minnesota power
AN ALLETE COMPANY

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June 19, 2014

VIA EMAIL

Mr. Darrell Nitschke
Executive Secretary
North Dakota Public Service Commission
600 E. Boulevard Ave., Dept. 408
Bismarck, ND 58505-0480

RE:	Bison 1 Wind Project Oliver/Morton Counties Siting Application Case No. PU-09-151	Bison 2 Wind Project Oliver/Morton Counties Siting Application Case No. PU-11-57	Bison 3Wind Project Oliver/Morton Counties Siting Application Case No. PU-11-162

Dear Mr. Nitschke:

Please find attached Minnesota Power's Post Construction Monitoring Report for the above-referenced cases.

Please let us know if you have any questions.

Yours truly,

David R. Moeller

DRM:sr
Attachments
c: Daniel McCourtney, Minnesota Power

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Post construction monitoring report
Allete, Inc.
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Post-Construction Fatality Surveys for the Bison Wind Energy Center Morton and Oliver Counties, North Dakota

Final Report
March 23 – October 31, 2013

Prepared for:

Minnesota Power

30 West Superior Street
Duluth, Minnesota 55802

Prepared by:

Kristen Chodachek, Clayton Derby, and Guy DiDonato

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April 11, 2014

WEST Inc.

EXECUTIVE SUMMARY

Minnesota Power, a division of ALLETE, Inc., operates the Bison Wind Energy Center (Bison), located in Morton and Oliver Counties, North Dakota. Bison is made up of three phases: Bison I, II, and III. The first phase, Bison I, began commercial operation in early 2010, followed by Phases II and III in 2012. Bison has a total combined capacity of 291.9 megawatts (MW) of electricity and consists of 85 D3 Siemens 3.0-MW turbines and 16 G2 Siemens 2.3-MW turbines.

A year of monitoring studies designed to estimate the bat and bird fatality rates attributable to wind turbine operations were conducted from March 23 through October 31, 2013. Monitoring included carcass removal and searcher efficiency trials to estimate potential sources of bias. Fatality estimates were generated for bats and birds using methods consistent with the approach outlined by Shoenfeld (2004) and Erickson et al. (2006).

Overall the combined bat fatality rate estimate was low, with 2.14 bat fatalities per MW per year, which is within the range reported for fatality rates at other facilities in the Midwest (0.16 to 30.61 bat fatalities per megawatt per year). Hoary bats composed the majority of bat fatalities in 2013, which is similar to results from other wind-energy facilities in the Midwest. Based on the timing of fatalities and habitat requirements for these bat species, most of the fatalities are likely migrating bats, a common trend at other wind energy facilities in North America.

Overall the combined bird fatality rate estimate was low, with 0.89 bird fatalities per MW per year, which is also within the range of reported for fatality rates at other facilities in the Midwest (0.27 to 8.25 bird fatalities per megawatt per year).

No state or federally endangered or threatened bat or bird carcasses were found during monitoring.

STUDY PARTICIPANTS

Western EcoSystems Technology

Kristen Chodachek	Project Manager
Clayton Derby	Senior Project Manager
Guy DiDonato	Statistician
Ann Dahl	GIS Technician
Andrea Palochak	Technical Editor
Kelsey Wohl	Field Technician

REPORT REFERENCE

Chodachek, K., C. Derby, and G. DiDonato. 2013. Post-Construction Fatality Surveys for the Bison Wind Energy Center, Morton and Oliver Counties, North Dakota. March 23 – October 31, 2013. Prepared for Minnesota Power, Duluth, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota.

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INTRODUCTION

Minnesota Power, a division of ALLETE, Inc., has developed the Bison Wind Energy Center (Bison), with a capacity of 291.8 megawatts (MW) in Morton and Oliver Counties, North Dakota (Figure 1). Bison is located approximately 10 miles (16 kilometers [km]) northwest of New Salem, North Dakota, in an area dominated by spring wheat (*Triticum* spp.), canola (*Brassica* spp.), corn (*Zea mays*), and sunflower (*Helianthus annuus*) fields. This project consists of 16 Siemens G2 Platform 2.3-MW wind turbines and 85 Siemens D3 Platform 3.0-MW wind turbines. Phase I of Bison became operational in early 2010, and Phases II and III in 2012.

Minnesota Power contracted Western EcoSystems Technology, Inc. (WEST) to conduct fatality monitoring to evaluate whether the estimated mortality is lower than, similar to, or higher than the average mortality observed at other local, regional, and national projects. Fatality monitoring included standardized carcass surveys, searcher efficiency trials, and carcass removal trials. During 2013 surveys, crop clearing was not conducted.

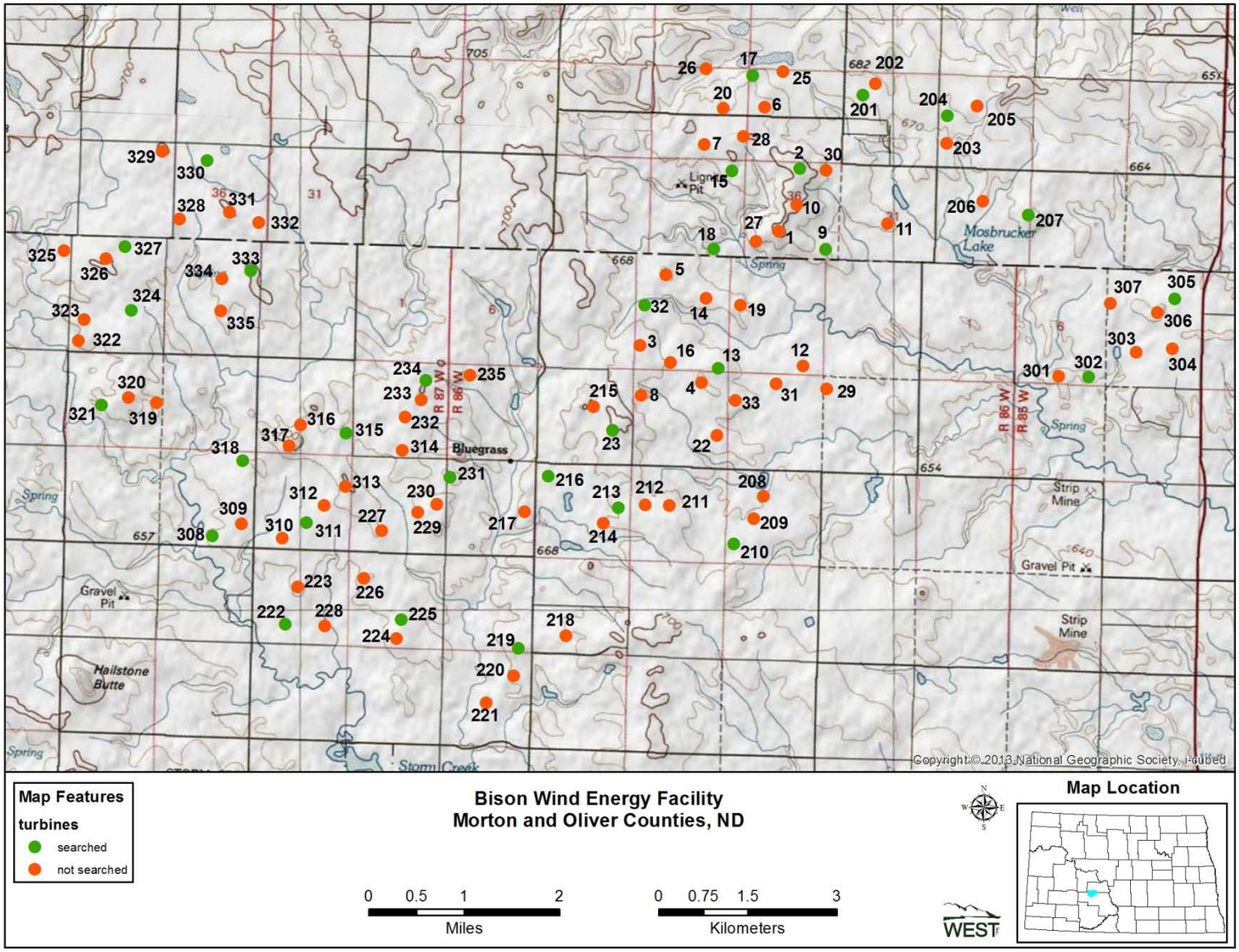

Figure 1. Location of the Bison Wind Energy Center and turbines.

STUDY AREA

Bison falls within the Missouri Plateau Ecoregion within the Northwestern Great Plains Ecoregion (Bryce et al. 1996). The Missouri Plateau is a glaciated region characterized by rolling plains and drainages. Sandstone buttes or outcrops are also common in this region. The area was historically short to mixed grass prairie. Some of the area remains in native grasslands as pastureland for grazing and other areas have been converted to cultivated agriculture. Topography in the region is gently rolling with elevations ranging from 2,100 to 2,343 feet (ft; 640 to 714 meters [m]).

METHODS

The fatality monitoring study at Bison consisted of the following components:

1) standardized carcass surveys at all turbines,
2) searcher efficiency trials to estimate the percentage of carcasses found by searchers, and
3) carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection.

In 2013, surveys were conducted from March 23 – October 31, a period corresponding to the likely spring and fall migration periods, and summer breeding period for bats and birds. All casualties located within areas surveyed, regardless of species, were recorded and a cause of death was determined if possible. The total number of bat and bird casualties (including dead and injured bats and birds) were estimated by adjusting for search frequency, removal bias (length of stay in the field), searcher efficiency bias (percent found), and area searched. For carcasses where the cause of death was not apparent, the assumption that the fatality was caused by a wind turbine collision was made for the analysis. This approach likely led to an overestimate of the true number of facility-related fatalities, particularly for birds, but most wind energy facilities have used this conservative approach because of the relatively high costs associated with obtaining accurate estimates of natural or reference mortality (see Johnson et al. 2000a).

Sample Size, Search Area, and Search Frequency

Approximately 30% of the 101 turbines were searched during surveys in 2013 (Figure 1). For each of the 30 turbines selected, a full 160-m x 160-m (524-ft x 524-ft) square plot centered on the turbine were searched (Figure 2). The minimum distance searched in any direction was equal to 80 m (262 ft). Transects were walked 10 m (33 ft) apart within each plot to sample the area under the structure (Figure 2).

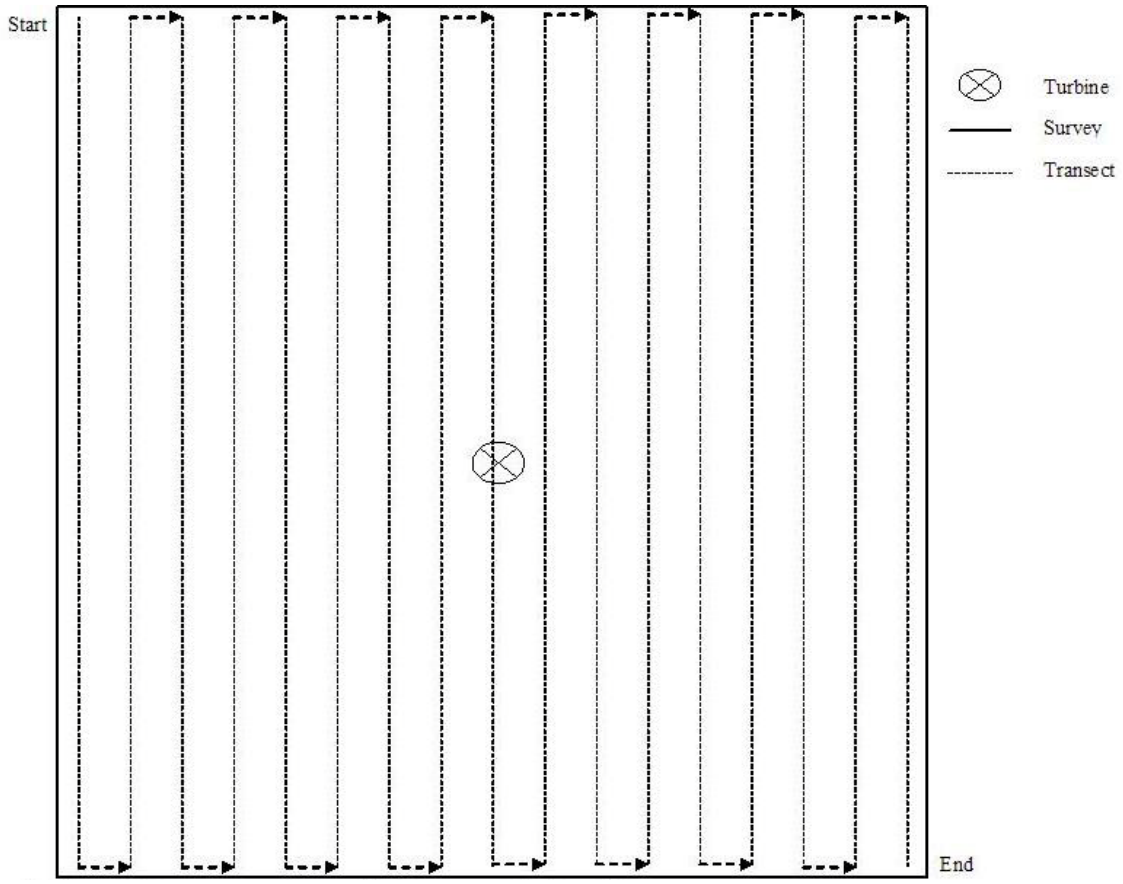

Figure 2. Example schematic of survey pattern (not to scale) for carcass search plots at the Bison Wind Energy Center. Transects were placed 10 meters apart. Turbine pad and access road (not shown) were included in the area searched.

Searches were conducted weekly during spring (March 19 – May 17) and fall (September 4 – October 31), and every other week during summer (May 18 – September 3). From June 26 – August 19, 2013, only road and pads (Figure 3) were searched at 19 turbines due to the ineffectiveness of surveying heavily vegetated fields.

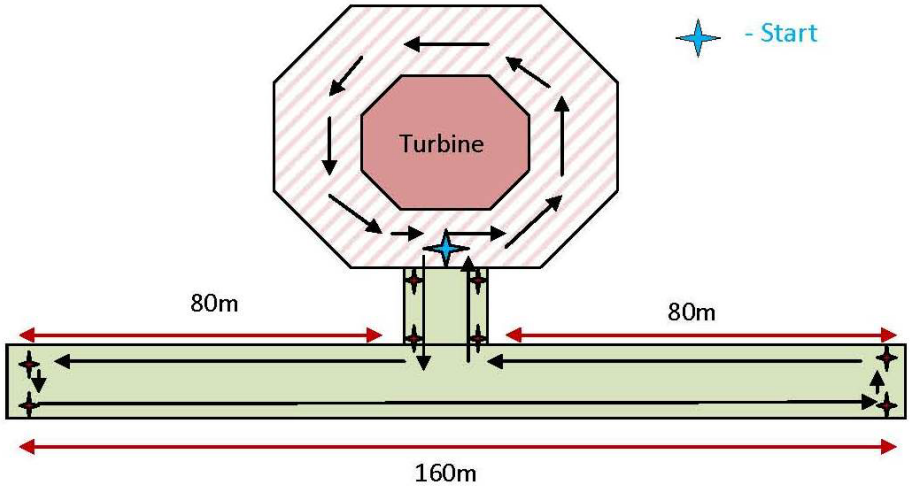

Figure 3. Example schematic of search area along road and turbine pad (not to scale) for carcass search plots at the Bison Wind Energy Center. Area searched varied, but was measured at each turbine searched.

Standardized Carcass Searches

Carcass searching began on March 23, 2013, and continued through October 31, 2013. All 30 turbines were systematically searched for bird and bat casualties that were attributable to collision with the turbines. Personnel trained in proper search techniques conducted the carcass searches. Searchers looked for casualties, walking at a casual walking rate of approximately 45-60 m per minute (about 148-197 ft per minute) scanning the turbine pad, road, and transects spaced 10 m apart on the cleared plots (Figure 2), and scanning both the turbine pad and road (Figure 3) for road/pad searches. The order that searches were performed was randomized so that each turbine was searched at various periods during the day.

The condition of each bird and bat carcass found was recorded using the following categories:

- Intact - a carcass that is completely intact, is not badly decomposed, and shows no sign of being fed upon by a predator or scavenger; or
- Scavenged/Dismembered - an entire carcass, which shows 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 has been heavily infested by insects.

For bird carcasses, the following category was also used in addition to the two categories listed above:

- Feather Spot - 10 or more feathers found at one location indicating predation or scavenging.

In addition to carcasses, any injured birds or bats observed in search plots or elsewhere in the study area were recorded and treated as a fatality. All bat carcasses found were labeled with a unique number, bagged, and frozen for future reference and possible necropsy. A freezer tag documenting facility, date, observer, carcass identification number, time, species, and location (i.e., turbine number) was placed in the bag with the frozen carcass. For all casualties found, data recorded included species, sex and age when possible, date and time collected, Universal Transverse Mercator (UTM) location, condition (intact, scavenged, feather spot), distance and bearing to turbine, and any comments that may indicate cause of death or injury. All casualties located were photographed as found and plotted on a detailed map of the study area showing the location of the wind turbines and associated facilities, such as overhead power lines and meteorological (met) towers. Bird carcasses were not collected as federal permits were not obtained. Birds were left in the field after being painted to help minimize re-counting the carcass during subsequent surveys.

Casualties found outside the formal search time but inside of search plots were treated following the above protocol as closely as possible and were included in the fatality estimate analysis. Bird and bat casualties found in non-search areas (e.g., near a transmission line) were coded as incidental discoveries and documented in a similar fashion as those found during standard searches, but these casualties were not included in the estimates of total fatalities.

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of casualties that were found by the searchers. All carcasses were placed at random locations within areas being searched prior to the carcass search on the same day. Estimates of searcher efficiency were used to correct for detection bias by adjusting the total number of carcasses found for those missed by the searchers.

Searcher efficiency trials were conducted by placing “detection” carcasses along roads/pads or in cleared plots. Efficiency trials commenced with the start of carcass searches and were conducted periodically throughout the survey period. Searchers conducting carcass searches did not know when the trials were being conducted or the locations where the “detection” carcasses were placed in a search plot. A total of 51 searcher efficiency carcasses were used for the study period, with 17 large bird carcasses, 24 small bird carcasses; and 10 bat carcasses. Bat carcasses consisted of eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), and silver-haired bat (*Lasionycteris noctivagans*). Avian carcasses consisted of non-native/non-protected or commercially available species, including house sparrows (*Passer domesticus*) and European starlings (*Sturnus vulgaris*) as small bird carcasses and rock pigeons (*Columba livia*) as large bird carcasses. All “detection” carcasses were placed at random locations within areas being searched prior to the carcass search on the same day. Carcasses were dropped from waist height or higher and allowed to land in a random posture. Each trial carcass was discreetly marked (e.g., tape or thread on the leg of the carcass) so that it could be identified as a “detection” carcass after it was found. The number and location of the “detection” carcasses found during the carcass search 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 length of time bat and bird carcasses remained in the search area before being removed by scavengers or by other means. Carcass removal includes removal by predation or scavenging, or removal by another means, such as being plowed into a field. Carcass removal studies were conducted during each season concurrently with standardized carcass searching. Estimates of carcass removal were used to adjust carcass counts for removal bias.

Removal trial carcasses were placed at random locations along roads/pads or in the cleared plots. A total of 66 carcasses were used for the study, including 25 large bird carcasses, 36 small bird carcasses, and five bat carcasses. Bird and bat species used were similar to species used in searcher efficiency trials. By spreading trials throughout the study period, the effects of varying weather, climatic conditions, and scavenger densities were taken into account. Bat and bird carcasses used were similar to those used in the searcher efficiency trials. All trial carcasses were discreetly marked using black electrical tape around the leg to avoid confusion with turbine fatalities. Major habitats represented around the turbines were included in these trials. Carcasses were dropped from waist height or higher and allowed to land in a random posture.

Personnel conducting carcass searches monitored the trial carcasses over a 30-day period according to the following schedule as closely as possible. Carcasses were checked every day for the first four days, and then on days seven, 10, 14, 20, and 30. Experimental carcasses not removed by scavengers were left at the location until the end of the carcass removal trial. At the end of the 30-day period any remaining evidence of the carcass was removed.

Statistical Methods for Fatality Estimates

Estimates of facility-related fatalities were based on:

1) Observed number of carcasses found during standardized searches during the monitoring period for which the cause of death was likely facility-related;
2) Probability of detection, including 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 searcher efficiency, expressed as the proportion of placed carcasses found by searchers during searcher efficiency trials; and
3) Adjustment factor for fatalities found on a road and pad plots from June 26 – August 19, 2013.

Fatality estimates were calculated for four categories: 1) all birds, 2) small birds, 3) large birds, and 4) bats; as well as by season.

Definition of Variables

The following variables were 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 was attributed to the facility
- n the number of search plots
- k the number of turbines searched (including the turbines centered within each search plot)
- $\bar{c}$ the average number of carcasses observed per turbine per monitoring year
- s the number of carcasses used in removal trials
- s_c the number of carcasses in removal trials that remained in the study area after 30 days
- se standard error (square of the sample variance of the mean)
- t_i the time (in days) a carcass remained in the study area before it was removed, as determined by the removal trials
- $\bar{t}$ the average time (in days) a carcass remained in the study area before it was removed, as determined by the removal trials
- d the total number of carcasses placed in searcher efficiency 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 was both available to be found during a search and was 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 was:

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

Estimation of Carcass Non-Removal Rates

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

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

Estimation of Searcher Efficiency Rates

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

Estimation of Facility-Related Fatality Rates

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

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

where $\hat{\pi}$ included adjustments for both carcass removal (from scavenging and other means) and searcher efficiency bias. Data for carcass removal and searcher efficiency bias was pooled across the study to estimate $\hat{\pi}$.

$\hat{\pi}$ was 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 final reported estimates of *m* and associated standard errors and 90% confidence intervals were calculated using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics.

For each bootstrap sample, $\bar{c}$, $\bar{t}$, p, $\hat{\pi}$, and *m* were calculated. A total of 5,000 bootstrap samples were used. The reported estimates were the mathematical means of the 5,000 bootstrap estimates. The standard deviation of the bootstrap estimates was the estimated standard error. The lower fifth and upper ninety-fifth percentiles of the 5,000 bootstrap estimates were estimates of the lower limit and upper limit of 90% confidence intervals.

The formula that WEST has used has been used widely and is relatively unbiased under most conditions. It is sensitive, however, to deviations from the assumption that carcass persistence is low relative to search interval. Initial estimates of carcass persistence were used to determine whether alternate formulas should be considered (e.g., Huso 2011).

DISPOSITION OF DATA AND REPORTING STANDARDS

This monitoring study provides information on fatalities and total bird and bat mortality associated with operations of Bison and the data used to evaluate the overall impacts of the facility on birds and bats. At the end of the study, all data will be provided to Minnesota Power, the facility owner, including the data forms and electronic data files. During the study, the raw data forms were housed by WEST, and individual carcasses collected during the study were housed in a freezer at Bison, under a North Dakota Salvage Collecting Permit.

RESULTS

Surveys began March 23, 2013, and continued through October 31, 2013. All casualties (including dead and injured bats and birds) located within areas surveyed, regardless of species, were recorded and a cause of death or injury determined, if possible (no injured bats or birds were located during this study). Surveys were implemented using a standardized plot search method. From June 26 through August 19, 2013, road and pad searches were conducted at 19 of the 30 turbines due to the height and density of agricultural crops. This change in search area was corrected for during analysis. Results of the standardized carcass searches for bats and birds, searcher efficiency, carcass removal trials, and adjusted fatality estimates for bats and birds are discussed in the sections below.

Search Area and Habitat

Total area searched (acres), percent area searched as a function of the maximum search area, and the proportion of detection types within each 160-m x 160-m search plot (plot only, no roads and pads; Table 1) and road and pads (Appendix A) were calculated. Overall, the majority of the plot was searched (Table 1). On average, the proportion of area searched for roads and pads was greatest from zero to 40 m (zero to 132 ft); however, the proportion of area searched decreased considerably after this distance band (Appendix A). The percent area searched ranged from approximately 93.6% to100% for the 0- to 10-m (0- to 33-ft) band to less than 1% for the 120-m (394-ft) band for road and pads (Appendix A).

Table 1. Proportion of the area searched in 10-meter (m) distance bands at the Bison Wind Energy Center for 160-m x 160-m plots, excluding the road and pads, from March 23 – October 31, 2013.

Distance (m)	Total Acres	Acres Searched	Percent Searched
10	0.078	0.078	100
20	0.233	0.233	100
30	0.388	0.388	100
40	0.543	0.543	100
50	0.698	0.698	100
60	0.854	0.854	100
70	1.009	1.009	100
80	1.164	1.164	100
90	1.319	0.771	58.5
100	1.474	0.409	27.8
110	1.630	0.170	10.4
120	1.785	0.010	0.6

Standardized Carcass Surveys

Surveys were conducted from March 23 – October 31, 2013. During the period of June 26 through August 17, 2013, only roads and pads were surveyed for 19 turbines because of the height and density of agricultural fields. Additionally, turbines were not searched during inclement weather or when facility operations personnel or local landowners were present because of health and safety concerns.

A total of 683 surveys were conducted at plots during 26 visits. The number, species, location, other characteristics of the bat and bird fatalities, and the fatality estimates adjusted for searcher efficiency and carcass removal biases are discussed below. Bat and bird carcasses found off survey plots were excluded from analysis of estimated total mortality.

Bat Fatalities

Characteristics of Bat Fatalities

Overall, a total of 111 bat fatalities were found during scheduled searches and an additional five bats were found incidentally (Table 2, Figures 4a and 4b). Hoary bat was the dominant bat species, making up 40.5% of all fatalities (Table 2). Other species of bat fatalities found included silver-haired bat, little brown bat (*Myotis lucifugus*), eastern red bat, and big brown bat (*Eptesicus fuscus*). No state or federally endangered or threatened bat species were found.

Table 2. Summary of bat species found during the fatality study at the Bison Wind Energy Center from March 23 – October 31, 2013.

	Scheduled Searches		Incidental (on plot)		Incidental (off plot)		All Fatalities	
Species	**Total**	**Percent**	**Total**	**Percent**	**Total**	**Percent**	**Total**	**Percent**
hoary bat	45	40.5	0	0	2	50.0	47	40.5
silver-haired bat	23	20.7	0	0	1	25.0	24	20.7
little brown bat	22	19.8	0	0	1	25.0	23	19.8
eastern red bat	15	13.5	1	100	0	0	16	13.8
big brown bat	4	3.6	0	0	0	0	4	3.4
unidentified bat	2	1.8	0	0	0	0	2	1.7
Overall	**111**	**100**	**1**	**100**	**4**	**100**	**116**	**100**

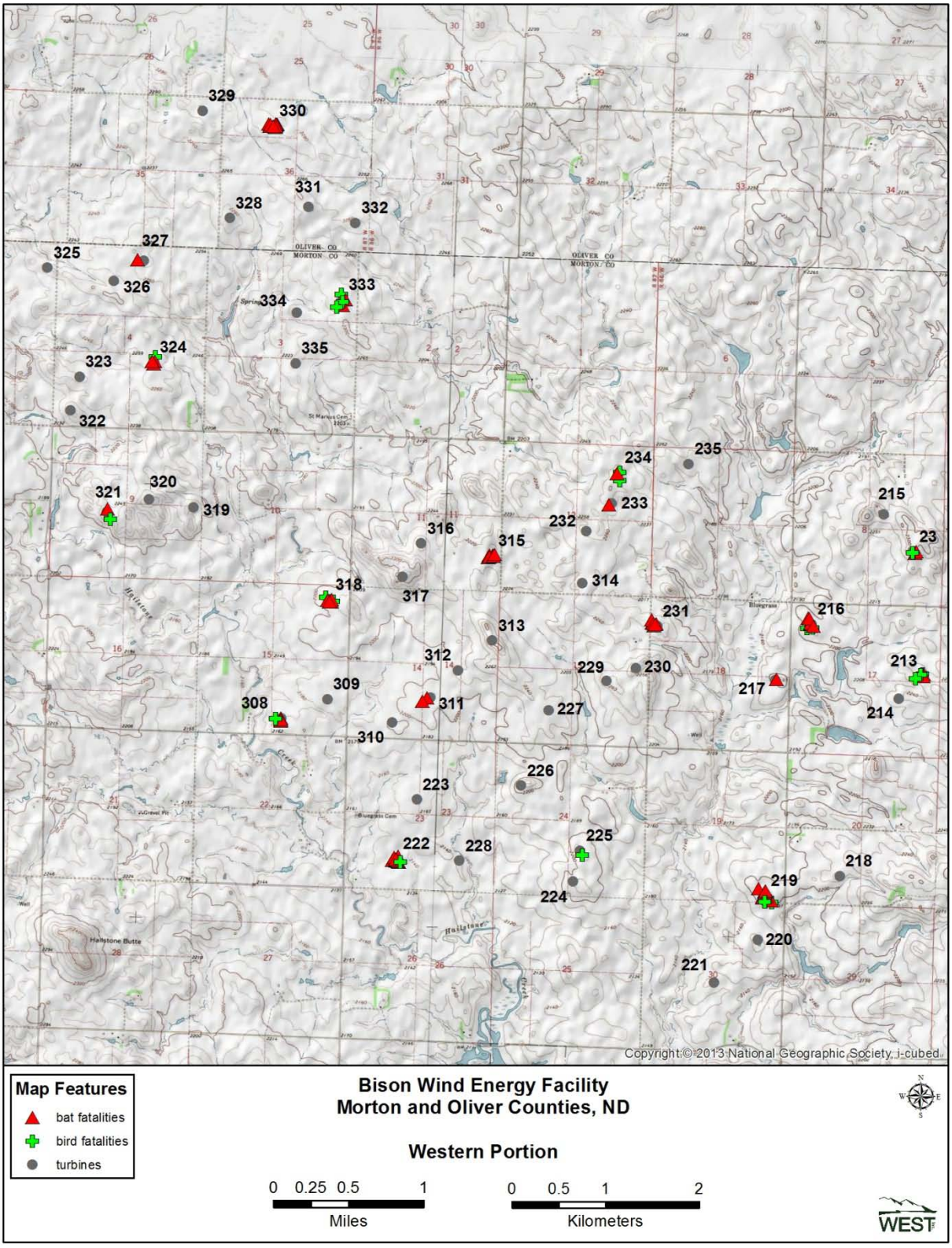

Figure 4a. Location of avian and bat fatalities within the Bison Wind Energy Center from March 23 – October 31, 2013 (Map 1 –western turbines).

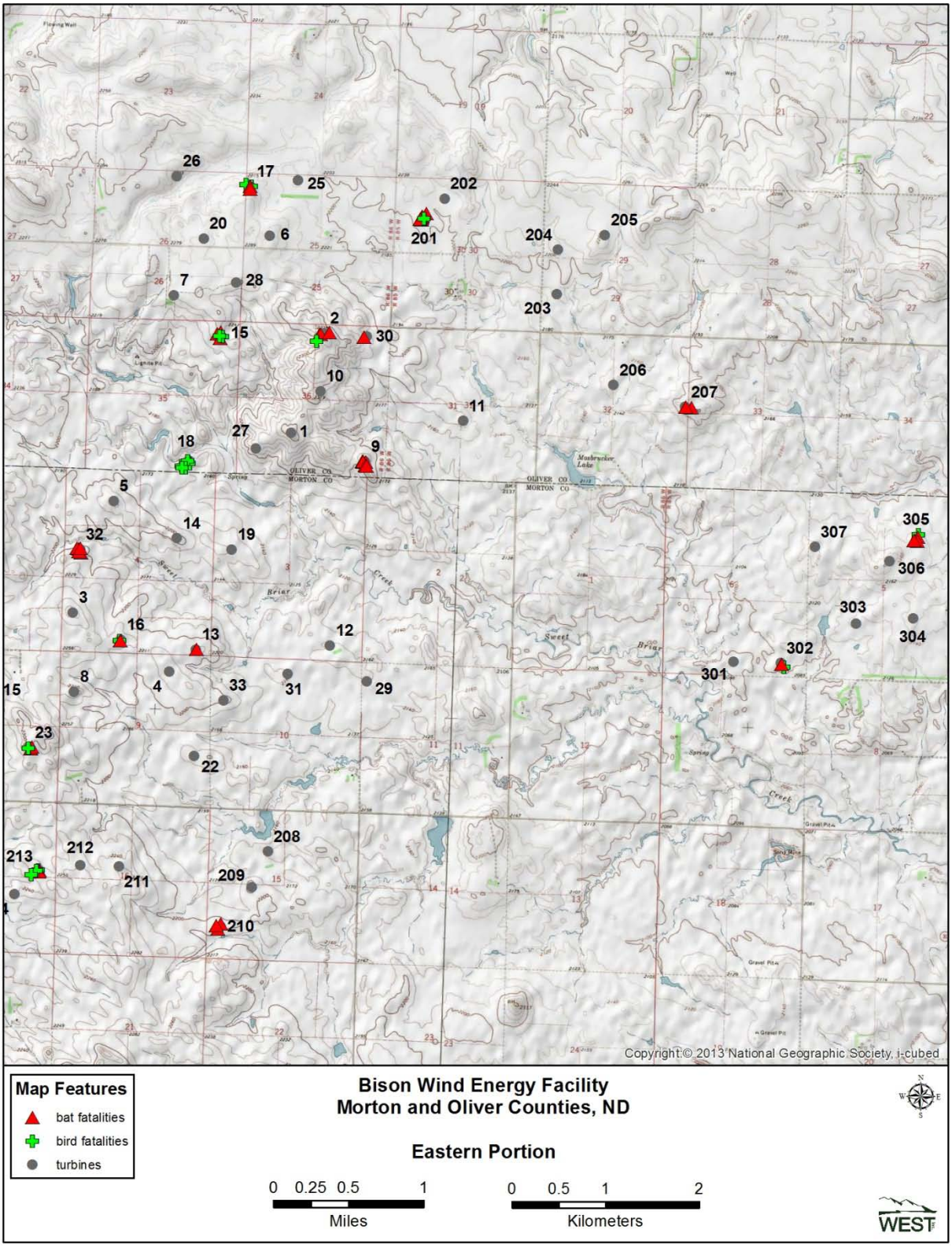

Figure 4b. Location of avian and bat fatalities within the Bison Wind Energy Center from March 23 – October 31, 2013 (Map 2 –eastern turbines).

Distribution of Bat Fatalities: Temporal Patterns

Bat fatalities peaked twice, once in early August and again early September (Figure 5).

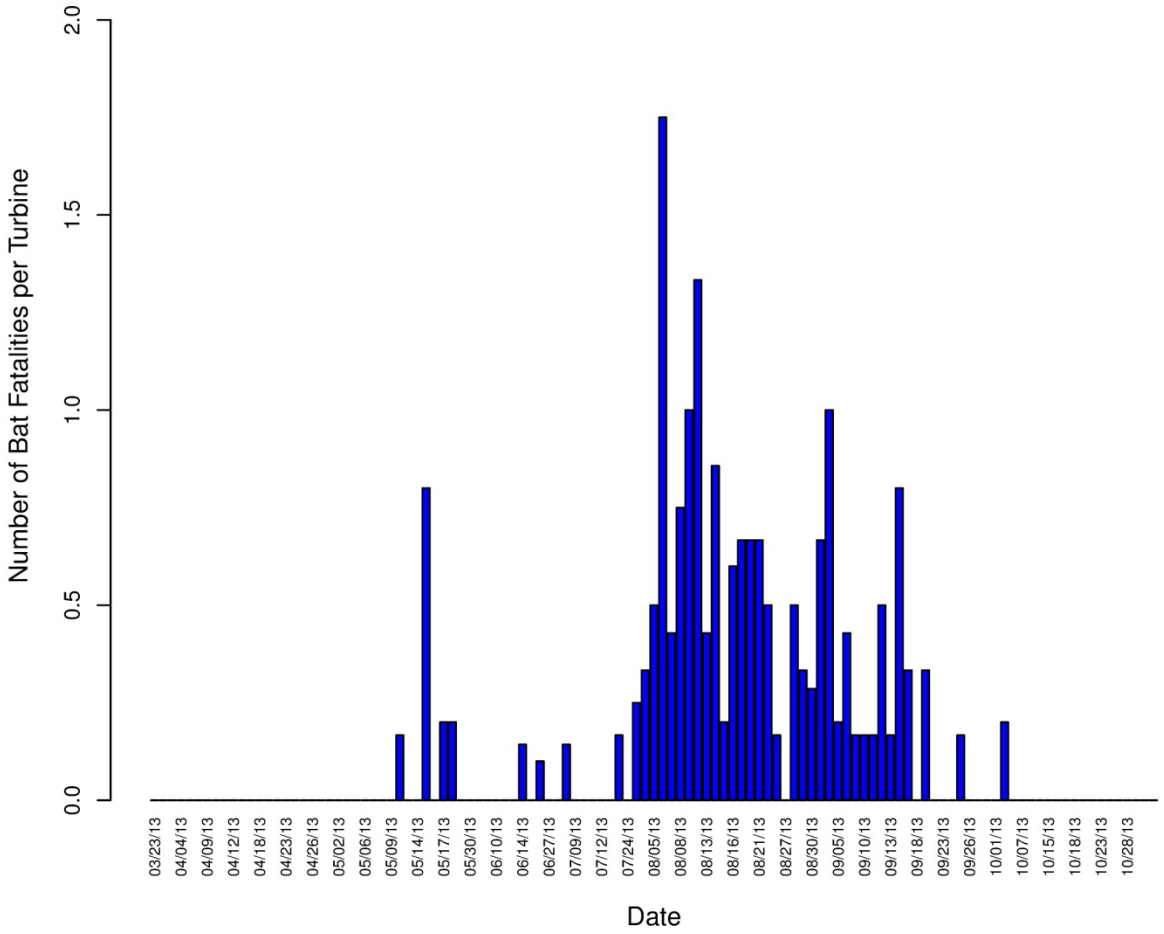

Figure 5. Temporal distribution of bat fatalities found during the survey period March 23 – October 31, 2013, at the Bison Wind Energy Center.

Distribution of Bat Fatalities: Spatial Patterns and Turbines

Bat fatalities were located at 27 of the 30 search turbines (Figure 6), with an average of 4.3 bats found per turbine. Bat fatalities were relatively evenly distributed among the turbines (Figures 4a and 4b). Turbines 330, 222, and 219 had the highest number of bat fatalities with 13, 11, and eight, respectively (Figure 6).

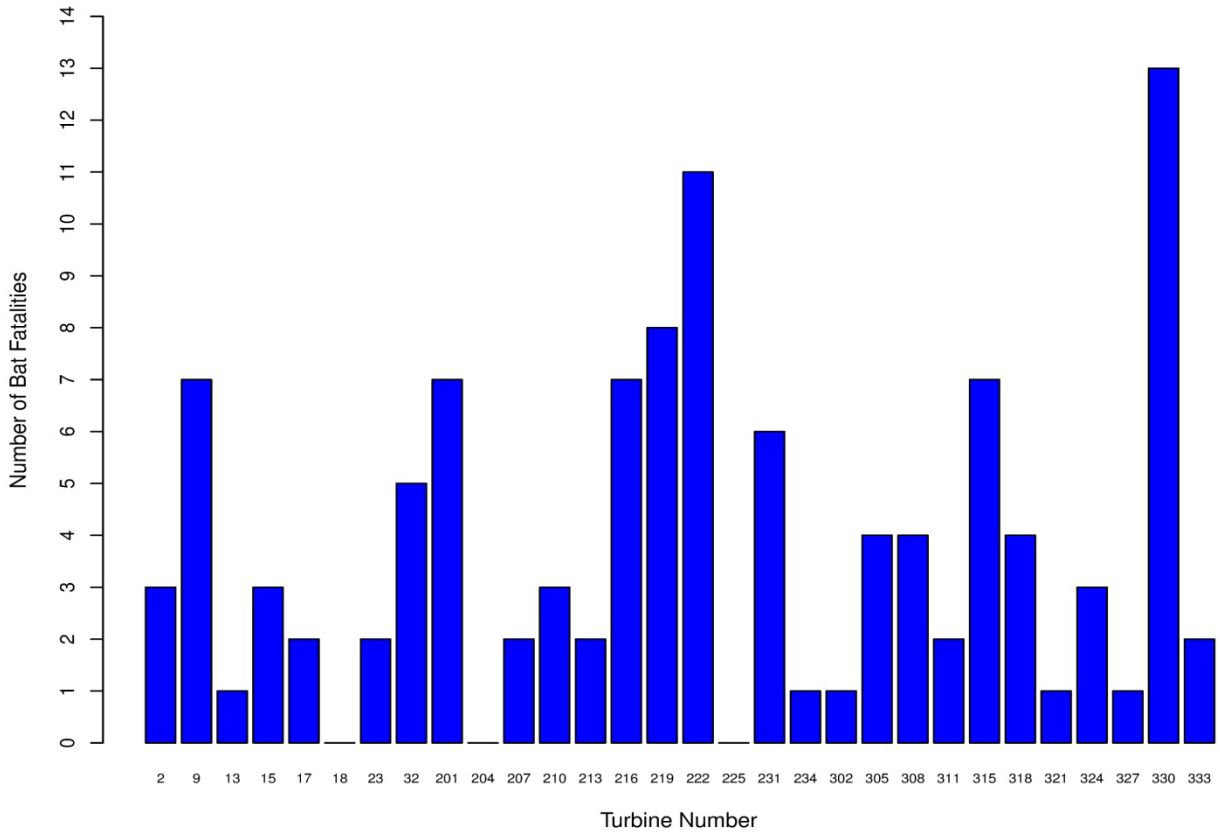

Figure 6. Spatial distribution by turbine location of bat fatalities within the Bison Wind Energy Center from March 23 – October 31, 2013.

Distribution of Bat Fatalities: Distance from Turbine

The majority of all fatalities were primarily located between zero and 40 m (zero and 131 ft) from the turbine (Table 3). However, these percentages did not account for detection and scavenging bias, or the searched area, which varies as a function of distance from turbine.

Table 3. Distribution of distances of bat casualties from turbines at the Bison Wind Energy Center from March 23 – October 31, 2013.

Distance to turbine (m)	Number of Fatalities	% of Bat Casualties
0 to 10	16	14.3
11 to 20	17	15.2
21 to 30	35	31.3
31 to 40	19	17.0
41 to 50	10	8.9
51 to 60	5	4.5
61 to 70	4	3.6
71 to 80	2	1.8
81 to 90	3	2.7
91 to 100	0	0
101 to 110	1	0.9

Estimated Time since Death

Most bat casualties were estimated to have been killed within two or three days (66.1%; Table 4).

Table 4. Estimated time since death of bat fatalities at the Bison Wind Energy Center from March 23 – October 31, 2013.

Estimated Time Since Death*	Number of Bat Fatalities	Percent Composition
last night	13	11.6
2-3 days	61	54.5
4-7 days	30	26.8
7-14 days	7	6.3
>2 weeks	0	0
>month	0	0
unknown	1	0.9

Bird Fatalities

Characteristics of Bird Fatalities

Overall, a total of 43 bird fatalities were found during scheduled searches and one additional bird was found incidentally (Table 5, Figures 4a and 4b). Common redpoll (*Carduelis flammea*), an unidentified sparrow, and mallard (*Anas platyrhnchos*) were the dominant bird species, making up 38.7% of all fatalities (Table 5). No state or federally endangered or threatened bird species were found.

Table 5. Summary of bird species found during the fatality study at the Bison Wind Energy Center from March 23 – October 31, 2013.

	Scheduled Searches		Incidental (on plot)		Incidental (off plot)		All Fatalities	
Species	**Total**	**Percent**	**Total**	**Percent**	**Total**	**Percent**	**Total**	**Percent**
common redpoll	7	16.3	0	0	0	0	7	15.9
unidentified sparrow	5	11.6	0	0	0	0	5	11.4
mallard	4	9.3	0	0	1	100	5	11.4
unidentified bird (small)	4	9.3	0	0	0	0	4	9.1
unidentified warbler	4	9.3	0	0	0	0	4	9.1
upland sandpiper	4	9.3	0	0	0	0	4	9.1
horned lark	3	7.0	0	0	0	0	3	6.8
unidentified hawk	3	7.0	0	0	0	0	3	6.8
blue-winged teal	2	4.7	0	0	0	0	2	4.5
European starling	1	2.3	0	0	0	0	1	2.3
gadwall	1	2.3	0	0	0	0	1	2.3
mourning dove	1	2.3	0	0	0	0	1	2.3
northern harrier	1	2.3	0	0	0	0	1	2.3
red-winged blackbird	1	2.3	0	0	0	0	1	2.3
ring-necked pheasant	1	2.3	0	0	0	0	1	2.3
western grebe	1	2.3	0	0	0	0	1	2.3
Overall	**43**	**100**	**0**	**0**	**1**	**100**	**44**	**100**

Distribution of Bird Fatalities: Temporal Patterns

Bird fatalities were found during the spring and fall migration periods, with one peak at the end of May (Figure 7).

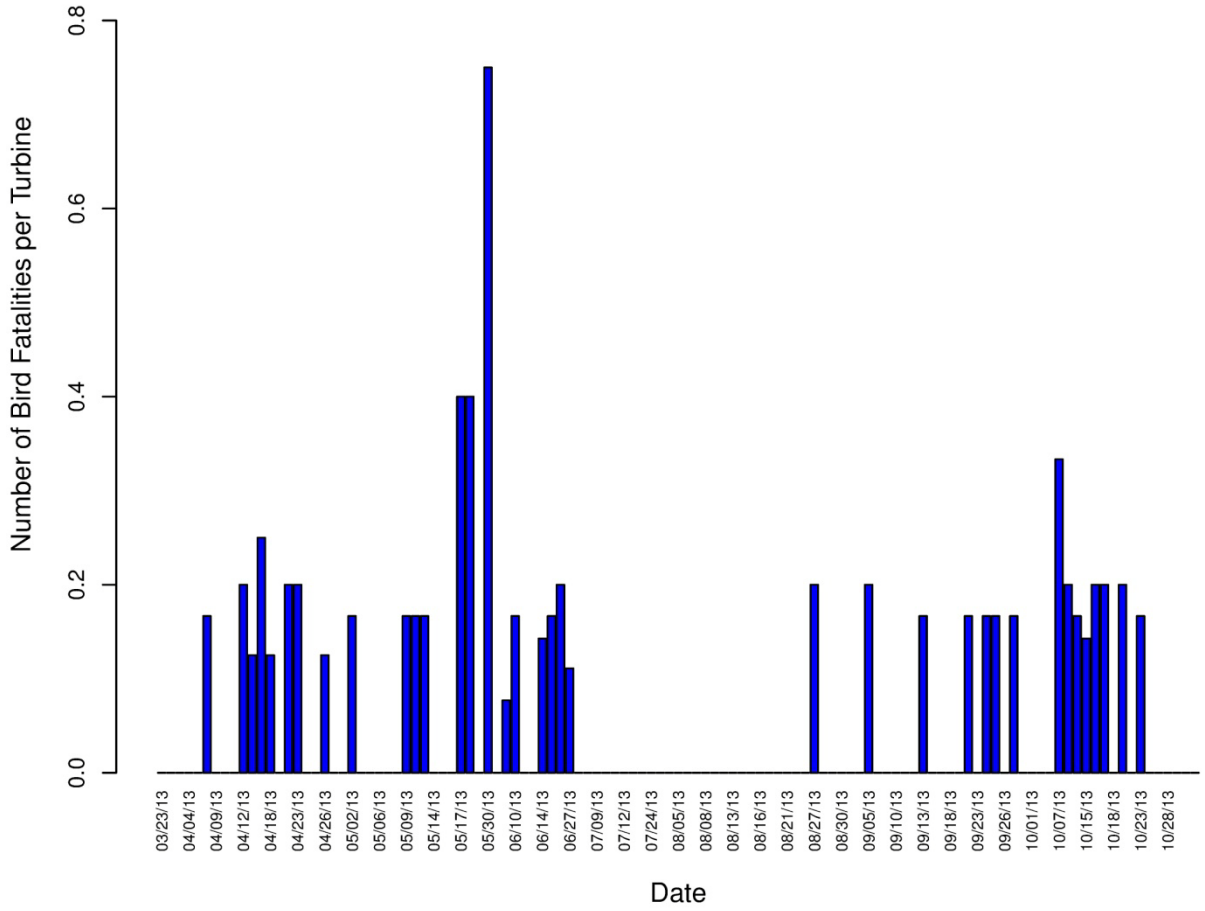

Figure 7. Temporal distribution of bird fatalities found during the survey period March 23 – October 31, 2013, at the Bison Wind Energy Center.

Distribution of Bird Fatalities: Spatial Patterns and Turbines

Bird fatalities were located at 20 of the 30 search turbines (Figures 4a, 4b, and 8), with an average of 1.5 birds found per turbine. Turbines 18 and 333 had the highest number of bird fatalities with six and four fatalities, respectively (Figure 8).

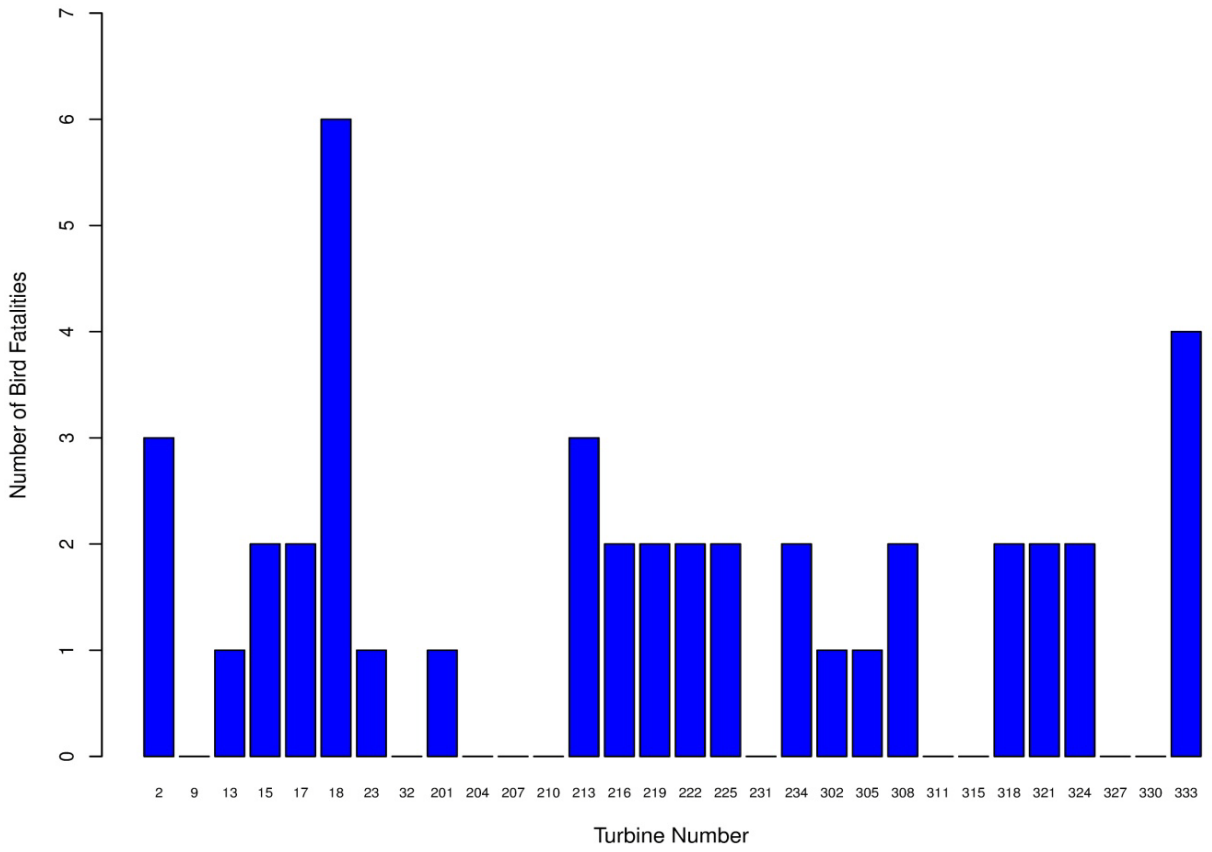

Figure 8. Spatial distribution by turbine location of bird fatalities within the Bison Wind Energy Center from March 23 – October 31, 2013.

Distribution of Bird Fatalities: Distance from Turbine

The majority of all bird fatalities were primarily located between zero and 50 m (zero and 164 ft) from the turbine (Table 6). However, these percentages did not account for detection and scavenging bias, or the searched area, which varies as a function of distance from turbine.

Table 6. Distribution of distances of bird casualties from turbines at the Bison Wind Energy Center from March 23 – October 31, 2013.

Distance to turbine (m)	Number of Fatalities	% of Bird Casualties
0 to 10	6	14.0
11 to 20	4	9.3
21 to 30	7	16.3
31 to 40	0	0
41 to 50	8	18.6
51 to 60	3	7.0
61 to 70	5	11.6
71 to 80	2	4.7
81 to 90	3	7.0
91 to 100	4	9.3
101 to 110	1	2.3

Estimated Time since Death

Most bird casualties were estimated to have been killed within seven days (69.8%, respectively; Table 7).

Table 7. Estimated time since death of bird fatalities at the Bison Wind Energy Center from March 23 – October 31, 2013.

Estimated Time Since Death	Number of Fatalities	Percent Composition
last night	3	7.0
2-3 days	11	25.6
4-7 days	16	37.2
7-14 days	10	23.3
>2 weeks	0	0
>month	1	2.3
unknown	2	4.7

Carcass Removal Trials

Overall, a total of 66 carcasses were used for the study in 2013, including 25 large bird carcasses, 36 small bird carcasses, and 10 bat carcasses. Due to the limited number of bat carcasses used, they were grouped with small birds. By Day 4, approximately 65% of small birds remained by Day 4 and 50% remained by Day 10. For large birds, approximately 80% of the large birds remained by Day 4, and 60% remained by Day 10 (Figure 9).

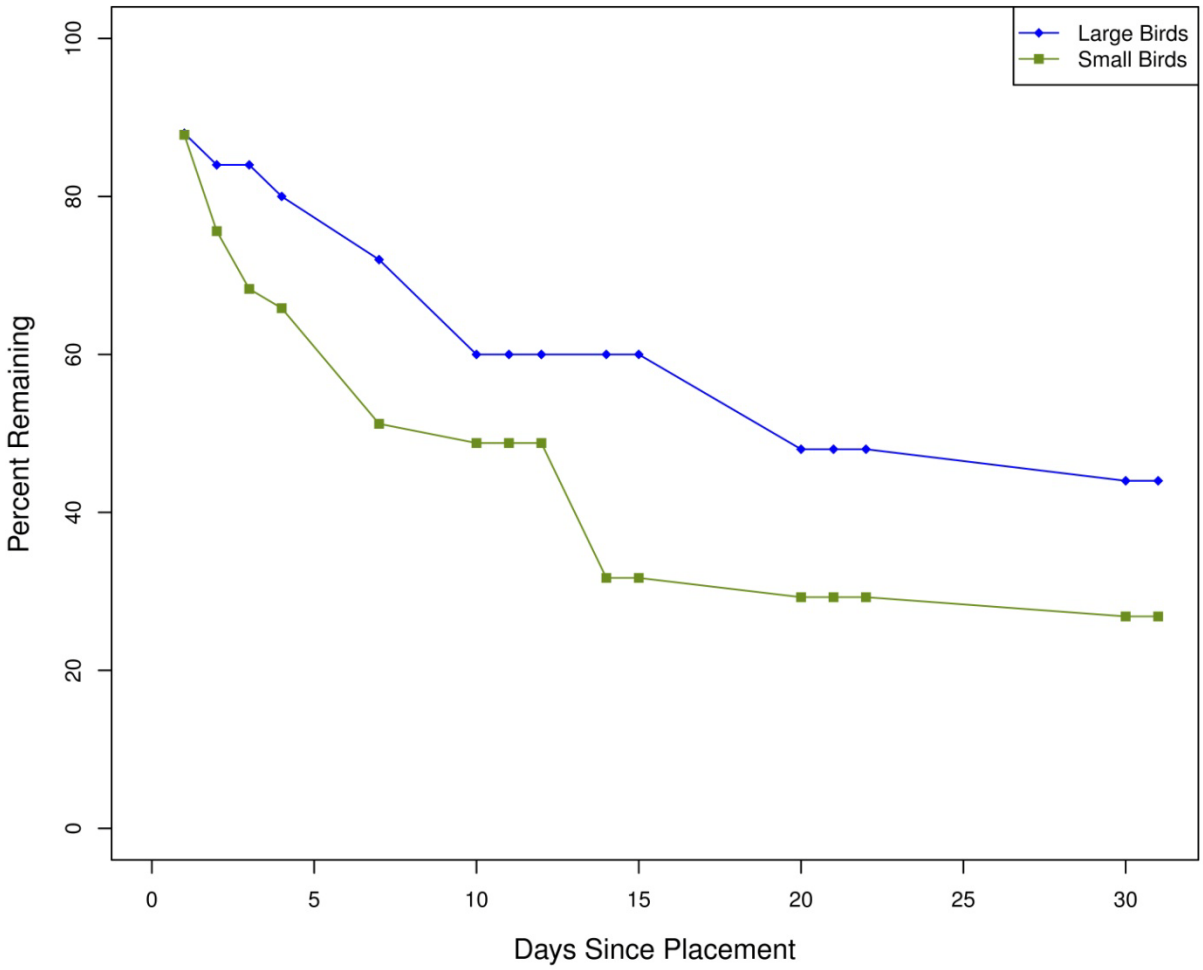

Figure 9. Scavenger removal rates for large birds and small birds within the Bison Wind Energy Center Wind from March 23 – October 31, 2013 (bats were grouped with small birds due to sample size).

Searcher Efficiency Trials

A total of 51 searcher efficiency carcasses were used for the study period, with 17 large bird carcasses and 34 small bird carcasses (Table 8). Due to limited number of bat carcasses used, small bird carcasses and bat carcasses were combined (24 small birds and 10 bats). Overall searcher efficiency for all trials was estimated to be 60.0% for small bird carcasses and 82.4% for large bird carcasses (Table 8).

Table 8. Searcher efficiency results at the Bison Wind Energy Center as a function of date and size class from March 23 – October 31, 2013.

	Large Birds				Small Birds			
Date	**Placed**	**Available**	**Found**	**Percent Found**	**Placed**	**Available**	**Found**	**Percent Found**
04/26/13	3	3	2	66.7	5	5	1	20.0
04/30/13	3	3	3	100	5	5	3	60.0
05/15/13	3	3	3	100	4	4	2	50.0
09/25/13	3	3	2	66.7	7	6	3	50.0
10/07/13	3	3	2	66.7	7	6	6	100.0
10/24/13	2	2	2	100	6	4	3	75.0
Overall	**17**	**17**	**14**	**82.4**	**34**	**30**	**18**	**60.0**

Adjusted Fatality Estimates

Fatality estimates, standard errors, and confidence intervals (CI) were calculated for large birds, small birds, and bats for the period of March 23 – October 31, 2013 (Tables 9a and 9b; Appendix B). The fatality estimates are adjusted based on the corrections for carcass removal, observer detection bias (searcher efficiency), and the proportion of the plot searched.

Table 9a. Adjusted bat fatality estimates (with 90% confidence interval [CI]) for Bison Wind Energy Center for studies conducted from March 23 – October 31, 2013. For more details concerning correction factors and confidence intervals, refer to Appendix B.

	Adjusted Fatality Estimate Full Plots (CI)	Adjusted Fatality Estimate Road and Pad Plots (CI)
# bat fatalities/turbine/year	6.28 (4.52, 9.38)	3.56 (2.51 - 5.15)
# bat fatalities/MW/year	2.14 (1.56, 3.25)	1.23

Table 9b. Adjusted bird fatality estimates (with 90% confidence interval [CI]) for Bison Wind Energy Center for studies conducted from March 23 – October 31, 2013. For more details concerning correction factors and confidence intervals, refer to Appendix B.

	Adjusted Fatality Estimate Full Plots (CI)	Adjusted Fatality Estimate Road and Pad Plots (CI)
All Birds		
# all bird fatalities/turbine/year	2.56 (1.84, 4.26)	0.40 (0 - 1.16)
# all bird fatalities/MW/year	0.89 (0.64, 1.47)	0.14 (0 - 0.4)
Large Birds		
# large bird fatalities/turbine/year	0.71 (0.44, 1.04)	0.13 (0 - 0.39)
# large bird fatalities/MW/year	0.24 (0.15, 0.36)	0.05 (0 - 0.13)
Small Birds		
# small bird fatalities/turbine/year	1.85 (1.2, 3.52)	0.27 (0 - 0.98)
#small bird fatalities/MW/year	0.64 (0.42, 1.22)	0.09 (0 - 0.34)
Raptors		
# raptor fatalities/turbine/year	0.16 (0.04, 0.32)	---
# raptor fatalities/MW/year	0.06 (0.01, 0.11)	---

* - Road and Pad estimates are for 19 turbines during the time period June 26 – August 19, 2013

The overall adjusted estimated number of bat fatalities for plots was 6.28 (CI: 4.52-9.38) bat fatalities per turbine per year, or 2.14 bats per MW per year (Table 9a). Overall bat fatality estimates for road and pads were 1.23 bat fatalities per MW per year

The overall adjusted estimated number of all bird fatalities for plots was 2.56 (CI: 1.84-4.26) bird fatalities per turbine per year, or 0.89 birds per MW per year (Table 9b). Bird fatality estimates ranged from 0.06 raptor fatalities per MW per year to 0.64 small bird fatalities per MW per year (Table 9b). Overall, bird fatality estimates for road and pads were all less than one fatality per MW per year (Table 9b).

Sensitive Species

No state or federally endangered or threatened bat or avian species were identified during fatality monitoring. However, the far western range of the northern long-eared bat (*Myotis septentrionalis*), a federal-proposed endangered species (USFWS 2013), borders Bison.

DISCUSSION

Biases

A number of biases can influence estimating bird and bat fatality rates at wind energy facilities. Below is a discussion of the most common potential biases and how this study attempted to address each of them. Concern has been raised regarding biases associated with fatality monitoring at wind facilities and the following paragraphs briefly identify these biases and how they were addressed. The approach used for calculating adjusted fatality estimates was consistent with the approach outlined by Shoenfeld (2004) and accounted for search interval, total area searched, proportion of area searched at specific distances from the turbine, searcher efficiency rates, and carcass removal rates. It is hypothesized that scavenging could change through time at a given location and must be accounted for when attempting to estimate fatality rates. This was accounted for by conducting scavenging trials for bats, and small and large birds throughout each search period. Searcher efficiency trials were also conducted throughout each search period within different plot conditions to account for any biases. As vegetation density or height increased, the level of difficulty in detection rates also increased. Separate fatality rate estimates were calculated for bats, small birds, large birds, and raptors based on search interval and season.

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 bat and bird casualties found within the standardized search plots during the study were included in the analysis. Second, it was assumed that all bat and bird carcasses found during the study were due to collision with wind turbines. True cause of death was unknown for most of the fatalities. It is possible that some of the bird or bat fatalities were caused by predators, and some of the casualties included in the data pool were potentially due to natural causes (background mortality).

Another possible bias is that no adjustments were made for fatalities possibly occurring outside of the search boundaries. Search boundaries were established a minimum distance of 80 m

(263 ft) from the turbines to account for birds and bats. However, given the small percentages of bird and bat fatalities found at these further distances, it is unlikely that many fatalities would have been outside the plots (Tables 3 and 6). This factor may lead to a slight underestimate of fatality rates, but estimates would still be within the overall confidence intervals as well as within the wide range of estimates given by the different estimators used.

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. 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 potentially access and remove all wind turbine collision fatalities (Smallwood et al. 2010). If this is the case, and the trial carcass density was much greater than actual turbine fatality density, the trials would underestimate scavenging rates compared to rates on actual fatalities. Conversely, placing carcasses in an area could bring in additional scavengers, therefore artificially overestimating scavenging rates compared to actual fatalities with ongoing trials.

Bat Fatalities

During this study, a combined total of 116 bat fatalities were found from March 23 to October 31, 2013. The majority of bat fatalities (102 bat fatalities) were located from early August through mid-September, with two peaks in fatalities during early August and early September. This is consistent with results from other fatality studies in the US which have shown a peak in mortality in August and September and generally lower mortality earlier in the summer (Johnson 2005, Arnett et al. 2008).

The majority of bat fatalities identified were primarily composed of hoary bats, which is similar to the species composition of fatalities at most other wind energy facilities in the Midwest (Jain 2005; Gruver et al. 2009, 2011). Based on the timing, the majority of bat fatalities were likely fall migrants through the site, as is the case at virtually all other wind energy facilities in North America (Johnson 2005, Arnett et al. 2008).

Bat fatality estimates from other wind energy facilities across North America ranged from 0.10 bat fatalities per MW per year at the Buffalo Gap I facility in Texas (Tierney 2007) to 39.70 at the Buffalo Mountain facility in Tennessee (Fiedler et al. 2007; Appendix C). Within in the Midwest, bat fatality estimates ranged from 0.16 to 30.61 bat fatalities per MW per year (Table 10).

The Shoenfeld estimated bat fatality rate of 2.14 bat fatalities per MW per year is within the range of other facilities in the Midwest, ranking 26th overall (Figure 10). The fatality estimates at Bison are similar to the Minot facility in North Dakota (Table 10).

Table 10. Wind energy facilities in the Midwest with comparable and publicly-available activity and fatality data for bat species.

Wind Energy Facility	Bat Activity Estimate[A]	Fatality Estimate[B]	No. of Turbines	Total MW
Cedar Ridge, WI (2009)	9.97[C,D,E,F]	30.61	41	67.6
Blue Sky Green Field, WI	7.7[F]	24.57	88	145
Cedar Ridge, WI (2010)	9.97[C,D,E,F]	24.12	41	68
Fowler I, II, III, IN (2011)		20.19	355	600
Fowler I, II, III, IN (2010)		18.96	355	600
Forward Energy Center, WI	6.97	18.17	86	129
Harrow, Ont (2010)		11.13	24	39.6
Top of Iowa, IA (2004)	35.7	10.27	89	80
Pioneer Prairie I, IA (Phase II)		10.06	62	102.3
Fowler I, IN (2009)		8.09	162	301
Crystal Lake II, IA		7.42	80	200
Top of Iowa, IA (2003)		7.16	89	80
Kewaunee County, WI		6.45	31	20.46
Ripley, Ont. (2008)		4.67	38	76
Winnebago, IA		4.54	10	20
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2[D]	4.35	143	107.25
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2[D]	3.71	138	103.5
Crescent Ridge, IL		3.27	33	54.45
Fowler I, II, III, IN (2012)		2.96	355	600
Elm Creek II, MN		2.81	62	148.8
Buffalo Ridge II, SD (2011)		2.81	105	210
Buffalo Ridge, MN (Phase III; 1999)		2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)		2.59	143	107.25
Moraine II, MN		2.42	33	49.5
Buffalo Ridge, MN (Phase II; 1998)		2.16	143	107.25
Bison Wind Energy Center (2013; this project)		**2.14**	**101**	**291.8**
Prairie Winds (Minot), ND		2.13	80	115.5
Grand Ridge, IL		2.1	66	99
Barton I & II, IA		1.85	80	160
Fowler III, IN (2009)		1.84	60	99
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9[D]	1.81	138	103.5
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9[D]	1.64	143	107.25
Rugby, ND		1.6	71	149
Elm Creek, MN		1.49	67	100
Wessington Springs, SD		1.48	34	51
Prairie Winds ND1 (Minot), ND 2011		1.39	80	115.5
Prairie Winds SD1 (Crow Lake), SD		1.23	108	162
NPPD Ainsworth, NE		1.16	36	20.5
Buffalo Ridge, MN (Phase I; 1999)		0.74	73	25
Wessington Springs, SD (2010)		0.41	34	51
Buffalo Ridge I, SD (2010)		0.16	24	50.4

A=bat passes per detector-night; B=number of bats fatalities/MW/year; C=Activity rate based on data collected at various heights; all other activity rates are from ground-based units only; D=Activity rate was averaged across phases and/or study years; E=Activity rate calculated by WEST from data presented in referenced report; F=Activity rate based on pre-construction monitoring; other data were collected concurrently

Table 10 (*continued*). Wind energy facilities in the Midwest with comparable and publicly-available activity and fatality data for bat species.

Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Bison Wind Energy Center ND		This study			
Barton I & II, IA		Derby et al. 2011a	Fowler III, IN (09)		Good et al. 2011
Blue Sky Green Field, WI	Gruver 2008	Gruver et al. 2009	Fowler I, II, III, IN (10)		Good et al. 2011
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000a	Fowler I, II, III, IN (11)		Good et al. 2012
Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000a	Fowler I, II, III, IN (12)		Good et al. 2013
Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000a	Grand Ridge I, IL		Derby et al. 2010g
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Harrow, Ont		NRSI 2011
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Kewaunee County, WI		Howe et al. 2002
Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000a	Moraine II, MN		Derby et al. 2010d
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	NPPD Ainsworth, NE		Derby et al. 2007
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Pioneer Prairie I, IA (Phase II)		Chodachek et al. 2012
Buffalo Ridge I, SD (10)		Derby et al. 2010b	PrairieWinds ND1 (Minot), ND		Derby et al. 2011c
Buffalo Ridge II, SD (11)		Derby et al. 2012a	PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012c
Cedar Ridge, WI (09)	BHE Environmental 2008	BHE Environmental 2010	PrairieWinds SD1 (Crow Lake), SD		Derby et al. 2012d
Cedar Ridge, WI (10)	BHE Environmental 2008	BHE Environmental 2011	Ripley, Ont (08)		Jacques Whitford 2009
Crescent Ridge, IL		Kerlinger et al. 2007	Rugby, ND		Derby et al. 2011b
Crystal Lake II, IA		Derby et al. 2010a	Top of Iowa, IA (03)		Jain 2005
Elm Creek, MN		Derby et al. 2010c	Top of Iowa, IA (04)	Jain 2005	Jain 2005
Elm Creek II, MN		Derby et al. 2012b	Wessington Springs, SD		Derby et al. 2010f
Forward Energy Center, WI (08-10)	Watt and Drake 2011	Grodsky and Drake 2011	Wessington Springs, SD (10)		Derby et al. 2011d
Fowler I, IN (09)		Good et al. 2011	Winnebago, IA (09-10)		Derby et al. 2010e

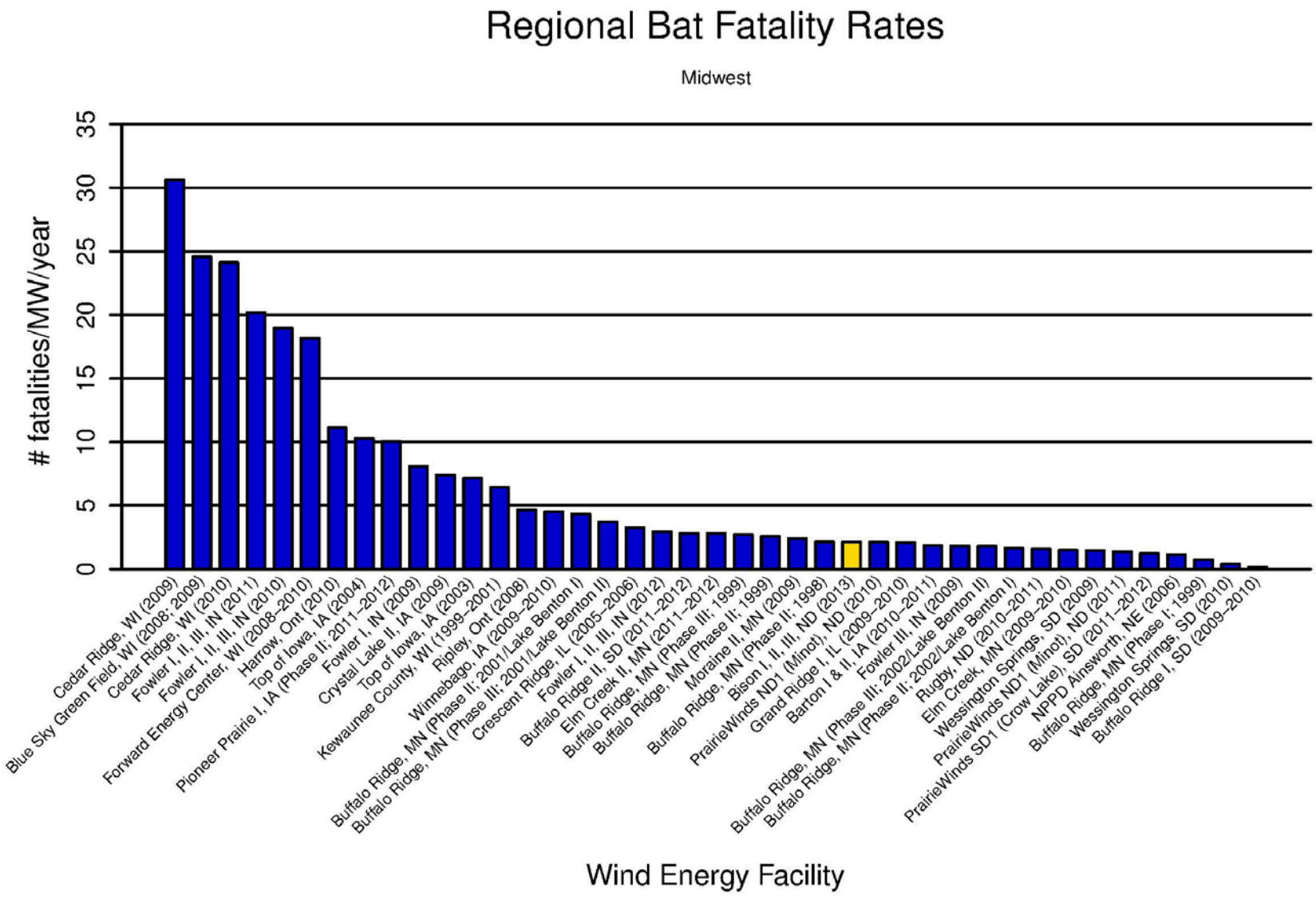

Figure 10. All bat fatality rates from comparable and publicly-available studies at Midwest wind energy facilities, with Bison Wind Energy Center highlighted in yellow.

Figure 10 (*continued*). All bat fatality rates from comparable and publicly-available studies at Midwest wind energy facilities.
Data from the following sources:

Facility, Location	Fatality Reference	Facility, Location	Fatality Reference	Facility, Location	Fatality Reference
Bison Wind Energy Center, ND	This study				
Cedar Ridge, WI (09)	BHE Environmental 2010	Winnebago, IA (09-10)	Derby et al. 2010e	Fowler III, IN (09)	Good et al. 2011
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Buffalo Ridge, MN (Ph. II; 01; 02/Lake Benton I)	Johnson et al. 2004	Buffalo Ridge, MN (Ph. III; 01;02/Lake Benton II)	Johnson et al. 2004
Cedar Ridge, WI (10)	BHE Environmental 2011	Buffalo Ridge, MN (Ph. III; 01;02/Lake Benton II)	Johnson et al. 2004	Buffalo Ridge, MN (Ph. II; 01; 02/Lake Benton I)	Johnson et al. 2004
Fowler I, II, III, IN (11)	Good et al. 2012	Crescent Ridge, IL (05-06)	Kerlinger et al. 2007	Rugby, ND (09-10)	Derby et al. 2011b
Fowler I, II, III, IN (10)	Good et al. 2011	Fowler I, II, III, IN (12)	Good et al. 2013	Elm Creek, MN (09-10)	Derby et al. 2010c
Forward Energy Center, WI (08-10)	Grodsky and Drake 2011	Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Wessington Springs, SD (09)	Derby et al. 2010f
Harrow, Ont. (10)	NRSI 2011	Elm Creek II, MN (11-12)	Derby et al. 2012b	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Top of Iowa, IA (04)	Jain 2005	Buffalo Ridge, MN (Ph. III; 99)	Johnson et al. 2000a	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
Pioneer Prairie, IA (Ph. II; 11-12)	Chodachek et al. 2012	Buffalo Ridge, MN (Ph. II; 99)	Johnson et al. 2000a	NPPD Ainsworth, NE (06)	Derby et al. 2007
Fowler I, IN (09)	Good et al. 2011	Moraine II, MN (09)	Derby et al. 2010d	Buffalo Ridge, MN (Ph. I; 99)	Johnson et al. 2000a
Crystal Lake II, IA (09)	Derby et al. 2010a	Buffalo Ridge, MN (Ph. II; 98)	Johnson et al. 2000a	Wessington Springs, SD (10)	Derby et al. 2011d
Top of Iowa, IA (03)	Jain 2005	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011c	Buffalo Ridge I, SD (10)	Derby et al. 2010b
Kewaunee County, WI (99-01)	Howe et al. 2002	Grand Ridge, IL (09-10)	Derby et al. 2010g		
Ripley, Ont (08)	Jacques Whitford 2009	Barton I& II, IA (10-11)	Derby et al. 2011a		

Bird Fatalities

During this study, a combined total of 44 bird fatalities were found from March 23 to October 31, 2013. Bird fatality estimates from other wind energy facilities across North America ranged from 0.08 bird fatalities per MW per year at the Red Hills facility in Oklahoma (Derby et al. 2013b) to 11.02 at the Buffalo Mountain facility in Tennessee (Nicholson et al. 2005; Appendix C). Within in the Midwest, bird fatality estimates ranged from 0.27 to 8.25 bird fatalities per MW per year (Appendix C). The Shoenfeld estimated all bird fatality rate of 0.89 bird fatalities per MW per year is within the range of other facilities in the Midwest, ranking 27th overall (Figure 11). The bird fatality estimate at Bison is less than the Minot facility in North Dakota, and is similar to the Wessington Springs facility in South Dakota during Year 2 of surveys (Appendix C).

A total of four raptor fatalities were found during scheduled carcass searches. The raptor fatality estimate of 0.06 raptor fatalities per MW per year is within the range of other facilities in the Midwest, ranking 9th overall, and similar to the Rugby facility in North Dakota (Figure 12).

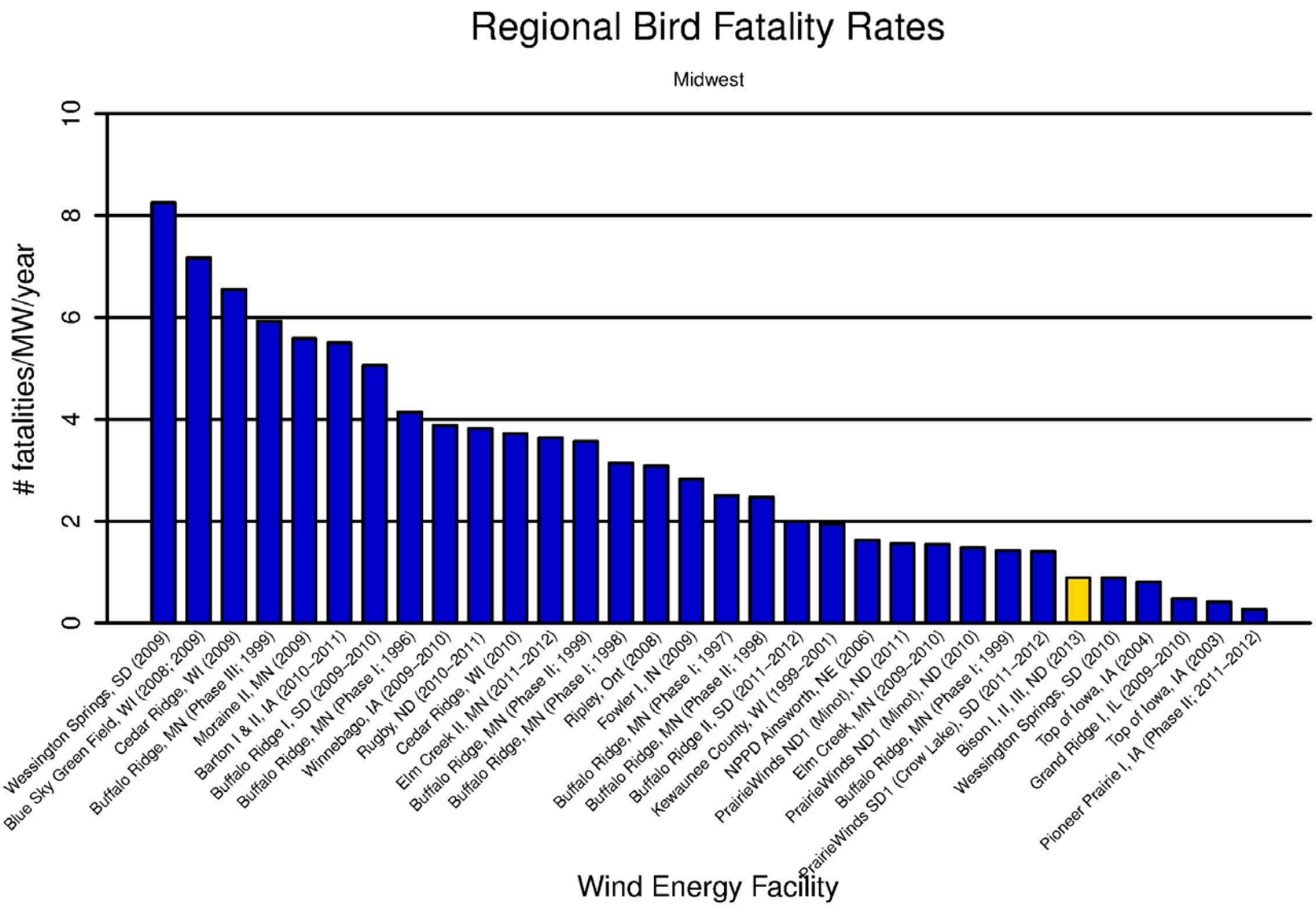

Figure 11. All bird fatality rates from comparable and publicly-available studies at Midwest wind energy facilities, with Bison Wind Energy Center highlighted in yellow.

Figure 11 (*continued*). All bird fatality rates from comparable and publicly-available studies at Midwest wind energy facilities.
Data from the following sources:

Facility, Location	Fatality Reference	Facility, Location	Fatality Reference	Facility, Location	Fatality Reference
Bison Wind Energy Center, ND	This study				
Wessington Springs, SD (09)	Derby et al. 2010f	Elm Creek II, MN (11-12)	Derby et al. 2012b	Elm Creek, MN (09-10)	Derby et al. 2010c
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011c
Cedar Ridge, WI (09)	BHE Environmental 2010	Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000a	Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a	Ripley, Ont (08)	Jacques Whitford 2009	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
Moraine II, MN (09)	Derby et al. 2010d	Fowler I, IN (09)	Good et al. 2011	Wessington Springs, SD (10)	Derby et al. 2011d
Barton I & II, IA (10-11)	Derby et al. 2011a	Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000a	Top of Iowa, IA (04)	Jain 2005
Buffalo Ridge I, SD (09-10)	Derby et al. 2010b	Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000a	Grand Ridge, IL (09-10)	Derby et al. 2010g
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000a	Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Top of Iowa, IA (03)	Jain 2005
Winnebago, IA (09-10)	Derby et al. 2010e	Kewaunee County, WI (99-01)	Howe et al. 2002	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Rugby, ND (10-11)	Derby et al. 2011b	NPPD Ainsworth, NE (06)	Derby et al. 2007		
Cedar Ridge, WI (10)	BHE Environmental 2011	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c		

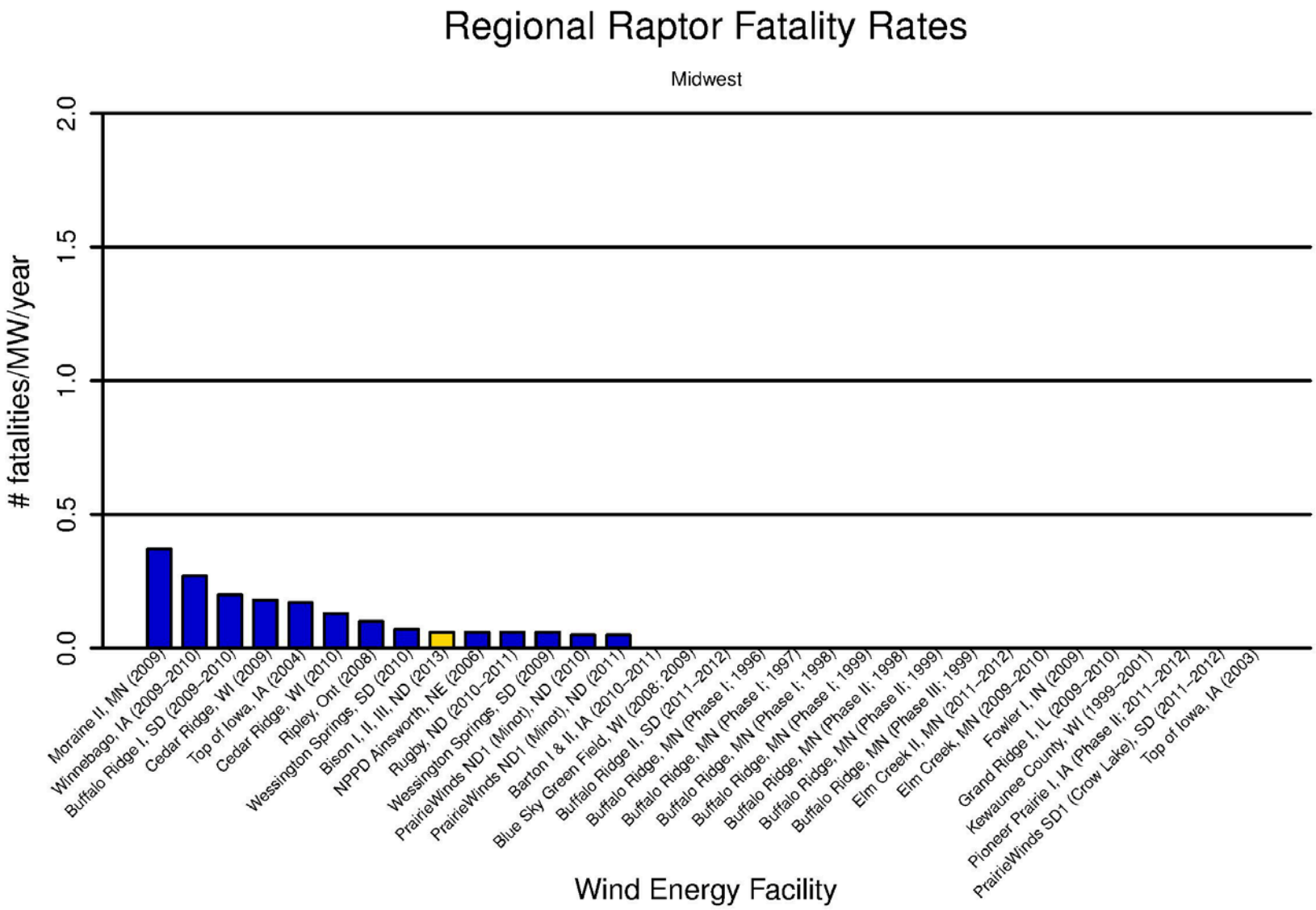

Figure 12. All raptor fatality rates from comparable and publicly-available studies at Midwest wind energy facilities, with Bison Wind Energy Center highlighted in yellow.

Figure 12 (*continued*). All raptor fatality rates from comparable and publicly-available studies at Midwest wind energy facilities.
Data from the following sources:

Facility, Location	Fatality Reference	Facility, Location	Fatality Reference	Facility, Location	Fatality Reference
Bison Wind Energy Center, ND	This study				
Moraine II, MN (09)	Derby et al. 2010d	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011c	Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a
Winnebago, IA (09-10)	Derby et al. 2010e	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c	Elm Creek II, MN (11-12)	Derby et al. 2012b
Buffalo Ridge I, SD (09-10)	Derby et al. 2010b	Barton I & II, IA (10-11)	Derby et al. 2011a	Elm Creek, MN (09-10)	Derby et al. 2010c
Cedar Ridge, WI (09)	BHE Environmental 2010	Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Fowler I, IN (09)	Good et al. 2011
Top of Iowa, IA (04)	Jain 2005	Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Grand Ridge, IL (09-10)	Derby et al. 2010g
Cedar Ridge, WI (10)	BHE Environmental 2011	Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000a	Kewaunee County, WI (99-01)	Howe et al. 2002
Ripley, Ont (08)	Jacques Whitford 2009	Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000a	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Wessington Springs, SD (10)	Derby et al. 2011d	Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000a	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
NPPD Ainsworth, NE (06)	Derby et al. 2007	Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000a	Top of Iowa, IA (03)	Jain 2005
Rugby, ND (10-11)	Derby et al. 2011b	Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000a		
Wessington Springs, SD (09)	Derby et al. 2010f	Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a		

SUMMARY

The bat and bird fatality rates at Bison are within the overall lower range for other Midwestern projects, and lower than many facilities in the east (Appendices C and D). Migratory bats, including but not limited to hoary bats, made up the majority of all bat fatalities. No state or federally endangered or threatened bat or bird species were located as a fatality.

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Appendix A. Summary of Search Area for Roads and Pads at the Bison Wind Energy Center from June 26 – August 19, 2013

Appendix A. Total area searched in 10-meter (m) bands for roads and pads at the Bison Wind Energy Center from March 23 – October 31, 2013.

Distance From Turbine	Total Acres	Turbine Number 13		15		18		23		32	
		Acres Searched	% Searched	Acres Searched	% Searched	Acres Searched	% Searched	Acres Searched	% Searched	Acres Searched	% Searched
10	0.08	0.08	97.4	0.08	100.0	0.07	93.6	0.08	100.0	0.08	100.0
20	0.23	0.17	71.7	0.19	79.8	0.14	59.7	0.17	73.4	0.18	77.3
30	0.39	0.24	62.1	0.26	66.8	0.20	51.3	0.24	61.3	0.21	53.4
40	0.54	0.21	39.4	0.23	41.6	0.24	43.5	0.17	32.0	0.16	29.5
50	0.70	0.16	22.5	0.14	20.5	0.17	23.8	0.08	11.0	0.06	8.0
60	0.85	0.15	17.9	0.10	11.5	0.13	15.6	0.06	6.4	0.03	3.2
70	1.01	0.16	15.8	0.06	5.5	0.10	9.8	0.07	7.0	0.02	2.3
80	1.16	0.19	16.5	0.04	3.1	0.06	4.7	0.12	10.3	0.02	1.8
90	1.32	0.13	10.2	0.03	2.5	0.03	2.4	0.05	3.9	0.01	0.5
100	1.47	0.09	6.1	0.01	0.3	0.03	1.8	0.00	0.2	0.00	0.0
110	1.63	0.07	4.2	0.00	0.0	0.00	0.2	0.00	0.0	0.00	0.0
120	1.79	0.01	0.3	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0

Appendix A (*continued*). Total area searched in 10-meter (m) bands for roads and pads at the Bison Wind Energy Center from March 23 – October 31, 2013.

Distance From Turbine	Total Acres	Turbine Number 210		213		216		222		231	
		Acres Searched	% Searched	Acres Searched	% Searched	Acres Searched	% Searched	Acres Searched	% Searched	Acres Searched	% Searched
10	0.08	0.08	100.0	0.08	100.0	0.08	100.0	0.08	100.0	0.08	100.0
20	0.23	0.23	100.0	0.23	100.0	0.23	100.0	0.22	93.1	0.23	100.0
30	0.39	0.33	84.3	0.39	99.7	0.34	87.1	0.27	70.4	0.39	100.0
40	0.54	0.32	58.6	0.36	65.6	0.37	68.9	0.30	54.3	0.54	99.3
50	0.70	0.15	21.1	0.19	27.2	0.24	34.7	0.20	28.2	0.58	83.2
60	0.85	0.09	10.8	0.12	14.3	0.17	19.3	0.12	14.5	0.64	74.8
70	1.01	0.07	7.1	0.11	10.4	0.11	11.3	0.10	9.4	0.47	46.1
80	1.16	0.07	5.7	0.09	7.7	0.09	7.9	0.06	4.7	0.45	38.9
90	1.32	0.02	1.4	0.02	1.8	0.05	3.6	0.01	0.6	0.28	21.4
100	1.47	0.00	0.0	0.00	0.0	0.01	0.3	0.00	0.0	0.19	12.6
110	1.63	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.09	5.2
120	1.79	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.01	0.3

Appendix A (*continued*). Total area searched in 10-meter (m) bands for roads and pads at the Bison Wind Energy Center from March 23 – October 31, 2013.

Distance From Turbine	Total Acres	Turbine Number 234 Acres Searched	234 % Searched	302 Acres Searched	302 % Searched	308 Acres Searched	308 % Searched	315 Acres Searched	315 % Searched	318 Acres Searched	318 % Searched
10	0.08	0.08	100.0	0.08	100.0	0.07	94.9	0.08	100.0	0.08	100.0
20	0.23	0.19	80.7	0.23	100.0	0.12	52.4	0.23	100.0	0.23	100.0
30	0.39	0.23	59.3	0.38	98.7	0.17	44.3	0.38	98.2	0.32	82.7
40	0.54	0.15	28.2	0.40	74.4	0.11	20.3	0.43	79.9	0.28	50.6
50	0.70	0.09	12.8	0.33	47.3	0.05	7.0	0.23	32.4	0.14	20.5
60	0.85	0.07	8.3	0.26	30.9	0.04	4.1	0.14	16.2	0.08	9.7
70	1.01	0.07	6.5	0.16	16.3	0.03	3.4	0.07	7.2	0.06	5.7
80	1.16	0.07	5.8	0.14	12.4	0.03	2.8	0.08	7.1	0.05	4.4
90	1.32	0.06	4.6	0.03	2.3	0.01	0.5	0.02	1.7	0.05	3.5
100	1.47	0.04	2.7	0.00	0.0	0.00	0.0	0.00	0.0	0.01	0.6
110	1.63	0.02	1.5	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
120	1.79	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0

Appendix A (*continued*). Total area searched in 10-meter (m) bands for roads and pads at the Bison Wind Energy Center from March 23 – October 31, 2013.

Distance From Turbine	Total Acres	Turbine Number 321 Acres Searched	321 % Searched	324 Acres Searched	324 % Searched	327 Acres Searched	327 % Searched	333 Acres Searched	333 % Searched
10	0.08	0.08	100.0	0.08	100.0	0.08	100.0	0.08	100.0
20	0.23	0.23	100.0	0.23	100.0	0.23	100.0	0.22	95.7
30	0.39	0.33	84.8	0.34	87.1	0.39	99.2	0.29	73.5
40	0.54	0.18	33.7	0.31	56.4	0.37	67.4	0.25	45.9
50	0.70	0.07	9.7	0.10	14.3	0.25	36.2	0.11	15.3
60	0.85	0.04	5.2	0.03	3.9	0.14	16.4	0.07	8.7
70	1.01	0.04	3.8	0.03	3.3	0.11	10.5	0.05	4.9
80	1.16	0.04	3.1	0.04	3.1	0.10	8.2	0.04	3.5
90	1.32	0.01	0.5	0.04	2.7	0.05	4.1	0.01	0.5
100	1.47	0.00	0.0	0.01	0.5	0.02	1.4	0.00	0.0
110	1.63	0.00	0.0	0.00	0.0	0.00	0.2	0.00	0.0
120	1.79	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0

Appendix B. Seasonal Bat and Bird Fatality Rate Estimations at the Bison Wind Energy Center from March 23 – October 31, 2013

Appendix B. Correction factors and bird and bat fatality rates by season for full plots searched within the Bison Wind Energy Complex from March 23 – October 31, 2013.

	Spring			Early Summer			Late Summer*			Early Fall*			Late Fall		
		90 % CI[A]			90% CI[A]			90% CI[A]			90% CI[A]			90% CI[A]	
	Estimate	LL	UL	Estimate	LL	UL	Estimate	LL	UL	Estimate	LL	UL	Estimate	LL	UL
Search Area Adjustment															
Bats	1.0	--	--	1.0	--	--	1.0	--	--	1.0	--	--	1.0	--	--
Small Birds	1.0	--	--	1.0	--	--	1.0	--	--	1.0	--	--	1.0	--	--
Large Birds	1.0	--	--	1.0	--	--	1.0	--	--	1.0	--	--	1.0	--	--
Raptors	1.0	--	--	1.0	--	--	1.0	--	--	1.0	--	--	1.0	--	--
Searcher Efficiency															
Bats	0.60	0.43	0.77	0.60	0.43	0.77	0.60	0.43	0.77	0.60	0.43	0.77	0.60	0.43	0.77
Small Birds	0.60	0.43	0.77	0.60	0.43	0.77	0.60	0.43	0.77	0.60	0.43	0.77	0.60	0.43	0.77
Large Birds	0.82	0.65	0.94	0.82	0.65	0.94	0.82	0.65	0.94	0.82	0.65	0.94	0.82	0.65	0.94
Raptors	0.82	0.65	0.94	0.82	0.65	0.94	0.82	0.65	0.94	0.82	0.65	0.94	0.82	0.65	0.94
Average Removal Time															
Bats	6.43	2.64	12.14	11.73	4.69	25.76	11.73	4.69	25.76	26.17	16.66	46.82	26.17	16.66	46.82
Small Birds	6.43	2.64	12.14	11.73	4.69	25.76	11.73	4.69	25.76	26.17	16.66	46.82	26.17	16.66	46.82
Large Birds	30.54	18.61	51.60	30.54	18.61	51.60	30.54	18.61	51.60	30.54	18.61	51.60	30.54	18.61	51.60
Raptors	30.54	18.61	51.60	30.54	18.61	51.60	30.54	18.61	51.60	30.54	18.61	51.60	30.54	18.61	51.60
Observed Fatality Rates (fatalities/turbine/season)															
Bats	0.20	0.03	0.47	0.07	0	0.13	0.36	0.09	0.64	1.55	0.64	2.55	1.80	1.3	2.3
Small Birds	0.37	0.2	0.53	0.1	0.03	0.2	0.09	0	0.27	0	--	--	0.30	0.13	0.47
Large Birds	0.13	0.03	0.27	0.20	0.07	0.37	0	--	--	0	--	--	0.23	0.1	0.37
Raptors	0.03	0	0.1	0.03	0	0.1	0	--	--	0	--	--	0.07	0	0.17
Average Probability of Carcass Available and Detected															
Bats	0.38	0.17	0.56	0.40	0.18	0.61	0.40	0.18	0.61	0.73	0.59	0.84	0.73	0.59	0.84
Small Birds	0.38	0.17	0.56	0.40	0.18	0.61	0.40	0.18	0.61	0.73	0.59	0.84	0.73	0.59	0.84
Large Birds	0.83	0.74	0.9	0.75	0.62	0.84	0.75	0.62	0.84	0.83	0.74	0.9	0.83	0.74	0.9
Raptors	0.83	0.74	0.9	0.75	0.62	0.84	0.75	0.62	0.84	0.83	0.74	0.9	0.83	0.74	0.9
Adjusted Fatality Estimates (fatalities/turbine/season)															
Bats	0.53	0.06	2.67	0.17	0	0.5	0.91	0.27	2.34	2.13	0.84	3.73	2.48	1.75	3.48
Small Birds	0.96	0.5	2.3	0.25	0.05	0.67	0.23	0	0.82	0	--	--	0.41	0.2	0.65
Large Birds	0.16	0.04	0.34	0.27	0.09	0.48	0	--	--	0	--	--	0.28	0.12	0.44
Raptors	0.04	0	0.12	0.04	0	0.13	0	--	--	0	--	--	0.08	0	0.19

Appendix B. Correction factors and bird and bat fatality rates by season for full plots searched within the Bison Wind Energy Complex from March 23 – October 31, 2013.

Overall Adjusted Fatality Estimates (fatalities/turbine/year)			
		90% CI[A]	
	Estimate	LL	UL
Bats	6.28	4.52	9.38
Small Birds	1.85	1.2	3.52
Large Birds	0.71	0.44	1.04
Raptors	0.16	0.04	0.32
All Birds	2.56	1.84	4.26

* - Plot estimates are for11 turbines during the time period June 26 – August 19, 2013

[A] ll = lower limit; ul = upper limit

Appendix C. North American Bat, Bird, and Raptor Fatality Summary Tables

Appendix C1. 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
Bison I, II, and III, ND			**2.14**	**101**	**291.8**
	Midwest				
Cedar Ridge, WI (2009)	9.97[A,B,C,D]	7/16/07-9/30/07	30.61	41	67.6
Blue Sky Green Field, WI (2008; 2009)	7.7[C]	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	9.97[A,B,C,D]	7/16/07-9/30/07	24.12	41	68
Fowler I, II, III, IN (2011)			20.19	355	600
Fowler I, II, III, IN (2010)			18.96	355	600
Forward Energy Center, WI (2008-2010)	6.97	8/5/08-11/08/08	18.17	86	129
Harrow, Ont (2010)			11.13	24 (four 6-turb facilities)	39.6
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Pioneer Prairie I, IA (Phase II; 2011-2012)			10.06	62	102.3
Fowler I, IN (2009)			8.09	162	301
Crystal Lake II, IA (2009)			7.42	80	200
Top of Iowa, IA (2003)			7.16	89	80
Kewaunee County, WI (1999-2001)			6.45	31	20.46
Ripley, Ont (2008)			4.67	38	76
Winnebago, IA (2009-2010)			4.54	10	20
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2[A]	6/15/01-9/15/01	4.35	143	107.25
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2[A]	6/15/01-9/15/01	3.71	138	103.5
Crescent Ridge, IL (2005-2006)			3.27	33	49.5
Fowler I, II, III, IN (2012)			2.96	355	600
Elm Creek II, MN (2011-2012)			2.81	62	148.8
Buffalo Ridge II, SD (2011-2012)			2.81	105	210
Buffalo Ridge, MN (Phase III; 1999)			2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)			2.59	143	107.25
Moraine II, MN (2009)			2.42	33	49.5
Buffalo Ridge, MN (Phase II; 1998)			2.16	143	107.25
PrairieWinds ND1 (Minot), ND (2010)			2.13	80	115.5
Grand Ridge I, IL (2009-2010)			2.1	66	99
Barton I & II, IA (2010-2011)			1.85	80	160
Fowler III, IN (2009)			1.84	60	99
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9[A]	6/15/02-9/15/02	1.81	138	103.5
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9[A]	6/15/02-9/15/02	1.64	143	107.25
Rugby, ND (2010-2011)			1.6	71	149
Elm Creek, MN (2009-2010)			1.49	67	100
Wessington Springs, SD (2009)			1.48	34	51
PrairieWinds ND1 (Minot), ND (2011)			1.39	80	115.5
PrairieWinds SD1 (Crow Lake), SD (2011-2012)			1.23	108	162
NPPD Ainsworth, NE (2006)			1.16	36	20.5
Buffalo Ridge, MN (Phase I; 1999)			0.74	73	25
Wessington Springs, SD (2010)			0.41	34	51
Buffalo Ridge I, SD (2009-2010)			0.16	24	50.4

Appendix C1. 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
Southern Plains					
Barton Chapel, TX			3.06	60	120
Big Smile, OK			2.90	66	132
Buffalo Gap II, TX			0.14	155	233
Red Hills, OK			0.11	82	123
Buffalo Gap I, TX			0.10	67	134
Northeast					
Mountaineer, WV (2003)			31.69	44	66
Mount Storm, WV (2009)	30.09	7/15/09-10/7/09	17.53	132	264
Noble Wethersfield, NY (2010)			16.30	84	126
Criterion, MD (2011)			15.61	28	70
Mount Storm, WV (2010)	36.67[E]	4/18/10-10/15/10	15.18	132	264
Locust Ridge, PA (Phase II; 2010)			14.38	51	102
Locust Ridge, PA (Phase II; 2009)			14.11	51	102
Casselman, PA (2008)			12.61	23	34.5
Maple Ridge, NY (2006)			11.21	120	198
Cohocton/Dutch Hills, NY (2010)			10.32	50	125
Wolfe Island, Ont (July-December 2010)			9.50	86	197.8
Cohocton/Dutch Hill, NY (2009)			8.62	50	125
Casselman, PA (2009)			8.60	23	34.5
Noble Bliss, NY (2008)			7.80	67	100
Criterion, MD (2012)			7.62	28	70
Mount Storm, WV (2011)			7.43	132	264
Mount Storm, WV (Fall 2008)	35.2	7/20/08-10/12/08	6.62	82	164
Maple Ridge, NY (2007)			6.49	195	321.75
Wolfe Island, Ont (July-December 2009)			6.42	86	197.8
Maple Ridge, NY (2007-2008)			4.96	195	321.75
Noble Clinton, NY (2009)	1.9[D]	8/1/09-09/31/09	4.50	67	100
Casselman Curtailment, PA (2008)			4.40	23	35.4
Noble Altona, NY (2010)			4.34	65	97.5
Noble Ellenburg, NY (2009)	16.1[D]	8/16/09-09/15/09	3.91	54	80
Noble Bliss, NY (2009)			3.85	67	100
Lempster, NH (2010)			3.57	12	24
Noble Ellenburg, NY (2008)			3.46	54	80
Noble Clinton, NY (2008)	2.1[D]	8/8/08-09/31/08	3.14	67	100
Lempster, NH (2009)			3.11	12	24
Mars Hill, ME (2007)			2.91	28	42
Wolfe Island, Ont (July-December 2011)			2.49	86	197.8
Noble Chateaugay, NY (2010)			2.44	71	106.5
High Sheldon, NY (2010)			2.33	75	112.5
Beech Ridge, WV (2012)			2.03	67	100.5
Munnsville, NY (2008)			1.93	23	34.5
High Sheldon, NY (2011)			1.78	75	112.5
Stetson Mountain II, ME (2010)			1.65	17	25.5
Stetson Mountain I, ME (2009)	28.5; 0.3[F]	7/10/09-10/15/09	1.40	38	57
Mars Hill, ME (2008)			0.45	28	42
Stetson Mountain I, ME (2011)			0.28	38	57
Kibby, ME (2011)			0.12	44	132

Appendix C1. 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
Southeast					
Buffalo Mountain, TN (2005)			39.70	18	28.98
Buffalo Mountain, TN (2000-2003)	23.7[C]		31.54	3	1.98
Rocky Mountains					
Summerview, Alb (2006; 2007)	7.65[A]	07/15/06-07-09/30/06-07	11.42	39	70.2
Summerview, Alb (2005-2006)			10.27	39	70.2
Judith Gap, MT (2006-2007)			8.93	90	135
Foote Creek Rim, WY (Phase I; 1999)			3.97	69	41.4
Judith Gap, MT (2009)			3.20	90	135
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2[A,B]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2[A,B]	6/15/00-9/1/00	1.05	69	41.4
Southwest					
Dry Lake I, AZ	8.8	4/29/10-11/10/10	3.43	30	63
Dry Lake II, AZ	11.5	5/11/11-10/26/11	1.66	31	65
California					
Shiloh I, CA			3.92	100	150
Shiloh II, CA			2.72	75	150
High Winds, CA (2004)			2.51	90	162
Dillon, CA			2.17	45	45
High Winds, CA (2005)			1.52	90	162
Alta Wind I, CA (2011)	4.42	6/26/2009 - 10/31/2009	1.28	100	150
Diablo Winds, CA			0.82	31	20.46
Alite, CA			0.24	8	24
Alta Wind II-V, CA (2011)	0.78	6/26/2009 - 10/31/2009	0.08	190	570
Pacific Northwest					
Biglow Canyon, OR (Phase II; 2009-2010)			2.71	65	150
Nine Canyon, WA (2002-2003)			2.47	37	48.1
Stateline, OR/WA (2003)			2.29	454	299
Elkhorn, OR (2010)			2.14	61	101
White Creek, WA (2007-2011)			2.04	89	204.7
Biglow Canyon, OR (Phase I; 2008)			1.99	76	125.4
Leaning Juniper, OR (2006-2008)			1.98	67	100.5
Big Horn, WA (2006-2007)			1.90	133	199.5
Combine Hills, OR (Phase I; 2004-2005)			1.88	41	41
Linden Ranch, WA (2010-2011)			1.68	25	50
Pebble Springs, OR (2009-2010)			1.55	47	98.7
Hopkins Ridge, WA (2008)			1.39	87	156.6
Harvest Wind, WA (2010-2012)			1.27	43	98.9
Elkhorn, OR (2008)			1.26	61	101
Vansycle, OR (1999)			1.12	38	24.9
Klondike III (Phase I), OR (2007-2009)			1.11	125	223.6
Stateline, OR/WA (2001-2002)			1.09	454	299
Stateline, OR/WA (2006)			0.95	454	299
Tuolumne (Windy Point I), WA (2009-2010)			0.94	62	136.6
Klondike, OR (2002-2003)			0.77	16	24

Appendix C1. 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
Combine Hills, OR (2011)			0.73	104	104
Hopkins Ridge, WA (2006)			0.63	83	150
Biglow Canyon, OR (Phase I; 2009)			0.58	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)			0.57	65	150
Hay Canyon, OR (2009-2010)			0.53	48	100.8
Klondike II, OR (2005-2006)			0.41	50	75
Windy Flats, WA (2010-2011)			0.41	114	262.2
Vantage, WA (2010-2011)			0.40	60	90
Wild Horse, WA (2007)			0.39	127	229
Goodnoe, WA (2009-2010)			0.34	47	94
Marengo II, WA (2009-2010)			0.27	39	70.2
Biglow Canyon, OR (Phase III; 2010-2011)			0.22	76	174.8
Marengo I, WA (2009-2010)			0.17	78	140.4
Klondike IIIa (Phase II), OR (2008-2010)			0.14	51	76.5
Kittitas Valley, WA (2011-2012)			0.12	48	100.8

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

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

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

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

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

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

Appendix C1 (*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
Alite, CA (09-10)		Chatfield et al. 2010	Kewaunee County, WI (99-01)		Howe et al. 2002
Alta Wind I, CA (11-12)	Solick et al. 2010	Chatfield et al. 2012	Kibby, ME (11)		Stantec 2012
Alta Wind II-V, CA (11-12)	Solick et al. 2010	Chatfield et al. 2012	Kittitas Valley, WA (11-12)		Stantec Consulting Services 2012
Barton I & II, IA (10-11)		Derby et al. 2011a	Klondike, OR (02-03)		Johnson et al. 2003a
Barton Chapel, TX (09-10)		WEST 2011	Klondike II, OR (05-06)		NWC and WEST 2007
Beech Ridge, WV (12)		Tidhar et al. 2013	Klondike III (Phase I), OR (07-09)		Gritski et al. 2010
Big Horn, WA (06-07)		Kronner et al. 2008	Klondike IIIa (Phase II), OR (08-10)		Gritski et al. 2011
Big Smile, OK (12-13)		Derby et al. 2013a	Leaning Juniper, OR (06-08)		Gritski et al. 2008
Biglow Canyon, OR (Phase I; 08)		Jeffrey et al. 2009a	Lempster, NH (09)		Tidhar et al. 2010
Biglow Canyon, OR (Phase I; 09)		Enk et al. 2010	Lempster, NH (10)		Tidhar et al. 2011
Biglow Canyon, OR (Phase II; 09-10)		Enk et al. 2011a	Linden Ranch, WA (10-11)		Enz and Bay 2011
Biglow Canyon, OR (Phase II; 10-11)		Enk et al. 2012b	Locust Ridge, PA (Phase II; 09)		Arnett et al. 2011
Biglow Canyon, OR (Phase III; 10-11)		Enk et al. 2012a	Locust Ridge, PA (Phase II; 10)		Arnett et al. 2011
Blue Sky Green Field, WI (08; 09)	Gruver 2008	Gruver et al. 2009	Maple Ridge, NY (06)		Jain et al. 2007
Buffalo Gap I, TX (06)		Tierney 2007	Maple Ridge, NY (07)		Jain et al. 2009a
Buffalo Gap II, TX (07-08)		Tierney 2009	Maple Ridge, NY (07-08)		Jain et al. 2009d
Buffalo Mountain, TN (00-03)	Fiedler 2004	Nicholson et al. 2005	Marengo I, WA (09-10)		URS Corporation 2010b
Buffalo Mountain, TN (05)		Fiedler et al. 2007	Marengo II, WA (09-10)		URS Corporation 2010c
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000a	Mars Hill, ME (07)		Stantec 2008
Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000a	Mars Hill, ME (08)		Stantec 2009a
Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000a	Moraine II, MN (09)		Derby et al. 2010d
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (Fall 08)	Young et al. 2009b	Young et al. 2009b
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (09)	Young et al. 2009a, 2010b	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000a	Mount Storm, WV (10)	Young et al. 2010a, 2011b	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (11)		Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mountaineer, WV (03)		Kerns and Kerlinger 2004
Buffalo Ridge I, SD (09-10)		Derby et al. 2010b	Munnsville, NY (08)		Stantec 2009b
Buffalo Ridge II, SD (11-12)		Derby et al. 2012a	Nine Canyon, WA (02-03)		Erickson et al. 2003b
Casselman, PA (08)		Arnett et al. 2009a	Noble Altona, NY (10)		Jain et al. 2011b
Casselman, PA (09)		Arnett et al. 2010	Noble Bliss, NY (08)		Jain et al.2009e
Casselman Curtailment, PA (08)		Arnett et al. 2009b	Noble Bliss, NY (09)		Jain et al. 2010a
Cedar Ridge, WI (09)	BHE Environmental 2008	BHE Environmental 2010	Noble Chateaugay, NY (10)		Jain et al. 2011c
Cedar Ridge, WI (10)	BHE Environmental 2008	BHE Environmental 2011	Noble Clinton, NY (08)	Reynolds 2010a	Jain et al. 2009c
Cohocton/Dutch Hill, NY (09)		Stantec 2010	Noble Clinton, NY (09)	Reynolds 2010a	Jain et al. 2010b
Cohocton/Dutch Hills, NY (10)		Stantec 2011	Noble Ellenburg, NY (08)		Jain et al. 2009b
Combine Hills, OR (Phase I; 04-05)		Young et al. 2006	Noble Ellenburg, NY (09)	Reynolds 2010b	Jain et al. 2010c
Combine Hills, OR (11)		Enz et al. 2012	Noble Wethersfield, NY (10)		Jain et al. 2011a
Crescent Ridge, IL (05-06)		Kerlinger et al. 2007	NPPD Ainsworth, NE (06)		Derby et al. 2007
Criterion, MD (11)		Young et al. 2012a	Pebble Springs, OR (09-10)		Gritski and Kronner 2010b
Criterion, MD (12)		Young et al. 2013	Pioneer Prairie I, IA (Phase II; 11-12)		Chodachek et al. 2012
Crystal Lake II, IA (09)		Derby et al. 2010a	PrairieWinds ND1 (Minot), ND (10)		Derby et al. 2011c
Diablo Winds, CA (05-07)		WEST 2006, 2008	PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012c
Dillon, CA (08-09)		Chatfield et al. 2009	PrairieWinds SD1 (Crow Lake), SD (11-12)		Derby et al. 2012d
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Thompson et al. 2011	Red Hills, OK (12-13)		Derby et al. 2013b
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Thompson and Bay 2012	Ripley, Ont (08)		Jacques Whitford 2009

Appendix C1 (*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	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)	Gruver 2002	Young et al. 2003b, 2003d	Stateline, OR/WA (06)		Erickson et al. 2007
Foote Creek Rim, WY (Phase I; 01-02)	Gruver 2002	Young et al. 2003b, 2003d	Stetson Mountain I, ME (09)	Stantec 2009c	Stantec 2009c
Forward Energy Center, WI (08-10)	Watt and Drake 2011	Grodsky and Drake 2011	Stetson Mountain I, ME (11)		Normandeau Associates 2011
Fowler I, IN (09)		Good et al. 2011	Stetson Mountain II, ME (10)		Normandeau Associates 2010
Fowler III, IN (09)		Good et al. 2011	Summerview, Alb (05-06)		Brown and Hamilton 2006
Fowler I, II, III, IN (10)		Good et al. 2011	Summerview, Alb (06; 07)	Baerwald 2008	Baerwald 2008
Fowler I, II, III, IN (11)		Good et al. 2012	Top of Iowa, IA (03)		Jain 2005
Fowler I, II, III, IN (12)		Good et al. 2013	Top of Iowa, IA (04)	Jain 2005	Jain 2005
Goodnoe, WA (09-10)		URS Corporation 2010a	Tuolumne (Windy Point I), WA (09-10)		Enz and Bay 2010
Grand Ridge I, IL (09-10)		Derby et al. 2010g	Vansycle, OR (99)		Erickson et al. 2000a
Harrow, Ont (10)		NRSI 2011	Vantage, WA (10-11)		Ventus 2012
Harvest Wind, WA (10-12)		Downes and Gritski 2012a	Wessington Springs, SD (09)		Derby et al. 2010f
Hay Canyon, OR (09-10)		Gritski and Kronner 2010a	Wessington Springs, SD (10)		Derby et al. 2011d
High Sheldon, NY (10)		Tidhar et al. 2012a	White Creek, WA (07-11)		Downes and Gritski 2012b
High Sheldon, NY (11)		Tidhar et al. 2012b	Wild Horse, WA (07)		Erickson et al. 2008
High Winds, CA (03-04)		Kerlinger et al. 2006	Windy Flats, WA (10-11)		Enz et al. 2011
High Winds, CA (04-05)		Kerlinger et al. 2006	Winnebago, IA (09-10)		Derby et al. 2010e
Hopkins Ridge, WA (06)		Young et al. 2007	Wolfe Island, Ont (July-December 09)		Stantec Ltd. 2010
Hopkins Ridge, WA (08)		Young et al. 2009c	Wolfe Island, Ont (July-December 10)		Stantec Ltd. 2011
Judith Gap, MT (06-07)		TRC 2008	Wolfe Island, Ont (July-December 11)		Stantec Ltd. 2012
Judith Gap, MT (09)		Poulton and Erickson 2010			

Appendix C2. 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
Bison I, II, and III, ND	**0.89**	**101**	**291.8**
Midwest			
Wessington Springs, SD (2009)	8.25	34	51
Blue Sky Green Field, WI (2008; 2009)	7.17	88	145
Cedar Ridge, WI (2009)	6.55	41	67.6
Buffalo Ridge, MN (Phase III; 1999)	5.93	138	103.5
Moraine II, MN (2009)	5.59	33	49.5
Barton I & II, IA (2010-2011)	5.50	80	160
Buffalo Ridge I, SD (2009-2010)	5.06	24	50.4
Buffalo Ridge, MN (Phase I; 1996)	4.14	73	25
Winnebago, IA (2009-2010)	3.88	10	20
Rugby, ND (2010-2011)	3.82	71	149
Cedar Ridge, WI (2010)	3.72	41	68
Elm Creek II, MN (2011-2012)	3.64	62	148.8
Buffalo Ridge, MN (Phase II; 1999)	3.57	143	107.25
Buffalo Ridge, MN (Phase I; 1998)	3.14	73	25
Ripley, Ont (2008)	3.09	38	76
Fowler I, IN (2009)	2.83	162	301
Buffalo Ridge, MN (Phase I; 1997)	2.51	73	25
Buffalo Ridge, MN (Phase II; 1998)	2.47	143	107.25
Buffalo Ridge II, SD (2011-2012)	1.99	105	210
Kewaunee County, WI (1999-2001)	1.95	31	20.46
NPPD Ainsworth, NE (2006)	1.63	36	20.5
PrairieWinds ND1 (Minot), ND (2011)	1.56	80	115.5
Elm Creek, MN (2009-2010)	1.55	67	100
PrairieWinds ND1 (Minot), ND (2010)	1.48	80	115.5
Buffalo Ridge, MN (Phase I; 1999)	1.43	73	25
PrairieWinds SD1 (Crow Lake), SD (2011-2012)	1.41	108	162
Wessington Springs, SD (2010)	0.89	34	51
Top of Iowa, IA (2004)	0.81	89	80
Grand Ridge I, IL (2009-2010)	0.48	66	99
Top of Iowa, IA (2003)	0.42	89	80
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	62	102.3
Southern Plains			
Buffalo Gap I, TX (2006)	1.32	67	134
Barton Chapel, TX (2009-2010)	1.15	60	120
Buffalo Gap II, TX (2007-2008)	0.15	155	233
Big Smile, OK (2012-2013)	0.09	66	132
Red Hills, OK (2012-2013)	0.08	82	123
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

Appendix C2. 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
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)	1.3	67	100
Beech Ridge, WV (2012)	1.19	67	100.5
Stetson Mountain I, ME (2011)	1.18	38	57
Noble Clinton, NY (2009)	1.11	67	100
Locust Ridge, PA (Phase II; 2009)	0.84	51	102
Noble Ellenburg, NY (2008)	0.83	54	80
Locust Ridge, PA (Phase II; 2010)	0.76	51	102
Southeast			
Buffalo Mountain, TN (2000-2003)	11.02	3	1.98
Buffalo Mountain, TN (2005)	1.10	18	28.98
Rocky Mountains			
Foote Creek Rim, WY (Phase I; 1999)	3.40	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.42	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	69	41.4
Summerview, Alb (2005-2006)	1.06	39	70.2
Southwest			
Dry Lake I, AZ (2009-2010)	2.02	30	63
Dry Lake II, AZ (2011-2012)	1.57	31	65
California			
Pine Tree, CA (2009-2010)	8.30	90	135
Alta Wind I, CA (2011-2012)	7.07	100	150
Shiloh I, CA (2006-2009)	6.96	100	150
Dillon, CA (2008-2009)	4.71	45	45
Diablo Winds, CA (2005-2007)	4.29	31	20.46
Alta Wind II-V, CA (2011-2012)	1.66	190	570
High Winds, CA (2003-2004)	1.62	90	162
Shiloh II, CA (2009-2010)	1.51	75	150
High Winds, CA (2004-2005)	1.10	90	162
Alite, CA (2009-2010)	0.55	8	24

Appendix C2. 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
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 C2 (*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
Alite, CA (09-10)	Chatfield et al. 2010	Klondike II, OR (05-06)	NWC and WEST 2007
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Klondike III, OR (Phase I; 07-09)	Gritski et al. 2010
Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Klondike IIIa, OR (Phase II; 08-10)	Gritski et al. 2011
Barton I & II, IA (10-11)	Derby et al. 2011a	Leaning Juniper, OR (06-08)	Gritski et al. 2008
Barton Chapel, TX (09-10)	WEST 2011	Lempster, NH (09)	Tidhar et al. 2010
Beech Ridge, WV (12)	Tidhar et al. 2013	Lempster, NH (10)	Tidhar et al. 2011
Big Horn, WA (06-07)	Kronner et al. 2008	Linden Ranch, WA (10-11)	Enz and Bay 2011
Big Smile, OK (12-13)	Derby et al. 2013a	Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Maple Ridge, NY (07)	Jain et al. 2009a
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Maple Ridge, NY (07-08)	Jain et al. 2009d
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Marengo I, WA (09-10)	URS Corporation 2010b
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Marengo II, WA (09-10)	URS Corporation 2010c
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Mars Hill, ME (07)	Stantec 2008
Buffalo Gap I, TX (06)	Tierney 2007	Mars Hill, ME (08)	Stantec 2009a
Buffalo Gap II, TX (07-08)	Tierney 2009	Moraine II, MN (09)	Derby et al. 2010d
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000a	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000a	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000a	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000a	Nine Canyon, WA (02-03)	Erickson et al. 2003b
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000a	Noble Altona, NY (10)	Jain et al. 2011b
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a	Noble Bliss, NY (08)	Jain et al. 2009e
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000a	Noble Bliss, NY (09)	Jain et al. 2010a
Buffalo Ridge I, SD (09-10)	Derby et al. 2010b	Noble Chateaugay, NY (10)	Jain et al. 2011c
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Noble Clinton, NY (08)	Jain et al. 2009c
Casselman, PA (08)	Arnett et al. 2009a	Noble Clinton, NY (09)	Jain et al. 2010b
Casselman, PA (09)	Arnett et al. 2010	Noble Ellenburg, NY (08)	Jain et al. 2009b
Cedar Ridge, WI (09)	BHE Environmental 2010	Noble Ellenburg, NY (09)	Jain et al. 2010c
Cedar Ridge, WI (10)	BHE Environmental 2011	Noble Wethersfield, NY (10)	Jain et al. 2011a
Cohocton/Dutch Hill, NY (09)	Stantec 2010	NPPD Ainsworth, NE (06)	Derby et al. 2007
Cohocton/Dutch Hill, NY (10)	Stantec 2011	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Combine Hills, OR (Ph. I; 04-05)	Young et al. 2006	Pine Tree, CA (09-10)	BioResource Consultants 2010
Combine Hills, OR (11)	Enz et al. 2012	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Criterion, MD (11)	Young et al. 2012a	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011c
Criterion, MD (12)	Young et al. 2013	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Diablo Winds, CA (05-07)	WEST 2006, 2008	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
Dillon, CA (08-09)	Chatfield et al. 2009	Red Hills, OK (12-13)	Derby et al. 2013b
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Ripley, Ont (08)	Jacques Whitford 2009
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Rugby, ND (10-11)	Derby et al. 2011b
Elkhorn, OR (08)	Jeffrey et al. 2009b	Shiloh I, CA (06-09)	Kerlinger et al. 2009
Elkhorn, OR (10)	Enk et al. 2011b	Shiloh II, CA (09-10)	Kerlinger et al. 2010b
Elm Creek, MN (09-10)	Derby et al. 2010c	Stateline, OR/WA (01-02)	Erickson et al. 2004
Elm Creek II, MN (11-12)	Derby et al. 2012b	Stateline, OR/WA (03)	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003b	Stateline, OR/WA (06)	Erickson et al. 2007
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003b	Stetson Mountain I, ME (09)	Stantec 2009c
Foote Creek Rim, WY (Ph. I; 01-02)	Young et al. 2003b	Stetson Mountain I, ME (11)	Normandeau Associates 2011
Fowler I, IN (09)	Good et al. 2011	Stetson Mountain II, ME (10)	Normandeau Associates 2010
Goodnoe, WA (09-10)	URS Corporation 2010a	Summerview, Alb (05-06)	Brown and Hamilton 2006
Grand Ridge, IL (09-10)	Derby et al. 2010g	Top of Iowa, IA (03)	Jain 2005
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Top of Iowa, IA (04)	Jain 2005
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
High Sheldon, NY (10)	Tidhar et al. 2012a	Vansycle, OR (99)	Erickson et al. 2000b
High Sheldon, NY (11)	Tidhar et al. 2012b	Vantage, WA (10-11)	Ventus 2012
High Winds, CA (03-04)	Kerlinger et al. 2006	Wessington Springs, SD (09)	Derby et al. 2010f
High Winds, CA (04-05)	Kerlinger et al. 2006	Wessington Springs, SD (10)	Derby et al. 2011d
Hopkins Ridge, WA (06)	Young et al. 2007	White Creek, WA (07-11)	Downes and Gritski 2012b
Hopkins Ridge, WA (08)	Young et al. 2009c	Wild Horse, WA (07)	Erickson et al. 2008
Kewaunee County, WI (99-01)	Howe et al. 2002	Windy Flats, WA (10-11)	Enz et al. 2011
Kittitas Valley, WA (11-12)	Stantec 2012	Winnebago, IA (09-10)	Derby et al. 2010e
Klondike, OR (02-03)	Johnson et al. 2003b		

Appendix C3. 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
Bison I, II, and III, ND		**0.06**	**101**	**291.8**
	Midwest			
Moraine II, MN (2009)		0.37	33	49.5
Winnebago, IA (2009-2010)		0.27	10	20
Buffalo Ridge I, SD (2009-2010)		0.2	24	50.4
Cedar Ridge, WI (2009)		0.18	41	67.6
Top of Iowa, IA (2004)		0.17	89	80
Cedar Ridge, WI (2010)		0.13	41	68
Ripley, Ont (2008)		0.1	38	76
Wessington Springs, SD (2010)	0.232	0.07	34	51
NPPD Ainsworth, NE (2006)		0.06	36	20.5
Wessington Springs, SD (2009)	0.232	0.06	34	51
Rugby, ND (2010-2011)		0.06	71	149
PrairieWinds ND1 (Minot), ND (2010)		0.05	80	115.5
PrairieWinds ND1 (Minot), ND (2011)		0.05	80	115.5
Kewaunee County, WI (1999-2001)		0	31	20.46
Buffalo Ridge, MN (Phase I; 1996)		0	73	25
Buffalo Ridge, MN (Phase I; 1997)		0	73	25
Buffalo Ridge, MN (Phase I; 1998)		0	73	25
Buffalo Ridge, MN (Phase I; 1999)		0	73	25
Top of Iowa, IA (2003)		0	89	80
Grand Ridge I, IL (2009-2010)	0.195	0	66	99
Elm Creek, MN (2009-2010)		0	67	100
Pioneer Prairie I, IA (Phase II; 2011-2012)		0	62	102.3
Buffalo Ridge, MN (Phase III; 1999)		0	138	103.5
Buffalo Ridge, MN (Phase II; 1998)		0	143	107.25
Buffalo Ridge, MN (Phase II; 1999)		0	143	107.25
Blue Sky Green Field, WI (2008; 2009)		0	88	145
Elm Creek II, MN (2011-2012)		0	62	148.8
Barton I & II, IA (2010-2011)		0	80	160
PrairieWinds SD1 (Crow Lake), SD (2011-2012)		0	108	162
Buffalo Ridge II, SD (2011-2012)		0	105	210
Fowler I, IN (2009)		0	162	301
	Southern Plains			
Barton Chapel, TX (2009-2010)		0.25	60	120
Buffalo Gap I, TX (2006)		0.1	67	134
Red Hills, OK (2012-2013)		0.04	82	123
Big Smile, OK (2012-2013)		0	66	132
Buffalo Gap II, TX (2007-2008)		0	155	233
	Northeast			
Munnsville, NY (2008)		0.59	23	34.5
Noble Ellenburg, NY (2009)		0.25	54	80
Noble Clinton, NY (2009)		0.16	67	100
Noble Wethersfield, NY (2010)		0.13	84	126
Noble Bliss, NY (2009)		0.12	67	100
Noble Ellenburg, NY (2008)		0.11	54	80
Noble Bliss, NY (2008)		0.1	67	100
Noble Clinton, NY (2008)		0.1	67	100

Appendix C3. 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
Mount Storm, WV (2010)		0.1	132	264
Noble Chateaugay, NY (2010)		0.08	71	106.5
Cohocton/Dutch Hills, NY (2010)		0.08	50	125
Mountaineer, WV (2003)		0.07	44	66
High Sheldon, NY (2010)		0.06	75	112.5
Mount Storm, WV (2011)		0.03	132	264
Maple Ridge, NY (2007-2008)		0.03	195	321.75
Criterion, MD (2011)		0.02	28	70
Beech Ridge, WV (2012)		0.01	67	100.5
Lempster, NH (2009)		0	12	24
Lempster, NH (2010)		0	12	24
Stetson Mountain II, ME (2010)		0	17	25.5
Casselman, PA (2008)		0	23	34.5
Casselman, PA (2009)		0	23	34.5
Mars Hill, ME (2007)		0	28	42
Mars Hill, ME (2008)		0	28	42
Stetson Mountain I, ME (2009)		0	38	57
Stetson Mountain I, ME (2011)		0	38	57
Noble Altona, NY (2010)		0	65	97.5
Locust Ridge, PA (Phase II; 2009)		0	51	102
Locust Ridge, PA (Phase II; 2010)		0	51	102
High Sheldon, NY (2011)		0	75	112.5
Cohocton/Dutch Hill, NY (2009)		0	50	125
Mount Storm, WV (2009)		0	132	264
Southeast				
Buffalo Mountain, TN (2000-2003)		0	3	1.98
Buffalo Mountain, TN (2005)		0	18	28.98
Rocky Mountains				
Summerview, Alb (2005-2006)		0.11	39	70.2
Foote Creek Rim, WY (Phase I; 1999)	0.554	0.08	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	0.554	0.05	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)	0.554	0	69	41.4
Southwest				
Dry Lake I, AZ	0.13	0	30	63
Dry Lake II, AZ		0	31	65
California				
High Winds, CA (2003-2004)	2.337	0.5	90	162
Shiloh I, CA (2006-2009)		0.42	100	150
Diablo Winds, CA (2005-2007)	2.161	0.4	31	20.46
High Winds, CA (2004-2005)	2.337	0.28	90	162
Alta Wind I, CA (2011-2012)	0.19	0.27	100	150
Pine Tree, CA (2009-2010)		0.133	90	135
Alite, CA (2009-2010)		0.12	8	24
Shiloh II, CA (2009-2010)		0.12	75	150
Alta Wind II-V, CA (2011-2012)	0.04	0.05	190	570
Dillon, CA (2008-2009)		0	45	45

Appendix C3. 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
Pacific Northwest				
White Creek, WA (2007-2011)		0.47	89	204.7
Vantage, WA (2010-2011)		0.29	60	90
Tuolumne (Windy Point I), WA (2009-2010)	0.77	0.29	62	136.6
Linden Ranch, WA (2010-2011)		0.27	25	50
Harvest Wind, WA (2010-2012)		0.23	43	98.9
Goodnoe, WA (2009-2010)		0.17	47	94
Leaning Juniper, OR (2006-2008)	0.522	0.16	67	100.5
Klondike III (Phase I), OR (2007-2009)		0.15	125	223.6
Hopkins Ridge, WA (2006)	0.698	0.14	83	150
Biglow Canyon, OR (Phase II; 2009-2010)	0.318	0.14	65	150
Big Horn, WA (2006-2007)	0.511	0.11	133	199.5
Stateline, OR/WA (2006)	0.478	0.11	454	299
Kittitas Valley, WA (2011-2012)		0.09	48	100.8
Wild Horse, WA (2007)	0.291	0.09	127	229
Stateline, OR/WA (2001-2002)	0.478	0.09	454	299
Stateline, OR/WA (2003)	0.478	0.09	454	299
Elkhorn, OR (2010)	1.07	0.08	61	101
Hopkins Ridge, WA (2008)	0.698	0.07	87	156.6
Klondike II, OR (2005-2006)	0.504	0.06	50	75
Klondike IIIa (Phase II), OR (2008-2010)		0.06	51	76.5
Elkhorn, OR (2008)	1.07	0.06	61	101
Marengo II, WA (2009-2010)		0.05	39	70.2
Combine Hills, OR (2011)	0.746	0.05	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	0.318	0.05	76	174.8
Pebble Springs, OR (2009-2010)		0.04	47	98.7
Windy Flats, WA (2010-2011)		0.04	114	262.2
Nine Canyon, WA (2002-2003)	0.35	0.03	37	48.1
Biglow Canyon, OR (Phase I; 2008)	0.318	0.03	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)	0.318	0.03	65	150
Klondike, OR (2002-2003)	0.504	0	16	24
Vansycle, OR (1999)	0.66	0	38	24.9
Combine Hills, OR (Phase I; 2004-2005)	0.746	0	41	41
Hay Canyon, OR (2009-2010)		0	48	100.8
Biglow Canyon, OR (Phase I; 2009)	0.318	0	76	125.4
Marengo I, WA (2009-2010)		0	78	140.4

Appendix C3 (*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
Alite, CA (09-10)		Chatfield et al. 2010	Klondike II, OR (05-06)	Johnson et al. 2002	NWC and WEST 2007
Alta Wind I, CA (11-12)	Erickson and Chatfield 2009	Chatfield et al. 2012	Klondike III (Phase I), OR (07-09)		Gritski et al. 2010
Alta Wind II-V, CA (11-12)	Erickson and Chatfield 2009	Chatfield et al. 2012	Klondike IIIa (Phase II), OR (08-10)		Gritski et al. 2011
Barton I & II, IA (10-11)		Derby et al. 2011a	Leaning Juniper, OR (06-08)	Kronner et al. 2005	Gritski et al. 2008
Barton Chapel, TX (09-10)		WEST 2011	Lempster, NH (09)		Tidhar et al. 2010
Beech Ridge, WV (12)		Tidhar et al. 2013	Lempster, NH (10)		Tidhar et al. 2011
Big Horn, WA (06-07)	Johnson and Erickson 2004	Kronner et al. 2008	Linden Ranch, WA (10-11)		Enz and Bay 2011
Big Smile, OK (12-13)		Derby et al. 2013a	Locust Ridge, PA (Phase II; 09)		Arnett et al. 2011
Biglow Canyon, OR (Phase I; 08)	WEST 2005b	Jeffrey et al. 2009a	Locust Ridge, PA (Phase II; 10)		Arnett et al. 2011
Biglow Canyon, OR (Phase I; 09)	WEST 2005b	Enk et al. 2010	Maple Ridge, NY (07-08)		Jain et al. 2009d
Biglow Canyon, OR (Phase II; 09-10)	WEST 2005b	Enk et al. 2011a	Marengo I, WA (09-10)		URS Corporation 2010b
Biglow Canyon, OR (Phase II; 10-11)	WEST 2005b	Enk et al. 2012b	Marengo II, WA (09-10)		URS Corporation 2010c
Biglow Canyon, OR (Phase III; 10-11)	WEST 2005b	Enk et al. 2012a	Mars Hill, ME (07)		Stantec 2008
Blue Sky Green Field, WI (08; 09)		Gruver et al. 2009	Mars Hill, ME (08)		Stantec 2009a
Buffalo Gap I, TX (06)		Tierney 2007	Moraine II, MN (09)		Derby et al. 2010d
Buffalo Gap II, TX (07-08)		Tierney 2009	Mount Storm, WV (09)		Young et al. 2009a, 2010b
Buffalo Mountain, TN (00-03)		Nicholson et al. 2005	Mount Storm, WV (10)		Young et al. 2010a, 2011b
Buffalo Mountain, TN (05)		Fiedler et al. 2007	Mount Storm, WV (11)		Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase I; 96)		Johnson et al. 2000a	Mountaineer, WV (03)		Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase I; 97)		Johnson et al. 2000a	Munnsville, NY (08)		Stantec 2009b
Buffalo Ridge, MN (Phase I; 98)		Johnson et al. 2000a	Nine Canyon, WA (02-03)	Erickson et al. 2001	Erickson et al. 2003b
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000a	Noble Altona, NY (10)		Jain et al. 2011b
Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000a	Noble Bliss, NY (08)		Jain et al. 2009e
Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000a	Noble Bliss, NY (09)		Jain et al. 2010a
Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000a	Noble Chateaugay, NY (10)		Jain et al. 2011c
Buffalo Ridge I, SD (09-10)		Derby et al. 2010b	Noble Clinton, NY (08)		Jain et al. 2009c
Buffalo Ridge II, SD (11-12)		Derby et al. 2012a	Noble Clinton, NY (09)		Jain et al. 2010b
Casselman, PA (08)		Arnett et al. 2009a	Noble Ellenburg, NY (08)		Jain et al. 2009b
Casselman, PA (09)		Arnett et al. 2010	Noble Ellenburg, NY (09)		Jain et al. 2010c
Cedar Ridge, WI (09)		BHE Environmental 2010	Noble Wethersfield, NY (10)		Jain et al. 2011a
Cedar Ridge, WI (10)		BHE Environmental 2011	NPPD Ainsworth, NE (06)		Derby et al. 2007
Cohocton/Dutch Hill, NY (09)		Stantec 2010	Pebble Springs, OR (09-10)		Gritski and Kronner 2010b
Cohocton/Dutch Hills, NY (10)		Stantec 2011	Pine Tree, CA (09-10)		BioResource Consultants 2010
Combine Hills, OR (Phase I; 04-05)	Young et al. 2003c	Young et al. 2006	Pioneer Prairie I, IA (Phase II; 11-12)		Chodachek et al. 2012
Combine Hills, OR (11)	Young et al. 2003c	Enz et al. 2012	PrairieWinds ND1 (Minot), ND (10)		Derby et al. 2011c
Criterion, MD (11)		Young et al. 2012a	PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012c
Diablo Winds, CA (05-07)	WEST 2006, 2008	WEST 2006, 2008	PrairieWinds SD1 (Crow Lake), SD (11-12)		Derby et al. 2012d
Dillon, CA (08-09)		Chatfield et al. 2009	Red Hills, OK (12-13)		Derby et al. 2013b
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Thompson et al. 2011	Ripley, Ont (08)		Jacques Whitford 2009
Dry Lake II, AZ (11-12)		Thompson and Bay 2012	Rugby, ND (10-11)		Derby et al. 2011b
Elkhorn, OR (08)	WEST 2005a	Jeffrey et al. 2009b	Shiloh I, CA (06-09)		Kerlinger et al. 2009
Elkhorn, OR (10)	WEST 2005a	Enk et al. 2011b	Shiloh II, CA (09-10)		Kerlinger et al. 2010b
Elm Creek, MN (09-10)		Derby et al. 2010c	Stateline, OR/WA (01-02)	Erickson et al. 2003a	Erickson et al. 2004
Elm Creek II, MN (11-12)		Derby et al. 2012b	Stateline, OR/WA (03)	Erickson et al. 2003a	Erickson et al. 2004

Appendix C3 (*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
Foote Creek Rim, WY (Phase I; 99)	Johnson et al. 2000b	Young et al. 2003b	Stateline, OR/WA (06)	Erickson et al. 2003a	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 00)	Johnson et al. 2000b	Young et al. 2003b	Stetson Mountain I, ME (09)		Stantec 2009c
Foote Creek Rim, WY (Phase I; 01-02)	Johnson et al. 2000b	Young et al. 2003b	Stetson Mountain I, ME (11)		Normandeau Associates 2011
Fowler I, IN (09)		Good et al. 2011	Stetson Mountain II, ME (10)		Normandeau Associates 2010
Goodnoe, WA (09-10)		URS Corporation 2010a	Summerview, Alb (05-06)		Brown and Hamilton 2006
Grand Ridge I, IL (09-10)	Derby et al. 2009	Derby et al. 2010g	Top of Iowa, IA (03)		Jain 2005
Harvest Wind, WA (10-12)		Downes and Gritski 2012a	Top of Iowa, IA (04)		Jain 2005
Hay Canyon, OR (09-10)		Gritski and Kronner 2010a	Tuolumne (Windy Point I), WA (09-10)	Johnson et al. 2006	Enz and Bay 2010
High Sheldon, NY (10)		Tidhar et al. 2012a	Vansycle, OR (99)	WCIA and WEST 1997	Erickson et al. 2000b
High Sheldon, NY (11)		Tidhar et al. 2012b	Vantage, WA (10-11)		Ventus 2012
High Winds, CA (03-04)	Kerlinger et al. 2005	Kerlinger et al. 2006	Wessington Springs, SD (09)	Derby et al. 2008	Derby et al. 2010f
High Winds, CA (04-05)	Kerlinger et al. 2005	Kerlinger et al. 2006	Wessington Springs, SD (10)	Derby et al. 2008	Derby et al. 2011d
Hopkins Ridge, WA (06)	Young et al. 2003a	Young et al. 2007	White Creek, WA (07-11)		Downes and Gritski 2012b
Hopkins Ridge, WA (08)	Young et al. 2003a	Young et al. 2009c	Wild Horse, WA (07)	Erickson et al. 2003c	Erickson et al. 2008
Kewaunee County, WI (99-01)		Howe et al. 2002	Windy Flats, WA (10-11)		Enz et al. 2011
Kittitas Valley, WA (11-12)		Stantec 2012	Winnebago, IA (09-10)		Derby et al. 2010e
Klondike, OR (02-03)	Johnson et al. 2002	Johnson et al. 2003b			

Appendix D. North American Bat, Bird, and Raptor Fatality Estimates Tables

Appendix D. Fatality estimates for Birds, Raptors, and Bats for North American wind energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Alite, CA (2009-2010)	0.55	0.12	0.24	Shrub/scrub & grassland	Chatfield et al. 2010
Alta Wind I, CA (2011-2012)	7.07	0.27	1.28	Woodland, grassland, shrubland	Chatfield et al. 2012
Alta Wind II-V, CA (2011-2012)	1.66	0.05	0.08	Desert scrub	Chatfield et al. 2012
Barton I & II, IA (2010-2011)	5.5	0	1.85	Agriculture	Derby et al. 2011a
Barton Chapel, TX (2009-2010)	1.15	0.25	3.06	Agriculture/forest	WEST 2011
Beech Ridge, WV (2012)	1.19	0.01	2.03	Forest	Tidhar et al. 2013
Big Horn, WA (2006-2007)	2.54	0.11	1.9	Agriculture/grassland	Kronner et al. 2008
Big Smile, OK (2012-2013)	0.09	0	2.9	Grassland, agriculture	Derby et al. 2013a
Biglow Canyon, OR (Phase I; 2008)	1.76	0.03	1.99	Agriculture/grassland	Jeffrey et al. 2009a
Biglow Canyon, OR (Phase I; 2009)	2.47	0	0.58	Agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	0.14	2.71	Agriculture	Enk et al. 2011a
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	0.03	0.57	Grassland/shrub-steppe, agriculture	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	0.05	0.22	Grassland/shrub-steppe, agriculture	Enk et al. 2012a
Blue Sky Green Field, WI (2008; 2009)	7.17	0	24.57	Agriculture	Gruver et al. 2009
Buffalo Gap I, TX (2006)	1.32	0.1	0.1	Grassland	Tierney 2007
Buffalo Gap II, TX (2007-2008)	0.15	0	0.14	Forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	11.02	0	31.54	Forest	Nicholson et al. 2005
Buffalo Mountain, TN (2005)	1.1	0	39.7	Forest	Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 1996)	4.14	0	-	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1997)	2.51	0	-	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1998)	3.14	0	-	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1999)	1.43	0	0.74	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1998)	2.47	0	2.16	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1999)	3.57	0	2.59	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	-	-	4.35	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	-	-	1.64	Agriculture	Johnson et al. 2004

Appendix D. Fatality estimates for Birds, Raptors, and Bats 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)	-	-	3.71	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	-	-	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)	-	-	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)	-	-	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		7.62	Forest, agriculture	Young et al. 2013
Crystal Lake II, IA (2009)			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

Appendix D. Fatality estimates for Birds, Raptors, and Bats for North American wind energy facilities.

Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	0	1.57	Grassland	Young et al. 2003b
Forward Energy Center, WI (2008-2010)	-	-	18.17	Agriculture	Grodsky and Drake 2011
Fowler I, IN (2009)	2.83	0	8.09	Agriculture	Good et al. 2011
Fowler III, IN (2009)	-	-	1.84	Agriculture	Good et al. 2011
Fowler I, II, III, IN (2010)	-	-	18.96	Agriculture	Good et al. 2011
Fowler I, II, III, IN (2011)	-	-	20.19	Agriculture	Good et al. 2012
Fowler I, II, III, IN (2012)	-	-	2.96	Agriculture	Good et al. 2013
Goodnoe, WA (2009-2010)	1.4	0.17	0.34	Grassland and shrub-steppe	URS Corporation 2010a
Grand Ridge I, IL (2009-2010)	0.48	0	2.1	Agriculture	Derby et al. 2010g
Harrow, Ont (2010)	-	-	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)	-	-	8.93	Agriculture/grassland	TRC 2008
Judith Gap, MT (2009)	-	-	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)	-	-	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

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Lempster, NH (2009)	3.38	0	3.11	Grasslands/forest/rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	2.64	0	3.57	Grasslands/forest/rocky embankments	Tidhar et al. 2011
Linden Ranch, WA (2010-2011)	6.65	0.27	1.68	Grassland/shrub-steppe, agriculture	Enz and Bay 2011
Locust Ridge, PA (Phase II; 2009)	0.84	0	14.11	Grassland	Arnett et al. 2011
Locust Ridge, PA (Phase II; 2010)	0.76	0	14.38	Grassland	Arnett et al. 2011
Maple Ridge, NY (2006)	-	-	11.21	Agriculture/forested	Jain et al. 2007
Maple Ridge, NY (2007-2008)	2.07	0.03	4.96	Agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007)	2.34	-	6.49	Agriculture/forested	Jain et al. 2009d
Marengo I, WA (2009-2010)	0.27	0	0.17	Agriculture	URS Corporation 2010b
Marengo II, WA (2009-2010)	0.16	0.05	0.27	Agriculture	URS Corporation 2010c
Mars Hill, ME (2007)	1.67	0	2.91	Forest	Stantec 2008
Mars Hill, ME (2008)	1.76	0	0.45	Forest	Stantec 2009a
Moraine II, MN (2009)	5.59	0.37	2.42	Agriculture/grassland	Derby et al. 2010d
Mount Storm, WV (Fall 2008)	-	-	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
NPPD Ainsworth, NE (2006)	1.63	0.06	1.16	Agriculture/grassland	Derby et al. 2007
Pebble Springs, OR (2009-2010)	1.93	0.04	1.55	Grassland	Gritski and Kronner 2010b

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Project	Bird Fatalities (birds/MW/ year)	Raptor Fatalities (raptors/MW/ year)	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Pine Tree, CA (2009-2010)	8.3	0.133	-	Grassland	BioResource Consultants 2010
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	0	10.06	Agriculture, grassland	Chodachek et al. 2012
PrairieWinds ND1 (Minot), ND (2010)	1.48	0.05	2.13	Agriculture	Derby et al. 2011c
PrairieWinds ND1 (Minot), ND (2011)	1.56	0.05	1.39	Agriculture, grassland	Derby et al. 2012c
PrairieWinds SD1 (Crow Lake), SD (2011-2012)	1.41	0	1.23	Grassland	Derby et al. 2012d
Red Hills, OK (2012-2013)	0.08	0.04	0.11	Grassland	Derby et al. 2013b
Ripley, Ont (2008)	3.09	0.1	4.67	Agriculture	Jacques Whitford 2009
Rugby, ND (2010-2011)	3.82	0.06	1.6	Agriculture	Derby et al. 2011b
Shiloh I, CA (2006-2009)	6.96	0.42	3.92	Agriculture/grassland	Kerlinger et al. 2010a
Shiloh II, CA (2009-2010)	1.51	0.12	2.72	Agriculture	Kerlinger et al. 2010b
Stateline, OR/WA (2001-2002)	3.17	0.09	1.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.68	0.09	2.29	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2006)	1.23	0.11	0.95	Agriculture/grassland	Erickson et al. 2007
Stetson Mountain I, ME (2009)	2.68	0	1.4	Forest	Stantec 2009c
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 2006
Summerview, Alb (2006; 2007)	-	-	11.42	Agriculture/grassland	Baerwald 2008
Top of Iowa, IA (2003)	0.42	0	7.16	Agriculture	Jain 2005
Top of Iowa, IA (2004)	0.81	0.17	10.27	Agriculture	Jain 2005
Tuolumne (Windy Point I), WA (2009-2010)	3.2	0.29	0.94	Grassland/shrub-steppe, agriculture and forest	Enz and Bay 2010
Vansycle, OR (1999)	0.95	0	1.12	Agriculture/grassland	Erickson et al. 2000a
Vantage, WA (2010-2011)	1.27	0.29	0.4	Shrub-steppe, grassland	Ventus Environmental Solutions 2012
Wessington Springs, SD (2009)	8.25	0.06	1.48	Grassland	Derby et al. 2010f
Wessington Springs, SD (2010)	0.89	0.07	0.41	Grassland	Derby et al. 2011d

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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)	-	-	6.42	Grassland	Stantec Ltd. 2010
Wolfe Island, Ont (July-December 2010)	-	-	9.5	Grassland	Stantec Ltd. 2011
Wolfe Island, Ont (July-December 2011)	NA	NA	2.49	Grassland	Stantec Ltd. 2012