2011	Hopkins Ridge, WA (06)	Young et al. 2007
Judith Gap, MT (06-07)	TRC 2008	Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003b, 2003d	Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b
Shiloh I, CA (06-09)	Kerlinger et al. 2009	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b	Hay Canyon, OR (09-10)	Gritski and Kronner 2010a
Dry Lake I, AZ (09-10)	Thompson et al. 2011	High Winds, CA (04-05)	Kerlinger et al. 2006	Klondike II, OR (05-06)	NWC and WEST 2007
Judith Gap, MT (09)	Poulton and Erickson 2010	Hopkins Ridge, WA (08)	Young et al. 2009c	Windy Flats, WA (10-11)	Enz et al. 2011
Shiloh II, CA (09-10)	Kerlinger et al. 2010b	Alta Wind I, CA (11-12)	Chatfield et al. 2012	Vantage, WA (10-11)	Ventus 2012
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Wild Horse, WA (07)	Erickson et al. 2008
High Winds, CA (03-04)	Kerlinger et al. 2006	Elkhorn, OR (08)	Jeffrey et a. 2009b	Goodnoe, WA (09-10)	URS Corporation 2010a
Nine Canyon, WA (02-03)	Erickson et al. 2003b	Vansycle, OR (99)	Erickson et al. 2000a	Marengo II, WA (09-10)	URS Corporation 2010c
Stateline, OR/WA (03)	Erickson et al. 2004	Klondike III (Phase I), OR (07-09)	Gritski et al. 2010	Alite, CA (09-10)	Chatfield et al. 2010
Dillon, CA (08-09)	Chatfield et al. 2009	Stateline, OR/WA (01-02)	Erickson et al. 2004	Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a
Elkhorn, OR (10)	Enk et al. 2011b	Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b, 2003d	Marengo I, WA (09-10)	URS Corporation 2010b
White Creek, WA (07-11)	Downes and Gritski 2012b	Stateline, OR/WA (06)	Erickson et al. 2007	Klondike IIIa (Phase II), OR (08-10)	Gritski et al. 2011
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010	Kittitas Valley, WA (11-12)	Stantec Consulting Services 2012
Leaning Juniper, OR (06-08)	Gritski et al. 2008	Diablo Winds, CA (05-07)	WEST 2006, 2008	Alta Wind II-V, CA (11-12)	Chatfield et al. 2012
Big Horn, WA (06-07)	Kronner et al. 2008	Klondike, OR (02-03)	Johnson et al. 2003a		

CONCLUSIONS AND RECOMMENDATIONS

Results of the first year of fatality monitoring at NSR further contribute to our understanding of the effects of wind energy on birds and bats. During this first year of monitoring, all bird, diurnal raptor, and bat fatality rates at the facility were generally low compared to other wind energy facilities in western North America, and consistent with other facilities in the Tehachapi region. Additional monitoring will be conducted at NSR during the second, third, and fourth years of operation (January 2014 – January 2017). The results of the surveys conducted to date do not suggest the need for deviation from the established protocol during the second year of mortality surveys. As additional years of the study are completed and results from post-construction mortality studies at other wind energy facilities in the TWRA become available, a clearer picture of the impacts will emerge.

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Appendix A. Complete Listing of Fatalities for the North Sky River Wind Energy Facility

Appendix A. Complete listing of fatalities for the North Sky River Wind Energy Facility.

Date	Common Name	Location	Distance from Turbine (m)	Type of Find	Search Type	Condition
1/18/2013	greater roadrunner	43	77	Incidental Find	bi-weekly	Feather Spot
1/21/2013	California quail	30	52	Incidental Find	bi-weekly	Feather Spot
1/29/2013	red-tailed hawk	49	39	Incidental Find	bi-weekly	Intact
2/18/2013	California quail	37	41	Carcass Search	bi-weekly	Feather Spot
2/25/2013	unidentified bird (small)	9	40	Carcass Search	bi-weekly	Feather Spot
2/26/2013	unidentified bird (small)	15	76	Carcass Search	bi-weekly	Feather Spot
3/18/2013	chukar	37	74	Carcass Search	bi-weekly	Feather Spot
3/18/2013	chukar	52	74	Carcass Search	bi-weekly	Feather Spot
3/18/2013	unidentified bird (small)	55	82	Carcass Search	bi-weekly	Feather Spot
3/20/2013	unidentified large bird	96	58	Carcass Search	bi-weekly	Feather Spot
4/10/2013	chukar	17	70	Carcass Search	intensive	Feather Spot
4/10/2013	yellow warbler	49	12	Carcass Search	bi-weekly	Intact
4/11/2013	western kingbird	57	50	Carcass Search	bi-weekly	Dismembered
4/22/2013	red-tailed hawk	6	22	Incidental Find	intensive	Dismembered
5/1/2013	chukar	19	69	Carcass Search	intensive	Feather Spot
5/7/2013	unidentified bird (small)	15	42	Carcass Search	bi-weekly	Feather Spot
5/14/2013	Mexican free-tailed bat	3	27	Carcass Search	intensive	Intact
5/14/2013	red-tailed hawk	16	41	Carcass Search	intensive	Feather Spot
6/5/2013	hoary bat	32	42	Carcass Search	bi-weekly	Intact
6/11/2013	Mexican free-tailed bat	61	10	Carcass Search	bi-weekly	Scavenged
6/11/2013	unidentified myotis	3	14	Carcass Search	intensive	Intact
6/12/2013	Mexican free-tailed bat	66	38	Carcass Search	bi-weekly	Scavenged
6/24/2013	red-tailed hawk	52	67	Carcass Search	bi-weekly	Dismembered
7/15/2013	Mexican free-tailed bat	9	45	Carcass Search	bi-weekly	Intact
7/24/2013	big brown bat	66	21	Carcass Search	bi-weekly	Scavenged
7/29/2013	Mexican free-tailed bat	1	13	Carcass Search	bi-weekly	Intact
8/20/2013	red-tailed hawk	86	96	Incidental Find	bi-weekly	Feather Spot
8/21/2013	unidentified myotis	66	10	Carcass Search	bi-weekly	Intact
8/29/2013	Mexican free-tailed bat	36	14	Carcass Search	bi-weekly	Intact
8/29/2013	western mastiff bat	21	22	Carcass Search	bi-weekly	Intact
9/4/2013	Mexican free-tailed bat	86	41	Carcass Search	bi-weekly	Intact
9/4/2013	Mexican free-tailed bat	86	50	Carcass Search	bi-weekly	Intact
9/9/2013	black-throated gray warbler	1	15	Carcass Search	bi-weekly	Intact
9/16/2013	canyon bat	52	31	Carcass Search	bi-weekly	Intact
9/18/2013	hoary bat	66	66	Carcass Search	bi-weekly	Intact
10/9/2013	fox sparrow	49	59	Carcass Search	bi-weekly	Intact
10/15/2013	hoary bat	74	74	Carcass Search	bi-weekly	Intact
10/23/2013	Mexican free-tailed bat	49	23	Carcass Search	bi-weekly	Dismembered

Appendix B. Complete Bird and Bat Fatality Table for the North Sky River Wind Energy Facility for Studies Conducted from January 14, 2013 – January 23, 2014

Appendix B1. Correction factors and bird and bat fatality rates by season from data collected at 30 turbines searched bi-weekly within the North Sky River Wind Energy Facility from January 14, 2013 – January 13, 2014.

	Summer		Fall		Winter		Spring	
	(30 turbines searched)							
Parameter	**Mean**	**CI**	**Mean**	**CI**	**Mean**	**CI**	**Mean**	**CI**
Search Area Adjustment								
A (small birds)	1.00	-	1.00	-	1.00	-	1.00	-
A (large birds)	1.00	-	1.00	-	1.00	-	1.00	-
A (bats)	1.00	-	1.00	-	1.00	-	1.00	-
Observer Detection Rate								
p (small birds)	0.80	0.70-0.89	0.80	0.70-0.89	0.80	0.70-0.89	0.80	0.70-0.89
p (large birds)	0.98	0.94-1	0.98	0.94-1	0.98	0.94-1	0.98	0.94-1
p (bats)[1]	0.83	0.74-0.91	0.83	0.74-0.91	0.83	0.74-0.91	0.83	0.74-0.91
Mean Carcass Removal Time (Days)								
$\bar{t}$ (small birds)	1.57	1.22-1.94	1.57	1.22-1.94	1.57	1.22-1.94	1.57	1.22-1.94
$\bar{t}$ (large birds)	18.59	8.34-38.38	44.71	25.22-84.01	44.71	25.22-84.01	67.69	32.92-171.5
$\bar{t}$ (bats)[2]	2.09	1.48-2.87	2.09	1.48-2.87	2.09	1.48-2.87	2.09	1.48-2.87
Observed Fatality Rates (Fatalities/Turbine/Season)								
small birds[3]	-	-	-	-	-	-	-	-
large birds	0.03	0-0.1	0.07	0-0.13	0.07	0-0.13	0.10	0.03-0.2
raptors	0.03	0-0.1	0.03	0-0.1	0.03	0-0.1	0	-
bats[3]	-	-	-	-	-	-	-	-
Average Probability of Carcass Availability and Detected								
small birds	0.09	0.07-0.11	0.09	0.07-0.11	0.09	0.07-0.11	0.09	0.07-0.11
large birds	0.69	0.46-0.83	0.85	0.76-0.92	0.85	0.76-0.92	0.90	0.81-0.95
bats	0.12	0.08-0.17	0.12	0.08-0.17	0.12	0.08-0.17	0.12	0.08-0.17
Observed Adjusted Fatality Rates (Fatalities/Turbine/Season)								
small birds	-	-	-	-	-	-	-	-
large birds	0.05	0-0.14	0.08	0-0.18	0.08	0-0.18	0.11	0.03-0.22
raptors	0.05	0-0.14	0.04	0-0.11	0.04	0-0.11	0	-
bats	-	-	-	-	-	-	-	-

Overall Adjusted Fatality Rates (Fatalities/Turbine/Year)		
	Mean	**CI**
small birds	3.04	1.11 – 5.51
large birds	0.24	0.09 – 0.42
raptors	0.09	0 – 0.21
all birds	3.27	1.36 – 5.75
bats	4.14	2.05 – 7.16

[1]During searcher efficiency trials, house sparrows were used as a surrogate for bats.
[2]During carcass removal trials, house sparrows were used as a surrogate for bats.
[3]Seasonal fatality estimates not calculated for small birds and bats.

Appendix B2. Correction factors and bird and bat fatality rates from data collected at seven turbines searched intensively within the North Sky River Wind Energy Facility from April 2, 2013 – June 11, 2013.

Parameter	Spring (7 Turbines Searched) Mean	CI
Search Area Adjustment		
A (small birds)	1.00	-
A (large birds)	1.00	-
A (bats)	1.00	-
Observer Detection Rate		
p (small birds)	0.80	0.70-0.89
p (large birds)	0.98	0.94-1
p (bats)[1]	0.83	0.74-0.91
Mean Carcass Removal Time (Days)		
$\bar{t}$ (small birds)	1.57	1.22-1.94
$\bar{t}$ (large birds)	67.69	32.92-171.5
$\bar{t}$ (bats)[2]	2.09	1.48-2.87
Observed Fatality Rates (Fatalities/Turbine/Season)		
small birds	0	-
large birds	0.57	0.29-0.86
raptors	0.29	0-0.57
bats	0.29	0-0.86
Average Probability of Carcass Availability and Detected		
small birds	0.26	0.2-0.33
large birds	0.97	0.93-0.99
bats	0.34	0.25-0.44
Observed Adjusted Fatality Rates (Fatalities/Turbine/Season)		
	Mean	**CI**
small birds	0	-
large birds	0.59	0.29-0.89
raptors	0.30	0-0.6
bats	0.83	0-2.52

[1]During searcher efficiency trials, house sparrows were used as a surrogate for bats.

[2]During carcass removal trials, house sparrows were used as a surrogate for bats.

Appendix C. North American Fatality Summary Tables

Appendix C1. 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
North Sky River, CA	**2.07**	**100**	**160**
California			
Pine Tree, CA (2009-2010)	8.3	90	135
Alta Wind I, CA (2011-2012)	7.07	100	150
Shiloh I, CA (2006-2009)	6.96	100	150
Dillon, CA (2008-2009)	4.71	45	45
Diablo Winds, CA (2005-2007)	4.29	31	20.46
Alta Wind II-V, CA (2011-2012)	1.66	190	570
High Winds, CA (2003-2004)	1.62	90	162
Shiloh II, CA (2009-2010)	1.51	75	150
High Winds, CA (2004-2005)	1.1	90	162
Alite, CA (2009-2010)	0.55	8	24
Pacific Northwest			
Windy Flats, WA (2010-2011)	8.45	114	262.2
Leaning Juniper, OR (2006-2008)	6.66	67	100.5
Linden Ranch, WA (2010-2011)	6.65	25	50
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	65	150
White Creek, WA (2007-2011)	4.05	89	204.7
Tuolumne (Windy Point I), WA (2009-2010)	3.2	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
Vantage, WA (2010-2011)	1.27	60	90
Hopkins Ridge, WA (2006)	1.23	83	150
Stateline, OR/WA (2006)	1.23	454	299
Kittitas Valley, WA (2011-2012)	1.06	48	100.8
Klondike, OR (2002-2003)	0.95	16	24
Vansycle, OR (1999)	0.95	38	24.9
Elkhorn, OR (2008)	0.64	61	101
Marengo I, WA (2009-2010)	0.27	78	140.4
Marengo II, WA (2009-2010)	0.16	39	70.2

Appendix C1. Wind energy facilities in North America with 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
Rocky Mountains			
Foote Creek Rim, WY (Phase I; 1999)	3.4	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.42	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	69	41.4
Summerview, Alb (2005-2006)	1.06	39	70.2
Southwest			
Dry Lake I, AZ (2009-2010)	2.02	30	63
Dry Lake II, AZ (2011-2012)	1.57	31	65
Midwest			
Wessington Springs, SD (2009)	8.25	34	51
Blue Sky Green Field, WI (2008; 2009)	7.17	88	145
Cedar Ridge, WI (2009)	6.55	41	67.6
Buffalo Ridge, MN (Phase III; 1999)	5.93	138	103.5
Moraine II, MN (2009)	5.59	33	49.5
Barton I & II, IA (2010-2011)	5.5	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
Buffalo Ridge II, SD (2011-2012)	1.99	105	210
Kewaunee County, WI (1999-2001)	1.95	31	20.46
NPPD Ainsworth, NE (2006)	1.63	36	20.5
PrairieWinds ND1 (Minot), ND (2011)	1.56	80	115.5
Elm Creek, MN (2009-2010)	1.55	67	100
PrairieWinds ND1 (Minot), ND (2010)	1.48	80	115.5
Buffalo Ridge, MN (Phase I; 1999)	1.43	73	25
PrairieWinds SD1 (Crow Lake), SD (2011-2012)	1.41	108	162
Wessington Springs, SD (2010)	0.89	34	51
Top of Iowa, IA (2004)	0.81	89	80
Grand Ridge I, IL (2009-2010)	0.48	66	99
Top of Iowa, IA (2003)	0.42	89	80
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	62	102.3
Southern Plains			
Buffalo Gap I, TX (2006)	1.32	67	134
Barton Chapel, TX (2009-2010)	1.15	60	120
Buffalo Gap II, TX (2007-2008)	0.15	155	233
Big Smile, OK (2012-2013)	0.09	66	132
Red Hills, OK (2012-2013)	0.08	82	123

Appendix C1. Wind energy facilities in North America with 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
Northeast			
Criterion, MD (2011)	6.4	28	70
Mount Storm, WV (2011)	4.24	132	264
Mount Storm, WV (2009)	3.85	132	264
Lempster, NH (2009)	3.38	12	24
Casselman, PA (2009)	2.88	23	34.5
Mountaineer, WV (2003)	2.69	44	66
Stetson Mountain I, ME (2009)	2.68	38	57
Noble Ellenburg, NY (2009)	2.66	54	80
Lempster, NH (2010)	2.64	12	24
Mount Storm, WV (2010)	2.6	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
Noble Altona, NY (2010)	1.84	65	97.5
Mars Hill, ME (2008)	1.76	28	42
High Sheldon, NY (2010)	1.76	75	112.5
Noble Wethersfield, NY (2010)	1.7	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
Munnsville, NY (2008)	1.48	23	34.5
Stetson Mountain II, ME (2010)	1.42	17	25.5
Cohocton/Dutch Hill, NY (2009)	1.39	50	125
Cohocton/Dutch Hills, NY (2010)	1.32	50	125
Noble Bliss, NY (2008)	1.3	67	100
Beech Ridge, WV (2012)	1.19	67	100.5
Stetson Mountain I, ME (2011)	1.18	38	57
Noble Clinton, NY (2009)	1.11	67	100
Locust Ridge, PA (Phase II; 2009)	0.84	51	102
Noble Ellenburg, NY (2008)	0.83	54	80
Locust Ridge, PA (Phase II; 2010)	0.76	51	102
Southeast			
Buffalo Mountain, TN (2000-2003)	11.02	3	1.98
Buffalo Mountain, TN (2005)	1.1	18	28.98

Appendix C1 (*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
North Sky River, CA	This study		
Alite, CA (09-10)	Chatfield et al. 2010	Klondike II, OR (05-06)	NWC and WEST 2007
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Klondike III, OR (Phase I; 07-09)	Gritski et al. 2010
Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Klondike IIIa, OR (Phase II; 08-10)	Gritski et al. 2011
Barton I & II, IA (10-11)	Derby et al. 2011a	Leaning Juniper, OR (06-08)	Gritski et al. 2008
Barton Chapel, TX (09-10)	WEST 2011	Lempster, NH (09)	Tidhar et al. 2010
Beech Ridge, WV (12)	Tidhar et al. 2013	Lempster, NH (10)	Tidhar et al. 2011
Big Horn, WA (06-07)	Kronner et al. 2008	Linden Ranch, WA (10-11)	Enz and Bay 2011
Big Smile, OK (12-13)	Derby et al. 2013a	Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Maple Ridge, NY (07)	Jain et al. 2009a
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Maple Ridge, NY (07-08)	Jain et al. 2009d
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Marengo I, WA (09-10)	URS Corporation 2010b
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Marengo II, WA (09-10)	URS Corporation 2010c
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Mars Hill, ME (07)	Stantec 2008
Buffalo Gap I, TX (06)	Tierney 2007	Mars Hill, ME (08)	Stantec 2009a
Buffalo Gap II, TX (07-08)	Tierney 2009	Moraine II, MN (09)	Derby et al. 2010d
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000a	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000a	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000a	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000a	Nine Canyon, WA (02-03)	Erickson et al. 2003b
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000a	Noble Altona, NY (10)	Jain et al. 2011b
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a	Noble Bliss, NY (08)	Jain et al. 2009e
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000a	Noble Bliss, NY (09)	Jain et al. 2010a
Buffalo Ridge I, SD (09-10)	Derby et al. 2010b	Noble Chateaugay, NY (10)	Jain et al. 2011c
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Noble Clinton, NY (08)	Jain et al. 2009c
Casselman, PA (08)	Arnett et al. 2009a	Noble Clinton, NY (09)	Jain et al. 2010b
Casselman, PA (09)	Arnett et al. 2010	Noble Ellenburg, NY (08)	Jain et al. 2009b
Cedar Ridge, WI (09)	BHE Environmental 2010	Noble Ellenburg, NY (09)	Jain et al. 2010c
Cedar Ridge, WI (10)	BHE Environmental 2011	Noble Wethersfield, NY (10)	Jain et al. 2011a
Cohocton/Dutch Hill, NY (09)	Stantec 2010	NPPD Ainsworth, NE (06)	Derby et al. 2007
Cohocton/Dutch Hill, NY (10)	Stantec 2011	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Combine Hills, OR (Ph. I; 04-05)	Young et al. 2006	Pine Tree, CA (09-10)	BioResource Consultants 2010
Combine Hills, OR (11)	Enz et al. 2012	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
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
Diablo Winds, CA (05-07)	WEST 2006, 2008	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
Dillon, CA (08-09)	Chatfield et al. 2009	Red Hills, OK (12-13)	Derby et al. 2013b
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	Rugby, ND (10-11)	Derby et al. 2011b
Elkhorn, OR (08)	Jeffrey et al. 2009b	Shiloh I, CA (06-09)	Kerlinger et al. 2009
Elkhorn, OR (10)	Enk et al. 2011b	Shiloh II, CA (09-10)	Kerlinger et al. 2010b
Elm Creek, MN (09-10)	Derby et al. 2010c	Stateline, OR/WA (01-02)	Erickson et al. 2004
Elm Creek II, MN (11-12)	Derby et al. 2012b	Stateline, OR/WA (03)	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	Stateline, OR/WA (06)	Erickson et al. 2007
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b	Stetson Mountain I, ME (09)	Stantec 2009c
Foote Creek Rim, WY (Ph. I; 01-02)	Young et al. 2003b	Stetson Mountain I, ME (11)	Normandeau Associates 2011
Fowler I, IN (09)	Good et al. 2011	Stetson Mountain II, ME (10)	Normandeau Associates 2010
Goodnoe, WA (09-10)	URS Corporation 2010a	Summerview, Alb (05-06)	Brown and Hamilton 2006b
Grand Ridge, IL (09-10)	Derby et al. 2010g	Top of Iowa, IA (03)	Jain 2005
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Top of Iowa, IA (04)	Jain 2005
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
High Sheldon, NY (10)	Tidhar et al. 2012a	Vansycle, OR (99)	Erickson et al. 2000b
High Sheldon, NY (11)	Tidhar et al. 2012b	Vantage, WA (10-11)	Ventus 2012
High Winds, CA (03-04)	Kerlinger et al. 2006	Wessington Springs, SD (09)	Derby et al. 2010f
High Winds, CA (04-05)	Kerlinger et al. 2006	Wessington Springs, SD (10)	Derby et al. 2011d
Hopkins Ridge, WA (06)	Young et al. 2007	White Creek, WA (07-11)	Downes and Gritski 2012b
Hopkins Ridge, WA (08)	Young et al. 2009c	Wild Horse, WA (07)	Erickson et al. 2008
Kewaunee County, WI (99-01)	Howe et al. 2002	Windy Flats, WA (10-11)	Enz et al. 2011
Kittitas Valley, WA (11-12)	Stantec 2012	Winnebago, IA (09-10)	Derby et al. 2010e
Klondike, OR (02-03)	Johnson et al. 2003b		

Appendix C2. 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
North Sky River, CA	**0.28**	**0.05**	**100**	**160**
	California			
High Winds, CA (2003-2004)	2.337	0.5	90	162
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
Pine Tree, CA (2009-2010)		0.133	90	135
Alite, CA (2009-2010)		0.12	8	24
Shiloh II, CA (2009-2010)		0.12	75	150
Alta Wind II-V, CA (2011-2012)	0.04	0.05	190	570
Dillon, CA (2008-2009)		0	45	45
	Pacific Northwest			
White Creek, WA (2007-2011)		0.47	89	204.7
Vantage, WA (2010-2011)		0.29	60	90
Tuolumne (Windy Point I), WA (2009-2010)	0.77	0.29	62	136.6
Linden Ranch, WA (2010-2011)		0.27	25	50
Harvest Wind, WA (2010-2012)		0.23	43	98.9
Goodnoe, WA (2009-2010)		0.17	47	94
Leaning Juniper, OR (2006-2008)	0.522	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
Klondike II, OR (2005-2006)	0.504	0.06	50	75
Klondike IIIa (Phase II), OR (2008-2010)		0.06	51	76.5
Elkhorn, OR (2008)	1.07	0.06	61	101
Marengo II, WA (2009-2010)		0.05	39	70.2
Combine Hills, OR (2011)	0.746	0.05	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	0.318	0.05	76	174.8
Pebble Springs, OR (2009-2010)		0.04	47	98.7
Windy Flats, WA (2010-2011)		0.04	114	262.2
Nine Canyon, WA (2002-2003)	0.35	0.03	37	48.1
Biglow Canyon, OR (Phase I; 2008)	0.318	0.03	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)	0.318	0.03	65	150
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
Hay Canyon, OR (2009-2010)		0	48	100.8
Biglow Canyon, OR (Phase I; 2009)	0.318	0	76	125.4
Marengo I, WA (2009-2010)		0	78	140.4

Appendix C2. 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
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
Foote Creek Rim, WY (Phase I; 2001-2002)	0.554	0	69	41.4
Southwest				
Dry Lake I, AZ	0.13	0	30	63
Dry Lake II, AZ		0	31	65
Midwest				
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
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
NPPD Ainsworth, NE (2006)		0.06	36	20.5
Wessington Springs, SD (2009)	0.232	0.06	34	51
Rugby, ND (2010-2011)		0.06	71	149
PrairieWinds ND1 (Minot), ND (2010)		0.05	80	115.5
PrairieWinds ND1 (Minot), ND (2011)		0.05	80	115.5
Kewaunee County, WI (1999-2001)		0	31	20.46
Buffalo Ridge, MN (Phase I; 1996)		0	73	25
Buffalo Ridge, MN (Phase I; 1997)		0	73	25
Buffalo Ridge, MN (Phase I; 1998)		0	73	25
Buffalo Ridge, MN (Phase I; 1999)		0	73	25
Top of Iowa, IA (2003)		0	89	80
Grand Ridge I, IL (2009-2010)	0.195	0	66	99
Elm Creek, MN (2009-2010)		0	67	100
Pioneer Prairie I, IA (Phase II; 2011-2012)		0	62	102.3
Buffalo Ridge, MN (Phase III; 1999)		0	138	103.5
Buffalo Ridge, MN (Phase II; 1998)		0	143	107.25
Buffalo Ridge, MN (Phase II; 1999)		0	143	107.25
Blue Sky Green Field, WI (2008; 2009)		0	88	145
Elm Creek II, MN (2011-2012)		0	62	148.8
Barton I & II, IA (2010-2011)		0	80	160
PrairieWinds SD1 (Crow Lake), SD (2011-12)		0	108	162
Buffalo Ridge II, SD (2011-2012)		0	105	210
Fowler I, IN (2009)		0	162	301
Southern Plains				
Barton Chapel, TX (2009-2010)		0.25	60	120
Buffalo Gap I, TX (2006)		0.1	67	134
Red Hills, OK (2012-2013)		0.04	82	123
Big Smile, OK (2012-2013)		0	66	132
Buffalo Gap II, TX (2007-2008)		0	155	233

Appendix C2. Wind energy facilities in North America with use and 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
	Northeast			
Munnsville, NY (2008)		0.59	23	34.5
Noble Ellenburg, NY (2009)		0.25	54	80
Noble Clinton, NY (2009)		0.16	67	100
Noble Wethersfield, NY (2010)		0.13	84	126
Noble Bliss, NY (2009)		0.12	67	100
Noble Ellenburg, NY (2008)		0.11	54	80
Noble Bliss, NY (2008)		0.1	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
Lempster, NH (2009)		0	12	24
Lempster, NH (2010)		0	12	24
Stetson Mountain II, ME (2010)		0	17	25.5
Casselman, PA (2008)		0	23	34.5
Casselman, PA (2009)		0	23	34.5
Mars Hill, ME (2007)		0	28	42
Mars Hill, ME (2008)		0	28	42
Stetson Mountain I, ME (2009)		0	38	57
Stetson Mountain I, ME (2011)		0	38	57
Noble Altona, NY (2010)		0	65	97.5
Locust Ridge, PA (Phase II; 2009)		0	51	102
Locust Ridge, PA (Phase II; 2010)		0	51	102
High Sheldon, NY (2011)		0	75	112.5
Cohocton/Dutch Hill, NY (2009)		0	50	125
Mount Storm, WV (2009)		0	132	264
	Southeast			
Buffalo Mountain, TN (2000-2003)		0	3	1.98
Buffalo Mountain, TN (2005)		0	18	28.98

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

Data from the following sources:

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

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

Data from the following sources:

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

Appendix C3. Wind energy facilities in North America with comparable activity and 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
North Sky River, CA	**13.88**	**8/17/2010 – 9/5/2011**	**2.59**	**100**	**160**
California					
Shiloh I, CA			3.92	100	150
Shiloh II, CA			2.72	75	150
High Winds, CA (2004)			2.51	90	162
Dillon, CA			2.17	45	45
High Winds, CA (2005)			1.52	90	162
Alta Wind I, CA (2011)	4.42	6/26/2009 - 10/31/2009	1.28	100	150
Diablo Winds, CA			0.82	31	20.46
Alite, CA			0.24	8	24
Alta Wind II-V, CA (2011)	0.78	6/26/2009 - 10/31/2009	0.08	190	570
Pacific Northwest					
Biglow Canyon, OR (Phase II; 2009-2010)			2.71	65	150
Nine Canyon, WA (2002-2003)			2.47	37	48.1
Stateline, OR/WA (2003)			2.29	454	299
Elkhorn, OR (2010)			2.14	61	101
White Creek, WA (2007-2011)			2.04	89	204.7
Biglow Canyon, OR (Phase I; 2008)			1.99	76	125.4
Leaning Juniper, OR (2006-2008)			1.98	67	100.5
Big Horn, WA (2006-2007)			1.9	133	199.5
Combine Hills, OR (Phase I; 2004-2005)			1.88	41	41
Linden Ranch, WA (2010-2011)			1.68	25	50
Pebble Springs, OR (2009-2010)			1.55	47	98.7
Hopkins Ridge, WA (2008)			1.39	87	156.6
Harvest Wind, WA (2010-2012)			1.27	43	98.9
Elkhorn, OR (2008)			1.26	61	101
Vansycle, OR (1999)			1.12	38	24.9
Klondike III (Phase I), OR (2007-2009)			1.11	125	223.6
Stateline, OR/WA (2001-2002)			1.09	454	299
Stateline, OR/WA (2006)			0.95	454	299
Tuolumne (Windy Point I), WA (2009-2010)			0.94	62	136.6
Klondike, OR (2002-2003)			0.77	16	24
Combine Hills, OR (2011)			0.73	104	104
Hopkins Ridge, WA (2006)			0.63	83	150
Biglow Canyon, OR (Phase I; 2009)			0.58	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)			0.57	65	150
Hay Canyon, OR (2009-2010)			0.53	48	100.8
Klondike II, OR (2005-2006)			0.41	50	75
Windy Flats, WA (2010-2011)			0.41	114	262.2
Vantage, WA (2010-2011)			0.4	60	90
Wild Horse, WA (2007)			0.39	127	229
Goodnoe, WA (2009-2010)			0.34	47	94
Marengo II, WA (2009-2010)			0.27	39	70.2
Biglow Canyon, OR (Phase III; 2010-2011)			0.22	76	174.8
Marengo I, WA (2009-2010)			0.17	78	140.4
Klondike IIIa (Phase II), OR (2008-2010)			0.14	51	76.5

Appendix C3. 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
Kittitas Valley, WA (2011-2012)			0.12	48	100.8
		Rocky Mountains			
Summerview, Alb (2006; 2007)	7.65[A]	07/15/06-07-09/30/06-07	11.42	39	70.2
Summerview, Alb (2005-2006)			10.27	39	70.2
Judith Gap, MT (2006-2007)			8.93	90	135
Foote Creek Rim, WY (Phase I; 1999)			3.97	69	41.4
Judith Gap, MT (2009)			3.2	90	135
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2[A,B]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2[A,B]	6/15/00-9/1/00	1.05	69	41.4
		Southwest			
Dry Lake I, AZ	8.8	4/29/10-11/10/10	3.43	30	63
Dry Lake II, AZ	11.5	5/11/11-10/26/11	1.66	31	65
		Midwest			
Cedar Ridge, WI (2009)	9.97[A,B,C,D]	7/16/07-9/30/07	30.61	41	67.6
Blue Sky Green Field, WI (2008; 2009)	7.7[C]	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	9.97[A,B,C,D]	7/16/07-9/30/07	24.12	41	68
Fowler I, II, III, IN (2011)			20.19	355	600
Fowler I, II, III, IN (2010)			18.96	355	600
Forward Energy Center, WI (2008-2010)	6.97	8/5/08-11/08/08	18.17	86	129
Harrow, Ont (2010)			11.13	24 (four 6-turb facilities)	39.6
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Pioneer Prairie I, IA (Phase II; 2011-2012)			10.06	62	102.3
Fowler I, IN (2009)			8.09	162	301
Crystal Lake II, IA (2009)			7.42	80	200
Top of Iowa, IA (2003)			7.16	89	80
Kewaunee County, WI (1999-2001)			6.45	31	20.46
Ripley, Ont (2008)			4.67	38	76
Winnebago, IA (2009-2010)			4.54	10	20
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2[A]	6/15/01-9/15/01	4.35	143	107.25
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2[A]	6/15/01-9/15/01	3.71	138	103.5
Crescent Ridge, IL (2005-2006)			3.27	33	49.5
Fowler I, II, III, IN (2012)			2.96	355	600
Elm Creek II, MN (2011-2012)			2.81	62	148.8
Buffalo Ridge II, SD (2011-2012)			2.81	105	210
Buffalo Ridge, MN (Phase III; 1999)			2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)			2.59	143	107.25
Moraine II, MN (2009)			2.42	33	49.5
Buffalo Ridge, MN (Phase II; 1998)			2.16	143	107.25
PrairieWinds ND1 (Minot), ND (2010)			2.13	80	115.5
Grand Ridge I, IL (2009-2010)			2.1	66	99
Barton I & II, IA (2010-2011)			1.85	80	160
Fowler III, IN (2009)			1.84	60	99
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9[A]	6/15/02-9/15/02	1.81	138	103.5

Appendix C3. 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
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9[A]	6/15/02-9/15/02	1.64	143	107.25
Rugby, ND (2010-2011)			1.6	71	149
Elm Creek, MN (2009-2010)			1.49	67	100
Wessington Springs, SD (2009)			1.48	34	51
PrairieWinds ND1 (Minot), ND (2011)			1.39	80	115.5
PrairieWinds SD1 (Crow Lake), SD (2011-2012)			1.23	108	162
NPPD Ainsworth, NE (2006)			1.16	36	20.5
Buffalo Ridge, MN (Phase I; 1999)			0.74	73	25
Wessington Springs, SD (2010)			0.41	34	51
Buffalo Ridge I, SD (2009-2010)			0.16	24	50.4
Southern Plains					
Barton Chapel, TX			3.06	60	120
Big Smile, OK			2.90	66	132
Buffalo Gap II, TX			0.14	155	233
Red Hills, OK			0.11	82	123
Buffalo Gap I, TX			0.10	67	134
Northeast					
Mountaineer, WV (2003)			31.69	44	66
Mount Storm, WV (2009)	30.09	7/15/09-10/7/09	17.53	132	264
Noble Wethersfield, NY (2010)			16.3	84	126
Criterion, MD (2011)			15.61	28	70
Mount Storm, WV (2010)	36.67[E]	4/18/10-10/15/10	15.18	132	264
Locust Ridge, PA (Phase II; 2010)			14.38	51	102
Locust Ridge, PA (Phase II; 2009)			14.11	51	102
Casselman, PA (2008)			12.61	23	34.5
Maple Ridge, NY (2006)			11.21	120	198
Cohocton/Dutch Hills, NY (2010)			10.32	50	125
Wolfe Island, Ont (July-December 2010)			9.5	86	197.8
Cohocton/Dutch Hill, NY (2009)			8.62	50	125
Casselman, PA (2009)			8.6	23	34.5
Noble Bliss, NY (2008)			7.8	67	100
Criterion, MD (2012)			7.62	28	70
Mount Storm, WV (2011)			7.43	132	264
Mount Storm, WV (Fall 2008)	35.2	7/20/08-10/12/08	6.62	82	164
Maple Ridge, NY (2007)			6.49	195	321.75
Wolfe Island, Ont (July-December 2009)			6.42	86	197.8
Maple Ridge, NY (2007-2008)			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)			4.4	23	35.4
Noble Altona, NY (2010)			4.34	65	97.5
Noble Ellenburg, NY (2009)	16.1[D]	8/16/09-09/15/09	3.91	54	80
Noble Bliss, NY (2009)			3.85	67	100
Lempster, NH (2010)			3.57	12	24
Noble Ellenburg, NY (2008)			3.46	54	80
Noble Clinton, NY (2008)	2.1[D]	8/8/08-09/31/08	3.14	67	100
Lempster, NH (2009)			3.11	12	24
Mars Hill, ME (2007)			2.91	28	42
Wolfe Island, Ont (July-December 2011)			2.49	86	197.8

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

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Noble Chateaugay, NY (2010)			2.44	71	106.5
High Sheldon, NY (2010)			2.33	75	112.5
Beech Ridge, WV (2012)			2.03	67	100.5
Munnsville, NY (2008)			1.93	23	34.5
High Sheldon, NY (2011)			1.78	75	112.5
Stetson Mountain II, ME (2010)			1.65	17	25.5
Stetson Mountain I, ME (2009)	28.5; 0.3[F]	7/10/09-10/15/09	1.4	38	57
Mars Hill, ME (2008)			0.45	28	42
Stetson Mountain I, ME (2011)			0.28	38	57
Kibby, ME (2011)			0.12	44	132
Southeast					
Buffalo Mountain, TN (2005)			39.7	18	28.98
Buffalo Mountain, TN (2000-2003)	23.7[C]		31.54	3	1.98

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

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

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

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

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

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

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

Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
North Sky River, CA	Chatfield et al. 2011	This study			
Alite, CA (09-10)		Chatfield et al. 2010	Kewaunee County, WI (99-01)		Howe et al. 2002
Alta Wind I, CA (11-12)	Solick et al. 2010	Chatfield et al. 2012	Kibby, ME (11)		Stantec 2012
Alta Wind II-V, CA (11-12)	Solick et al. 2010	Chatfield et al. 2012	Kittitas Valley, WA (11-12)		Stantec Consulting Services 2012
Barton I & II, IA (10-11)		Derby et al. 2011a	Klondike, OR (02-03)		Johnson et al. 2003a
Barton Chapel, TX (09-10)		WEST 2011	Klondike II, OR (05-06)		NWC and WEST 2007
Beech Ridge, WV (12)		Tidhar et al. 2013	Klondike III (Phase I), OR (07-09)		Gritski et al. 2010
Big Horn, WA (06-07)		Kronner et al. 2008	Klondike IIIa (Phase II), OR (08-10)		Gritski et al. 2011
Big Smile, OK (12-13)		Derby et al. 2013a	Leaning Juniper, OR (06-08)		Gritski et al. 2008
Biglow Canyon, OR (Phase I; 08)		Jeffrey et al. 2009a	Lempster, NH (09)		Tidhar et al. 2010
Biglow Canyon, OR (Phase I; 09)		Enk et al. 2010	Lempster, NH (10)		Tidhar et al. 2011
Biglow Canyon, OR (Phase II; 09-10)		Enk et al. 2011a	Linden Ranch, WA (10-11)		Enz and Bay 2011
Biglow Canyon, OR (Phase II; 10-11)		Enk et al. 2012b	Locust Ridge, PA (Phase II; 09)		Arnett et al. 2011
Biglow Canyon, OR (Phase III; 10-11)		Enk et al. 2012a	Locust Ridge, PA (Phase II; 10)		Arnett et al. 2011
Blue Sky Green Field, WI (08; 09)	Gruver 2008	Gruver et al. 2009	Maple Ridge, NY (06)		Jain et al. 2007
Buffalo Gap I, TX (06)		Tierney 2007	Maple Ridge, NY (07)		Jain et al. 2009a
Buffalo Gap II, TX (07-08)		Tierney 2009	Maple Ridge, NY (07-08)		Jain et al. 2009d
Buffalo Mountain, TN (00-03)	Fiedler 2004	Nicholson et al. 2005	Marengo I, WA (09-10)		URS Corporation 2010b
Buffalo Mountain, TN (05)		Fiedler et al. 2007	Marengo II, WA (09-10)		URS Corporation 2010c
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000a	Mars Hill, ME (07)		Stantec 2008
Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000a	Mars Hill, ME (08)		Stantec 2009a
Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000a	Moraine II, MN (09)		Derby et al. 2010d
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (Fall 08)	Young et al. 2009b	Young et al. 2009b
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (09)	Young et al. 2009a, 2010b	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000a	Mount Storm, WV (10)	Young et al. 2010a, 2011b	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (11)		Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mountaineer, WV (03)		Kerns and Kerlinger 2004
Buffalo Ridge I, SD (09-10)		Derby et al. 2010b	Munnsville, NY (08)		Stantec 2009b
Buffalo Ridge II, SD (11-12)		Derby et al. 2012a	Nine Canyon, WA (02-03)		Erickson et al. 2003b
Casselman, PA (08)		Arnett et al. 2009a	Noble Altona, NY (10)		Jain et al. 2011b
Casselman, PA (09)		Arnett et al. 2010	Noble Bliss, NY (08)		Jain et al.2009e
Casselman Curtailment, PA (08)		Arnett et al. 2009b	Noble Bliss, NY (09)		Jain et al. 2010a
Cedar Ridge, WI (09)	BHE Environmental 2008	BHE Environmental 2010	Noble Chateaugay, NY (10)		Jain et al. 2011c
Cedar Ridge, WI (10)	BHE Environmental 2008	BHE Environmental 2011	Noble Clinton, NY (08)	Reynolds 2010a	Jain et al. 2009c
Cohocton/Dutch Hill, NY (09)		Stantec 2010	Noble Clinton, NY (09)	Reynolds 2010a	Jain et al. 2010b
Cohocton/Dutch Hills, NY (10)		Stantec 2011	Noble Ellenburg, NY (08)		Jain et al. 2009b
Combine Hills, OR (Phase I; 04-05)		Young et al. 2006	Noble Ellenburg, NY (09)	Reynolds 2010b	Jain et al. 2010c
Combine Hills, OR (11)		Enz et al. 2012	Noble Wethersfield, NY (10)		Jain et al. 2011a
Crescent Ridge, IL (05-06)		Kerlinger et al. 2007	NPPD Ainsworth, NE (06)		Derby et al. 2007
Criterion, MD (11)		Young et al. 2012a	Pebble Springs, OR (09-10)		Gritski and Kronner 2010b
Criterion, MD (12)		Young et al. 2013	Pioneer Prairie I, IA (Phase II; 11-12)		Chodachek et al. 2012
Crystal Lake II, IA (09)		Derby et al. 2010a	PrairieWinds ND1 (Minot), ND (10)		Derby et al. 2011c
Diablo Winds, CA (05-07)		WEST 2006, 2008	PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012c
Dillon, CA (08-09)		Chatfield et al. 2009	PrairieWinds SD1 (Crow Lake), SD (11-12)		Derby et al. 2012d
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Thompson et al. 2011	Red Hills, OK (12-13)		Derby et al. 2013b
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Thompson and Bay 2012	Ripley, Ont (08)		Jacques Whitford 2009
Elkhorn, OR (08)		Jeffrey et a. 2009b	Rugby, ND (10-11)		Derby et al. 2011b
Elkhorn, OR (10)		Enk et al. 2011b	Shiloh I, CA (06-09)		Kerlinger et al. 2009

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

Data from the following sources:

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

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

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Alite, CA (2009-2010)	0.55	0.12	0.24	Shrub/scrub & grassland	Chatfield et al. 2010
Alta Wind I, CA (2011-2012)	7.07	0.27	1.28	Woodland, grassland, shrubland	Chatfield et al. 2012
Alta Wind II-V, CA (2011-2012)	1.66	0.05	0.08	Desert scrub	Chatfield et al. 2012
Barton I & II, IA (2010-2011)	5.5	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. 2013
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. 2013a
Biglow Canyon, OR (Phase I; 2008)	1.76	0.03	1.99	Agriculture/grassland	Jeffrey et al. 2009a
Biglow Canyon, OR (Phase I; 2009)	2.47	0	0.58	Agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	0.14	2.71	Agriculture	Enk et al. 2011a
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	0.03	0.57	Grassland/shrub-steppe, agriculture	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	0.05	0.22	Grassland/shrub-steppe, agriculture	Enk et al. 2012a
Blue Sky Green Field, WI (2008; 2009)	7.17	0	24.57	Agriculture	Gruver et al. 2009
Buffalo Gap I, TX (2006)	1.32	0.1	0.1	Grassland	Tierney 2007
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. 2000a

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

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Buffalo Ridge, MN (Phase I; 1997)	2.51	0	NA	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1998)	3.14	0	NA	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1999)	1.43	0	0.74	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1998)	2.47	0	2.16	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1999)	3.57	0	2.59	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	NA	NA	4.35	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	NA	NA	1.64	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 1999)	5.93	0	2.72	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	NA	NA	3.71	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	NA	NA	1.81	Agriculture	Johnson et al. 2004
Buffalo Ridge I, SD (2009-2010)	5.06	0.2	0.16	Agriculture/grassland	Derby et al. 2010b
Buffalo Ridge II, SD (2011-2012)	1.99	0	2.81	Agriculture, grassland	Derby et al. 2012a
Casselman, PA (2008)	1.51	0	12.61	Forest	Arnett et al. 2009a
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. 2009b
Cedar Ridge, WI (2009)	6.55	0.18	30.61	Agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	3.72	0.13	24.12	Agriculture	BHE Environmental 2011
Cohocton/Dutch Hill, NY (2009)	1.39	0	8.62	Agriculture/forest	Stantec 2010

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

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

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

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Fowler I, IN (2009)	2.83	0	8.09	Agriculture	Good et al. 2011
Fowler III, IN (2009)	NA	NA	1.84	Agriculture	Good et al. 2011
Fowler I, II, III, IN (2010)	NA	NA	18.96	Agriculture	Good et al. 2011
Fowler I, II, III, IN (2011)	NA	NA	20.19	Agriculture	Good et al. 2012
Fowler I, II, III, IN (2012)	NA	NA	2.96	Agriculture	Good et al. 2013
Goodnoe, WA (2009-2010)	1.4	0.17	0.34	Grassland and shrub-steppe	URS Corporation 2010a
Grand Ridge I, IL (2009-2010)	0.48	0	2.1	Agriculture	Derby et al. 2010g
Harrow, Ont (2010)	NA	NA	11.13	Agriculture	Natural Resource Solutions Inc. (NRSI) 2011
Harvest Wind, WA (2010-2012)	2.94	0.23	1.27	Grassland/shrub-steppe	Downes and Gritski 2012a
Hay Canyon, OR (2009-2010)	2.21	0	0.53	Agriculture	Gritski and Kronner 2010a
High Sheldon, NY (2010)	1.76	0.06	2.33	Agriculture	Tidhar et al. 2012a
High Sheldon, NY (2011)	1.57	0	1.78	Agriculture	Tidhar et al. 2012b
High Winds, CA (2003-2004)	1.62	0.5	2.51	Agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2004-2005)	1.1	0.28	1.52	Agriculture/grassland	Kerlinger et al. 2006
Hopkins Ridge, WA (2006)	1.23	0.14	0.63	Agriculture/grassland	Young et al. 2007
Hopkins Ridge, WA (2008)	2.99	0.07	1.39	Agriculture/grassland	Young et al. 2009c
Judith Gap, MT (2006-2007)	NA	NA	8.93	Agriculture/grassland	TRC 2008
Judith Gap, MT (2009)	NA	NA	3.2	Agriculture/grassland	Poulton and Erickson 2010
Kewaunee County, WI (1999-2001)	1.95	0	6.45	Agriculture	Howe et al. 2002
Kibby, ME (2011)	NA	NA	0.12	Forest; commercial forest	Stantec 2012
Kittitas Valley, WA (2011-2012)	1.06	0.09	0.12	Sagebrush-steppe, grassland	Stantec Consulting Services 2012
Klondike, OR (2002-2003)	0.95	0	0.77	Agriculture/grassland	Johnson et al. 2003a
Klondike II, OR (2005-2006)	3.14	0.06	0.41	Agriculture/grassland	NWC and WEST 2007
Klondike III (Phase I), OR (2007-2009)	3.02	0.15	1.11	Agriculture/grassland	Gritski et al. 2010

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

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Klondike IIIa (Phase II), OR (2008-2010)	2.61	0.06	0.14	Grassland/shrub-steppe and agriculture	Gritski et al. 2011
Leaning Juniper, OR (2006-2008)	6.66	0.16	1.98	Agriculture	Gritski et al. 2008
Lempster, NH (2009)	3.38	0	3.11	Grasslands/forest/rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	2.64	0	3.57	Grasslands/forest/rocky embankments	Tidhar et al. 2011
Linden Ranch, WA (2010-2011)	6.65	0.27	1.68	Grassland/shrub-steppe, agriculture	Enz and Bay 2011
Locust Ridge, PA (Phase II; 2009)	0.84	0	14.11	Grassland	Arnett et al. 2011
Locust Ridge, PA (Phase II; 2010)	0.76	0	14.38	Grassland	Arnett et al. 2011
Maple Ridge, NY (2006)	NA	NA	11.21	Agriculture/forested	Jain et al. 2007
Maple Ridge, NY (2007-2008)	2.07	0.03	4.96	Agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007)	2.34		6.49	Agriculture/forested	Jain et al. 2009d
Marengo I, WA (2009-2010)	0.27	0	0.17	Agriculture	URS Corporation 2010b
Marengo II, WA (2009-2010)	0.16	0.05	0.27	Agriculture	URS Corporation 2010c
Mars Hill, ME (2007)	1.67	0	2.91	Forest	Stantec 2008
Mars Hill, ME (2008)	1.76	0	0.45	Forest	Stantec 2009a
Moraine II, MN (2009)	5.59	0.37	2.42	Agriculture/grassland	Derby et al. 2010d
Mount Storm, WV (Fall 2008)	NA	NA	6.62	Forest	Young et al. 2009b
Mount Storm, WV (2009)	3.85	0	17.53	Forest	Young et al. 2009a, 2010b
Mount Storm, WV (2010)	2.6	0.1	15.18	Forest	Young et al. 2010a, 2011b
Mount Storm, WV (2011)	4.24	0.03	7.43	Forest	Young et al. 2011a, 2012b
Mountaineer, WV (2003)	2.69	0.07	31.69	Forest	Kerns and Kerlinger 2004
Munnsville, NY (2008)	1.48	0.59	1.93	Agriculture/forest	Stantec 2009b
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

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

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Noble Bliss, NY (2009)	2.28	0.12	3.85	Agriculture/forest	Jain et al. 2010a
Noble Chateaugay, NY (2010)	1.66	0.08	2.44	Agriculture	Jain et al. 2011c
Noble Clinton, NY (2008)	1.59	0.1	3.14	Agriculture/forest	Jain et al. 2009c
Noble Clinton, NY (2009)	1.11	0.16	4.5	Agriculture/forest	Jain et al. 2010b
Noble Ellenburg, NY (2008)	0.83	0.11	3.46	Agriculture/forest	Jain et al. 2009b
Noble Ellenburg, NY (2009)	2.66	0.25	3.91	Agriculture/forest	Jain et al. 2010c
Noble Wethersfield, NY (2010)	1.7	0.13	16.3	Agriculture	Jain et al. 2011a
NPPD Ainsworth, NE (2006)	1.63	0.06	1.16	Agriculture/grassland	Derby et al. 2007
Pebble Springs, OR (2009-2010)	1.93	0.04	1.55	Grassland	Gritski and Kronner 2010b
Pine Tree, CA (2009-2010)	8.3	0.133	NA	Grassland	BioResource Consultants 2010
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	0	10.06	Agriculture, grassland	Chodachek et al. 2012
PrairieWinds ND1 (Minot), ND (2010)	1.48	0.05	2.13	Agriculture	Derby et al. 2011c
PrairieWinds ND1 (Minot), ND (2011)	1.56	0.05	1.39	Agriculture, grassland	Derby et al. 2012c
PrairieWinds SD1 (Crow Lake), SD (2011-2012)	1.41	0	1.23	Grassland	Derby et al. 2012d
Red Hills, OK (2012-2013)	0.08	0.04	0.11	Grassland	Derby et al. 2013b
Ripley, Ont (2008)	3.09	0.1	4.67	Agriculture	Jacques Whitford 2009
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. 2010a
Shiloh II, CA (2009-2010)	1.51	0.12	2.72	Agriculture	Kerlinger et al. 2010b
Stateline, OR/WA (2001-2002)	3.17	0.09	1.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.68	0.09	2.29	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2006)	1.23	0.11	0.95	Agriculture/grassland	Erickson et al. 2007
Stetson Mountain I, ME (2009)	2.68	0	1.4	Forest	Stantec 2009c

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

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

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Alite, CA (2009-2010)	8	24	80	8	200 m x 200 m	1 year	Weekly (spring, fall), bi-monthly (summer, winter)
Alta Wind I, CA (2011-2012)	100	150	80	25	120-m radius circle	12.5 months	Every two weeks
Alta Wind II-V, CA (2011-2012)	190	570	NA	41	120-m radius circle	14.5 months	Every two weeks
Barton Chapel, TX (2009-2010)	60	120	78	30	200 m x 200 m	1 year	10 turbines weekly, 20 monthly
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)
Beech Ridge, WV (2012)	67	100.5	80	67	40 m radius	7 months	Every two days
Big Horn, WA (2006-2007)	133	199.5	80	133	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Big Smile, OK (2012-2013)	66	132	NA	17 (plus one met tower)	100 x 100	1 year	Weekly (spring, summer, fall), monthly (winter)
Biglow Canyon, OR (Phase I; 2008)	76	125.4	80	50	110 m x 110 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase I; 2009)	76	125.4	80	50	110 m x 110 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2009-2010)	65	150	80	50	250 m x 250 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Biglow Canyon, OR (Phase II; 2010-2011)	65	150	NA	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Biglow Canyon, OR (Phase III; 2010-2011)	76	174.8	NA	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
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	NA	21	215 m x 215 m	10 months	Every 3 weeks
Buffalo Gap II, TX (2007-2008)	155	233	80	36	215 m x 215 m	14 months	Every 21 days
Buffalo Mountain, TN (2000-2003)	3	1.98	65	3	50-m radius	3 years	Bi-weekly, weekly, bi-monthly
Buffalo Mountain, TN (2005)	18	28.98	V47 = 65; V80 = 78	18	50-m radius	1 year	Bi-weekly, weekly, bi-monthly, and 2 to 5 day intervals
Buffalo Ridge, MN (1994-1995)	73	25	37	1994:10 plots (3 turbines/plot), 20 addition plots in Sept & Oct 1994, 1995: 30 turbines search every other week (Jan-Mar), 60 searched weekly (Apr, July, Aug) 73 searched weekly (May-June and Sept-Oct), 30 searched weekly (Nov-Dec)	100 x 100m	20 months	Varies. See number turbines searched or page 44 of report

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Buffalo Ridge, MN (Phase I; 1996)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1997)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1998)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1999)	73	25	36	21	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1998)	143	107.25	50	40	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1999)	143	107.25	50	40	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	143	107.25	50	83	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	143	107.25	50	103	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge, MN (Phase III; 1999)	138	103.5	50	30	126 m x 126 m	1 year	Bi-monthly (spring, summer, and fall)
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)

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Buffalo Ridge II, SD (2011-2012)	105	210	78	65 (60 road and pad, 5 turbine plots)	100 x 100m	1 year	Weekly (spring, summer, fall), monthly (winter)
Casselman, PA (2008)	23	34.5	80	10	126 m x 120 m	7 months	Daily
Casselman, PA (2009)	23	34.5	80	10	126 m x 120 m	7.5 months	Daily searches
Casselman Curtailment, PA (2008)	23	35.4	80	12 experimental; 10 control	126 m x 120 m	2.5 months	Daily
Castle River, Alb (2001-2002)	60	39.6	50	60	50-m radius	2 years	Weekly, bi-weekly
Castle River, Alb (2001-2002)	60	39.6	50	60	50-m radius	2 years	Weekly, bi-weekly
Cedar Ridge, WI (2009)	41	67.6	80	20	160 m x 160 m	Spring, summer, fall	Daily, every 4 days; late fall searched every 3 days
Cedar Ridge, WI (2010)	41	68	80	20	160 m x 160 m	1 year	Five turbines were surveyed daily, 15 turbines surveyed every 4 days in rotating groups each day. All 20 surveyed every three days during late fall
Cohocton/Dutch Hill, NY (2009)	50	125	80	17	130 m x 130 m	Spring, summer, fall	Daily (5 turbines), weekly (12 turbines)
Cohocton/Dutch Hills, NY (2010)	50	125	80	17	120 m x 120 m	Spring, summer, fall	Daily, weekly
Combine Hills, OR (Phase I; 2004-2005)	41	41	53	41	90-m radius	1 year	Monthly
Combine Hills, OR (2011)	104	104	53	52 (plus 1 MET tower)	180 m x 180 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Condon, OR	84	NA	NA	NA	NA	NA	NA
Crescent Ridge, IL (2005-2006)	33	49.5	80	33	70-m radius	1 year	Weekly (fall, spring)

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

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

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
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 III, IN (2009)	60	99	78	12	160 m x 160 m	10 weeks	Weekly, bi-weekly
Fowler I, II, III, IN (2010)	355	600	Vestas = 80, Clipper = 80, GE = 80	36 turbines, 100 road and pads	80 m x 80 m for turbines ; 40-m radius for roads and pads	Spring, fall	Daily, weekly
Fowler I, II, III, IN (2011)	355	600	Vestas = 80, Clipper = 80, GE = 80	177 road and pads (spring), 9 turbines & 168 roads and pads (fall)	turbines (80 m circular plot), roads and pads (out to 80 m)	Spring, fall	Daily, weekly
Fowler I, II, III, IN (2012)	355	600	Vestas = 80, Clipper = 80, GE = 80	118 roads and pads	roads and pads (out to 80 m)	2.5 months	Weekly
Goodnoe, WA (2009-2010)	47	94	80	24	180 m x 180 m	1 year	14 days during migration periods, 28 days during non-migration periods
Grand Ridge I, IL (2009-2010)	66	99	80	30	160 m x 160 m	1 year	Weekly, monthly

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Harrow, Ont (2010)	24 (four 6-turb facilities)	39.6	NA	12 in July, 24 Aug-Oct	50-m radius from turbine base	4 months	Twice-weekly
Harvest Wind, WA (2010-2012)	43	98.9	80	32	180 m x 180 m & 240 m x 240 m	2 years	Twice a week, weekly and monthly
Hay Canyon, OR (2009-2010)	48	100.8	79	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
High Winds, CA (2003-2004)	90	162	60	90	75-m radius	1 year	Bi-monthly
High Winds, CA (2004-2005)	90	162	60	90	75-m radius	1 year	Bi-monthly
Hopkins Ridge, WA (2006)	83	150	67	41	180 m x 180 m	1 year	Monthly, weekly (subset of 22 turbines spring and fall migration)
Hopkins Ridge, WA (2008)	87	156.6	67	41-43	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Jersey Atlantic, NJ (2008)	5	7.5	80	5	130 m x 120 m	9 months	Weekly
Judith Gap, MT (2006-2007)	90	135	80	20	190 m x 190 m	7 months	Monthly
Judith Gap, MT (2009)	90	135	80	30	100 m x 100 m	5 months	Bi-monthly
Kewaunee County, WI (1999-2001)	31	20.46	65	31	60 m x 60 m	2 years	Bi-weekly (spring, summer), daily (spring, fall migration), weekly (fall, winter)
Kibby, ME (2011)	44	132	124	22 turbines	75-m diameter circular plots	22 weeks	Avg. 5-day
Kittitas Valley, WA (2011-2012)	48	100.8	80	48	100 m x 102 m	1 year	Bi weekly from Aug 15 - Oct 31 and March 16 - May 15; every 4 weeks from Nov 1 - March 15 and May 16 - Aug 14

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Klondike, OR (2002-2003)	16	24	80	16	140 m x 140 m	1 year	Monthly
Klondike II, OR (2005-2006)	50	75	80	25	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (summer, winter)
Klondike III (Phase I), OR (2007-2009)	125	223.6	GE = 80; Siemens= 80, Mitsubishi = 80	46	240 m x 240 m (1.5MW) 252 m x 252 m (2.3MW)	2 year	Bi-monthly (spring, fall migration), monthly (summer, winter)
Klondike IIIa (Phase II), OR (2008-2010)	51	76.5	GE = 80	34	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (summer, winter)
Leaning Juniper, OR (2006-2008)	67	100.5	80	17	240 m x 240 m	2 years	Bi-monthly (spring, fall), monthly (winter, summer)
Lempster, NH (2009)	12	24	78	4	120 m x 130 m	6 months	Daily
Lempster, NH (2010)	12	24	78	12	120 m x 130 m	6 months	Weekly
Linden Ranch, WA (2010-2011)	25	50	80	25	110 m x 110 m	1 year	Bi-weekly(spring, fall), monthly (summer, winter)
Locust Ridge, PA (Phase II; 2009)	51	102	80	15	120m x 126m	6.5 months	Daily
Locust Ridge, PA (Phase II; 2010)	51	102	80	15	120m x 126m	6.5 months	Daily
Madison, NY (2001-2002)	7	11.55	67	7	60-m radius	1 year	Weekly (spring, fall), monthly (summer)
Maple Ridge, NY (2006)	120	198	80	50	130 m x 120 m	5 months	Daily (10 turbines), every 3 days (10 turbines), weekly (30 turbines)
Maple Ridge, NY (2007)	195	321.75	80	64	130 m x 120 m	7 months	Weekly
Maple Ridge, NY (2007-2008)	195	321.75	80	64	130 m x 120 m	7 months	Weekly

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Marengo I, WA (2009-2010)	78	140.4	67	39	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Marengo II, WA (2009-2010)	39	70.2	67	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Mars Hill, ME (2007)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	Spring, summer, fall	Daily (2 random turbines), weekly (all turbines): extended plot searched once per season
Mars Hill, ME (2008)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	Spring, summer, fall	Weekly: extended plot searched once per season
McBride, Alb (2004)	114	75	50	114	4 parallel transects 120-m wide	1 year	Weekly, bi-weekly
Melancthon, Ont (Phase I; 2007)	45	NA	NA	45	35m radius	5 months	Weekly, twice weekly
Meyersdale, PA (2004)	20	30	80	20	130 m x 120 m	6 weeks	Daily (half turbines), weekly (half turbines)
Moraine II, MN (2009)	33	49.5	82.5	30	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
Mount Storm, WV (2009)	132	264	78	44	varied	4.5 months	Weekly (28 turbines), daily (16 turbines)
Mount Storm, WV (2010)	132	264	78	24	20 to 60 m from turbine	6 months	Daily
Mount Storm, WV (2011)	132	264	78	24	varied	6 months	Daily
Mount Storm, WV (Fall 2008)	82	164	78	27	varied	3 months	Weekly (18 turbines), daily (9 turbines)
Mountaineer, WV (2003)	44	66	80	44	60-m radius	7 months	Weekly, monthly
Mountaineer, WV (2004)	44	66	80	44	130 m x 120 m	6 weeks	Daily, weekly

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Munnsville, NY (2008)	23	34.5	69.5	12	120 m x 120 m	Spring, summer, fall	Weekly
Nine Canyon, WA (2002-2003)	37	48.1	60	37	90-m radius	1 year	Bi-monthly (spring, summer, fall), monthly (winter)
Noble Altona, NY (2010)	65	97.5	80	22	120 m x 120 m	Spring, summer, fall	Daily, weekly
Noble Bliss, NY (2008)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
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 Chateaugay, NY (2010)	71	106.5	80	24	120 m x 120 m	Spring, summer, fall	Weekly
Noble Clinton, NY (2008)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Clinton, NY (2009)	67	100	80	23	120 m x 120 m	Spring, summer, fall	Daily (8 turbines), weekly (15 turbines), all turbines weekly from July 1 to August 15
Noble Ellenburg, NY (2008)	54	80	80	18	120 m x 120 m	Spring, summer, fall	Daily (6 turbines), 3-day (6 turbines), weekly (6 turbines)
Noble Ellenburg, NY (2009)	54	80	80	18	120 m x 120 m	Spring, summer, fall	Daily (6 turbines), weekly (12 turbines), all turbines weekly from July 1 to August 15
Noble Wethersfield, NY (2010)	84	126	80	28	120 m x 120 m	Spring, summer, fall	Weekly
NPPD Ainsworth, NE (2006)	36	20.5	70	36	220 m x 220 m	Spring, summer, fall	Bi-monthly
Oklahoma Wind Energy Center, OK (2004; 2005)	68	102	70	68	20m radius	3 months (2 years)	Bi-monthly

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
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)	90	135	65	40	NA	1 year	Bi-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)
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 (Crow Lake), SD (2011-2012)	108	162	80	50	200 x 200m	1 year	Twice monthly (spring, summer, fall), monthly (winter)
Prince Wind Farm, Ont (2006)	126	189	80	38	63-m radius	4 months	Daily, weekly
Prince Wind Farm, Ont (2007)	126	189	80	38 turbines from January 1st - July 8th, 126 turbines from July 9th-October 31st	63- to 45-m radius	10 months	Daily, weekly
Prince Wind Farm, Ont (2008)	126	189	80	126	45m radius	6.5 months	Daily, 3x/week, 2x/week
Red Canyon, TX (2006-2007)	56	84	70	28	200 m x 200 m in fall and winter; 160 m x 160 m in spring and summer	1 year	Every 14 days in fall and winter; 7 days in spring, 3 days in summer
Red Hills, OK (2012-2013)	82	123	NA	20 (plus one met tower)	100 x 100	1 year	Weekly (spring, summer, fall), monthly (winter)

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Ripley, Ont (2008)	38	76	64	38	80 m x 80 m	Spring, fall	Twice weekly for odd turbines; weekly for even turbines.
Ripley, Ont (2008-2009)	38	76	64	38	80 m x 80 m	6 weeks	Twice weekly for odd turbines; weekly for even turbines.
Rugby, ND (2010-2011)	71	149	78	32	200 m x 200 m	1 year	Weekly (spring, fall; migratory turbines), monthly (non-migratory turbines)
San Gorgonio, CA (1997-1998; 1999-2000)	3000	NA	24.4-42.7	NA	50-m radius	2 years	Quarterly
Searsburg, VT (1997)	11	7	65	11	20- to 55-m radius	Spring, fall	Weekly (fall migration)
High Sheldon, NY (2010)	75	112.5	80	25	115 m x 115 m	7 months	Daily (8 turbines), weekly (17 turbines)
High Sheldon, NY (2011)	75	112.5	80	25	115 m x 115 m	7 months	Daily (8 turbines), weekly (17 turbines)
Shiloh I, CA (2006-2009)	100	150	65	100	105-m radius	3 years	Weekly
Shiloh II, CA (2009-2010)	75	150	33 turbs = 115; 42 turbs = 125	25	100m radius	1 year	Once/week
SMUD Solano, CA (2004-2005)	22	15	65	22	60-m radius	1 year	Bi-monthly
Stateline, OR/WA (2001-2002)	454	299	50	124	minimum 126 m x 126 m	17 months	Bi-weekly, monthly
Stateline, OR/WA (2003)	454	299	50	153	minimum 126 m x 126 m	1 year	Bi-weekly, monthly

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

Project Name	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Stateline, OR/WA (2006)	454	299	50	39	variable turbine strings	1 year	Bi-weekly
Stetson Mountain I, ME (2009)	38	57	80	19	76-m diameter	27 weeks (spring, summer, fall)	Weekly
Stetson Mountain I, ME (2011)	38	57	80	19	varied	6 months	Weekly
Stetson Mountain II, ME (2010)	17	25.5	80	17	varied	6 months	Weekly (3 turbines twice a week)
Summerview, Alb (2005-2006)	39	70.2	67	39	140 m x 140 m	1 year	Weekly, bi-weekly (May to July, September)
Summerview, Alb (2006; 2007)	39	70.2	65	39	52-m radius; 2 spiral transects 7 m apart	Summer, fall (2 years)	Daily (10 turbines), weekly (29 turbines)
Tehachapi, CA (1996-1998)	3300	NA	14.7 to 57.6	201	50-m radius	20 months	Quarterly
Top of Iowa, IA (2003)	89	80	71.6	26	76 m x 76 m	Spring, summer, fall	Once every 2 to 3 days
Top of Iowa, IA (2004)	89	80	71.6	26	76 m x 76 m	Spring, summer, fall	Once every 2 to 3 days
Tuolumne (Windy Point I), WA (2009-2010)	62	136.6	80	21	180 m x 180 m	1 year	Monthly throughout the year, a sub-set of 10 turbines were also searched weekly during the spring, summer, and fall
Vansycle, OR (1999)	38	24.9	50	38	126 m x 126 m	1 year	Monthly
Vantage, WA (2010-2011)	60	90	80	30	240 m x 240 m	1 year	Monthly, a subset of 10 searched weekly during migration
Wessington Springs, SD (2009)	34	51	80	20	200 m x 200 m	Spring, summer, fall	Bi-monthly

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

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

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

Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Alite, CA (09-10)	Chatfield et al. 2010	Klondike II, OR (05-06)	NWC and WEST 2007
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Klondike III (Phase I), OR (07-09)	Gritski et al. 2010
Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Klondike IIIa (Phase II), OR (08-10)	Gritski et al. 2011
Barton I & II, IA (10-11)	Derby et al. 2011a	Leaning Juniper, OR (06-08)	Gritski et al. 2008
Barton Chapel, TX (09-10)	WEST 2011	Lempster, NH (09)	Tidhar et al. 2010
Beech Ridge, WV (12)	Tidhar et al. 2013	Lempster, NH (10)	Tidhar et al. 2011
Big Horn, WA (06-07)	Kronner et al. 2008	Linden Ranch, WA (10-11)	Enz and Bay 2011
Big Smile, OK (12-13)	Derby et al. 2013a	Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Madison, NY (01-02)	Kerlinger 2002b
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Maple Ridge, NY (06)	Jain et al. 2007
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Maple Ridge, NY (07)	Jain et al. 2009a
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Maple Ridge, NY (07-08)	Jain et al. 2009d
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Marengo I, WA (09-10)	URS Corporation 2010b
Buena Vista, CA (08-09)	Insignia Environmental 2009	Marengo II, WA (09-10)	URS Corporation 2010c
Buffalo Gap I, TX (06)	Tierney 2007	Mars Hill, ME (07)	Stantec 2008
Buffalo Gap II, TX (07-08)	Tierney 2009	Mars Hill, ME (08)	Stantec 2009a
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	McBride, Alb (04)	Brown and Hamilton 2004
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Melancthon, Ont (Phase I; 07)	Stantec Ltd. 2008
Buffalo Ridge, MN (94-95)	Osborn et al. 1996, 2000	Meyersdale, PA (04)	Arnett et al. 2005
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000a	Moraine II, MN (09)	Derby et al. 2010d
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000a	Mount Storm, WV (Fall 08)	Young et al. 2009b
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000a	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000a	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000a	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Mountaineer, WV (04)	Arnett et al. 2005
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000a	Nine Canyon, WA (02-03)	Erickson et al. 2003b
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Noble Altona, NY (10)	Jain et al. 2011b
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Noble Bliss, NY (08)	Jain et al.2009e
Buffalo Ridge I, SD (09-10)	Derby et al. 2010b	Noble Bliss, NY (09)	Jain et al. 2010a
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Noble Chateaugay, NY (10)	Jain et al. 2011c
Casselman, PA (08)	Arnett et al. 2009a	Noble Clinton, NY (08)	Jain et al. 2009c
Casselman, PA (09)	Arnett et al. 2010	Noble Clinton, NY (09)	Jain et al. 2010b
Casselman Curtailment, PA (08)	Arnett et al. 2009b	Noble Ellenburg, NY (08)	Jain et al. 2009b
Castle River, Alb. (01)	Brown and Hamilton 2006a	Noble Ellenburg, NY (09)	Jain et al. 2010c
Castle River, Alb. (02)	Brown and Hamilton 2006a	Noble Wethersfield, NY (10)	Jain et al. 2011a
Cedar Ridge, WI (09)	BHE Environmental 2010	NPPD Ainsworth, NE (06)	Derby et al. 2007
Cedar Ridge, WI (10)	BHE Environmental 2011	Oklahoma Wind Energy Center, OK (04; 05)	Piorkowski and O'Connell 2010
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Cohocton/Dutch Hills, NY (10)	Stantec 2011	Pine Tree, CA (09-10)	BioResource Consultants 2010
Combine Hills, OR (Phase I; 04-05)	Young et al. 2006	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Combine Hills, OR (11)	Enz et al. 2012	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011c
Condon, OR	Fishman Ecological Services 2003	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Crescent Ridge, IL (05-06)	Kerlinger et al. 2007	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
Criterion, MD (11)	Young et al. 2012a	Prince Wind Farm, Ont (06)	Natural Resource Solutions 2009
Criterion, MD (12)	Young et al. 2013	Prince Wind Farm, Ont (07)	Natural Resource Solutions 2009
Crystal Lake II, IA (09)	Derby et al. 2010a	Prince Wind Farm, Ont (08)	Natural Resource Solutions 2009
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. 2013b
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Ripley, Ont (08)	Jacques Whitford 2009
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Ripley, Ont (08-09)	Golder Associates 2010
Elkhorn, OR (08)	Jeffrey et a. 2009b	Rugby, ND (10-11)	Derby et al. 2011b
Elkhorn, OR (10)	Enk et al. 2011b	San Gorgonio, CA (97-98; 99-00)	Anderson et al. 2005
Elm Creek, MN (09-10)	Derby et al. 2010c	Searsburg, VT (97)	Kerlinger 2002a
Elm Creek II, MN (11-12)	Derby et al. 2012b	Shiloh I, CA (06-09)	Kerlinger et al. 2009
Erie Shores, Ont. (06)	James 2008	Shiloh II, CA (09-10)	Kerlinger et al. 2010b
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	SMUD Solano, CA (04-05)	Erickson and Sharp 2005
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b	Stateline, OR/WA (01-02)	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003b	Stateline, OR/WA (03)	Erickson et al. 2004
Forward Energy Center, WI (08-10)	Grodsky and Drake 2011	Stateline, OR/WA (06)	Erickson et al. 2007

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

Data from the following sources:

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