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

## Final Report for the Second Year of Operation

## January 2014 – January 2015

**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 (Mitigation Measure [MM] 4.4-17) and breeding raptor monitoring (MM 4.4-16) during the second year of operation of NSR, January 2014 to January 2015. Results of monitoring during the initial year of operation can be found in Levenstein et al. (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.

A sample of 30 turbines (30% of 100 total turbines), was searched every two weeks during standardized carcass searches from January 14, 2014, to January 16, 2015, for a total of 748 turbine 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 turbines in this part of the facility during spring migration for a total of 126 turbine searches. Over the course of fatality monitoring conducted during the second year of operation, 14 bird fatalities, representing seven identifiable species, were found during carcass surveys or incidentally. The bird species most commonly found as fatalities were unidentified passerine (four fatalities), mourning dove (two fatalities), and red-tailed hawk (two fatalities). Aside from the two red-tailed hawk fatalities, the only other diurnal raptor fatality was a single golden eagle found on January 9, 2015, during the last round of scheduled searches of the second year of monitoring. Six of the 14 bird fatalities documented during the study were found during the intensive spring searches. These included one of the red-tailed hawk fatalities and two of the unidentified passerine fatalities. Bird fatalities were found during each season, but were slightly more concentrated during spring (five fatalities) and summer (four fatalities). No state or federally listed bird species were found during the study; however, the golden eagle is protected under the federal Bald and Golden Eagle Protection Act.

During the study a total of 13 bats, representing two identifiable species, were found during carcass surveys or incidentally. The bat species found as fatalities during the study were Mexican free-tailed bat (eight fatalities) and hoary bat (four fatalities); one bat fatality was not identifiable. Two of the 13 bat fatalities documented during the study were found during the intensive spring searches (one Mexican free-tailed and one hoary bat). No state or federally listed bat species were found during the study. The hoary bat is not listed, but appears on the CDFW Special Animals List (CDFW 2015) and is protected under CEQA. All bat fatalities occurred between late April and early October.

A total of 105 bird carcasses were placed for searcher efficiency trials: 24 large birds and 81 small birds. Due to the unavailability of bat carcasses, small birds (house sparrows and Coturnix quail) were used as surrogates for bats. Overall searcher efficiency rates were 95.7% for large birds, 78.9% for small birds, and 78.9% for bats. A total of 180 carcasses were placed during carcass removal trials. By day 10, fewer than half of the large birds remained, while approximately 5% of small birds/bat surrogates remained. Mean carcass removal time for small birds/bat surrogates varied by season: 2.16 days in summer, fall, and spring, and 4.57 days in winter. The mean carcass removal time for large birds remained the same throughout the year: 12.16 days.

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 varied by season: 0.12 for small birds and bats during summer, fall, and spring, and 0.24 in winter. For large birds, the probability was higher and remained the same throughout the year at 0.56.

Based on the 1.6-megawatt (MW) capacity of the turbines at NSR, the estimated fatality rate for all birds was 1.23 birds per MW per year, with an estimated fatality rate of 0.07 diurnal raptors per MW per year. The estimated fatality rate for bats was 1.45 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) and gathered reproductive success data where possible, within the NSR project area. Three complete surveys of the project area were conducted, with the first occurring in March, the second in April, and the third in May. Active raptor nests documented during the survey included four red-tailed hawk nests and one great-horned owl nest. Two of the red-tailed hawk nests successfully fledged young while the results of the other two nests were undetermined. The great-horned owl nest also successfully fledged young. Additionally, 18 inactive nest structures were recorded.

## STUDY PARTICIPANTS

**Western EcoSystems Technology**

| | |
|---|---|
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## REPORT REFERENCE

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# 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). As described in Mitigation Measures (MM) 4.4-17 and 4.4-16 of the *North Sky River Wind Energy Project and Jawbone Wind Energy Project Draft 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 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 second year of operation, from January 2014 to January 2015. Results from the initial year of monitoring (January 2013 – January 2014) can be found in Levenstein et al. (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 [formerly CDFG]) 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 MM 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 during the 2014 breeding season.

Post-construction monitoring at NSR was conducted from January 14, 2014, through January 16, 2015. In addition to site-specific data, this report presents existing information and results of post-construction studies conducted at other wind energy facilities in the region and 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, in Kern County, California (Figure 1). The NSR 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.

The NSR 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 drainages 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*).

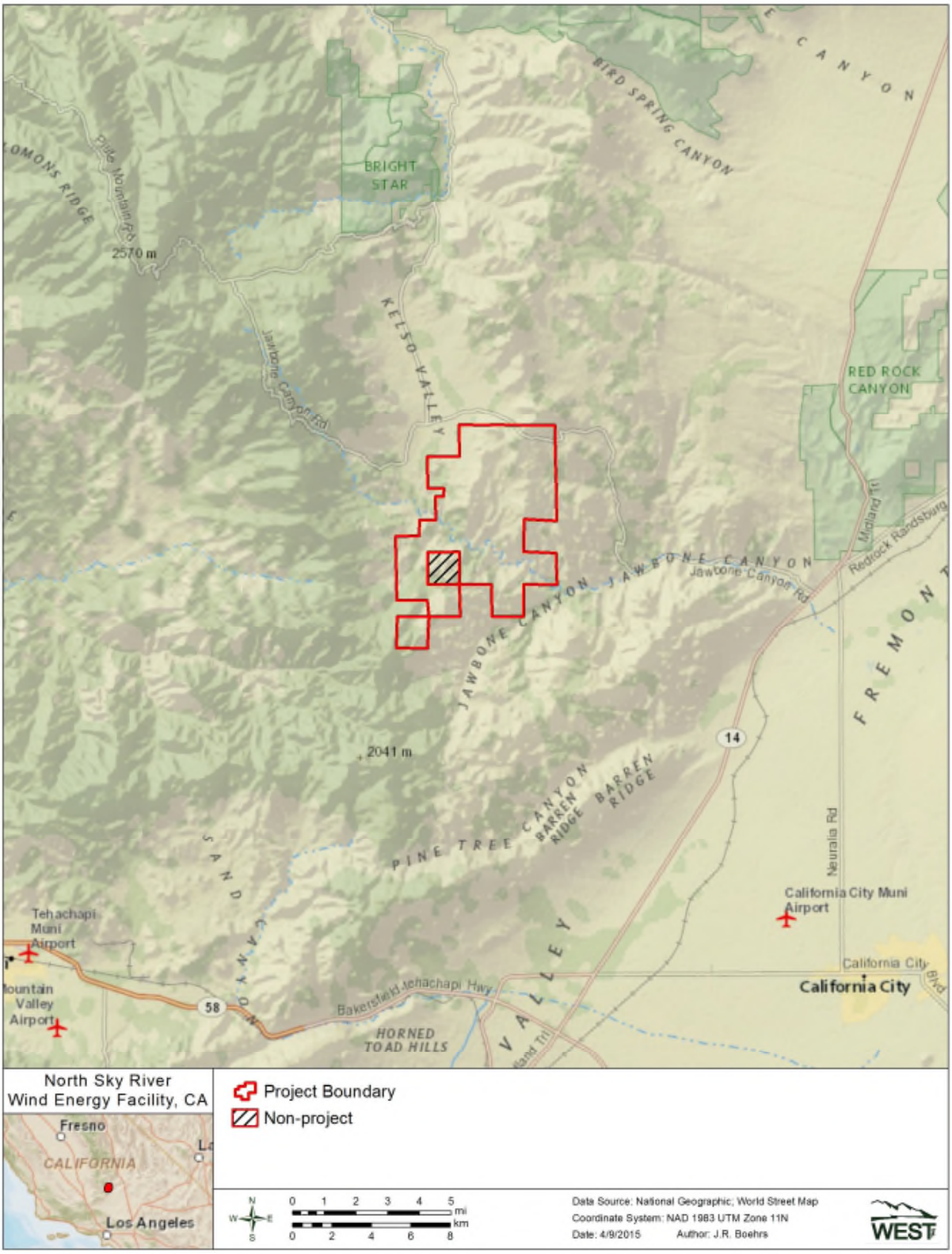


**Figure 1. Location of the North Sky River Wind Energy Facility.**

# METHODS

## Avian and Bat Fatality Monitoring

The primary objective of the fatality monitoring study was to estimate the level of bird and bat mortality attributable to collisions with wind turbines at the facility on an annual basis. The methods for the fatality study were broken into four primary components: 1) standardized carcass surveys of selected turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass 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.

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 persistence 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 was to systematically search the ground beneath turbines for avian and bat casualties that are attributable to collision with project facilities. Prior to the initiation of the 4-year fatality monitoring study, in accordance with the CEC and USFWS Guidelines (CDFG and CEC 2007, USFWS 2012), a sample of 30 turbines (30% of NSR's 100 turbines) was selected for conducting the carcass searches. 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). The same turbine sample was used for the first two years of the study, and will continued to be used for each of the remaining two years of the study.

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; however, only casualties found within standard search areas were used in the estimation of fatality rates. 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 November 17), winter (November 18 to March 1), spring (March 3 to May 31), and summer (June 2 to September 6) at each of the 30 sampled turbines.

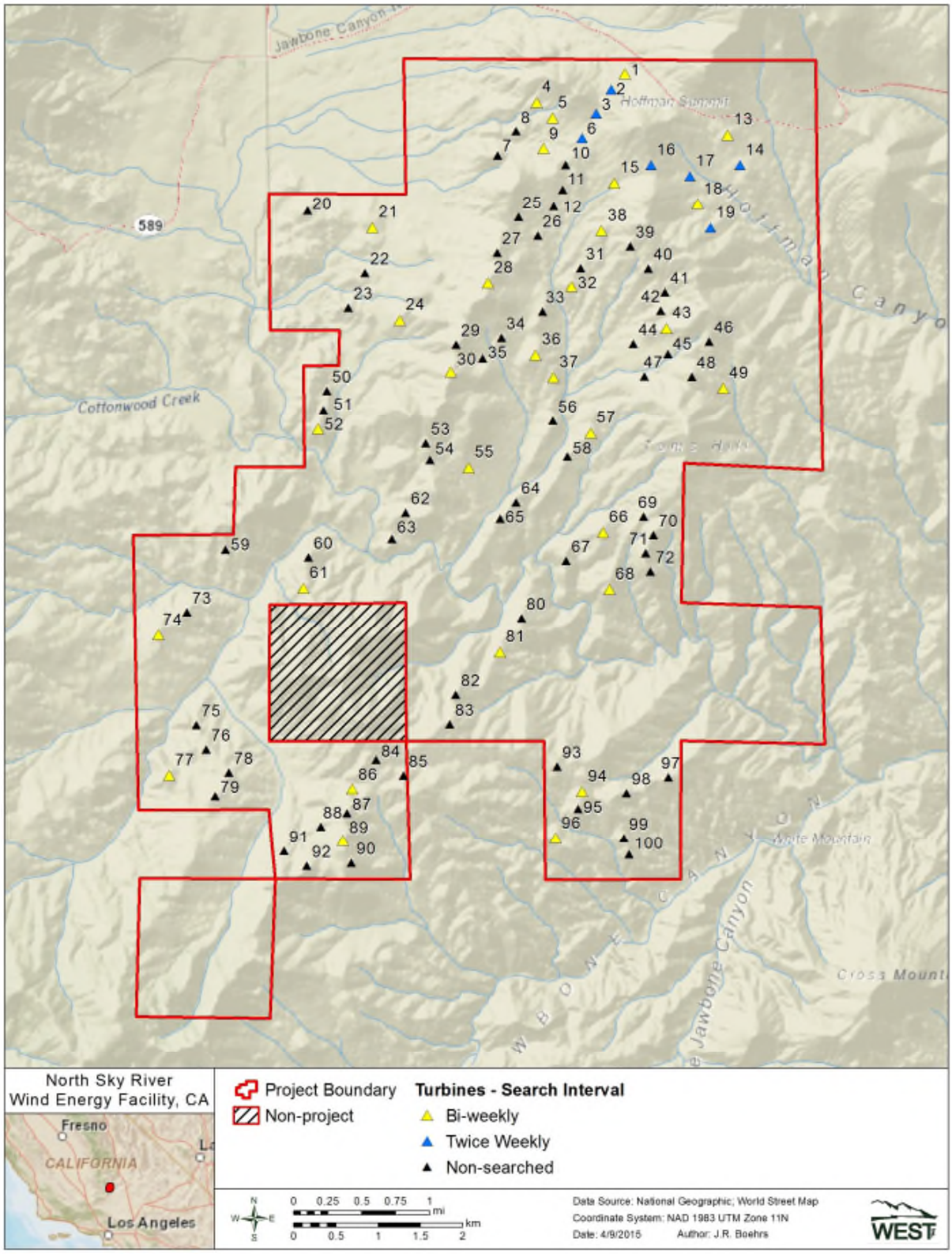


**Figure 2. Turbine layout at the North Sky River Wind Energy Facility showing turbines selected for fatality monitoring.**

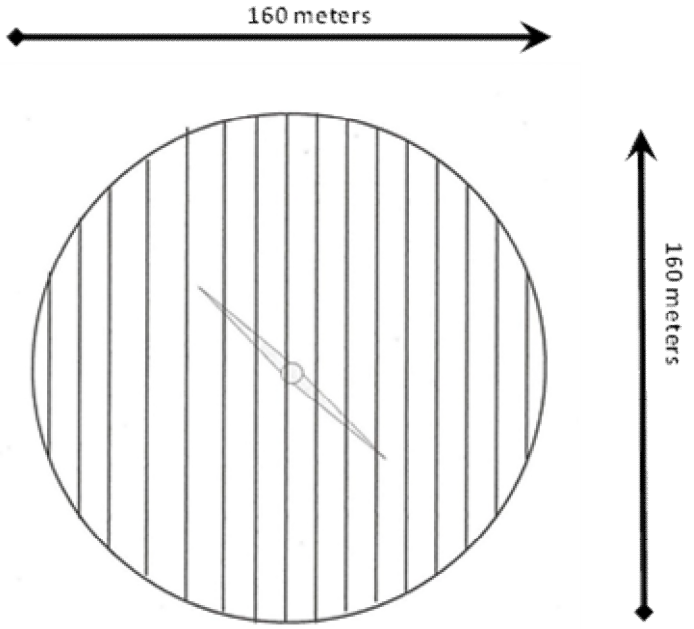


**Figure 3. Schematic of turbine search plot and transects.**

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, we implemented a monitoring study protocol that included an intensive carcass search effort conducted each spring at seven turbines located in the northeast corner of NSR (Figure 2). For approximately eight weeks (April 15 – June 12, 2014), during spring migration, we searched each of these seven turbines 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.

Five searcher efficiency trials were conducted throughout the year to encompass variable field conditions that may affect surveyor carcass detection, and approximately two to six large bird and 13 to 19 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*) and rock pigeons (*Columba livia*), while small birds included house

sparrows (*Passer domesticus*) and Coturnix quail (*Coturnix* sp.). Due to the unavailability of bat carcasses, small birds were used as proxies.

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 large bird carcasses and 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:

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

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:

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

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 90% confidence intervals for reported estimates 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 lower 5$^{th}$ and upper 95$^{th}$ percentiles of the 1,000 bootstrap estimates are estimates of the lower limit and upper limit of 90% confidence intervals.

**Raptor Breeding Monitoring**

The primary objective of the raptor breeding monitoring was to determine the presence or absence of raptor nests, particularly mid-sized to large raptor nests, and associated reproductive success information where possible within areas of suitable habitat in the NSR project area. Following guidance of MM 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 2014 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 in March, the second in April, and the third in May.

Global Positioning System 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) ArcGIS 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 every two weeks during the year-round standardized carcass searches, for a total of 748 plot searches. Additionally, searches were conducted at seven turbines twice per week during spring migration for a total of 126 plot searches. Over the course of the fatality monitoring study, 14 birds and 23 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 casualties is presented in Appendix A.

**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, 2014 – January 16, 2015.**

| | Fatalities during Scheduled Searches | | Incidental Fatalities at Search Plots* | | Other Incidentals | | Total | |
|---|---|---|---|---|---|---|---|---|
| **Species** | **Total** | **% Comp.** | **Total** | **% Comp.** | **Total** | **% Comp.** | **Total** | **% Comp.** |
| **Birds** | | | | | | | | |
| mourning dove | 2 | 14.3 | 0 | 0 | 0 | 0 | 2 | 14.3 |
| red-tailed hawk | 2 | 14.3 | 0 | 0 | 0 | 0 | 2 | 14.3 |
| unidentified small bird | 2 | 14.3 | 0 | 0 | 0 | 0 | 2 | 14.3 |
| unidentified passerine | 2 | 14.3 | 0 | 0 | 0 | 0 | 2 | 14.3 |
| golden eagle | 1 | 7.1 | 0 | 0 | 0 | 0 | 1 | 7.1 |
| horned lark | 1 | 7.1 | 0 | 0 | 0 | 0 | 1 | 7.1 |
| lark sparrow | 1 | 7.1 | 0 | 0 | 0 | 0 | 1 | 7.1 |
| unidentified large bird | 1 | 7.1 | 0 | 0 | 0 | 0 | 1 | 7.1 |
| unidentified sparrow | 1 | 7.1 | 0 | 0 | 0 | 0 | 1 | 7.1 |
| Wilson's warbler | 1 | 7.1 | 0 | 0 | 0 | 0 | 1 | 7.1 |
| **Overall Birds** | **14** | **100** | **0** | **0** | **0** | **0** | **14** | **100** |
| **Bats** | | | | | | | | |
| Mexican free-tailed bat | 5 | 50 | 1 | 100 | 2 | 100 | 8 | 61.5 |
| hoary bat | 4 | 40 | 0 | 0 | 0 | 0 | 4 | 30.8 |
| unidentified bat | 1 | 10 | 0 | 0 | 0 | 0 | 1 | 7.7 |
| **Overall Bats** | **10** | **100** | **1** | **100** | **2** | **100** | **13** | **100** |

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

### *Bird Fatalities*

During the second year of the fatality monitoring study, 14 birds comprising six identifiable species were found during scheduled searches (Table 1, Figure 4). No bird casualties were found incidentally to the formal carcass searches. The bird species most commonly found as casualties during the study were red-tailed hawk (*Buteo jamaicensis*; two carcasses) and mourning dove (*Zenaida macroura*; two carcasses; Table 1). All other identifiable bird species found during the study were represented by individual carcasses/feather spots. Aside from the

two red-tailed hawk casualties, the only other diurnal raptor casualty was a single golden eagle (*Aquila chrysaetos*) found at the end of the study year (Table 1). Only four of the 14 bird casualties 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 of the red-tailed hawk casualties (Appendix A). No state or federally listed bird species were found during the study; however, the golden eagle is a fully protected species in California and it is protected under the federal Bald and Golden Eagle Protection Act (BGEPA 1940).

In general, casualties 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 two carcasses at Turbines 14 and 57; all other search plots had one or no bird fatalities (Figures 4 and 5). Of the bird fatalities, all (100%) were found between 20 and 80 m (66 and 262 ft) from the turbine, with 71.5% found between 50 and 80 m (164 and 262 ft) of the turbine (Table 2, Figure 6). Bird fatalities were found during each season, but were slightly more concentrated during spring (Figure 7). Additionally, there was a spike in the number of bird carcasses found per turbine in early July, when two unidentified small birds and a red-tailed hawk were found during a single search period; however, no other birds were found during the summer (Figure 7, Appendix A).

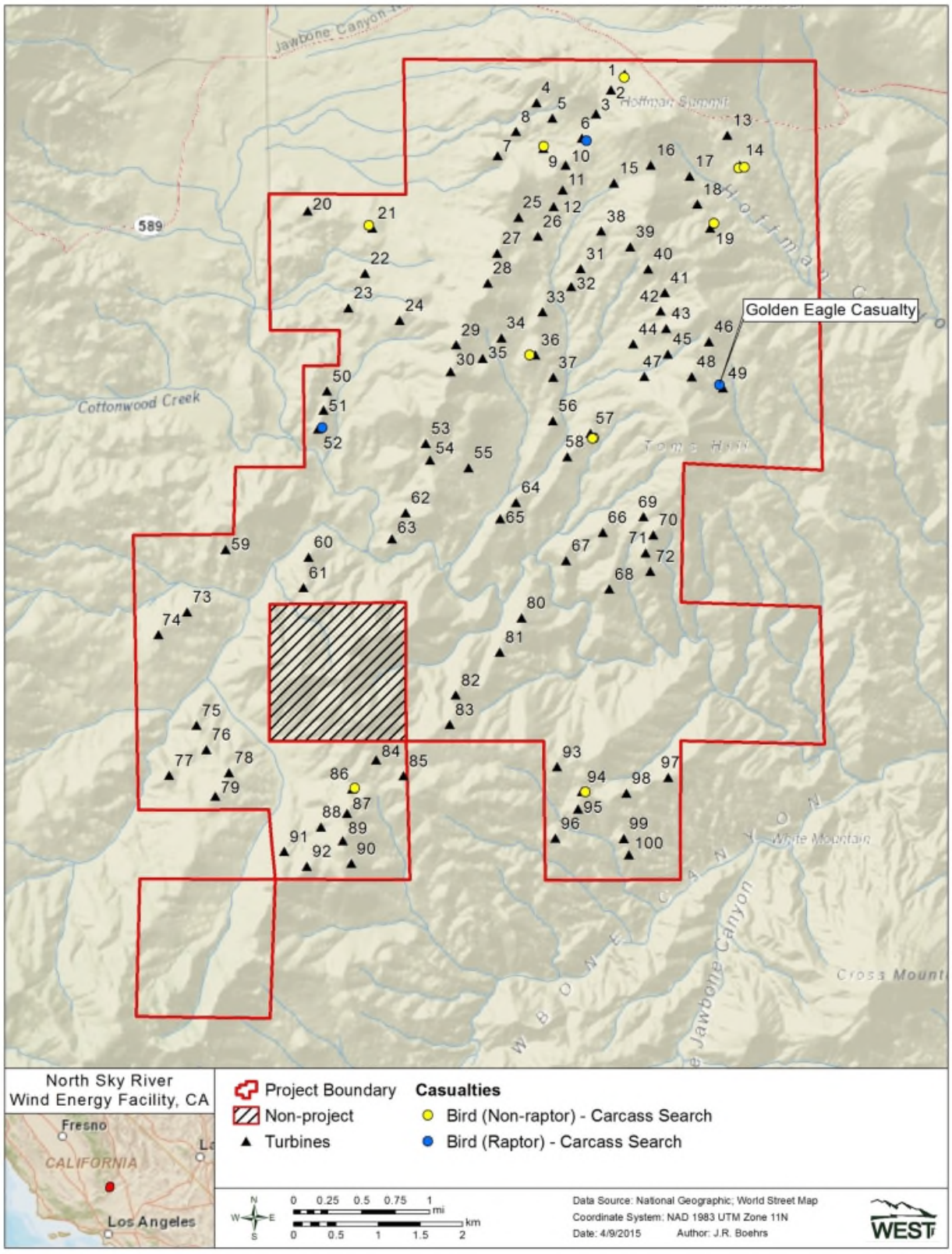


**Figure 4. Location of all bird casualties found at the North Sky River Wind Energy Facility during the second year of fatality monitoring, January 14, 2014 – January 16, 2015.**

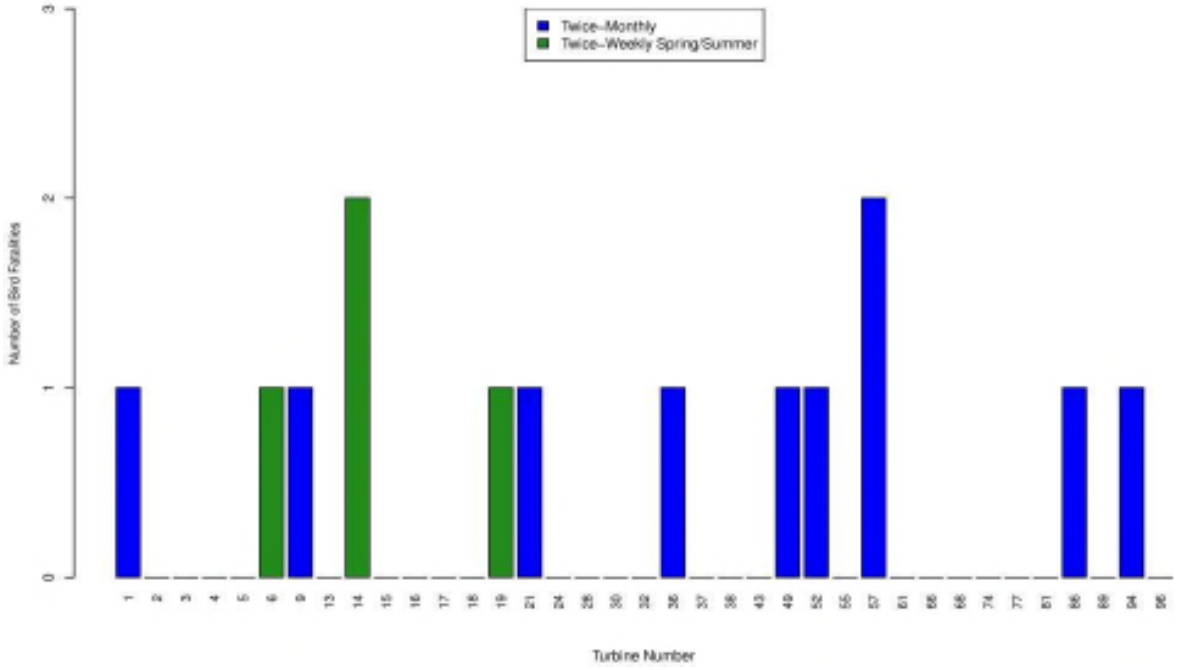


**Figure 5. Number of bird fatalities by turbine found during scheduled searches or incidentally on search plots at the North Sky River Wind Energy Facility, January 14, 2014 – January 16, 2015.**

**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, January 14, 2014 – January 16, 2015.**

| Distance to Turbine (m) | % Bird Casualties | % Bat Casualties |
|---|---|---|
| 0 to 10 | 0 | 9.1 |
| 10 to 20 | 0 | 27.3 |
| 20 to 30 | 7.1 | 18.2 |
| 30 to 40 | 14.3 | 9.1 |
| 40 to 50 | 7.1 | 27.3 |
| 50 to 60 | 28.6 | 9.1 |
| 60 to 70 | 14.3 | 0 |
| 70 to 80 | 28.6 | 0 |
| > 80 | 0 | 0 |

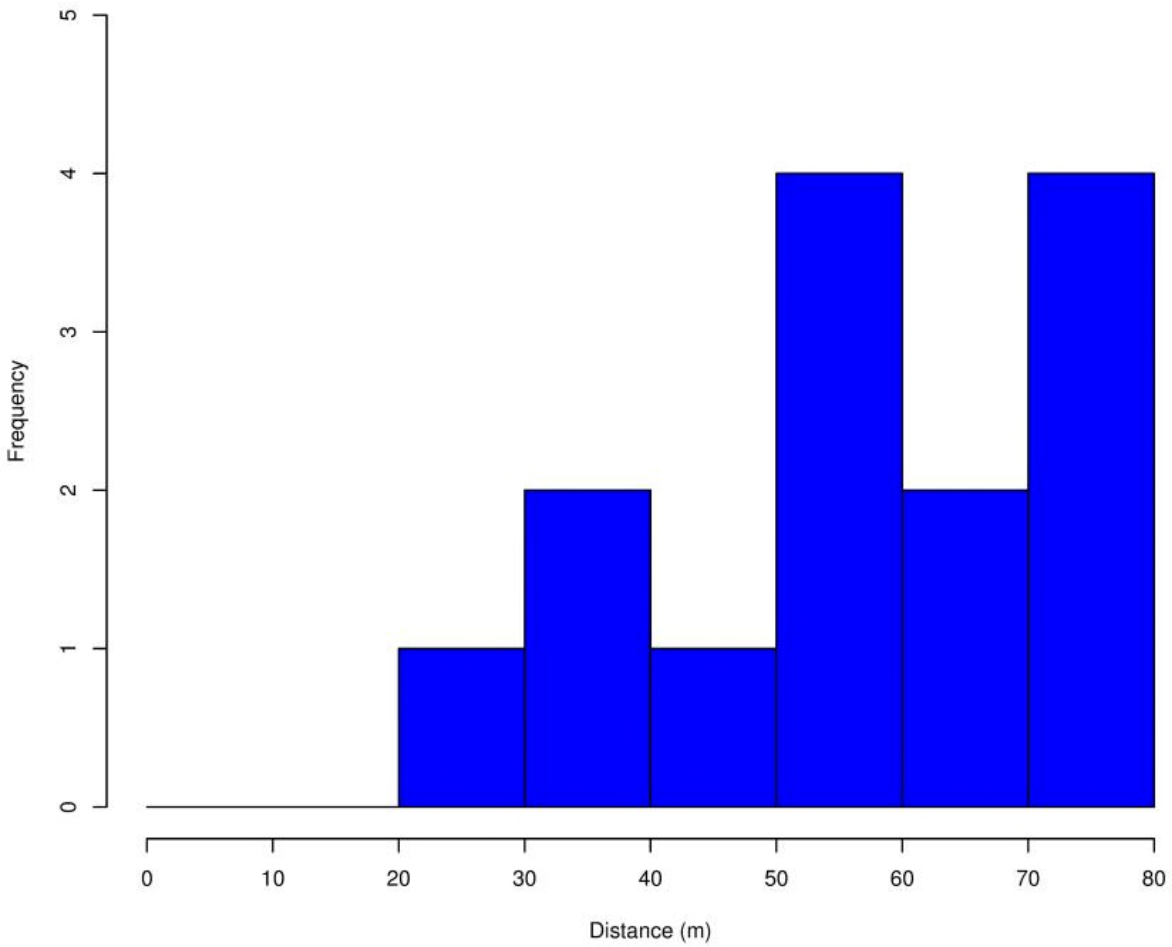


**Figure 6. Distance of bird fatalities from the turbine found during scheduled searches at the North Sky River Wind Energy Facility, January 14, 2014 – January 16, 2015.**

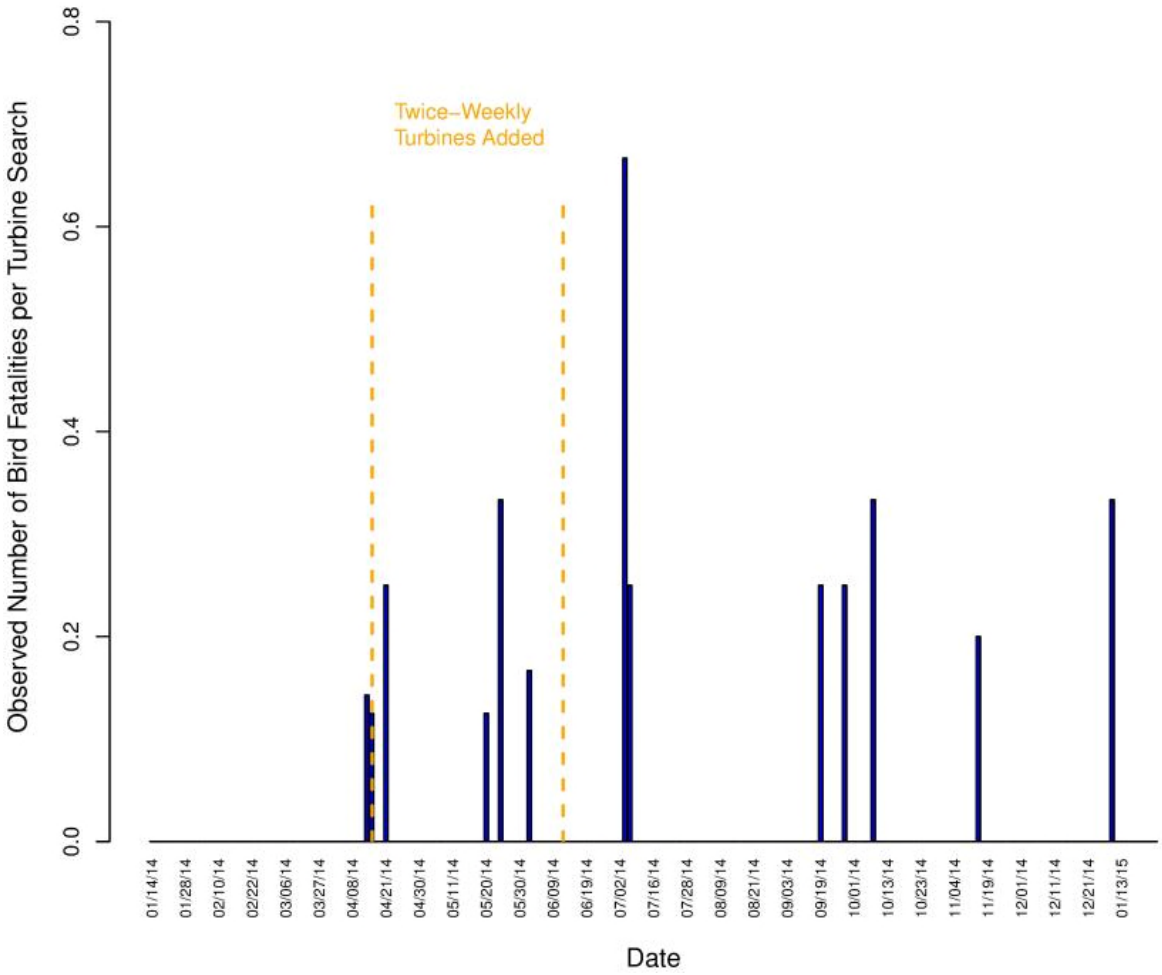


**Figure 7. Timing of bird fatalities by turbine found during scheduled searches at the North Sky River Wind Energy Facility, January 14, 2014 – January 16, 2015.**

*Bat Fatalities*

During the study, 10 bats comprising two identifiable species were found during scheduled searches. Three additional bat fatalities were found incidentally during the study, one within a search plot and two outside of search plots (Table 1, Figure 8). The two bat species found as fatalities during the study were Mexican free-tailed bat (*Tadarida brasiliensis*; eight carcasses) and hoary bat (*Lasiurus cinereus;* four carcasses). A single unidentified bat was also found (Table 1). Two of the 13 bat fatalities documented during the study were found during the intensive spring searches at the seven turbines in the northeast portion of the NSR; one Mexican free-tailed bat and one hoary bat (Appendix A). The hoary bat appears on the California Special Animals List (CDFW 2015) and is protected under CEQA. Neither bat species found during the study is state or federally listed (California Natural Diversity Database [CNDDB] 2014).

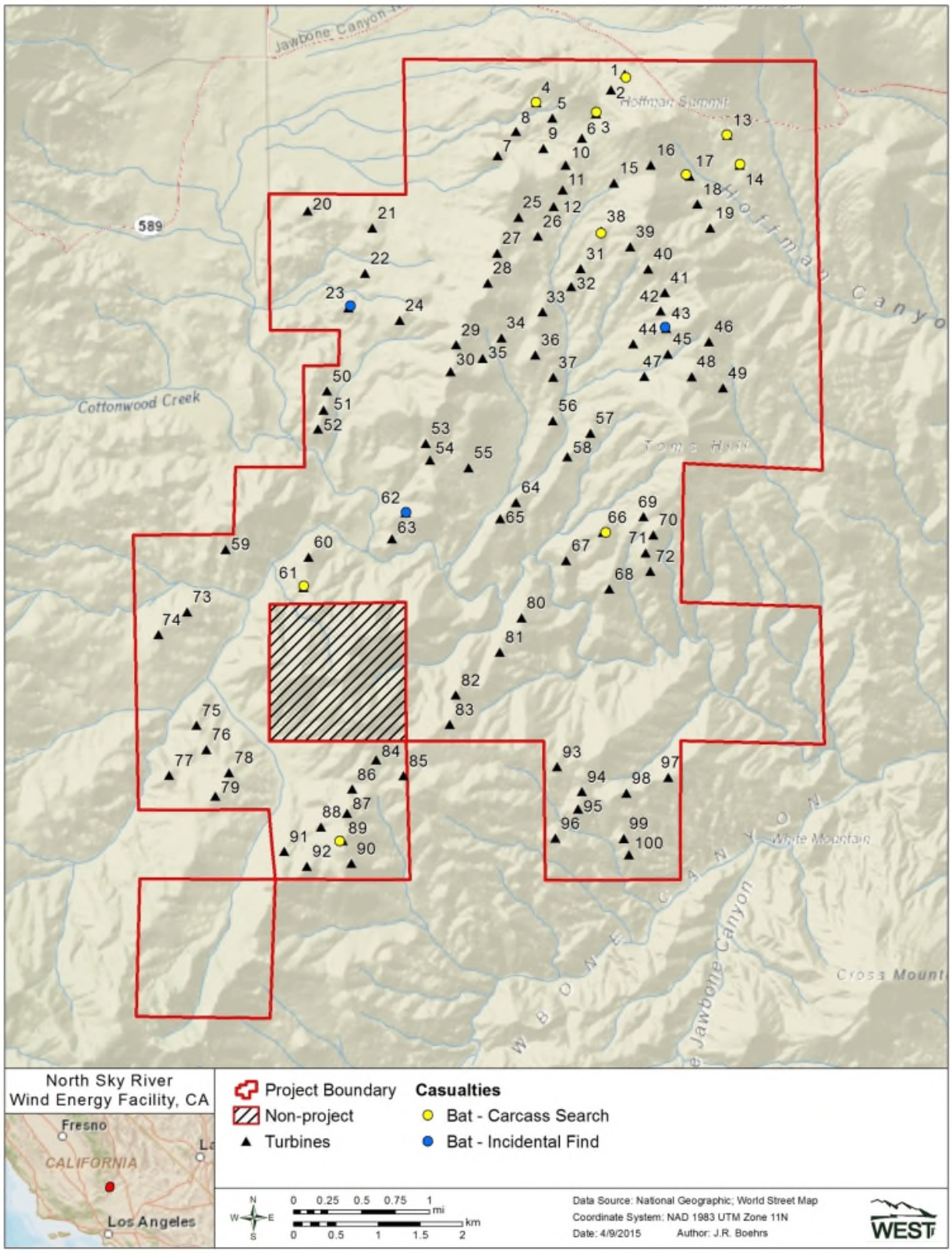


**Figure 8. Location of all bat casualties found at the North Sky River Wind Energy Facility during the second year of fatality monitoring, January 14, 2014 – January 16, 2015.**

Bat fatalities were more commonly encountered in the northern portion of the NSR project area. No more than one bat carcass was encountered at any single search plot (Figures 8 and 9). Among bat fatalities, 100% were found within 60 m of the turbine (Table 2, Figure 10). All bat fatalities were found between the end of April and early October (Figure 11).

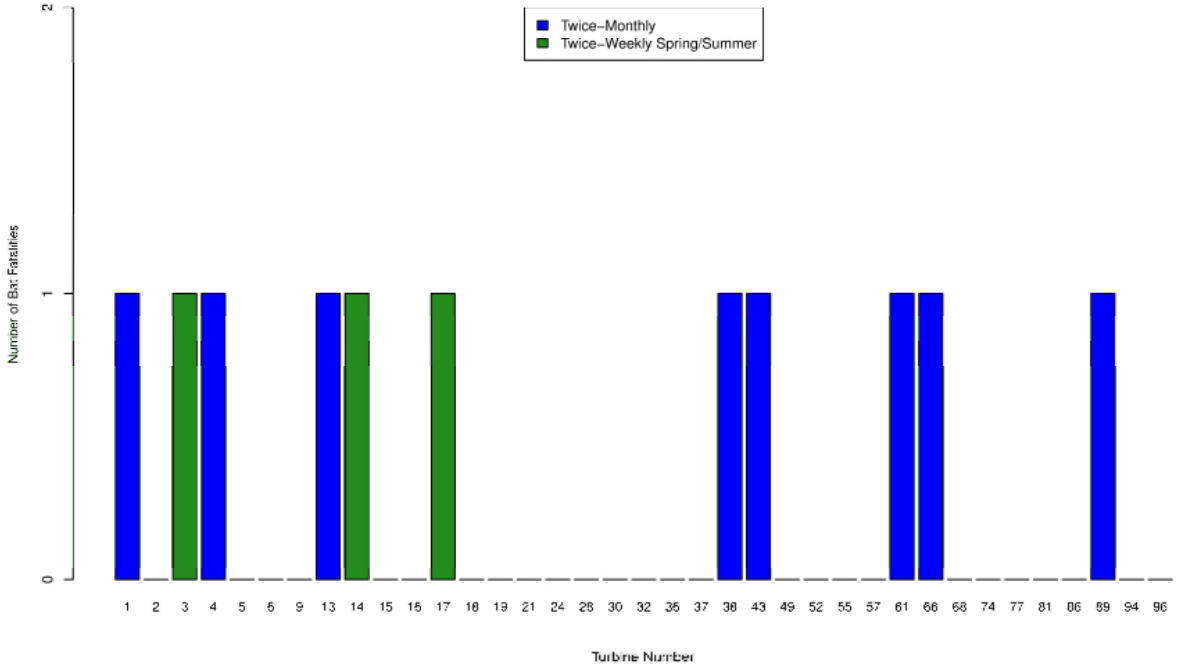


**Figure 9. Number of bat fatalities by turbine found during scheduled searches or incidentally on search plots at the North Sky River Wind Energy Facility, January 14, 2014 – January 16, 2015.**

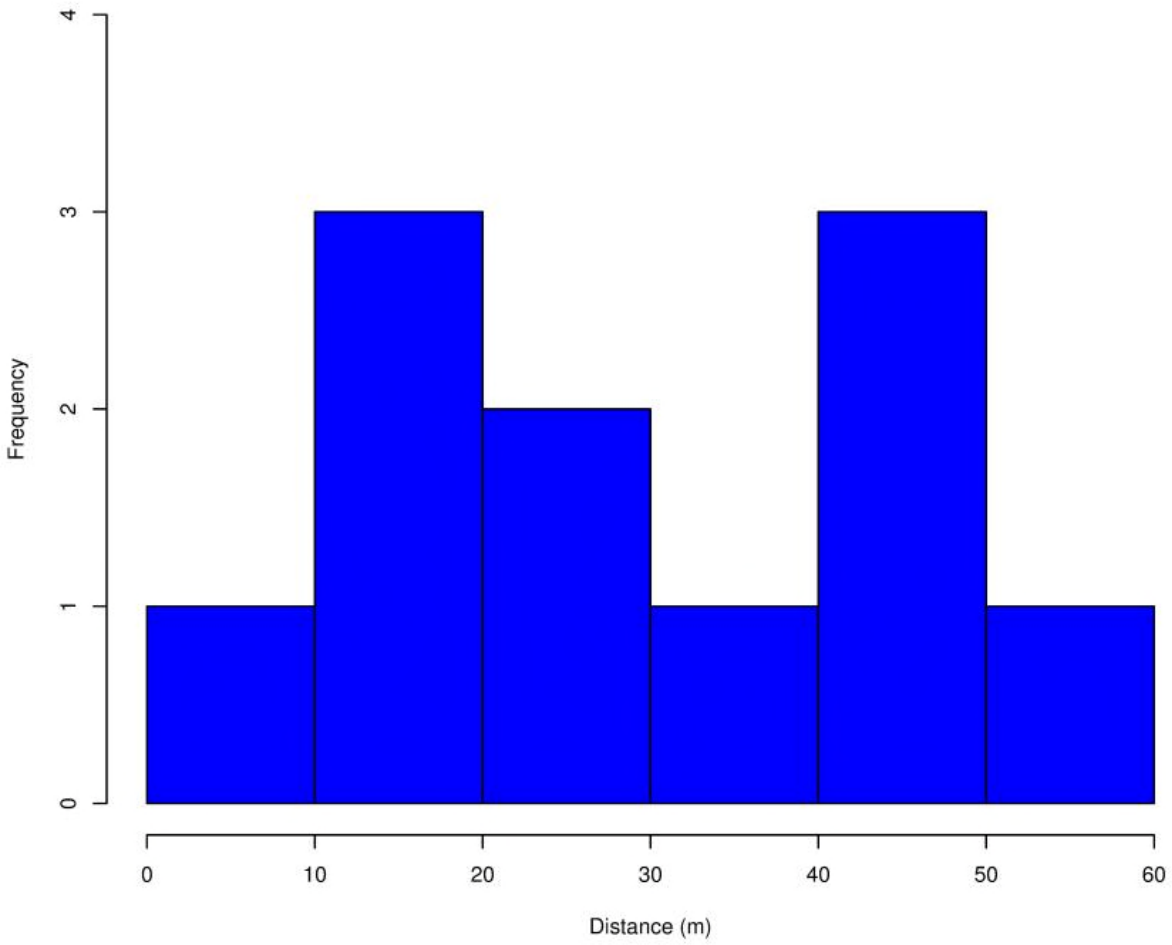


**Figure 10. Distance of bat fatalities from the turbine found during scheduled searches or incidentally on search plots at the North Sky River Wind Energy Facility, January 14, 2014 – January 16, 2015.**

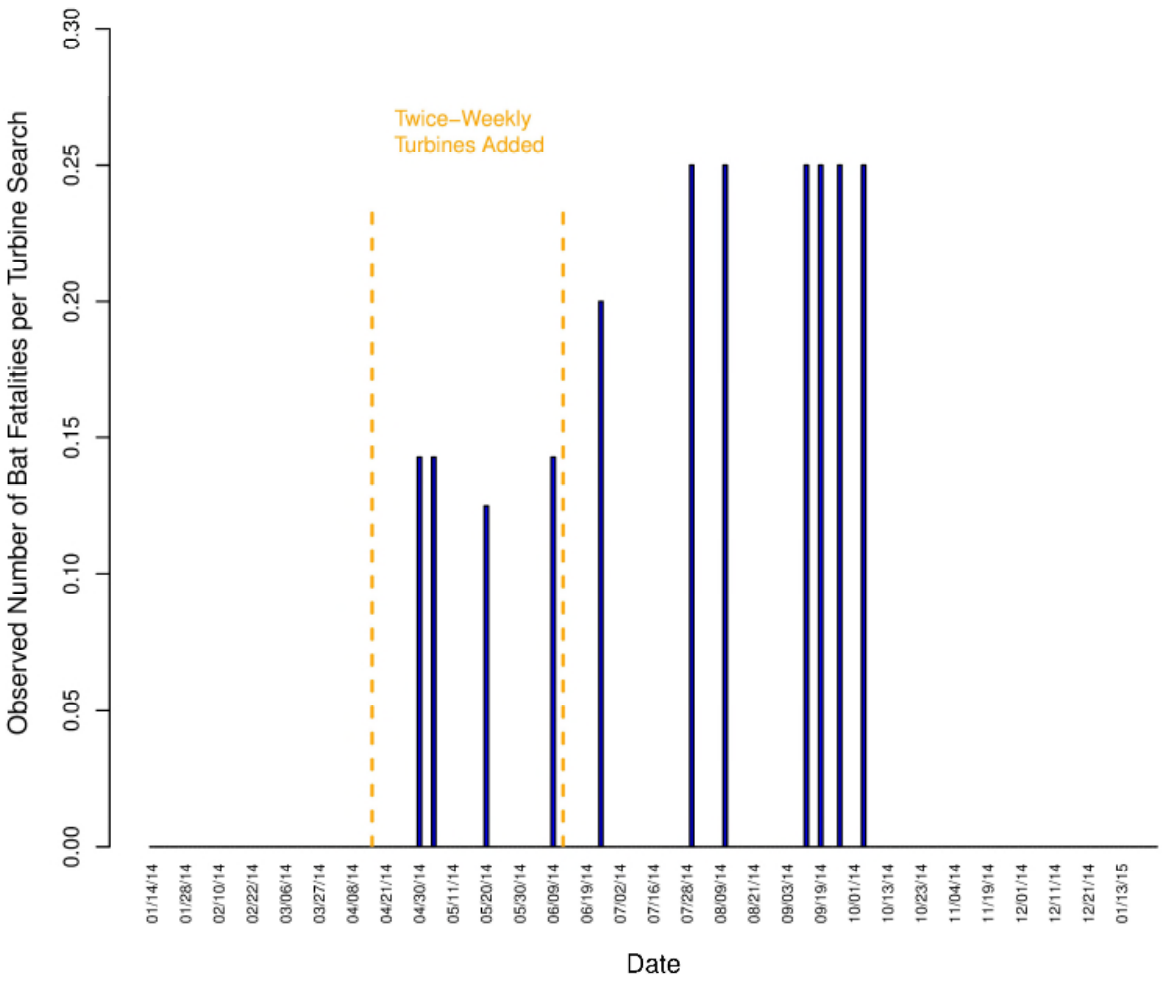


**Figure 11. Timing of bat fatalities by turbine found during scheduled searches or incidentally on search plots at the North Sky River Wind Energy Facility, January 14, 2014 – January 16, 2015.**

*Searcher Efficiency Trials*

During searcher efficiency trials, a total of 105 bird carcasses (24 large birds and 81 small birds) were placed within search plots on five separate dates (Table 3). The overall searcher efficiency rate was 95.7% for large birds and 79.0% for small birds (Table 3). The searcher efficiency rate for small birds was also used for bats.

**Table 3. Searcher efficiency results at the North Sky River Wind Energy Facility as a function of season and carcass size. The searcher efficiency rate for small birds was used for bats.**

| Size | Date | # Placed | # Available | # Found | % Found |
|---|---|---|---|---|---|
| *Small Birds* | 2/19/2013 | 19 | 19 | 17 | 89.5 |
| | 5/7/2013 | 18 | 13 | 11 | 84.6 |
| | 6/27/2013 | 16 | 16 | 11 | 68.8 |
| | 8/14/2013 | 13 | 13 | 10 | 76.9 |
| | 10/1/2013 | 15 | 15 | 11 | 73.3 |
| **Small Bird Total** | | **81** | **76** | **60** | **79.0** |

**Table 3. Searcher efficiency results at the North Sky River Wind Energy Facility as a function of season and carcass size. The searcher efficiency rate for small birds was used for bats.**

| Size | Date | # Placed | # Available | # Found | % Found |
|---|---|---|---|---|---|
| *Large Birds* | 2/21/2014 | 6 | 5 | 4 | 80.0 |
| | 5/9/2014 | 6 | 6 | 6 | 100 |
| | 6/10/2014 | 5 | 5 | 5 | 100 |
| | 8/9/2014 | 2 | 2 | 2 | 100 |
| | 10/30/2014 | 5 | 5 | 5 | 100 |
| **Large Bird Total** | | **24** | **23** | **22** | **95.7** |

*Carcass Removal Trials*

During carcass removal trials, a total of 180 carcasses (45 large birds and 135 small birds) were placed within the NSR project area. Small birds were used to estimate carcass removal rates for bats. By day 10, approximately 28% of large birds remained in the search area, while approximately 5% of small birds (surrogate bats) remained. By day 30, approximately 18% of large bird carcasses remained, while less than 2% of small birds persisted within the study area (Figure 12).The carcass removal times for small birds/bat surrogates varied by season: 2.16 days in spring, summer, and fall, and 4.57 days in winter. The mean carcass removal time for large birds remained the same throughout the year at 12.16 days (Appendix B).

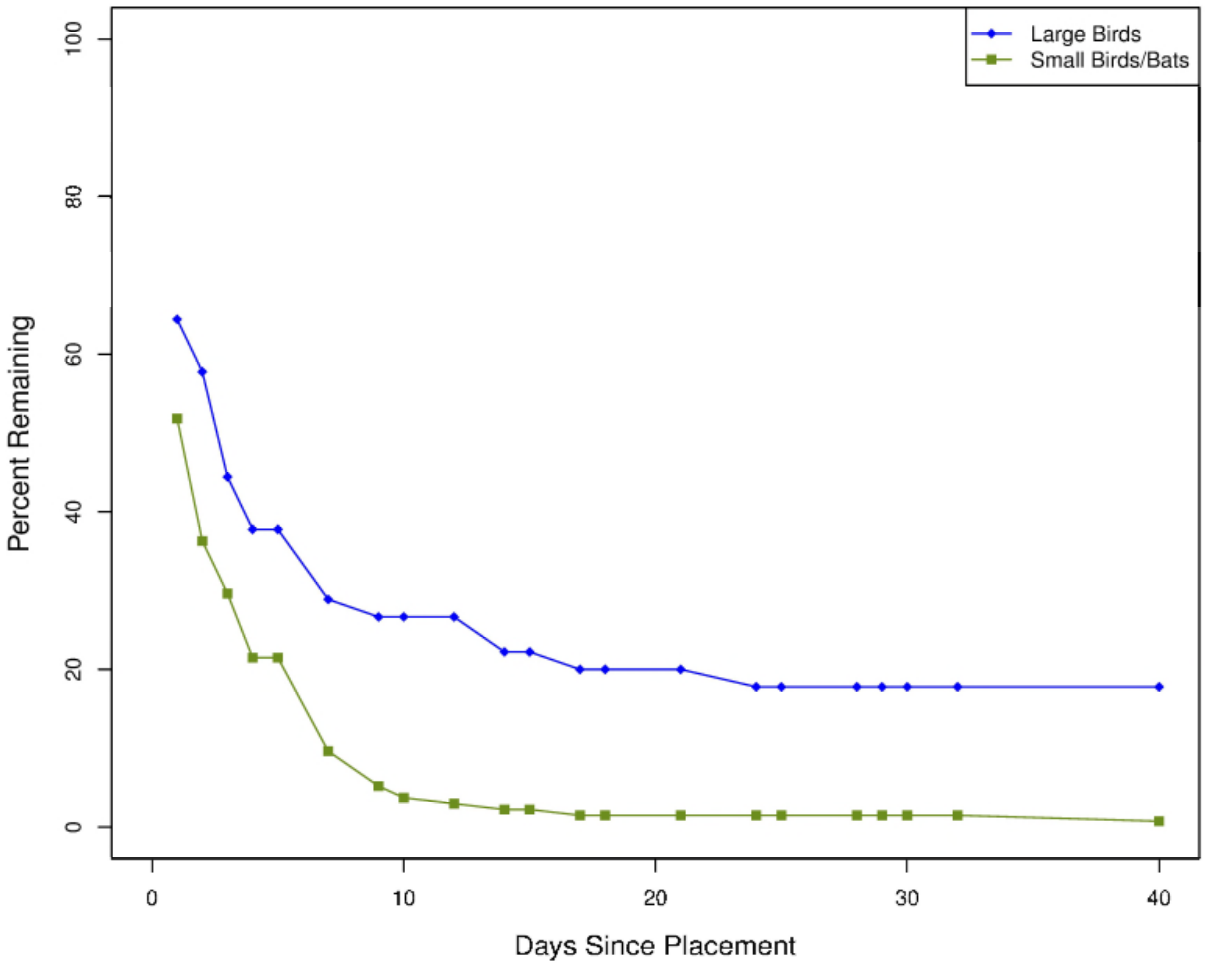


**Figure 12. Carcass removal rates at the North Sky River Wind Energy Facility, January 14, 2014 – January 16, 2015. Small birds were used as surrogates for bats.**

*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 carcass searches conducted every two weeks 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. At the 30 turbines searched throughout the year, the probability that a small bird or bat carcass would remain in the search plot and be found by a searcher was 0.12 in spring, summer, and fall, and 0.24 in winter. For large birds, the probability was considerably higher and remained the same throughout the year at 0.56 (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 0.87 for large birds and 0.42 for small birds and bats (Appendix B2).

**Table 4a. Adjusted annual bird and bat fatality estimates for the North Sky River Wind Energy Facility from searches conducted every two weeks at 30 turbines from January 14, 2014 – January 16, 2015. 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 | 1.73 | (1.01, 3.45) |
| large birds | 0.24 | (0.23, 0.61) |
| diurnal raptors | 0.12 | (0.10, 0.36) |
| all birds | 1.97 | (1.37, 3.85) |
| bats | 2.31 | (1.32, 4.51) |
| | **# fatalities/MW/year** | |
| small birds | 1.08 | (0.63, 2.15) |
| large birds | 0.15 | (0.14, 0.38) |
| diurnal raptors | 0.07 | 0.07, 0.23) |
| all birds | 1.23 | (0.86, 2.4) |
| bats | 1.45 | (0.83, 2.82) |

**Table 4b. Adjusted seasonal bird and bat fatality estimates for the North Sky River Wind Energy Facility from the seven turbines searched twice per week during the spring migration period (April 15 - June 12, 2014). 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 | 0.68 | (0.60, 2.01) |
| large birds | 0.33 | (0.16, 0.72) |
| diurnal raptors | 0.17 | (0.15, 0.52) |
| all birds | 1.01 | (0.87, 2.42) |
| bats | 1.02 | (0.64, 2.34) |
| | **# fatalities/MW/season** | |
| small birds | 0.43 | (0.37, 1.26) |
| large birds | 0.21 | (0.10, 0.45) |
| diurnal raptors | 0.11 | (0.10, 0.32) |
| all birds | 0.63 | (0.54, 1.51) |
| bats | 0.64 | (0.40, 1.46) |

Small Birds

The estimated fatality rate for small birds varied by season: 0.58 birds per turbine during summer, 0.87 during fall, zero during winter, and 0.29 during spring (Appendix B1). Combining all seasons, the overall estimated small bird fatality rate was 1.73 birds per turbine per year (Table 4a). The small bird fatality rate at the seven turbines searched during spring migration was 0.68 fatalities per turbine per season (Table 4b; Appendix B2). A detailed breakdown of small bird fatality rates and the associated correction factors is presented in Appendix B.

Large Birds

The estimated fatality rate for large birds remained the same throughout the year at 0.60 per turbine per season. (Appendix B1). 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 0.33 fatalities per turbine per season (Table 4b; Appendix B2). A detailed breakdown of large bird fatality rates and the associated correction factors is presented in Appendix B.

Diurnal Raptors

The estimated fatality rate for diurnal raptors was 0.06 birds per turbine in winter, spring, and summer; no raptor fatalities were found during spring (Appendix B1). Combining all seasons, the overall estimated fatality rate for diurnal raptors was 0.12 birds per turbine per year (Table 4a). The diurnal raptor fatality rate at the seven turbines searched intensively during spring migration was 0.17 fatalities per turbine per season (Table 4b; Appendix B2). A detailed breakdown of diurnal raptor fatality rates and the associated correction factors is presented in Appendix B.

All Birds

The estimated seasonal fatality rate for all bird species was 0.64 birds per turbine in summer, 0.93 in fall, 0.06 in winter, and 0.35 in spring (Appendix B1). Combining all seasons, the overall estimated fatality rate for all bird was 1.97 birds per turbine per year (Table 4a). The estimated annual fatality rate for all bird species at turbines searched intensely in spring was 1.01 birds per turbine per season (Table 4b; Appendix B2). A detailed breakdown of all bird fatality rates and the associated correction factors is presented in Appendix B.

Bats

The estimated seasonal fatality rate for bats was 0.87 bats per turbine in summer and fall, zero in winter, and 0.29 in spring (Appendix B1). Combining all seasons, the estimated annual bat fatality rate was 2.31 bats per turbine per year (Table 4a). The bat fatality rate at the seven turbines searched intensively during spring migration was 1.02 fatalities per turbine per season (Table 4b; Appendix B2). A detailed breakdown of bat fatality rates and the associated correction factors is presented in Appendix B.

*Overall Fatality Estimates*

Using the data collected during standardized searches conducted every two weeks 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 1.23 birds per MW per year, with an estimated fatality rate of 1.08 small birds per MW per year and 0.07 diurnal raptors per MW per year. The estimated fatality rate for bats was 1.45 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 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 0.63 birds per MW per season, with an estimated 0.43 small birds per MW per season and 0.11 diurnal raptors per MW

per season. The estimated spring fatality rate for bats at these seven turbines was 0.64 bats per MW per season (Table 4b).

### Raptor Nest Surveys

Raptor nest surveys were conducted throughout the NSR project area in March, April, and May 2014. A total of seven active nests were located during surveys including one great horned owl (*Bubo virginianus*) nest, four red-tailed hawk nests, and five common raven (*Corvus corax*) nests (Figure 13). A total of 18 inactive raptor/raven nests were also located within the NSR project area during surveys. The great-horned owl nest and two of the red-tailed hawk nests successfully fledged two young each. One of the red-tailed hawk nests apparently failed and the fate of the fourth red-tailed hawk nest was undetermined. One of the common raven nests fledged three young, one nest failed (the female adult was found dead near the nest), and the success of the remaining three raven nests was undetermined.

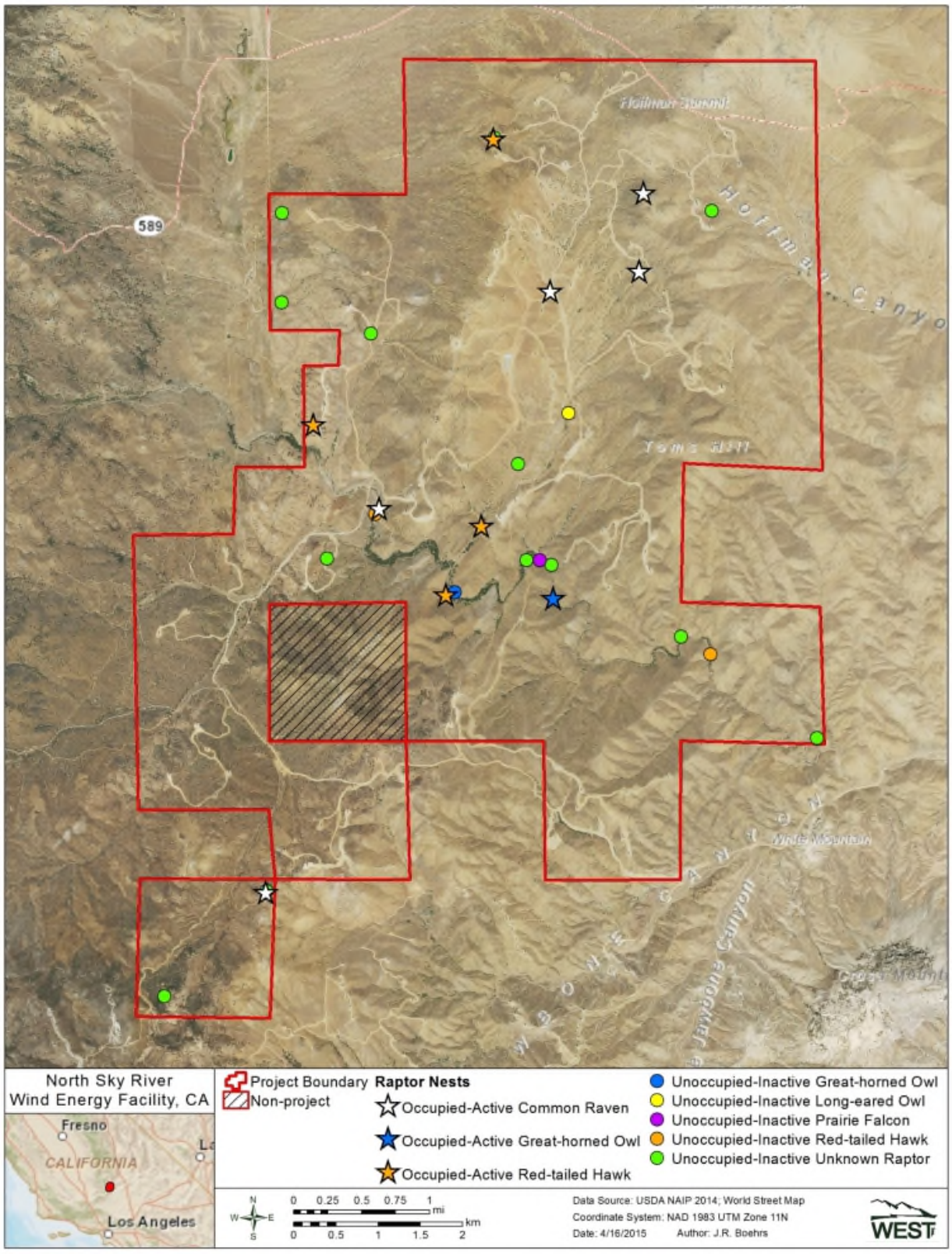


**Figure 13. Raptor nests identified at the North Sky River Project in 2014.**

## 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 with 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 at 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. 2003c, 2005) 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, small birds (house sparrows and juvenile Coturnix quail) 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.

There are inherent biases that exist under certain conditions in the models used to estimate fatalities—the Shoenfeld estimator included (Huso 2010). In particular, when carcass counts are low (e.g. fewer than 5), regardless of turbine sample size, estimates and confidence intervals can be unstable and must be interpreted with caution (Korner-Nievergelt et. al 2011). Since all size class and season factor combinations resulted in fewer than five carcasses, adjusted fatality estimates by size and season should be interpreted with caution (appendix B1). Overall estimates by size class were based on greater than five carcasses (with the exception of large birds, with four); thus, overall estimates should not be affected by effects from low carcass counts.

*Bird Fatalities*

Overall bird fatality estimates at wind energy facilities across North America have ranged from 0.08 to 17.44 birds/MW/year (Appendix C1). In California, bird fatality rates have ranged from 0.55 to 17.44 birds/MW/year (Appendix C1, Figure 14). 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 17.44 birds/MW/year (BioResource Consultants [BRC] 2012). Though, if we were to attribute approximately 131 of 167 fatalities to predation as was the case in the Pine Tree report (BRC 2012), the fatality rate would become 3.76 birds/MW/year. While some fatalities were undoubtedly due to predation events, it can be very difficult to determine which fatalities those were, and the more conservative assumption is typically made in reporting that fatalities are due to the presence of the wind farm whether the deaths were due to collision with turbines or not. 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 (1.23 birds/MW/year; Table 4a) is low compared to other wind energy facilities in western North America (Appendix C1), as well other facilities within the TWRA, and it is lower than the fatality rate during the first year of study at NSR (2.05 birds/MW/year; Figure 14, Appendix C1). During the study at NSR, small birds, all passerines, composed the majority (57%) of bird fatalities found within search plots during the study, and diurnal raptors composed 21% (Appendix A).

In general, fatalities were more commonly found at turbines located in the northern half of the NSR project area; however, no obvious areas of 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: a red-tailed hawk, the remains of an unidentified large bird (ruled out as a golden eagle), and the remains of two unidentified passerines. The spring fatality rate calculated for these seven turbines was 0.63 birds/MW/season (Table 4b). While overall, bird fatalities were found during each season of the study, they were more concentrated during spring (Figure 7). In addition, there was a spike in the number of bird carcasses found per turbine in early July, when two unidentified small birds and a red-tailed hawk were found (Figure 7, Appendix A).

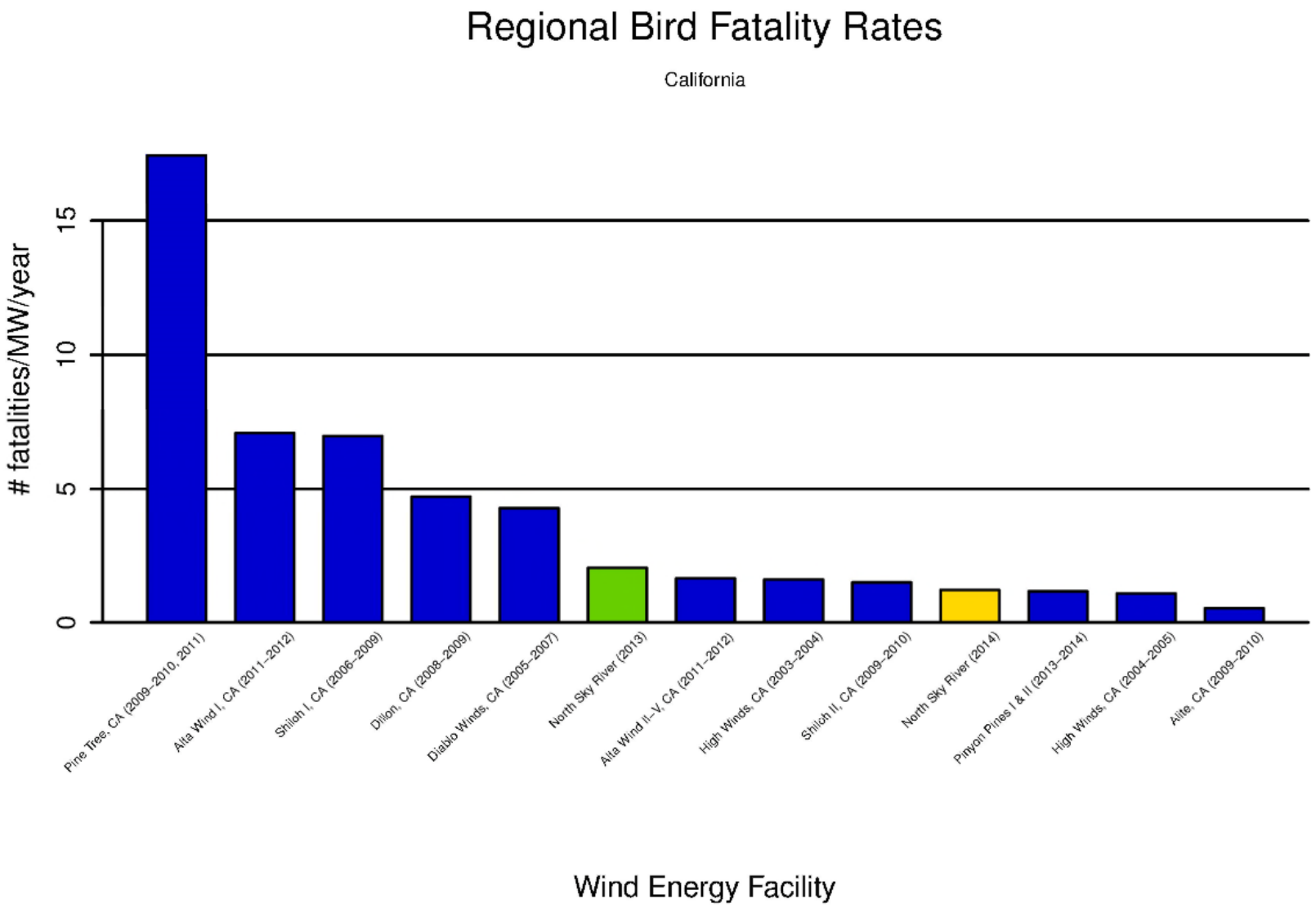


**Figure 14. Fatality rates for all birds (number of birds per MW per year) at the North Sky River Wind Energy Facility compared with publicly-available wind energy facilities in California. Results for the first year of fatality monitoring (2013) is indicated in green, while results for the second year (2014) is indicated in yellow.**

**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 California.**

Data from the following sources:

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

Diurnal raptor fatality estimates at wind energy facilities in California have ranged from zero to 0.50 birds/MW/year (Figure 15, Appendix C2), 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 during a 2011 – 2012 study, while Alta II-V had an estimate of 0.05 raptors/MW/year during the same period (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 (0.07 raptors/MW/year; Table 4a) while slightly higher than the estimate during the period 2013 – 2014 (0.05 raptors/MW/year; Levenstein et al. 2014) was low compared to other wind energy facilities in western North America (i.e., California, Pacific Northwest, Rocky Mountain, and Southwest regions; Appendix C2). This 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 two red-tailed hawks and one golden eagle.

*Bat Fatalities*

A total of 13 bats, representing two identifiable species, were documented during the study. In California, bat fatality rates have ranged from 0.04 to 3.92 bats/MW/year (Figure 16; Appendix C3). The estimated bat fatality rate at NSR (1.45 bats/MW/year; Table 4a) was in the mid-range when compared to other projects in California. 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 0.04 to 11.42 bats/MW/year (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 hoary bat). The spring bat fatality rate at these seven turbines was 0.64 bats/MW/season (Table 4b).

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 (BRC 2012). 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 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*; Arnett et al. 2008, 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 these findings, in that hoary and Mexican free-tailed bats composed 92% of overall bat fatalities found during the study.

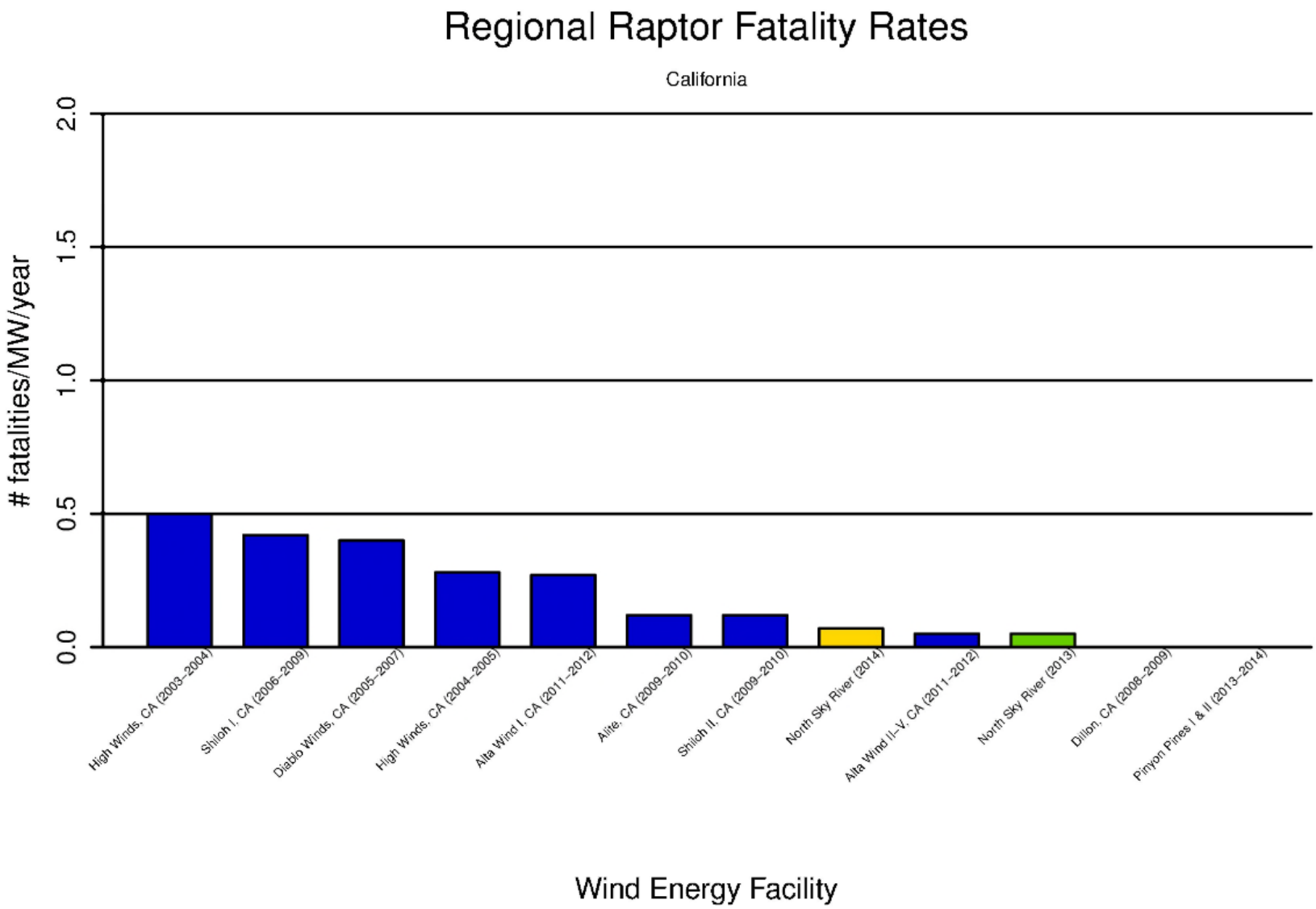


**Figure 15. Fatality rates for raptors (number of raptors per MW per year) at the North Sky River Wind Energy Facility compared with publicly-available wind energy facilities in California. Results for the first year of fatality monitoring (2013) is indicated in green, while results for the second year (2014) is indicated in yellow.**

**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 California.**

Data from the following sources:

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

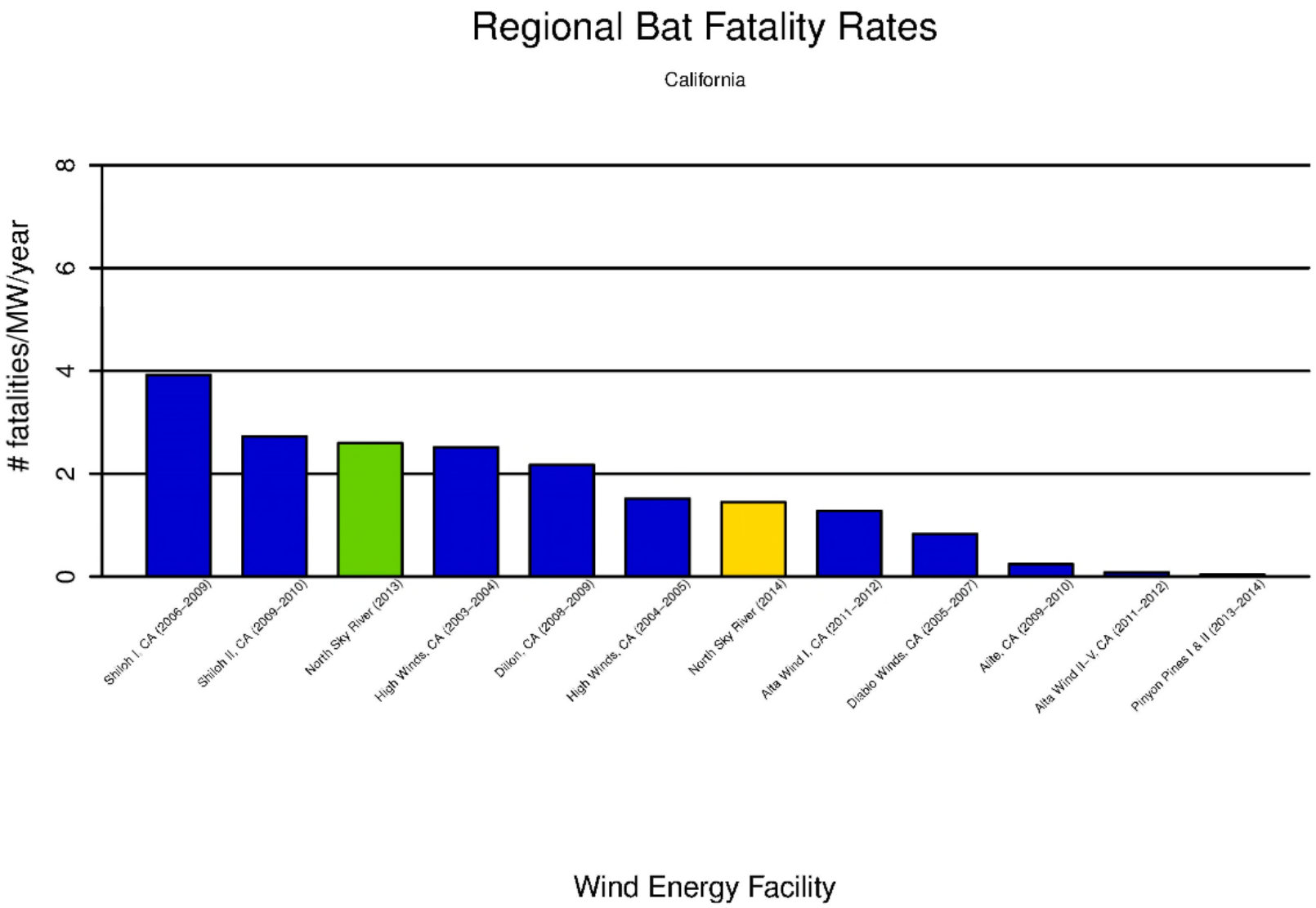


**Figure 16. Fatality rates for bats (number of bats per MW per year) at the North Sky River Wind Energy Facility compared with publicly-available wind energy facilities in California. Results for the first year of fatality monitoring (2013) is indicated in green, while results for the second year (2014) is indicated in yellow.**

**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 California.**

Data from the following sources:

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

## CONCLUSIONS AND RECOMMENDATIONS

Results of the second year of fatality monitoring at NSR further contribute to our understanding of the effects of wind energy on birds and bats. During this second 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 TWRA region. Additional monitoring will be conducted at NSR during the third and fourth years of operation (January 2015 – January 2017). The results of the surveys conducted to date do not suggest the need for deviation from the established protocol during the third 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 During the Second Year of Avian and Bat Fatality Monitoring at the North Sky River Wind Energy Facility, January 14, 2014 –January 16, 2015**

**Appendix A. Complete listing of fatalities for the North Sky River Wind Energy Facility, January 14, 2014 – January 16, 2015.**

| Date | Common Name | Turbine # | Distance from Turbine (m) | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 5/5/2014 | hoary bat | 4 | 42 | Scheduled Search | Bi-weekly | Dismembered |
| 5/20/2014 | lark sparrow | 9 | 25 | Scheduled Search | Bi-weekly | Intact |
| 4/21/2014 | unidentified passerine | 14 | 47 | Scheduled Search | Twice weekly | Feather Spot |
| 4/16/2014 | red-tailed hawk | 6 | 68 | Scheduled Search | Twice weekly | Feather Spot |
| 4/15/2014 | unidentified large bird | 14 | 62 | Scheduled Search | Twice weekly | Feather Spot |
| 4/30/2014 | hoary bat | 17 | 48 | Scheduled Search | Twice weekly | Intact |
| 5/23/2014 | mourning dove | 57 | 76 | Scheduled Search | Bi-weekly | Intact |
| 5/20/2014 | Mexican free-tailed bat | 3 | 12 | Scheduled Search | Twice weekly | Intact |
| 6/2/2014 | unidentified passerine | 19 | 74 | Scheduled Search | Twice weekly | Feather Spot |
| 6/9/2014 | hoary bat | 14 | 17 | Scheduled Search | Twice weekly | Intact |
| 6/25/2014 | unidentified bat | 66 | 47 | Scheduled Search | Bi-weekly | Scavenged |
| 7/3/2014 | unidentified small bird | 21 | 53 | Scheduled Search | Bi-weekly | Feather Spot |
| 7/3/2014 | unidentified small bird | 57 | 73 | Scheduled Search | Bi-weekly | Feather Spot |
| 7/8/2014 | red-tailed hawk | 52 | 51 | Scheduled Search | Bi-weekly | Feather Spot |
| 7/29/2014 | Mexican free-tailed bat | 13 | 9 | Scheduled Search | Bi-weekly | Intact |
| 8/10/2014 | Mexican free-tailed bat | 1 | 57 | Scheduled Search | Bi-weekly | Scavenged |
| 9/9/2014 | hoary bat | 38 | 28 | Scheduled Search | Bi-weekly | Intact |
| 9/17/2014 | Mexican free-tailed bat | 62 | 13 | Incidental Find | Bi-weekly | Intact |
| 9/18/2014 | Mexican free-tailed bat | 23 | 33 | Incidental Find | Bi-weekly | Intact |
| 9/19/2014 | Mexican free-tailed bat | 61 | 21 | Scheduled Search | Bi-weekly | Scavenged |
| 9/19/2014 | Wilson's warbler | 86 | 33 | Scheduled Search | Bi-weekly | Scavenged |
| 9/25/2014 | horned lark | 36 | 71 | Scheduled Search | Bi-weekly | Feather Spot |
| 10/3/2014 | Mexican free-tailed bat | 89 | 37 | Scheduled Search | Bi-weekly | Intact |
| 10/7/2014 | unidentified sparrow | 1 | 59 | Scheduled Search | Bi-weekly | Dismembered |
| 9/22/2014 | Mexican free-tailed bat | 43 | 19 | Incidental Find | Bi-weekly | Intact |
| 11/17/2014 | mourning dove | 94 | 36 | Scheduled Search | Bi-weekly | Feather Spot |
| 1/9/2015 | golden eagle | 49 | 60 | Scheduled Search | Bi-weekly | Scavenged |

**Appendix B. Complete Bird and Bat Fatality Table for the North Sky River Wind Energy Facility for Carcass Searches Conducted from January 14, 2014 – January 16, 2015**

**Appendix B1. Correction factors and bird and bat fatality rates by season from data collected at 30 turbines searched every two weeks within the North Sky River Wind Energy Facility from January 14, 2014 – January 16, 2015.**

| | 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) | 0.79 | (0.71, 0.87) | 0.79 | (0.71, 0.87) | 0.79 | (0.71, 0.87) | 0.79 | (0.71, 0.87) |
| p (large birds) | 0.96 | (0.87, 1.00) | 0.96 | (0.87, 1.00) | 0.96 | (0.87, 1.00) | 0.96 | (0.87, 1.00) |
| p (bats)[1] | 0.79 | (0.71, 0.87) | 0.79 | (0.71, 0.87) | 0.79 | (0.71, 0.87) | 0.79 | (0.71, 0.87) |
| **Mean Carcass Removal Time (Days)** | | | | | | | | |
| $\bar{t}$ (small birds) | 2.16 | (1.54, 2.87) | 2.16 | (1.54, 2.87) | 4.57 | - | 2.16 | (1.54, 2.87) |
| $\bar{t}$ (large birds) | 12.16 | (7.28, 18.71) | 12.16 | (7.28, 18.71) | 12.16 | (7.28, 18.71) | 12.16 | (7.28, 18.71) |
| $\bar{t}$ (bats)[2] | 2.16 | (1.54, 2.87) | 2.16 | (1.54, 2.87) | 4.57 | - | 2.16 | (1.54, 2.87) |
| **Observed Fatality Rates (Fatalities/Turbine/Season)** | | | | | | | | |
| small birds | 0.07 | (0.03, 0.13) | 0.10 | (0.03, 0.20) | 0 | - | 0.03 | (0.03, 0.10) |
| large birds | 0.03 | (0.03, 0.20) | 0.03 | (0.03, 0.10) | 0.03 | (0.03, 0.10) | 0.03 | (0.03, 0.10) |
| raptors | 0.03 | (0.03, 0.20) | 0 | - | 0.03 | (0.03, 0.10) | 0.03 | (0.03, 0.10) |
| bats | 0.10 | (0.03, 0.20) | 0.13 | (0.03, 0.27) | 0 | - | 0.03 | (0.03, 0.10) |
| **Average Probability of Carcass Availability and Detected** | | | | | | | | |
| small birds | 0.12 | (0.08, 0.16) | 0.12 | (0.08, 0.16) | 0.24 | - | 0.12 | (0.08, 0.16) |
| large birds | 0.56 | (0.41, 0.67) | 0.56 | (0.41, 0.67) | 0.56 | (0.41, 0.67) | 0.56 | (0.41, 0.67) |
| bats | 0.12 | (0.08, 0.16) | 0.12 | (0.08, 0.16) | 0.24 | - | 0.12 | (0.08, 0.16) |
| **Observed Adjusted Fatality Rates (Fatalities/Turbine/Season)** | | | | | | | | |
| small birds | 0.58 | (0.25, 1.39) | 0.87 | (0.27, 1.96) | 0 | - | 0.29 | (0.23, 0.99) |
| large birds | 0.06 | (0.05, 0.20) | 0.06 | (0.05, 0.20) | 0.06 | (0.05, 0.19) | 0.06 | (0.05, 0.20) |
| raptors | 0.06 | (0.05, 0.20) | 0 | - | 0.06 | (0.05, 0.19) | 0.06 | (0.05, 0.20) |
| bats | 0.87 | (0.27, 1.98) | 1.16 | (0.38, 2.46) | 0 | - | 0.29 | (0.23, 0.95) |

| **Overall Adjusted Fatality Rates (Fatalities/Turbine/Year)** | | |
|---|---|---|
| | **Mean** | **CI** |
| small birds | 1.73 | (1.01, 3.45) |
| large birds | 0.24 | (0.23, 0.61) |
| raptors | 0.12 | (0.10, 0.36) |
| all birds | 1.97 | (1.37, 3.85) |
| bats | 2.31 | (1.32, 4.51) |

[1]During searcher efficiency trials, small brown birds were used as a surrogate for bats.
[2]During carcass removal trials, small brown birds were used as a surrogate for 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 15, 2014 – June 12, 2015.**

| 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) | 0.79 | (0.71, 0.87) |
| p (large birds) | 0.96 | (0.87, 1.00) |
| p (bats)[1] | 0.79 | (0.71, 0.87) |
| **Mean Carcass Removal Time (Days)** | | |
| $\bar{t}$ (small birds) | 2.16 | (1.54, 2.87) |
| $\bar{t}$ (large birds) | 12.16 | (7.28, 18.71) |
| $\bar{t}$ (bats)[2] | 2.16 | (1.54, 2.87) |
| **Observed Fatality Rates (Fatalities/Turbine/Season)** | | |
| small birds | 0.29 | (0.29, 0.71) |
| large birds | 0.29 | (0.14, 0.57) |
| raptors | 0.14 | (0.14, 0.43) |
| bats | 0.43 | (0.29, 0.86) |
| **Average Probability of Carcass Availability and Detected** | | |
| small birds | 0.42 | (0.32, 0.51) |
| large birds | 0.87 | (0.78, 0.91) |
| bats | 0.42 | (0.32, 0.51) |
| **Observed Adjusted Fatality Rates (Fatalities/Turbine/Season)** | | |
| | **Mean** | **CI** |
| small birds | 1.01 | (0.60, 2.01) |
| large birds | 0.33 | (0.16, 0.72) |
| raptors | 0.17 | (0.15, 0.52) |
| bats | 1.02 | (0.64, 2.34) |

[1]During searcher efficiency trials, small brown birds were used as a surrogate for bats.
[2]During carcass removal trials, small brown birds 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 (2014)** | **1.23** | **100** | **160** |
| **North Sky River, CA (2013)** | **2.05** | **100** | **160** |
| ***California*** | | | |
| Pine Tree, CA (2009-2010, 2011) | 17.44 | 90 | 135 |
| Alta Wind I, CA (2011-2012) | 7.07 | 100 | 150 |
| Shiloh I, CA (2006-2009) | 6.96 | 100 | 150 |
| Dillon, CA (2008-2009) | 4.71 | 45 | 45 |
| Diablo Winds, CA (2005-2007) | 4.29 | 31 | 20.46 |
| Alta Wind II-V, CA (2011-2012) | 1.66 | 190 | 570 |
| High Winds, CA (2003-2004) | 1.62 | 90 | 162 |
| Shiloh II, CA (2009-2010) | 1.51 | 75 | 150 |
| Pinyon Pines I & II (2013-2014) | 1.18 | 100 | 300 |
| High Winds, CA (2004-2005) | 1.10 | 90 | 162 |
| Alite, CA (2009-2010) | 0.55 | 8 | 24 |
| ***Pacific Northwest*** | | | |
| Windy Flats, WA (2010-2011) | 8.45 | 114 | 262.2 |
| Leaning Juniper, OR (2006-2008) | 6.66 | 67 | 100.5 |
| Linden Ranch, WA (2010-2011) | 6.65 | 25 | 50 |
| Biglow Canyon, OR (Phase II; 2009-2010) | 5.53 | 65 | 150 |
| White Creek, WA (2007-2011) | 4.05 | 89 | 204.7 |
| Tuolumne (Windy Point I), WA (2009-2010) | 3.20 | 62 | 136.6 |
| Stateline, OR/WA (2001-2002) | 3.17 | 454 | 299 |
| Klondike II, OR (2005-2006) | 3.14 | 50 | 75 |
| Klondike III (Phase I), OR (2007-2009) | 3.02 | 125 | 223.6 |
| Hopkins Ridge, WA (2008) | 2.99 | 87 | 156.6 |
| Harvest Wind, WA (2010-2012) | 2.94 | 43 | 98.9 |
| Nine Canyon, WA (2002-2003) | 2.76 | 37 | 48.1 |
| Biglow Canyon, OR (Phase II; 2010-2011) | 2.68 | 65 | 150 |
| Stateline, OR/WA (2003) | 2.68 | 454 | 299 |
| Klondike IIIa (Phase II), OR (2008-2010) | 2.61 | 51 | 76.5 |
| Combine Hills, OR (Phase I; 2004-2005) | 2.56 | 41 | 41 |
| Big Horn, WA (2006-2007) | 2.54 | 133 | 199.5 |
| Biglow Canyon, OR (Phase I; 2009) | 2.47 | 76 | 125.4 |
| Combine Hills, OR (2011) | 2.33 | 104 | 104 |
| Biglow Canyon, OR (Phase III; 2010-2011) | 2.28 | 76 | 174.8 |
| Hay Canyon, OR (2009-2010) | 2.21 | 48 | 100.8 |
| Elkhorn, OR (2010) | 1.95 | 61 | 101 |
| Pebble Springs, OR (2009-2010) | 1.93 | 47 | 98.7 |
| Biglow Canyon, OR (Phase I; 2008) | 1.76 | 76 | 125.4 |
| Wild Horse, WA (2007) | 1.55 | 127 | 229 |
| Goodnoe, WA (2009-2010) | 1.40 | 47 | 94 |
| Vantage, WA (2010-2011) | 1.27 | 60 | 90 |
| Hopkins Ridge, WA (2006) | 1.23 | 83 | 150 |
| Stateline, OR/WA (2006) | 1.23 | 454 | 299 |
| Kittitas Valley, WA (2011-2012) | 1.06 | 48 | 100.8 |
| Klondike, OR (2002-2003) | 0.95 | 16 | 24 |
| Vansycle, OR (1999) | 0.95 | 38 | 24.9 |
| Elkhorn, OR (2008) | 0.64 | 61 | 101 |
| Marengo I, WA (2009-2010) | 0.27 | 78 | 140.4 |
| Marengo II, WA (2009-2010) | 0.16 | 39 | 70.2 |

**Appendix C1. Wind energy facilities in North America with 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) | 3.40 | 69 | 41.4 |
| Foote Creek Rim, WY (Phase I; 2000) | 2.42 | 69 | 41.4 |
| Foote Creek Rim, WY (Phase I; 2001-2002) | 1.93 | 69 | 41.4 |
| Summerview, Alb (2005-2006) | 1.06 | 39 | 70.2 |
| ***Southwest*** | | | |
| Buffalo Mountain, TN (2000-2003) | 11.02 | 3 | 1.98 |
| Buffalo Mountain, TN (2005) | 1.10 | 18 | 28.98 |
| ***Midwest*** | | | |
| Wessington Springs, SD (2009) | 8.25 | 34 | 51 |
| Blue Sky Green Field, WI (2008; 2009) | 7.17 | 88 | 145 |
| Cedar Ridge, WI (2009) | 6.55 | 41 | 67.6 |
| Buffalo Ridge, MN (Phase III; 1999) | 5.93 | 138 | 103.5 |
| Moraine II, MN (2009) | 5.59 | 33 | 49.5 |
| Barton I & II, IA (2010-2011) | 5.50 | 80 | 160 |
| Buffalo Ridge I, SD (2009-2010) | 5.06 | 24 | 50.4 |
| Buffalo Ridge, MN (Phase I; 1996) | 4.14 | 73 | 25 |
| Winnebago, IA (2009-2010) | 3.88 | 10 | 20 |
| Rugby, ND (2010-2011) | 3.82 | 71 | 149 |
| Cedar Ridge, WI (2010) | 3.72 | 41 | 68 |
| Elm Creek II, MN (2011-2012) | 3.64 | 62 | 148.8 |
| Buffalo Ridge, MN (Phase II; 1999) | 3.57 | 143 | 107.25 |
| Buffalo Ridge, MN (Phase I; 1998) | 3.14 | 73 | 25 |
| Ripley, Ont (2008) | 3.09 | 38 | 76 |
| Fowler I, IN (2009) | 2.83 | 162 | 301 |
| Buffalo Ridge, MN (Phase I; 1997) | 2.51 | 73 | 25 |
| Buffalo Ridge, MN (Phase II; 1998) | 2.47 | 143 | 107.25 |
| PrairieWinds SD1, SD (2012-2013) | 2.01 | 108 | 162 |
| Buffalo Ridge II, SD (2011-2012) | 1.99 | 105 | 210 |
| Kewaunee County, WI (1999-2001) | 1.95 | 31 | 20.46 |
| NPPD Ainsworth, NE (2006) | 1.63 | 36 | 20.5 |
| PrairieWinds ND1 (Minot), ND (2011) | 1.56 | 80 | 115.5 |
| Elm Creek, MN (2009-2010) | 1.55 | 67 | 100 |
| PrairieWinds ND1 (Minot), ND (2010) | 1.48 | 80 | 115.5 |
| Buffalo Ridge, MN (Phase I; 1999) | 1.43 | 73 | 25 |
| PrairieWinds SD1, SD (2011-2012) | 1.41 | 108 | 162 |
| 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) | 6.40 | 28 | 70 |
| Mount Storm, WV (2011) | 4.24 | 132 | 264 |
| Mount Storm, WV (2009) | 3.85 | 132 | 264 |
| Lempster, NH (2009) | 3.38 | 12 | 24 |
| Casselman, PA (2009) | 2.88 | 23 | 34.5 |
| Mountaineer, WV (2003) | 2.69 | 44 | 66 |
| Stetson Mountain I, ME (2009) | 2.68 | 38 | 57 |
| Noble Ellenburg, NY (2009) | 2.66 | 54 | 80 |
| Lempster, NH (2010) | 2.64 | 12 | 24 |
| Mount Storm, WV (2010) | 2.60 | 132 | 264 |
| Maple Ridge, NY (2007) | 2.34 | 195 | 321.75 |
| Noble Bliss, NY (2009) | 2.28 | 67 | 100 |
| Criterion, MD (2012) | 2.14 | 28 | 70 |
| Maple Ridge, NY (2007-2008) | 2.07 | 195 | 321.75 |
| Noble Altona, NY (2010) | 1.84 | 65 | 97.5 |
| Mars Hill, ME (2008) | 1.76 | 28 | 42 |
| High Sheldon, NY (2010) | 1.76 | 75 | 112.5 |
| Noble Wethersfield, NY (2010) | 1.70 | 84 | 126 |
| Mars Hill, ME (2007) | 1.67 | 28 | 42 |
| Noble Chateaugay, NY (2010) | 1.66 | 71 | 106.5 |
| Noble Clinton, NY (2008) | 1.59 | 67 | 100 |
| High Sheldon, NY (2011) | 1.57 | 75 | 112.5 |
| Casselman, PA (2008) | 1.51 | 23 | 34.5 |
| Munnsville, NY (2008) | 1.48 | 23 | 34.5 |
| Stetson Mountain II, ME (2010) | 1.42 | 17 | 25.5 |
| Cohocton/Dutch Hill, NY (2009) | 1.39 | 50 | 125 |
| Cohocton/Dutch Hills, NY (2010) | 1.32 | 50 | 125 |
| Noble Bliss, NY (2008) | 1.30 | 67 | 100 |
| Beech Ridge, WV (2012) | 1.19 | 67 | 100.5 |
| Stetson Mountain I, ME (2011) | 1.18 | 38 | 57 |
| Noble Clinton, NY (2009) | 1.11 | 67 | 100 |
| Locust Ridge, PA (Phase II; 2009) | 0.84 | 51 | 102 |
| Noble Ellenburg, NY (2008) | 0.83 | 54 | 80 |
| Locust Ridge, PA (Phase II; 2010) | 0.76 | 51 | 102 |
| ***Southeast*** | | | |
| Buffalo Mountain, TN (2000-2003) | 11.02 | 3 | 1.98 |
| Buffalo Mountain, TN (2005) | 1.10 | 18 | 28.98 |

**Appendix C1 (*continued*). Wind energy facilities in North America with 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 (14) | This study | | |
| North Sky River, CA (2013) | Levenstein et al. 2014 | | |
| Alite, CA (09-10) | Chatfield et al. 2010 | Klondike III, OR (Phase I; 07-09) | Gritski et al. 2010 |
| Alta Wind I, CA (11-12) | Chatfield et al. 2012 | Klondike IIIa, OR (Phase II; 08-10) | Gritski et al. 2011 |
| Alta Wind II-V, CA (11-12) | Chatfield et al. 2012 | Leaning Juniper, OR (06-08) | Gritski et al. 2008 |
| Barton I & II, IA (10-11) | Derby et al. 2011a | Lempster, NH (09) | Tidhar et al. 2010 |
| Barton Chapel, TX (09-10) | WEST 2011 | Lempster, NH (10) | Tidhar et al. 2011 |
| Beech Ridge, WV (12) | Tidhar et al. 2013b | Linden Ranch, WA (10-11) | Enz and Bay 2011 |
| Big Horn, WA (06-07) | Kronner et al. 2008 | Locust Ridge, PA (Phase II; 09) | Arnett et al. 2011 |
| Big Smile, OK (12-13) | Derby et al. 2013b | Locust Ridge, PA (Phase II; 10) | Arnett et al. 2011 |
| Biglow Canyon, OR (Phase I; 08) | Jeffrey et al. 2009a | Maple Ridge, NY (07) | Jain et al. 2009a |
| Biglow Canyon, OR (Phase I; 09) | Enk et al. 2010 | Maple Ridge, NY (07-08) | Jain et al. 2009d |
| Biglow Canyon, OR (Phase II; 09-10) | Enk et al. 2011a | Marengo I, WA (09-10) | URS Corporation 2010b |
| Biglow Canyon, OR (Phase II; 10-11) | Enk et al. 2012b | Marengo II, WA (09-10) | URS Corporation 2010c |
| Biglow Canyon, OR (Phase III; 10-11) | Enk et al. 2012a | Mars Hill, ME (07) | Stantec 2008 |
| Blue Sky Green Field, WI (08; 09) | Gruver et al. 2009 | Mars Hill, ME (08) | Stantec 2009a |
| 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. 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 Hill, NY (10) | Stantec 2011 | Pine Tree, CA (09-10, 11) | BioResource Consultants 2012 |
| Combine Hills, OR (Ph. I; 04-05) | Young et al. 2006 | Pinyon Pines I & II, CA (13-14) | Chatfield and Russo 2014 |
| Combine Hills, OR (11) | Enz et al. 2012 | Pioneer Prairie I, IA (Phase II; 11-12) | Chodachek et al. 2012 |
| 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 | PrairieWinds SD1 (Crow Lake), SD (12-13) | Derby et al. 2013a |
| Dry Lake I, AZ (09-10) | Thompson et al. 2011 | Red Hills, OK (12-13) | Derby et al. 2013c |
| Dry Lake II, AZ (11-12) | Thompson and Bay 2012 | Ripley, Ont (08) | Jacques Whitford 2009 |
| Elkhorn, OR (08) | Jeffrey et al. 2009b | Rugby, ND (10-11) | Derby et al. 2011b |
| Elkhorn, OR (10) | Enk et al. 2011b | Shiloh I, CA (06-09) | Kerlinger et al. 2009 |
| Elm Creek, MN (09-10) | Derby et al. 2010c | Shiloh II, CA (09-10) | Kerlinger et al. 2010b |
| Elm Creek II, MN (11-12) | Derby et al. 2012b | Stateline, OR/WA (01-02) | Erickson et al. 2004 |
| Foote Creek Rim, WY (Phase I; 99) | Young et al. 2003b | Stateline, OR/WA (03) | Erickson et al. 2004 |
| Foote Creek Rim, WY (Phase I; 00) | Young et al. 2003b | Stateline, OR/WA (06) | Erickson et al. 2007 |
| Foote Creek Rim, WY (Ph. I; 01-02) | Young et al. 2003b | Stetson Mountain I, ME (09) | Stantec 2009c |
| Fowler I, IN (09) | Johnson et al. 2010a | Stetson Mountain I, ME (11) | Normandeau Associates 2011 |
| Goodnoe, WA (09-10) | URS Corporation 2010a | Stetson Mountain II, ME (10) | Normandeau Associates 2010 |
| Grand Ridge, IL (09-10) | Derby et al. 2010g | Summerview, Alb (05-06) | Brown and Hamilton 2006b |
| Harvest Wind, WA (10-12) | Downes and Gritski 2012a | Top of Iowa, IA (03) | Jain 2005 |
| Hay Canyon, OR (09-10) | Gritski and Kronner 2010a | Top of Iowa, IA (04) | Jain 2005 |
| High Sheldon, NY (10) | Tidhar et al. 2012a | Tuolumne (Windy Point I), WA (09-10) | Enz and Bay 2010 |
| High Sheldon, NY (11) | Tidhar et al. 2012b | Vansycle, OR (99) | Erickson et al. 2000b |
| High Winds, CA (03-04) | Kerlinger et al. 2006 | Vantage, WA (10-11) | Ventus 2012 |
| High Winds, CA (04-05) | Kerlinger et al. 2006 | Wessington Springs, SD (09) | Derby et al. 2010f |
| Hopkins Ridge, WA (06) | Young et al. 2007 | Wessington Springs, SD (10) | Derby et al. 2011d |
| Hopkins Ridge, WA (08) | Young et al. 2009c | White Creek, WA (07-11) | Downes and Gritski 2012b |
| Kewaunee County, WI (99-01) | Howe et al. 2002 | Wild Horse, WA (07) | Erickson et al. 2008 |
| Kittitas Valley, WA (11-12) | Stantec 2012 | Windy Flats, WA (10-11) | Enz et al. 2011 |
| Klondike, OR (02-03) | Johnson et al. 2003b | Winnebago, IA (09-10) | Derby et al. 2010e |
| Klondike II, OR (05-06) | NWC and WEST 2007 | | |

**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 (2014)** | **0.28** | **0.07** | **100** | **160** |
| **North Sky River, CA (2013)** | **NA** | **0.05** | **100** | **160** |
| | ***California*** | | | |
| High Winds, CA (2003-2004) | 2.337 | 0.50 | 90 | 162 |
| Shiloh I, CA (2006-2009) | NA | 0.42 | 100 | 150 |
| Diablo Winds, CA (2005-2007) | 2.161 | 0.40 | 31 | 20.46 |
| High Winds, CA (2004-2005) | 2.337 | 0.28 | 90 | 162 |
| Alta Wind I, CA (2011-2012) | 0.19 | 0.27 | 100 | 150 |
| Alite, CA (2009-2010) | NA | 0.12 | 8 | 24 |
| Shiloh II, CA (2009-2010) | NA | 0.12 | 75 | 150 |
| Alta Wind II-V, CA (2011-2012) | 0.04 | 0.05 | 190 | 570 |
| Dillon, CA (2008-2009) | NA | 0 | 45 | 45 |
| Pinyon Pines I & II, CA (2013-2014) | NA | 0 | 100 | 300 |
| | ***Pacific Northwest*** | | | |
| White Creek, WA (2007-2011) | NA | 0.47 | 89 | 204.7 |
| Vantage, WA (2010-2011) | NA | 0.29 | 60 | 90 |
| Tuolumne (Windy Point I), WA (2009-2010) | 0.77 | 0.29 | 62 | 136.6 |
| Linden Ranch, WA (2010-2011) | NA | 0.27 | 25 | 50 |
| Harvest Wind, WA (2010-2012) | NA | 0.23 | 43 | 98.9 |
| Goodnoe, WA (2009-2010) | NA | 0.17 | 47 | 94 |
| Leaning Juniper, OR (2006-2008) | 0.522 | 0.16 | 67 | 100.5 |
| Klondike III (Phase I), OR (2007-2009) | NA | 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) | NA | 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) | NA | 0.06 | 51 | 76.5 |
| Elkhorn, OR (2008) | 1.07 | 0.06 | 61 | 101 |
| Marengo II, WA (2009-2010) | NA | 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) | NA | 0.04 | 47 | 98.7 |
| Windy Flats, WA (2010-2011) | NA | 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) | NA | 0 | 48 | 100.8 |
| Biglow Canyon, OR (Phase I; 2009) | 0.318 | 0 | 76 | 125.4 |
| Marengo I, WA (2009-2010) | NA | 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) | NA | 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 (2009-2010) | 0.13 | 0 | 30 | 63 |
| Dry Lake II, AZ (2011-2012) | NA | 0 | 31 | 65 |
| ***Midwest*** | | | | |
| Buffalo Ridge, MN (Phase I; 1999) | NA | 0.47 | 73 | 25 |
| Moraine II, MN (2009) | NA | 0.37 | 33 | 49.5 |
| Winnebago, IA (2009-2010) | NA | 0.27 | 10 | 20 |
| Buffalo Ridge I, SD (2009-2010) | NA | 0.20 | 24 | 50.4 |
| Cedar Ridge, WI (2009) | NA | 0.18 | 41 | 67.6 |
| Top of Iowa, IA (2004) | NA | 0.17 | 89 | 80 |
| Cedar Ridge, WI (2010) | NA | 0.13 | 41 | 68 |
| Ripley, Ont (2008) | NA | 0.10 | 38 | 76 |
| Wessington Springs, SD (2010) | 0.232 | 0.07 | 34 | 51 |
| NPPD Ainsworth, NE (2006) | NA | 0.06 | 36 | 20.5 |
| Wessington Springs, SD (2009) | 0.232 | 0.06 | 34 | 51 |
| Rugby, ND (2010-2011) | NA | 0.06 | 71 | 149 |
| PrairieWinds ND1 (Minot), ND (2011) | NA | 0.05 | 80 | 115.5 |
| PrairieWinds ND1 (Minot), ND (2010) | NA | 0.05 | 80 | 115.5 |
| PrairieWinds SD1, SD (2012-2013) | NA | 0.03 | 108 | 162 |
| Kewaunee County, WI (1999-2001) | NA | 0 | 31 | 20.46 |
| Buffalo Ridge, MN (Phase I; 1996) | NA | 0 | 73 | 25 |
| Buffalo Ridge, MN (Phase I; 1997) | NA | 0 | 73 | 25 |
| Buffalo Ridge, MN (Phase I; 1998) | NA | 0 | 73 | 25 |
| Top of Iowa, IA (2003) | NA | 0 | 89 | 80 |
| Grand Ridge I, IL (2009-2010) | 0.195 | 0 | 66 | 99 |
| Elm Creek, MN (2009-2010) | NA | 0 | 67 | 100 |
| Pioneer Prairie I, IA (Phase II; 2011-2012) | NA | 0 | 62 | 102.3 |
| Buffalo Ridge, MN (Phase III; 1999) | NA | 0 | 138 | 103.5 |
| Buffalo Ridge, MN (Phase II; 1998) | NA | 0 | 143 | 107.25 |
| Buffalo Ridge, MN (Phase II; 1999) | NA | 0 | 143 | 107.25 |
| Blue Sky Green Field, WI (2008; 2009) | NA | 0 | 88 | 145 |
| Elm Creek II, MN (2011-2012) | NA | 0 | 62 | 148.8 |
| Barton I & II, IA (2010-2011) | NA | 0 | 80 | 160 |
| PrairieWinds SD1, SD (2011-2012) | NA | 0 | 108 | 162 |
| Buffalo Ridge II, SD (2011-2012) | NA | 0 | 105 | 210 |
| Fowler I, IN (2009) | NA | 0 | 162 | 301 |
| ***Southern Plains*** | | | | |
| Barton Chapel, TX (2009-2010) | NA | 0.25 | 60 | 120 |
| Buffalo Gap I, TX (2006) | NA | 0.10 | 67 | 134 |
| Red Hills, OK (2012-2013) | NA | 0.04 | 82 | 123 |
| Big Smile, OK (2012-2013) | NA | 0 | 66 | 132 |
| Buffalo Gap II, TX (2007-2008) | NA | 0 | 155 | 233 |

**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) | NA | 0.59 | 23 | 34.5 |
| Noble Ellenburg, NY (2009) | NA | 0.25 | 54 | 80 |
| Noble Clinton, NY (2009) | NA | 0.16 | 67 | 100 |
| Noble Wethersfield, NY (2010) | NA | 0.13 | 84 | 126 |
| Noble Bliss, NY (2009) | NA | 0.12 | 67 | 100 |
| Noble Ellenburg, NY (2008) | NA | 0.11 | 54 | 80 |
| Noble Bliss, NY (2008) | NA | 0.10 | 67 | 100 |
| Noble Clinton, NY (2008) | NA | 0.10 | 67 | 100 |
| Mount Storm, WV (2010) | NA | 0.10 | 132 | 264 |
| Noble Chateaugay, NY (2010) | NA | 0.08 | 71 | 106.5 |
| Cohocton/Dutch Hills, NY (2010) | NA | 0.08 | 50 | 125 |
| Mountaineer, WV (2003) | NA | 0.07 | 44 | 66 |
| High Sheldon, NY (2010) | NA | 0.06 | 75 | 112.5 |
| Mount Storm, WV (2011) | NA | 0.03 | 132 | 264 |
| Maple Ridge, NY (2007-2008) | NA | 0.03 | 195 | 321.75 |
| Criterion, MD (2011) | NA | 0.02 | 28 | 70 |
| Beech Ridge, WV (2012) | NA | 0.01 | 67 | 100.5 |
| Lempster, NH (2009) | NA | 0 | 12 | 24 |
| Lempster, NH (2010) | NA | 0 | 12 | 24 |
| Stetson Mountain II, ME (2010) | NA | 0 | 17 | 25.5 |
| Casselman, PA (2009) | NA | 0 | 23 | 34.5 |
| Casselman, PA (2008) | NA | 0 | 23 | 34.5 |
| Mars Hill, ME (2007) | NA | 0 | 28 | 42 |
| Mars Hill, ME (2008) | NA | 0 | 28 | 42 |
| Stetson Mountain I, ME (2011) | NA | 0 | 38 | 57 |
| Stetson Mountain I, ME (2009) | NA | 0 | 38 | 57 |
| Noble Altona, NY (2010) | NA | 0 | 65 | 97.5 |
| Locust Ridge, PA (Phase II; 2009) | NA | 0 | 51 | 102 |
| Locust Ridge, PA (Phase II; 2010) | NA | 0 | 51 | 102 |
| High Sheldon, NY (2011) | NA | 0 | 75 | 112.5 |
| Cohocton/Dutch Hill, NY (2009) | NA | 0 | 50 | 125 |
| Mount Storm, WV (2009) | NA | 0 | 132 | 264 |
| | ***Southeast*** | | | |
| Buffalo Mountain, TN (2000-2003) | NA | 0 | 3 | 1.98 |
| Buffalo Mountain, TN (2005) | NA | 0 | 18 | 28.98 |

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

Data from the following sources:

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

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

**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 (2014)** | **13.88** | **8/17/2010 – 9/5/2011** | **1.45** | **100** | **160** |
| **North Sky River, CA (2013)** | **13.88** | **8/17/2010 – 9/5/2011** | **2.59** | **100** | **160** |
| | | ***California*** | | | |
| Shiloh I, CA (2006-2009) | NA | NA | 3.92 | 100 | 150 |
| Shiloh II, CA (2009-2010) | NA | NA | 2.72 | 75 | 150 |
| High Winds, CA (2003-2004) | NA | NA | 2.51 | 90 | 162 |
| Dillon, CA (2008-2009) | NA | NA | 2.17 | 45 | 45 |
| High Winds, CA (2004-2005) | NA | NA | 1.52 | 90 | 162 |
| Alta Wind I, CA (2011-2012) | 4.42 | 6/26/2009 - 10/31/2009 | 1.28 | 100 | 150 |
| Diablo Winds, CA (2005-2007) | NA | NA | 0.82 | 31 | 20.46 |
| Alite, CA (2009-2010) | NA | NA | 0.24 | 8 | 24 |
| Alta Wind II-V, CA (2011-2012) | 0.78[A] | 6/26/2009 - 10/31/2009 | 0.08 | 190 | 570 |
| Pinyon Pines I & II (2013-2014) | NA | NA | 0.04 | 100 | 300 |
| | | ***Pacific Northwest*** | | | |
| Biglow Canyon, OR (Phase II; 2009-2010) | NA | NA | 2.71 | 65 | 150 |
| Nine Canyon, WA (2002-2003) | NA | NA | 2.47 | 37 | 48.1 |
| Stateline, OR/WA (2003) | NA | NA | 2.29 | 454 | 299 |
| Elkhorn, OR (2010) | NA | NA | 2.14 | 61 | 101 |
| White Creek, WA (2007-2011) | NA | NA | 2.04 | 89 | 204.7 |
| Biglow Canyon, OR (Phase I; 2008) | NA | NA | 1.99 | 76 | 125.4 |
| Leaning Juniper, OR (2006-2008) | NA | NA | 1.98 | 67 | 100.5 |
| Big Horn, WA (2006-2007) | NA | NA | 1.9 | 133 | 199.5 |
| Combine Hills, OR (Phase I; 2004-2005) | NA | NA | 1.88 | 41 | 41 |
| Linden Ranch, WA (2010-2011) | NA | NA | 1.68 | 25 | 50 |
| Pebble Springs, OR (2009-2010) | NA | NA | 1.55 | 47 | 98.7 |
| Hopkins Ridge, WA (2008) | NA | NA | 1.39 | 87 | 156.6 |
| Harvest Wind, WA (2010-2012) | NA | NA | 1.27 | 43 | 98.9 |
| Elkhorn, OR (2008) | NA | NA | 1.26 | 61 | 101 |
| Vansycle, OR (1999) | NA | NA | 1.12 | 38 | 24.9 |
| Klondike III (Phase I), OR (2007-2009) | NA | NA | 1.11 | 125 | 223.6 |
| Stateline, OR/WA (2001-2002) | NA | NA | 1.09 | 454 | 299 |
| Stateline, OR/WA (2006) | NA | NA | 0.95 | 454 | 299 |
| Tuolumne (Windy Point I), WA (2009-2010) | NA | NA | 0.94 | 62 | 136.6 |
| Klondike, OR (2002-2003) | NA | NA | 0.77 | 16 | 24 |
| Combine Hills, OR (2011) | NA | NA | 0.73 | 104 | 104 |
| Hopkins Ridge, WA (2006) | NA | NA | 0.63 | 83 | 150 |
| Biglow Canyon, OR (Phase I; 2009) | NA | NA | 0.58 | 76 | 125.4 |
| Biglow Canyon, OR (Phase II; 2010-2011) | NA | NA | 0.57 | 65 | 150 |
| Hay Canyon, OR (2009-2010) | NA | NA | 0.53 | 48 | 100.8 |
| Klondike II, OR (2005-2006) | NA | NA | 0.41 | 50 | 75 |
| Windy Flats, WA (2010-2011) | NA | NA | 0.41 | 114 | 262.2 |
| Vantage, WA (2010-2011) | NA | NA | 0.4 | 60 | 90 |
| Wild Horse, WA (2007) | NA | NA | 0.39 | 127 | 229 |
| Goodnoe, WA (2009-2010) | NA | NA | 0.34 | 47 | 94 |
| Marengo II, WA (2009-2010) | NA | NA | 0.27 | 39 | 70.2 |

**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 |
|---|---|---|---|---|---|
| Biglow Canyon, OR (Phase III; 2010-2011) | NA | NA | 0.22 | 76 | 174.8 |
| Marengo I, WA (2009-2010) | NA | NA | 0.17 | 78 | 140.4 |
| Klondike IIIa (Phase II), OR (2008-2010) | NA | NA | 0.14 | 51 | 76.5 |
| Kittitas Valley, WA (2011-2012) | NA | NA | 0.12 | 48 | 100.8 |
| ***Rocky Mountains*** | | | | | |
| Summerview, Alb (2006; 2007) | 7.65[B] | 07/15/06-07-09/30/06-07 | 11.42 | 39 | 70.2 |
| Summerview, Alb (2005-2006) | NA | NA | 10.27 | 39 | 70.2 |
| Judith Gap, MT (2006-2007) | NA | NA | 8.93 | 90 | 135 |
| Foote Creek Rim, WY (Phase I; 1999) | NA | NA | 3.97 | 69 | 41.4 |
| Judith Gap, MT (2009) | NA | NA | 3.2 | 90 | 135 |
| Foote Creek Rim, WY (Phase I; 2001-2002) | 2.2[B,C] | 6/15/01-9/1/01 | 1.57 | 69 | 41.4 |
| Foote Creek Rim, WY (Phase I; 2000) | 2.2[B,C] | 6/15/00-9/1/00 | 1.05 | 69 | 41.4 |
| ***Southwest*** | | | | | |
| Dry Lake I, AZ (2009-2010) | 8.8 | 4/29/10-11/10/10 | 3.43 | 30 | 63 |
| Dry Lake II, AZ (2011-2012) | 11.5 | 5/11/11-10/26/11 | 1.66 | 31 | 65 |
| ***Midwest*** | | | | | |
| Cedar Ridge, WI (2009) | 9.97[B,C,D,E] | 7/16/07-9/30/07 | 30.61 | 41 | 67.6 |
| Blue Sky Green Field, WI (2008; 2009) | 7.7[D] | 7/24/07-10/29/07 | 24.57 | 88 | 145 |
| Cedar Ridge, WI (2010) | 9.97[B,C,D,E] | 7/16/07-9/30/07 | 24.12 | 41 | 68 |
| Fowler I, II, III, IN (2011) | NA | NA | 20.19 | 355 | 600 |
| Fowler I, II, III, IN (2010) | NA | NA | 18.96 | 355 | 600 |
| Forward Energy Center, WI (2008-2010) | 6.97 | 8/5/08-11/08/08 | 18.17 | 86 | 129 |
| Harrow, Ont (2010) | NA | NA | 11.13 | 24 (four 6-turb facilities) | 39.6 |
| Top of Iowa, IA (2004) | 35.7 | 5/26/04-9/24/04 | 10.27 | 89 | 80 |
| Pioneer Prairie I, IA (Phase II; 2011-2012) | NA | NA | 10.06 | 62 | 102.3 |
| Fowler I, IN (2009) | NA | NA | 8.09 | 162 | 301 |
| Crystal Lake II, IA (2009) | NA | NA | 7.42 | 80 | 200 |
| Top of Iowa, IA (2003) | NA | NA | 7.16 | 89 | 80 |
| Kewaunee County, WI (1999-2001) | NA | NA | 6.45 | 31 | 20.46 |
| Ripley, Ont (2008) | NA | NA | 4.67 | 38 | 76 |
| Winnebago, IA (2009-2010) | NA | NA | 4.54 | 10 | 20 |
| Buffalo Ridge, MN (Phase II; 2001/Lake Benton I) | 2.2[B] | 6/15/01-9/15/01 | 4.35 | 143 | 107.25 |
| Buffalo Ridge, MN (Phase III; 2001/Lake Benton II) | 2.2[B] | 6/15/01-9/15/01 | 3.71 | 138 | 103.5 |
| Crescent Ridge, IL (2005-2006) | NA | NA | 3.27 | 33 | 49.5 |
| Fowler I, II, III, IN (2012) | NA | NA | 2.96 | 355 | 600 |
| Elm Creek II, MN (2011-2012) | NA | NA | 2.81 | 62 | 148.8 |
| Buffalo Ridge II, SD (2011-2012) | NA | NA | 2.81 | 105 | 210 |
| Buffalo Ridge, MN (Phase III; 1999) | NA | NA | 2.72 | 138 | 103.5 |
| Buffalo Ridge, MN (Phase II; 1999) | NA | NA | 2.59 | 143 | 107.25 |
| Moraine II, MN (2009) | NA | NA | 2.42 | 33 | 49.5 |
| Buffalo Ridge, MN (Phase II; 1998) | NA | NA | 2.16 | 143 | 107.25 |
| PrairieWinds ND1 (Minot), ND (2010) | NA | NA | 2.13 | 80 | 115.5 |
| Grand Ridge I, IL (2009-2010) | NA | NA | 2.1 | 66 | 99 |

**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 |
|---|---|---|---|---|---|
| Barton I & II, IA (2010-2011) | NA | NA | 1.85 | 80 | 160 |
| Fowler III, IN (2009) | NA | NA | 1.84 | 60 | 99 |
| Buffalo Ridge, MN (Phase III; 2002/Lake Benton II) | 1.9[B] | 6/15/02-9/15/02 | 1.81 | 138 | 103.5 |
| Buffalo Ridge, MN (Phase II; 2002/Lake Benton I) | 1.9[B] | 6/15/02-9/15/02 | 1.64 | 143 | 107.25 |
| Rugby, ND (2010-2011) | NA | NA | 1.6 | 71 | 149 |
| Elm Creek, MN (2009-2010) | NA | NA | 1.49 | 67 | 100 |
| Wessington Springs, SD (2009) | NA | NA | 1.48 | 34 | 51 |
| PrairieWinds ND1 (Minot), ND (2011) | NA | NA | 1.39 | 80 | 115.5 |
| PrairieWinds SD1, SD (2011-2012) | NA | NA | 1.23 | 108 | 162 |
| NPPD Ainsworth, NE (2006) | NA | NA | 1.16 | 36 | 20.5 |
| PrairieWinds SD1, SD (2012-2013) | NA | NA | 1.05 | 108 | 162 |
| Buffalo Ridge, MN (Phase I; 1999) | NA | NA | 0.74 | 73 | 25 |
| Wessington Springs, SD (2010) | NA | NA | 0.41 | 34 | 51 |
| Buffalo Ridge I, SD (2009-2010) | NA | NA | 0.16 | 24 | 50.4 |
| ***Southern Plains*** | | | | | |
| Barton Chapel, TX (2009-2010) | NA | NA | 3.06 | 60 | 120 |
| Big Smile, OK (2012-2013) | NA | NA | 2.9 | 66 | 132 |
| Buffalo Gap II, TX (2007-2008) | NA | NA | 0.14 | 155 | 233 |
| Red Hills, OK (2012-2013) | NA | NA | 0.11 | 82 | 123 |
| Buffalo Gap I, TX (2006) | NA | NA | 0.1 | 67 | 134 |
| ***Northeast*** | | | | | |
| Mountaineer, WV (2003) | NA | NA | 31.69 | 44 | 66 |
| Mount Storm, WV (2009) | 30.09 | 7/15/09-10/7/09 | 17.53 | 132 | 264 |
| Noble Wethersfield, NY (2010) | NA | NA | 16.3 | 84 | 126 |
| Criterion, MD (2011) | NA | NA | 15.61 | 28 | 70 |
| Mount Storm, WV (2010) | 36.67[F] | 4/18/10-10/15/10 | 15.18 | 132 | 264 |
| Locust Ridge, PA (Phase II; 2010) | NA | NA | 14.38 | 51 | 102 |
| Locust Ridge, PA (Phase II; 2009) | NA | NA | 14.11 | 51 | 102 |
| Casselman, PA (2008) | NA | NA | 12.61 | 23 | 34.5 |
| Maple Ridge, NY (2006) | NA | NA | 11.21 | 120 | 198 |
| Cohocton/Dutch Hills, NY (2010) | NA | NA | 10.32 | 50 | 125 |
| Wolfe Island, Ont (July-December 2010) | NA | NA | 9.5 | 86 | 197.8 |
| Cohocton/Dutch Hill, NY (2009) | NA | NA | 8.62 | 50 | 125 |
| Casselman, PA (2009) | NA | NA | 8.6 | 23 | 34.5 |
| Noble Bliss, NY (2008) | NA | NA | 7.8 | 67 | 100 |
| Criterion, MD (2012) | NA | NA | 7.62 | 28 | 70 |
| Mount Storm, WV (2011) | NA | NA | 7.43 | 132 | 264 |
| Maple Ridge, NY (2012) | NA | NA | 7.3 | 195 | 321.75 |
| Mount Storm, WV (Fall 2008) | 35.2 | 7/20/08-10/12/08 | 6.62 | 82 | 164 |
| Maple Ridge, NY (2007) | NA | NA | 6.49 | 195 | 321.75 |
| Wolfe Island, Ont (July-December 2009) | NA | NA | 6.42 | 86 | 197.8 |
| Maple Ridge, NY (2007-2008) | NA | NA | 4.96 | 195 | 321.75 |
| Noble Clinton, NY (2009) | 1.9[E] | 8/1/09-09/31/09 | 4.5 | 67 | 100 |
| Casselman Curtailment, PA (2008) | NA | NA | 4.4 | 23 | 35.4 |
| Noble Altona, NY (2010) | NA | NA | 4.34 | 65 | 97.5 |
| Noble Ellenburg, NY (2009) | 16.1[E] | 8/16/09-09/15/09 | 3.91 | 54 | 80 |
| Noble Bliss, NY (2009) | NA | NA | 3.85 | 67 | 100 |

**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 |
|---|---|---|---|---|---|
| Lempster, NH (2010) | NA | NA | 3.57 | 12 | 24 |
| Noble Ellenburg, NY (2008) | NA | NA | 3.46 | 54 | 80 |
| Noble Clinton, NY (2008) | 2.1[E] | 8/8/08-09/31/08 | 3.14 | 67 | 100 |
| Lempster, NH (2009) | NA | NA | 3.11 | 12 | 24 |
| Mars Hill, ME (2007) | NA | NA | 2.91 | 28 | 42 |
| Wolfe Island, Ont (July-December 2011) | NA | NA | 2.49 | 86 | 197.8 |
| Noble Chateaugay, NY (2010) | NA | NA | 2.44 | 71 | 106.5 |
| High Sheldon, NY (2010) | NA | NA | 2.33 | 75 | 112.5 |
| Beech Ridge, WV (2012) | NA | NA | 2.03 | 67 | 100.5 |
| Munnsville, NY (2008) | NA | NA | 1.93 | 23 | 34.5 |
| High Sheldon, NY (2011) | NA | NA | 1.78 | 75 | 112.5 |
| Stetson Mountain II, ME (2010) | NA | NA | 1.65 | 17 | 25.5 |
| Stetson Mountain I, ME (2009) | 28.5; 0.3[G] | 7/10/09-10/15/09 | 1.4 | 38 | 57 |
| Mars Hill, ME (2008) | NA | NA | 0.45 | 28 | 42 |
| Stetson Mountain I, ME (2011) | NA | NA | 0.28 | 38 | 57 |
| Kibby, ME (2011) | NA | NA | 0.12 | 44 | 132 |
| ***Southeast*** | | | | | |
| Buffalo Mountain, TN (2005) | NA | NA | 39.7 | 18 | 28.98 |
| Buffalo Mountain, TN (2000-2003) | 23.7 | NA | 31.54 | 3 | 1.98 |

A = Average of ground-based detectors at CPC Proper (Phase I) for late summer/fall period only
B = Activity rate was averaged across phases and/or years
C = Activity rate calculated by WEST from data presented in referenced report
D = Activity rate based on pre-construction monitoring; data for all other activity and fatality rates were collected concurrently
E = Activity rate based on data collected at various heights all other activity rates are from ground-based units only
F = Activity rate based on data collected from ground-based units excluding reference stations during the spring, summer and fall seasons
G = The overall activity rate of 28.5 is from reference stations located along forest edges which may be attractive to bats; the activity rate of 0.3 is from one unit placed on a nacelle

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

**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 |
|---|---|---|---|---|---|
| Elkhorn, OR (08) | | Jeffrey et a. 2009b | Red Hills, OK (12-13) | | Derby et al. 2013c |
| Elkhorn, OR (10) | | Enk et al. 2011b | Ripley, Ont (08) | | Jacques Whitford 2009 |
| Elm Creek, MN (09-10) | | Derby et al. 2010c | Rugby, ND (10-11) | | Derby et al. 2011b |
| Elm Creek II, MN (11-12) | | Derby et al. 2012b | Shiloh I, CA (06-09) | | Kerlinger et al. 2009 |
| Foote Creek Rim, WY (Phase I; 99) | | Young et al. 2003b | Shiloh II, CA (09-10) | | Kerlinger et al. 2010b |
| Foote Creek Rim, WY (Phase I; 00) | Gruver 2002 | Young et al. 2003b, 2003d | Stateline, OR/WA (01-02) | | Erickson et al. 2004 |
| Foote Creek Rim, WY (Phase I; 01-02) | Gruver 2002 | Young et al. 2003b, 2003d | Stateline, OR/WA (03) | | Erickson et al. 2004 |
| Forward Energy Center, WI (08-10) | Watt and Drake 2011 | Grodsky and Drake 2011 | Stateline, OR/WA (06) | | Erickson et al. 2007 |
| Fowler I, IN (09) | | Johnson et al. 2010a | Stetson Mountain I, ME (09) | Stantec 2009c | Stantec 2009c |
| Fowler III, IN (09) | | Johnson et al. 2010b | 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 | Baerwald 2008 |
| Goodnoe, WA (09-10) | | URS Corporation 2010a | Top of Iowa, IA (03) | | Jain 2005 |
| Grand Ridge I, IL (09-10) | | Derby et al. 2010g | Top of Iowa, IA (04) | Jain 2005 | Jain 2005 |
| Harrow, Ont (10) | | NRSI 2011 | Tuolumne (Windy Point I), WA (09-10) | | Enz and Bay 2010 |
| Harvest Wind, WA (10-12) | | Downes and Gritski 2012a | Vansycle, OR (99) | | Erickson et al. 2000a |
| Hay Canyon, OR (09-10) | | Gritski and Kronner 2010a | Vantage, WA (10-11) | | Ventus 2012 |
| High Sheldon, NY (10) | | Tidhar et al. 2012a | Wessington Springs, SD (09) | | Derby et al. 2010f |
| High Sheldon, NY (11) | | Tidhar et al. 2012b | Wessington Springs, SD (10) | | Derby et al. 2011d |
| High Winds, CA (03-04) | | Kerlinger et al. 2006 | White Creek, WA (07-11) | | Downes and Gritski 2012b |
| High Winds, CA (04-05) | | Kerlinger et al. 2006 | Wild Horse, WA (07) | | Erickson et al. 2008 |
| Hopkins Ridge, WA (06) | | Young et al. 2007 | Windy Flats, WA (10-11) | | Enz et al. 2011 |
| Hopkins Ridge, WA (08) | | Young et al. 2009c | Winnebago, IA (09-10) | | Derby et al. 2010e |
| Judith Gap, MT (06-07) | | TRC 2008 | Wolfe Island, Ont (July-December 09) | | Stantec Ltd. 2010b |
| Judith Gap, MT (09) | | Poulton and Erickson 2010 | Wolfe Island, Ont (July-December 10) | | Stantec Ltd. 2011b |
| Kewaunee County, WI (99-01) | | Howe et al. 2002 | 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. 2013b |
| Big Horn, WA (2006-2007) | 2.54 | 0.11 | 1.9 | Agriculture/grassland | Kronner et al. 2008 |
| Big Smile, OK (2012-2013) | 0.09 | 0 | 2.9 | Grassland, agriculture | Derby et al. 2013b |
| Biglow Canyon, OR (Phase I; 2008) | 1.76 | 0.03 | 1.99 | Agriculture/grassland | Jeffrey et al. 2009a |
| Biglow Canyon, OR (Phase I; 2009) | 2.47 | 0 | 0.58 | Agriculture/grassland | Enk et al. 2010 |
| Biglow Canyon, OR (Phase II; 2009-2010) | 5.53 | 0.14 | 2.71 | Agriculture | Enk et al. 2011a |
| Biglow Canyon, OR (Phase II; 2010-2011) | 2.68 | 0.03 | 0.57 | Grassland/shrub-steppe, agriculture | Enk et al. 2012b |
| Biglow Canyon, OR (Phase III; 2010-2011) | 2.28 | 0.05 | 0.22 | Grassland/shrub-steppe, agriculture | Enk et al. 2012a |
| Blue Sky Green Field, WI (2008; 2009) | 7.17 | 0 | 24.57 | Agriculture | Gruver et al. 2009 |
| Buffalo Gap I, TX (2006) | 1.32 | 0.1 | 0.1 | Grassland | Tierney 2007 |
| 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 |
| Buffalo Ridge, MN (Phase I; 1997) | 2.51 | 0 | NA | Agriculture | Johnson et al. 2000a |
| Buffalo Ridge, MN (Phase I; 1998) | 3.14 | 0 | NA | Agriculture | Johnson et al. 2000a |
| Buffalo Ridge, MN (Phase I; 1999) | 1.43 | 0.47 | 0.74 | Agriculture | Johnson et al. 2000a |
| Buffalo Ridge, MN (Phase II; 1998) | 2.47 | 0 | 2.16 | Agriculture | Johnson et al. 2000a |
| Buffalo Ridge, MN (Phase II; 1999) | 3.57 | 0 | 2.59 | Agriculture | Johnson et al. 2000a |
| Buffalo Ridge, MN (Phase II; 2001/Lake Benton I) | NA | NA | 4.35 | Agriculture | Johnson et al. 2004 |
| Buffalo Ridge, MN (Phase II; 2002/Lake Benton I) | NA | NA | 1.64 | Agriculture | Johnson et al. 2004 |

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

| Project | Bird Fatalities (birds/MW/ year) | Raptor Fatalities (raptors/MW/ year) | Bat Fatalities (bats/MW/ year) | Predominant Habitat Type | Citation |
|---|---|---|---|---|---|
| Buffalo Ridge, MN (Phase III; 1999) | 5.93 | 0 | 2.72 | Agriculture | Johnson et al. 2000a |
| Buffalo Ridge, MN (Phase III; 2001/Lake Benton II) | NA | NA | 3.71 | Agriculture | Johnson et al. 2004 |
| Buffalo Ridge, MN (Phase III; 2002/Lake Benton II) | NA | NA | 1.81 | Agriculture | Johnson et al. 2004 |
| Buffalo Ridge I, SD (2009-2010) | 5.06 | 0.2 | 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 |
| 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 |

**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 |
|---|---|---|---|---|---|
| Forward Energy Center, WI (2008-2010) | NA | NA | 18.17 | Agriculture | Grodsky and Drake 2011 |
| Fowler I, IN (2009) | 2.83 | 0 | 8.09 | Agriculture | Johnson et al. 2010a |
| Fowler I, II, III, IN (2010) | NA | NA | 18.96 | Agriculture | Good et al. 2011 |
| Fowler I, II, III, IN (2011) | NA | NA | 20.19 | Agriculture | Good et al. 2012 |
| Fowler I, II, III, IN (2012) | NA | NA | 2.96 | Agriculture | Good et al. 2013 |
| Fowler III, IN (2009) | NA | NA | 1.84 | Agriculture | Johnson et al. 2010b |
| Goodnoe, WA (2009-2010) | 1.4 | 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 |
| 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 |

**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 |
|---|---|---|---|---|---|
| Lempster, NH (2010) | 2.64 | 0 | 3.57 | Grasslands/forest/rocky embankments | Tidhar et al. 2011 |
| Linden Ranch, WA (2010-2011) | 6.65 | 0.27 | 1.68 | Grassland/shrub-steppe, agriculture | Enz and Bay 2011 |
| Locust Ridge, PA (Phase II; 2009) | 0.84 | 0 | 14.11 | Grassland | Arnett et al. 2011 |
| Locust Ridge, PA (Phase II; 2010) | 0.76 | 0 | 14.38 | Grassland | Arnett et al. 2011 |
| Maple Ridge, NY (2006) | NA | NA | 11.21 | Agriculture/forested | Jain et al. 2007 |
| Maple Ridge, NY (2007-2008) | 2.07 | 0.03 | 4.96 | Agriculture/forested | Jain et al. 2009a |
| Maple Ridge, NY (2007) | 2.34 | NA | 6.49 | Agriculture/forested | Jain et al. 2009d |
| Maple Ridge, NY (2012) | NA | NA | 7.3 | Agriculture/forested | Tidhar et al. 2013a |
| Marengo I, WA (2009-2010) | 0.27 | 0 | 0.17 | Agriculture | URS Corporation 2010b |
| Marengo II, WA (2009-2010) | 0.16 | 0.05 | 0.27 | Agriculture | URS Corporation 2010c |
| Mars Hill, ME (2007) | 1.67 | 0 | 2.91 | Forest | Stantec 2008 |
| Mars Hill, ME (2008) | 1.76 | 0 | 0.45 | Forest | Stantec 2009a |
| 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 |
| 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 |
| **North Sky River (2013)** | **2.05** | **0.05** | **2.59** | **Woodland & scrub** | **Levenstein et al. 2014** |
| **North Sky River (2014)** | **1.23** | **0.07** | **1.45** | **Woodland & scrub** | **This study.** |
| NPPD Ainsworth, NE (2006) | 1.63 | 0.06 | 1.16 | Agriculture/grassland | Derby et al. 2007 |

**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 |
|---|---|---|---|---|---|
| Pebble Springs, OR (2009-2010) | 1.93 | 0.04 | 1.55 | Grassland | Gritski and Kronner 2010b |
| Pine Tree, CA (2009-2010, 2011) | 17.44 | NA | NA | Grassland | BioResource Consultants 2012 |
| Pinyon Pines I & II (2013-2014) | 1.18 | 0 | 0.04 | Scrub and woodland | Chatfield and Russo 2014 |
| Pioneer Prairie I, IA (Phase II; 2011-2012) | 0.27 | 0 | 10.06 | Agriculture, grassland | Chodachek et al. 2012 |
| PrairieWinds ND1 (Minot), ND (2010) | 1.48 | 0.05 | 2.13 | Agriculture | Derby et al. 2011c |
| PrairieWinds ND1 (Minot), ND (2011) | 1.56 | 0.05 | 1.39 | Agriculture, grassland | Derby et al. 2012c |
| PrairieWinds SD1, SD (2011-2012) | 1.41 | 0 | 1.23 | Grassland | Derby et al. 2012d |
| PrairieWinds SD1, SD (2012-2013) | 2.01 | 0.03 | 1.05 | Grassland | Derby et al. 2013a |
| Red Hills, OK (2012-2013) | 0.08 | 0.04 | 0.11 | Grassland | Derby et al. 2013c |
| Ripley, Ont (2008) | 3.09 | 0.1 | 4.67 | Agriculture | Jacques Whitford 2009 |
| 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 |
| 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 |

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

| Project | Bird Fatalities (birds/MW/ year) | Raptor Fatalities (raptors/MW/ year) | Bat Fatalities (bats/MW/ year) | Predominant Habitat Type | Citation |
|---|---|---|---|---|---|
| Wessington Springs, SD (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 |
| Beech Ridge, WV (2013) | 67 | 100.5 | 80 | 67 | 40 m radius | 7.5 months | Every two days |
| Big Horn, WA (2006-2007) | 133 | 199.5 | 80 | 133 | 180 m x 180 m | 1 year | Bi-monthly (spring, fall), monthly (winter, summer) |
| Big Smile, OK (2012-2013) | 66 | 132 | NA | 17 (plus one met tower) | 100 x 100 | 1 year | Weekly (spring, summer, fall), monthly (winter) |
| Biglow Canyon, OR (Phase I; 2008) | 76 | 125.4 | 80 | 50 | 110 m x 110 m | 1 year | Bi-monthly (spring, fall), monthly (winter, summer) |
| Biglow Canyon, OR (Phase I; 2009) | 76 | 125.4 | 80 | 50 | 110 m x 110 m | 1 year | Bi-monthly (spring, fall), monthly (winter, summer) |
| Biglow Canyon, OR (Phase II; 2009-2010) | 65 | 150 | 80 | 50 | 250 m x 250 m | 1 year | Bi-monthly (spring, fall), monthly (winter, summer) |
| Biglow Canyon, OR (Phase II; 2010-2011) | 65 | 150 | NA | 50 | 252 m x 252 m | 1 year | Bi-weekly(spring, fall), monthly (summer, winter) |
| Biglow Canyon, OR (Phase III; 2010-2011) | 76 | 174.8 | NA | 50 | 252 m x 252 m | 1 year | Bi-weekly(spring, fall), monthly (summer, winter) |

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

| Project Name | Total # of Turbines | Total MW | Tower Size (m) | Number Turbines Searched | Plot Size | Length of Study | Survey Frequency |
|---|---|---|---|---|---|---|---|
| Blue Sky Green Field, WI (2008; 2009) | 88 | 145 | 80 | 30 | 160 m x 160 m | Fall, spring | Daily(10 turbines), weekly (20 turbines) |
| Buena Vista, CA (2008-2009) | 38 | 38 | 45-55 | 38 | 75-m radius | 1 year | Monthly to bi-monthly starting in September 2008 |
| Buffalo Gap I, TX (2006) | 67 | 134 | 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 |
| Buffalo Ridge, MN (Phase I; 1996) | 73 | 25 | 36 | 21 | 126 m x 126 m | 1 year | Bi-monthly (spring, summer, and fall) |
| Buffalo Ridge, MN (Phase I; 1997) | 73 | 25 | 36 | 21 | 126 m x 126 m | 1 year | Bi-monthly (spring, summer, and fall) |
| Buffalo Ridge, MN (Phase I; 1998) | 73 | 25 | 36 | 21 | 126 m x 126 m | 1 year | Bi-monthly (spring, summer, and fall) |
| Buffalo Ridge, MN (Phase I; 1999) | 73 | 25 | 36 | 21 | 126 m x 126 m | 1 year | Bi-monthly (spring, summer, and fall) |
| Buffalo Ridge, MN (Phase II; 1998) | 143 | 107.25 | 50 | 40 | 126 m x 126 m | 1 year | Bi-monthly (spring, summer, and fall) |

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

| Project Name | Total # of Turbines | Total MW | Tower Size (m) | Number Turbines Searched | Plot Size | Length of Study | Survey Frequency |
|---|---|---|---|---|---|---|---|
| Buffalo Ridge, MN (Phase II; 1999) | 143 | 107.25 | 50 | 40 | 126 m x 126 m | 1 year | Bi-monthly (spring, summer, and fall) |
| Buffalo Ridge, MN (Phase II; 2001/Lake Benton I) | 143 | 107.25 | 50 | 83 | 60 m x 60 m | Summer, fall | Bi-monthly |
| Buffalo Ridge, MN (Phase II; 2002/Lake Benton I) | 143 | 107.25 | 50 | 103 | 60 m x 60 m | Summer, fall | Bi-monthly |
| Buffalo Ridge, MN (Phase III; 1999) | 138 | 103.5 | 50 | 30 | 126 m x 126 m | 1 year | Bi-monthly (spring, summer, and fall) |
| Buffalo Ridge, MN (Phase III; 2001/Lake Benton II) | 138 | 103.5 | 50 | 83 | 60 m x 60 m | Summer, fall | Bi-monthly |
| Buffalo Ridge, MN (Phase III; 2002/Lake Benton II) | 138 | 103.5 | 50 | 103 | 60 m x 60 m | Summer, fall | Bi-monthly |
| Buffalo Ridge I, SD (2009-2010) | 24 | 50.4 | 79 | 24 | 200 m x 200 m | 1 year | Weekly (migratory), monthly (non-migratory) |
| Buffalo Ridge II, SD (2011-2012) | 105 | 210 | 78 | 65 (60 road and pad, 5 turbine plots) | 100 x 100m | 1 year | Weekly (spring, summer, fall), monthly (winter) |
| Casselman, PA (2008) | 23 | 34.5 | 80 | 10 | 126 m x 120 m | 7 months | Daily |
| Casselman, PA (2009) | 23 | 34.5 | 80 | 10 | 126 m x 120 m | 7.5 months | Daily searches |
| Casselman Curtailment, PA (2008) | 23 | 35.4 | 80 | 12 experimental; 10 control | 126 m x 120 m | 2.5 months | Daily |
| Castle River, Alb (2001-2002) | 60 | 39.6 | 50 | 60 | 50-m radius | 2 years | Weekly, bi-weekly |
| Castle River, Alb (2001-2002) | 60 | 39.6 | 50 | 60 | 50-m radius | 2 years | Weekly, bi-weekly |
| Cedar Ridge, WI (2009) | 41 | 67.6 | 80 | 20 | 160 m x 160 m | Spring, summer, fall | Daily, every 4 days; late fall searched every 3 days |
| 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 |

**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 |
|---|---|---|---|---|---|---|---|
| Cohocton/Dutch Hill, NY (2009) | 50 | 125 | 80 | 17 | 130 m x 130 m | Spring, summer, fall | Daily (5 turbines), weekly (12 turbines) |
| Cohocton/Dutch Hills, NY (2010) | 50 | 125 | 80 | 17 | 120 m x 120 m | Spring, summer, fall | Daily, weekly |
| Combine Hills, OR (Phase I; 2004-2005) | 41 | 41 | 53 | 41 | 90-m radius | 1 year | Monthly |
| Combine Hills, OR (2011) | 104 | 104 | 53 | 52 (plus 1 MET tower) | 180 m x 180 m | 1 year | Bi-weekly(spring, fall), monthly (summer, winter) |
| Condon, OR | 84 | NA | NA | NA | NA | NA | NA |
| Crescent Ridge, IL (2005-2006) | 33 | 49.5 | 80 | 33 | 70-m radius | 1 year | Weekly (fall, spring) |
| Criterion, MD (2011) | 28 | 70 | 80 | 28 | 40-50m radius | 7.3 months | Daily |
| Criterion, MD (2012) | 28 | 70 | 80 | 14 | 40-50m radius | 7.5 months | Weekly |
| Crystal Lake II, IA (2009) | 80 | 200 | 80 | 16 turbines through week 6, and then 15 for duration of study | 100 m x 100 m | Spring, summer, fall | 3 times per week for 26 weeks |
| Diablo Winds, CA (2005-2007) | 31 | 20.46 | 50 and 55 | 31 | 75 m x 75 m | 2 years | Monthly |
| Dillon, CA (2008-2009) | 45 | 45 | 69 | 15 | 200 m x 200 m | 1 year | Weekly, bi-monthly in winter |
| Dry Lake I, AZ (2009-2010) | 30 | 63 | 78 | 15 | 160 m x 160 m | 1 year | Bi-monthly (spring, fall), monthly (winter, summer) |
| Dry Lake II, AZ (2011-2012) | 31 | 65 | 78 | 31: 5 (full plot), 26 (road & pad) | 160 m x 160 m | 1 year | Twice weekly (spring, summer, fall), weekly (winter) |
| Elkhorn, OR (2008) | 61 | 101 | 80 | 61 | 220 m x 220 m | 1 year | Monthly |
| Elkhorn, OR (2010) | 61 | 101 | 80 | 31 | 220 m x 220 m | 1 year | Bi-monthly (spring, fall), monthly (winter, summer) |
| Elm Creek, MN (2009-2010) | 67 | 100 | 80 | 29 | 200 m x 200 m | 1 year | Weekly, monthly |
| 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) |

**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; 1999) | 69 | 41.4 | 40 | 69 | 126 m x 126 m | 1 year | Monthly |
| Foote Creek Rim, WY (Phase I; 2000) | 69 | 41.4 | 40 | 69 | 126 m x 126 m | 1 year | Monthly |
| Foote Creek Rim, WY (Phase I; 2001-2002) | 69 | 41.4 | 40 | 69 | 126 m x 126 m | 1 year | Monthly |
| Forward Energy Center, WI (2008-2010) | 86 | 129 | 80 | 29 | 160 m x 160 m | 2 years | 11 turbines daily, 9 every 3 days, 9 every 5 days |
| Fowler I, IN (2009) | 162 | 301 | 78 (Vestas), 80 (Clipper) | 25 | 160 m x 160 m | Spring, summer, fall | Weekly, bi-weekly |
| Fowler I, II, III, IN (2010) | 355 | 600 | Vestas = 80, Clipper = 80, GE = 80 | 36 turbines, 100 road and pads | 80 m x 80 m for turbines ; 40-m radius for roads and pads | Spring, fall | Daily, weekly |
| Fowler I, II, III, IN (2011) | 355 | 600 | Vestas = 80, Clipper = 80, GE = 80 | 177 road and pads (spring), 9 turbines & 168 roads and pads (fall) | turbines (80 m circular plot), roads and pads (out to 80 m) | Spring, fall | Daily, weekly |
| Fowler I, II, III, IN (2012) | 355 | 600 | Vestas = 80, Clipper = 80, GE = 80 | 118 roads and pads | roads and pads (out to 80 m) | 2.5 months | Weekly |
| Fowler III, IN (2009) | 60 | 99 | 78 | 12 | 160 m x 160 m | 10 weeks | Weekly, bi-weekly |
| Goodnoe, WA (2009-2010) | 47 | 94 | 80 | 24 | 180 m x 180 m | 1 year | 14 days during migration periods, 28 days during non-migration periods |
| Grand Ridge I, IL (2009-2010) | 66 | 99 | 80 | 30 | 160 m x 160 m | 1 year | Weekly, monthly |
| 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 |

**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 |
|---|---|---|---|---|---|---|---|
| Harvest Wind, WA (2010-2012) | 43 | 98.9 | 80 | 32 | 180 m x 180 m & 240 m x 240 m | 2 years | Twice a week, weekly and monthly |
| Hay Canyon, OR (2009-2010) | 48 | 100.8 | 79 | 20 | 180 m x 180 m | 1 year | Bi-monthly (spring, fall), monthly (winter, summer) |
| High Sheldon, NY (2010) | 75 | 112.5 | 80 | 25 | 115 m x 115 m | 7 months | Daily (8 turbines), weekly (17 turbines) |
| High Sheldon, NY (2011) | 75 | 112.5 | 80 | 25 | 115 m x 115 m | 7 months | Daily (8 turbines), weekly (17 turbines) |
| High Winds, CA (2003-2004) | 90 | 162 | 60 | 90 | 75-m radius | 1 year | Bi-monthly |
| High Winds, CA (2004-2005) | 90 | 162 | 60 | 90 | 75-m radius | 1 year | Bi-monthly |
| Hopkins Ridge, WA (2006) | 83 | 150 | 67 | 41 | 180 m x 180 m | 1 year | Monthly, weekly (subset of 22 turbines spring and fall migration) |
| Hopkins Ridge, WA (2008) | 87 | 156.6 | 67 | 41-43 | 180 m x 180 m | 1 year | Bi-monthly (spring, fall), monthly (winter, summer) |
| Jersey Atlantic, NJ (2008) | 5 | 7.5 | 80 | 5 | 130 m x 120 m | 9 months | Weekly |
| Judith Gap, MT (2006-2007) | 90 | 135 | 80 | 20 | 190 m x 190 m | 7 months | Monthly |
| Judith Gap, MT (2009) | 90 | 135 | 80 | 30 | 100 m x 100 m | 5 months | Bi-monthly |
| Kewaunee County, WI (1999-2001) | 31 | 20.46 | 65 | 31 | 60 m x 60 m | 2 years | Bi-weekly (spring, summer), daily (spring, fall migration), weekly (fall, winter) |
| Kibby, ME (2011) | 44 | 132 | 124 | 22 turbines | 75-m diameter circular plots | 22 weeks | Avg 5-day |
| Kittitas Valley, WA (2011-2012) | 48 | 100.8 | 80 | 48 | 100 m x 102 m | 1 year | Bi weekly from Aug 15 - Oct 31 and March 16 - May 15; every 4 weeks from Nov 1 - March 15 and May 16 - Aug 14 |
| Klondike, OR (2002-2003) | 16 | 24 | 80 | 16 | 140 m x 140 m | 1 year | Monthly |
| Klondike II, OR (2005-2006) | 50 | 75 | 80 | 25 | 180 m x 180 m | 1 year | Bi-monthly (spring, fall), monthly (summer, winter) |

**Appendix 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 III (Phase I), OR (2007-2009) | 125 | 223.6 | GE = 80; Siemens= 80, Mitsubishi = 80 | 46 | 240 m x 240 m (1.5MW) 252 m x 252 m (2.3MW) | 2 year | Bi-monthly (spring, fall migration), monthly (summer, winter) |
| Klondike IIIa (Phase II), OR (2008-2010) | 51 | 76.5 | GE = 80 | 34 | 240 m x 240 m | 2 years | Bi-monthly (spring, fall), monthly (summer, winter) |
| Leaning Juniper, OR (2006-2008) | 67 | 100.5 | 80 | 17 | 240 m x 240 m | 2 years | Bi-monthly (spring, fall), monthly (winter, summer) |
| Lempster, NH (2009) | 12 | 24 | 78 | 4 | 120 m x 130 m | 6 months | Daily |
| Lempster, NH (2010) | 12 | 24 | 78 | 12 | 120 m x 130 m | 6 months | Weekly |
| Linden Ranch, WA (2010-2011) | 25 | 50 | 80 | 25 | 110 m x 110 m | 1 year | Bi-weekly(spring, fall), monthly (summer, winter) |
| Locust Ridge, PA (Phase II; 2009) | 51 | 102 | 80 | 15 | 120m x 126m | 6.5 months | Daily |
| Locust Ridge, PA (Phase II; 2010) | 51 | 102 | 80 | 15 | 120m x 126m | 6.5 months | Daily |
| Madison, NY (2001-2002) | 7 | 11.55 | 67 | 7 | 60-m radius | 1 year | Weekly (spring, fall), monthly (summer) |
| Maple Ridge, NY (2006) | 120 | 198 | 80 | 50 | 130 m x 120 m | 5 months | Daily (10 turbines), every 3 days (10 turbines), weekly (30 turbines) |
| Maple Ridge, NY (2007) | 195 | 321.75 | 80 | 64 | 130 m x 120 m | 7 months | Weekly |
| Maple Ridge, NY (2007-2008) | 195 | 321.75 | 80 | 64 | 130 m x 120 m | 7 months | Weekly |
| Maple Ridge, NY (2012) | 195 | 321.75 | 80 | 105 (5 turbines, 100 roads/pads) | 100 m x 100 m | 3 months | Weekly |
| Marengo I, WA (2009-2010) | 78 | 140.4 | 67 | 39 | 180 m x 180 m | 1 year | Bi-monthly (spring, fall), monthly (winter, summer) |
| Marengo II, WA (2009-2010) | 39 | 70.2 | 67 | 20 | 180 m x 180 m | 1 year | Bi-monthly (spring, fall), monthly (winter, summer) |
| Mars Hill, ME (2007) | 28 | 42 | 80.5 | 28 | 76-m diameter, extended plot 238-m diameter | Spring, summer, fall | Daily (2 random turbines), weekly (all turbines): extended plot searched once per season |
| Mars Hill, ME (2008) | 28 | 42 | 80.5 | 28 | 76-m diameter, extended plot 238-m diameter | Spring, summer, fall | Weekly: extended plot searched once per season |

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

| Project Name | Total # of Turbines | Total MW | Tower Size (m) | Number Turbines Searched | Plot Size | Length of Study | Survey Frequency |
|---|---|---|---|---|---|---|---|
| McBride, Alb (2004) | 114 | 75 | 50 | 114 | 4 parallel transects 120-m wide | 1 year | Weekly, bi-weekly |
| Melancthon, Ont (Phase I; 2007) | 45 | NA | NA | 45 | 35m radius | 5 months | Weekly, twice weekly |
| Meyersdale, PA (2004) | 20 | 30 | 80 | 20 | 130 m x 120 m | 6 weeks | Daily (half turbines), weekly (half turbines) |
| Moraine II, MN (2009) | 33 | 49.5 | 82.5 | 30 | 200 m x 200 m | 1 year | Weekly (migratory), monthly (non-migratory) |
| Mount Storm, WV (Fall 2008) | 82 | 164 | 78 | 27 | varied | 3 months | Weekly (18 turbines), daily (9 turbines) |
| Mount Storm, WV (2009) | 132 | 264 | 78 | 44 | varied | 4.5 months | Weekly (28 turbines), daily (16 turbines) |
| Mount Storm, WV (2010) | 132 | 264 | 78 | 24 | 20 to 60 m from turbine | 6 months | Daily |
| Mount Storm, WV (2011) | 132 | 264 | 78 | 24 | varied | 6 months | Daily |
| Mountaineer, WV (2003) | 44 | 66 | 80 | 44 | 60-m radius | 7 months | Weekly, monthly |
| Mountaineer, WV (2004) | 44 | 66 | 80 | 44 | 130 m x 120 m | 6 weeks | Daily, weekly |
| 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 Bliss/Wethersfield, NY (2011) | 151 | 226 | 80 | 48 (24 from each site:12 ag, 12 forest) | road & pad 70 m out from turbine | 2 months | Daily |
| Noble Chateaugay, NY (2010) | 71 | 106.5 | 80 | 24 | 120 m x 120 m | Spring, summer, fall | Weekly |
| Noble Clinton, NY (2008) | 67 | 100 | 80 | 23 | 120 m x 120 m | Spring, summer, fall | Daily (8 turbines), 3-day (8 turbines), weekly (7 turbines) |

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

| Project Name | Total # of Turbines | Total MW | Tower Size (m) | Number Turbines Searched | Plot Size | Length of Study | Survey Frequency |
|---|---|---|---|---|---|---|---|
| Noble 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 |
| **North Sky River (2013)** | **100** | **160** | **80** | **30** | **80 m radius** | **1 year** | **Every two weeks; and twice per week at 7 additional turbines during spring migration = intensive)** |
| **North Sky River (2014)** | **100** | **160** | **80** | **30** | **80 m radius** | **1 year** | **Every two weeks; and twice per week at 7 additional turbines during spring migration = intensive)** |
| NPPD Ainsworth, NE (2006) | 36 | 20.5 | 70 | 36 | 220 m x 220 m | Spring, summer, fall | Bi-monthly |
| Oklahoma Wind Energy Center, OK (2004; 2005) | 68 | 102 | 70 | 68 | 20m radius | 3 months (2 years) | Bi-monthly |
| Pebble Springs, OR (2009-2010) | 47 | 98.7 | 79 | 20 | 180 m x 180 m | 1 year | Bi-monthly (spring, fall), monthly (winter, summer) |
| Pine Tree, CA (2009-2010, 2011) | 90 | 135 | 65 | 40 | 100 m radius | 1.5 year | Bi-weekly, weekly |
| Pinyon Pines I & II (2013-2014) | 100 | 300 | 90 | 25 plots/31 turbines | 240 x 240m | 1 year | Every two weeks |
| Pioneer Prairie I, IA (Phase II; 2011-2012) | 62 | 102.3 | 80 | 62 (57 road/pad) 5 full search plots | 80 x 80m | 1 year | Weekly (spring and fall), every two weeks (summer), monthly (winter) |
| PrairieWinds ND1 (Minot), ND (2010) | 80 | 115.5 | 89 | 35 | minimum of 100 m x 100 m | 3 seasons | Bi-monthly |
| PrairieWinds ND1 (Minot), ND (2011) | 80 | 115.5 | 80 | 35 | minimum 100 x 100m | 3 season | Twice monthly |

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

| Project Name | Total # of Turbines | Total MW | Tower Size (m) | Number Turbines Searched | Plot Size | Length of Study | Survey Frequency |
|---|---|---|---|---|---|---|---|
| PrairieWinds SD1, SD (2011-2012) | 108 | 162 | 80 | 50 | 200 x 200m | 1 year | Twice monthly (spring, summer, fall), monthly (winter) |
| PrairieWinds SD1, SD (2012-2013) | 108 | 162 | 80 | 50 | 200 x 200m | 1 year | Bi-weekly |
| PrairieWinds SD1, SD (2013-2014) | 108 | 162 | 80 | 45 | 200 x 200m | 1 year | Twice monthly (spring, summer, fall), monthly (winter) |
| Prince Wind Farm, Ont (2006) | 126 | 189 | 80 | 38 | 63-m radius | 4 months | Daily, weekly |
| Prince Wind Farm, Ont (2007) | 126 | 189 | 80 | 38 turbines from January 1st - July 8th, 126 turbines from July 9th-October 31st | 63- to 45-m radius | 10 months | Daily, weekly |
| Prince Wind Farm, Ont (2008) | 126 | 189 | 80 | 126 | 45m radius | 6.5 months | Daily, 3x/week, 2x/week |
| Red Canyon, TX (2006-2007) | 56 | 84 | 70 | 28 | 200 m x 200 m in fall and winter; 160 m x 160 m in spring and summer | 1 year | Every 14 days in fall and winter; 7 days in spring, 3 days in summer |
| Red Hills, OK (2012-2013) | 82 | 123 | NA | 20 (plus one met tower) | 100 x 100 | 1 year | Weekly (spring, summer, fall), monthly (winter) |
| Ripley, Ont (2008) | 38 | 76 | 64 | 38 | 80 m x 80 m | Spring, fall | Twice weekly for odd turbines; weekly for even turbines. |
| Ripley, Ont (2008-2009) | 38 | 76 | 64 | 38 | 80 m x 80 m | 6 weeks | Twice weekly for odd turbines; weekly for even turbines. |
| Rugby, ND (2010-2011) | 71 | 149 | 78 | 32 | 200 m x 200 m | 1 year | Weekly (spring, fall; migratory turbines), monthly ( non-migratory turbines) |
| San Gorgonio, CA (1997-1998; 1999-2000) | 3000 | NA | 24.4-42.7 | NA | 50-m radius | 2 years | Quarterly |
| Searsburg, VT (1997) | 11 | 7 | 65 | 11 | 20- to 55-m radius | Spring, fall | Weekly (fall migration) |
| Shiloh I, CA (2006-2009) | 100 | 150 | 65 | 100 | 105-m radius | 3 years | Weekly |

**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 |
|---|---|---|---|---|---|---|---|
| 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 |
| Stateline, OR/WA (2006) | 454 | 299 | 50 | 39 | variable turbine strings | 1 year | Bi-weekly |
| Steel Winds I, NY (2007) | 8 | 20 | 80 | 8 | 176m x 176m | 6.5 months | Every 10 days (spring, fall) every 21 days (summer) |
| Stetson Mountain I, ME (2009) | 38 | 57 | 80 | 19 | 76-m diameter | 27 weeks (spring, summer, fall) | Weekly |
| Stetson Mountain I, ME (2011) | 38 | 57 | 80 | 19 | varied | 6 months | Weekly |
| Stetson Mountain II, ME (2010) | 17 | 25.5 | 80 | 17 | varied | 6 months | Weekly (3 turbines twice a week) |
| Summerview, Alb (2005-2006) | 39 | 70.2 | 67 | 39 | 140 m x 140 m | 1 year | Weekly, bi-weekly (May to July, September) |
| Summerview, Alb (2006; 2007) | 39 | 70.2 | 65 | 39 | 52-m radius; 2 spiral transects 7 m apart | Summer, fall (2 years) | Daily (10 turbines), weekly (29 turbines) |
| Tehachapi, CA (1996-1998) | 3300 | NA | 14.7 to 57.6 | 201 | 50-m radius | 20 months | Quarterly |
| Top of Iowa, IA (2003) | 89 | 80 | 71.6 | 26 | 76 m x 76 m | Spring, summer, fall | Once every 2 to 3 days |
| Top of Iowa, IA (2004) | 89 | 80 | 71.6 | 26 | 76 m x 76 m | Spring, summer, fall | Once every 2 to 3 days |
| 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 |

**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 |
|---|---|---|---|---|---|---|---|
| Vansycle, OR (1999) | 38 | 24.9 | 50 | 38 | 126 m x 126 m | 1 year | Monthly |
| Vantage, WA (2010-2011) | 60 | 90 | 80 | 30 | 240 m x 240 m | 1 year | Monthly, a subset of 10 searched weekly during migration |
| Vasco, CA (2012-2013) | 34 | 78.2 | 80 | 34 | 105 m radius | 1 year | Weekly, monthly |
| Wessington Springs, SD (2009) | 34 | 51 | 80 | 20 | 200 m x 200 m | Spring, summer, fall | Bi-monthly |
| Wessington Springs, SD (2010) | 34 | 51 | 80 | 20 | 200 m x 200 m | 8 months | Bi-weekly (spring, summer, fall) |
| White Creek, WA (2007-2011) | 89 | 204.7 | 80 | 89 | 180 m x 180 m & 240 m x 240 m | 4 years | Twice a week, weekly and monthly |
| Wild Horse, WA (2007) | 127 | 229 | 67 | 64 | 110 m from two turbines in plot | 1 year | Monthly, weekly (fall, spring migration at 16 turbines) |
| Windy Flats, WA (2010-2011) | 114 | 262.2 | NA | 36 (plus 1 MET tower) | 180 m x 180 m (120m at MET tower) | 1 year | Monthly (spring, summer, fall, and winter), weekly (spring and fall migration) |
| Winnebago, IA (2009-2010) | 10 | 20 | 78 | 10 | 200 m x 200 m | 1 year | Weekly (migratory), monthly (non-migratory) |
| Wolfe Island, Ont (May-June 2009) | 86 | 197.8 | 80 | 86 | 60-m radius | Spring | 43 twice weekly, 43 weekly |
| Wolfe Island, Ont (July-December 2009) | 86 | 197.8 | 80 | 86 | 60-m radius | Summer, fall | 43 twice weekly, 43 weekly |
| Wolfe Island, Ont (January-June 2010) | 86 | 197.8 | 80 | 86 | 60-m radius | 6 months | 43 twice weekly, 43 weekly |
| Wolfe Island, Ont (July-December 2010) | 86 | 197.8 | 80 | 86 | 50-m radius | 6 months | 43 twice weekly, 43 weekly |
| Wolfe Island, Ont (January-June 2011) | 86 | 197.8 | 80 | 86 | 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 |
|---|---|---|---|
| North Sky River, CA (13) | Levenstein et al. 2014 | | |
| North Sky River, CA (14) | This study. | | |
| Alite, CA (09-10) | Chatfield et al. 2010 | Leaning Juniper, OR (06-08) | Gritski et al. 2008 |
| Alta Wind I, CA (11-12) | Chatfield et al. 2012 | Lempster, NH (09) | Tidhar et al. 2010 |
| Alta Wind II-V, CA (11-12) | Chatfield et al. 2012 | Lempster, NH (10) | Tidhar et al. 2011 |
| Barton I & II, IA (10-11) | Derby et al. 2011a | Linden Ranch, WA (10-11) | Enz and Bay 2011 |
| Barton Chapel, TX (09-10) | WEST 2011 | Locust Ridge, PA (Phase II; 09) | Arnett et al. 2011 |
| Beech Ridge, WV (12) | Tidhar et al. 2013b | Locust Ridge, PA (Phase II; 10) | Arnett et al. 2011 |
| Beech Ridge, WV (13) | Young et al. 2014 | Madison, NY (01-02) | Kerlinger 2002b |
| Big Horn, WA (06-07) | Kronner et al. 2008 | Maple Ridge, NY (06) | Jain et al. 2007 |
| Big Smile, OK (12-13) | Derby et al. 2013b | Maple Ridge, NY (07) | Jain et al. 2009a |
| Biglow Canyon, OR (Phase I; 08) | Jeffrey et al. 2009a | Maple Ridge, NY (07-08) | Jain et al. 2009d |
| Biglow Canyon, OR (Phase I; 09) | Enk et al. 2010 | Maple Ridge, NY (12) | Tidhar et al. 2013a |
| Biglow Canyon, OR (Phase II; 09-10) | Enk et al. 2011a | Marengo I, WA (09-10) | URS Corporation 2010b |
| Biglow Canyon, OR (Phase II; 10-11) | Enk et al. 2012b | Marengo II, WA (09-10) | URS Corporation 2010c |
| Biglow Canyon, OR (Phase III; 10-11) | Enk et al. 2012a | Mars Hill, ME (07) | Stantec 2008 |
| Blue Sky Green Field, WI (08; 09) | Gruver et al. 2009 | Mars Hill, ME (08) | Stantec 2009a |
| Buena Vista, CA (08-09) | Insignia Environmental 2009 | McBride, Alb (04) | Brown and Hamilton 2004 |
| Buffalo Gap I, TX (06) | Tierney 2007 | Melancthon, Ont (Phase I; 07) | Stantec Ltd. 2008 |
| Buffalo Gap II, TX (07-08) | Tierney 2009 | Meyersdale, PA (04) | Arnett et al. 2005 |
| Buffalo Mountain, TN (00-03) | Nicholson et al. 2005 | Moraine II, MN (09) | Derby et al. 2010d |
| Buffalo Mountain, TN (05) | Fiedler et al. 2007 | Mount Storm, WV (Fall 08) | Young et al. 2009b |
| Buffalo Ridge, MN (94-95) | Osborn et al. 1996, 2000 | Mount Storm, WV (09) | Young et al. 2009a, 2010b |
| Buffalo Ridge, MN (Phase I; 96) | Johnson et al. 2000a | Mount Storm, WV (10) | Young et al. 2010a, 2011b |
| Buffalo Ridge, MN (Phase I; 97) | Johnson et al. 2000a | Mount Storm, WV (11) | Young et al. 2011a, 2012b |
| Buffalo Ridge, MN (Phase I; 98) | Johnson et al. 2000a | Mountaineer, WV (03) | Kerns and Kerlinger 2004 |
| Buffalo Ridge, MN (Phase I; 99) | Johnson et al. 2000a | Mountaineer, WV (04) | Arnett et al. 2005 |
| Buffalo Ridge, MN (Phase II; 98) | Johnson et al. 2000a | Munnsville, NY (08) | Stantec 2009b |
| Buffalo Ridge, MN (Phase II; 99) | Johnson et al. 2000a | Nine Canyon, WA (02-03) | Erickson et al. 2003b |
| Buffalo Ridge, MN (Phase II; 01/Lake Benton I) | Johnson et al. 2004 | Noble Altona, NY (10) | Jain et al. 2011b |
| Buffalo Ridge, MN (Phase II; 02/Lake Benton I) | Johnson et al. 2004 | Noble Bliss, NY (08) | Jain et al.2009e |
| Buffalo Ridge, MN (Phase III; 99) | Johnson et al. 2000a | Noble Bliss, NY (09) | Jain et al. 2010a |
| Buffalo Ridge, MN (Phase III; 01/Lake Benton II) | Johnson et al. 2004 | Noble Bliss/Wethersfield, NY (11) | Kerlinger et al. 2011 |
| Buffalo Ridge, MN (Phase III; 02/Lake Benton II) | Johnson et al. 2004 | Noble Chateaugay, NY (10) | Jain et al. 2011c |
| Buffalo Ridge I, SD (09-10) | Derby et al. 2010b | Noble Clinton, NY (08) | Jain et al. 2009c |
| Buffalo Ridge II, SD (11-12) | Derby et al. 2012a | Noble Clinton, NY (09) | Jain et al. 2010b |
| Casselman, PA (08) | Arnett et al. 2009a | Noble Ellenburg, NY (08) | Jain et al. 2009b |
| Casselman, PA (09) | Arnett et al. 2010 | Noble Ellenburg, NY (09) | Jain et al. 2010c |
| Casselman Curtailment, PA (08) | Arnett et al. 2009b | Noble Wethersfield, NY (10) | Jain et al. 2011a |
| Castle River, Alb. (01) | Brown and Hamilton 2006a | NPPD Ainsworth, NE (06) | Derby et al. 2007 |
| Castle River, Alb. (02) | Brown and Hamilton 2006a | Oklahoma Wind Energy Center, OK (04; 05) | Piorkowski and O'Connell 2010 |
| Cedar Ridge, WI (09) | BHE Environmental 2010 | Pebble Springs, OR (09-10) | Gritski and Kronner 2010b |
| Cedar Ridge, WI (10) | BHE Environmental 2011 | Pine Tree, CA (09-10, 11) | BioResource Consultants 2012 |
| Cohocton/Dutch Hill, NY (09) | Stantec 2010 | Pioneer Prairie I, IA (Phase II; 11-12) | Chodachek et al. 2012 |
| Cohocton/Dutch Hills, NY (10) | Stantec 2011 | Pinyon Pines I&II, CA (13-14) | Chatfield and Russo 2014 |
| Combine Hills, OR (Phase I; 04-05) | Young et al. 2006 | PrairieWinds ND1 (Minot), ND (10) | Derby et al. 2011c |
| Combine Hills, OR (11) | Enz et al. 2012 | PrairieWinds ND1 (Minot), ND (11) | Derby et al. 2012c |
| Condon, OR | Fishman Ecological Services 2003 | PrairieWinds SD1 (Crow Lake), SD (11-12) | Derby et al. 2012d |
| Crescent Ridge, IL (05-06) | Kerlinger et al. 2007 | PrairieWinds SD1 (Crow Lake), SD (12-13) | Derby et al. 2013a |
| Criterion, MD (11) | Young et al. 2012a | PrairieWinds SD1 (Crow Lake), SD (13-14) | Derby et al. 2014 |
| Criterion, MD (12) | Young et al. 2013 | Prince Wind Farm, Ont (06) | Natural Resource Solutions 2009 |
| Crystal Lake II, IA (09) | Derby et al. 2010a | Prince Wind Farm, Ont (07) | Natural Resource Solutions 2009 |
| Diablo Winds, CA (05-07) | WEST 2006, 2008 | Prince Wind Farm, Ont (08) | Natural Resource Solutions 2009 |
| Dillon, CA (08-09) | Chatfield et al. 2009 | Red Canyon, TX (06-07) | Miller 2008 |
| Dry Lake I, AZ (09-10) | Thompson et al. 2011 | Red Hills, OK (12-13) | Derby et al. 2013c |
| Dry Lake II, AZ (11-12) | Thompson and Bay 2012 | Ripley, Ont (08) | Jacques Whitford 2009 |
| Elkhorn, OR (08) | Jeffrey et a. 2009b | Ripley, Ont (08-09) | Golder Associates 2010 |
| Elkhorn, OR (10) | Enk et al. 2011b | Rugby, ND (10-11) | Derby et al. 2011b |
| Elm Creek, MN (09-10) | Derby et al. 2010c | San Gorgonio, CA (97-98; 99-00) | Anderson et al. 2005 |
| Elm Creek II, MN (11-12) | Derby et al. 2012b | Searsburg, VT (97) | Kerlinger 2002a |
| Erie Shores, Ont. (06) | James 2008 | Shiloh I, CA (06-09) | Kerlinger et al. 2009 |
| Foote Creek Rim, WY (Phase I; 99) | Young et al. 2003b | Shiloh II, CA (09-10) | Kerlinger et al. 2010b |
| Foote Creek Rim, WY (Phase I; 00) | Young et al. 2003b | SMUD Solano, CA (04-05) | Erickson and Sharp 2005 |
| Foote Creek Rim, WY (Phase I; 01-02) | Young et al. 2003b | Stateline, OR/WA (01-02) | Erickson et al. 2004 |
| Forward Energy Center, WI (08-10) | Grodsky and Drake 2011 | Stateline, OR/WA (03) | Erickson et al. 2004 |

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