Black Oak Wind LLC

# PERMIT COMPLIANCE FILING

| | |
|---|---|
| **Permittee:** | Black Oak Wind, LLC |
| **Permit Type:** | LWECS Site Permit |
| **Project Location:** | Stearns County |
| **Docket No:** | IP6853/WS-10-1240 and IP6866/WS-11-831 |
| **Permit Section:** | Site Permit Section 6.7.1 |
| **Date of Submission:** | March 15th, 2019 |

Black Oak Wind, LLC ("Black Oak") respectfully submits this filing in compliance with Section 6.7.1 of the Site Permits issued for the Black Oak Wind Farm and Getty Wind Project:

The Permittee shall, by March 15 following each complete or partial calendar year of operation, file with the Commission an annual report detailing findings of its annual audit of ABPP practices. The annual report shall include;

(1) Summarized and raw data of bird and bat fatalities and injuries and shall include bird and bat fatality estimates for the Project using multiple agreed upon estimators from the prior calendar year.

**Attachment 1**

(2) The annual report shall also identify any deficiencies or recommended changes in the operation of the Project or in the ABPP to reduce avian and bat fatalities

**Discussion - Attachment 1**

(3) And shall provide a schedule for implementing the corrective or modified actions.

**Discussion - Attachment 1**

The Permittee shall provide a copy of the report to DNR and to the U.S. Fish and Wildlife Service at the time of filing with the Commission.

For questions relating to this filing please contact Marie VanZandt via email at mvanzandt@sempraglobal.com or telephone at (619)-696-3003

# Attachment 1

# 2018 Post-Construction Monitoring Study

# Black Oak Getty Wind Project
# Stearns County, Minnesota

---

## April 4 – November 1, 2018

**Prepared for:**

**Black Oak Wind, LLC**

---


**Prepared by:**

**Joyce Pickle, John Lombardi, Jennifer Stucker, and Guy DiDonato**

Western EcoSystems Technology, Inc.
7575 Golden Valley Road, Suite 300
Golden Valley, Minnesota 55427


**March 15, 2019**

# EXECUTIVE SUMMARY

Black Oak Wind, LLC is currently operating the 78-megawatt (MW) Black Oak Getty Wind Project (Project) in Stearns County, Minnesota (Figure 1). The Project became operational on December 23, 2016 and consists of 39 Vestas 2.0 megawatt (MW) V110 conical tubular steel tower wind turbine generators. Each turbine is a three-bladed, upwind, horizontal axis wind turbine with a rotor diameter of 361 feet and blades measuring 177 feet. Due to concerns regarding higher than anticipated bat fatalities in 2017, in 2018 turbines were split into two groups, a treatment group (20 turbines) and a control group (19 turbines), to assess the efficacy of a modified curtailment program. Treatment group turbines were feathered below manufacturer's cut-in speed (3.0 meters/second [m/s]) every night from half an hour before sunset until half an hour after sunrise starting at midnight from April 1 through June 30, and were feathered up to 3.5 m/s from July 1 through September 30; these curtailment treatments occurred as long as the temperature during 10 minute rolling averages remained above 10 degrees Celsius (C; 50 degrees Fahrenheit). No feathering occurred for control group turbines from April 1 through September 30. Due to a programming error, the treatment and control groups received the opposite treatments from October 1 through 31, with no feathering occurring for the treatment turbines while the control turbines were feathered up to 3.0 m/s.

The second year of post-construction bird and bat mortality monitoring studies began on April 4, 2018, and continued through November 1, 2018. The objectives of the monitoring studies were to provide a summary of documented bird and bat fatalities, present estimates of searcher efficiency and carcass persistence, calculate annual fatality rates at per turbine and per MW levels, and assess the effectiveness of extending the period of feathering below manufacturer's cut-in speed to the bat active period coupled with an increased cut-in speed between July 1 and September 30.

A total of four turbines had a search area of 120 meters x 120 meters cleared of vegetation and centered on the turbine; these cleared plots were searched twice per week. The gravel roads and pads at the remaining 35 turbines were searched within 60 meters of the turbine (the pads around turbines extended approximately 10 meters, and the access roads were searched out to 60 meters from the turbine); these road and pad searches occurred once a week during the study period. Searcher efficiency and carcass persistence trials were conducted throughout the study period using bat, small bird, large bird, and raptor carcasses.

A total of 43 bird carcasses comprising 24 unique species and seven unidentified carcasses were found during the study. The ruby crowned-kinglet and sedge wren were the two most commonly documented species (each with between three and four carcasses found). No obvious spatial or temporal patterns were detected in bird fatalities. One raptor carcass was found during the study: a Cooper's hawk. While no federal- or state-listed species of birds were found as carcasses, two American white pelican carcasses, a species of special concern in Minnesota, were found during surveys. Using the Huso estimator, cleared plot estimates for small birds was 4.96 birds/MW/study period (90% CI of 1.08 - 9.58, using the Huso estimator)

while the small bird road and pad estimate was 3.11 birds/MW/study period (90% CI of 1.59 - 4.91, using the Huso estimator). Estimates for large birds were roughly similar between the two search types, ranging between 0.25 birds/MW/study period (90% CI of 0.0 - 0.73) at cleared plots and 0.38 birds/MW/study period (90% CI of 0.11 - 0.79) at road and pads.

A total of 377 bat carcasses were found at the Project. Five species of bats were found: silver-haired bats (176 found), hoary bat (118 found), eastern red bat (48 found), big brown bat (31 found), and little brown bat (1 found). Additionally, three unidentified bats were found at the Project. Two special status bat species were documented; the big brown bat and the little brown bat are state species of special concern in Minnesota. No bat carcasses were found until late April. A noted increase in number of fatalities per turbine was observed from late July through September, and no bat carcasses were found after October 29. Across the Project, fewer bat carcasses were found per turbine in the northwestern portion of the Project compared to turbines in the southwestern, southeastern, and northeastern portions of the Project. The adjusted fatality rate estimate using the Huso estimator for cleared plots was 34.97 bats/MW/study period (90% CI of 1.82 - 83.02) for the control group and 26.67 bats/MW/study period (90% CI of 0.44 - 55.21) for the treatment group, and the road and pad estimate was 37.59 bats/MW/study period (90% CI of 28.06 - 53.72) for the control group and 21.00 bats/MW/study period (90% CI of 12.90 – 26.64) for the treatment group.

The curtailment strategy did appear to be effective in reducing bat mortality; the road and pad confidence interval did not overlap with the normal operation confidence interval for road and pad. Cleared plot estimates were higher for 2018 for both the control and treatment groups when compared to 2017; the estimate for 2017 on cleared plots was 13.03 bats/MW/study period (90% CI of 10.46 – 16.15). The road and pad estimate for treatment groups was lower than in 2017; the 2017 estimate for road and pad was 29.88 bats/MW/study period (90% CI of 17.81 – 49.10).

## STUDY PARTICIPANTS

**Western EcoSystems Technology, Inc.**

| | |
|---|---|
| Todd Mattson | Senior Manager |
| Joyce Pickle | Project Manager |
| Guy DiDonato | Project Statistician |
| Jennifer Stucker | Field Supervisor |
| John Lombardi | Senior Statistician |
| Aaron Suehring | Bias Trial Proctor |
| Jeff Fruhwith | GIS Technician |
| David Klein | Technical Editing Manager |
| Katie Wynne | Technical Editing Coordinator |

## REPORT REFERENCE

Pickle, J., J. Lombardi, J. Stucker, and G. DiDontao. 2019. 2018 Post-Construction Monitoring Study, Black Oak Getty Wind Project, Stearns County, Minnesota, April 4 – November 1, 2018. Prepared for Black Oak Wind, LLC. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. March 15, 2019.

## TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF APPENDICES

# INTRODUCTION

Black Oak Wind, LLC is currently operating the 78-megawatt (MW) Black Oak Getty Wind Project (Project) in Stearns County, Minnesota (Figure 1). The Project became operational on December 23, 2016 and consists of 39 Vestas 2.0 MW V110 conical tubular steel tower wind turbine generators. Each turbine is a three-bladed, upwind, horizontal axis wind turbine with a rotor diameter of 110 meters (m; 361 feet [ft]) and blades measuring 54 m (177 ft). Black Oak Wind, LLC developed an Avian and Bat Protection Plan (ABPP) for the Project, which included a Tier 4 post-construction mortality (PCM) study designed to estimate potential impacts to bird and bat species. As committed to in the ABPP, direct impacts of the Project on bird and bat populations were quantified through PCM monitoring during the first year of operation. In 2017 all turbines were feathered (i.e., the blades were pitched parallel to the wind to slow the rotation) below the manufacturer's cut-in speed (3.0 meters/second [m/s]) starting at midnight on August 1 through October 31 to reduce bat mortality rates; however, PCM results from 2017 showed higher than anticipated bat fatalities. Black Oak Wind, LLC, coordinated with the US Fish and Wildlife Service (USFWS) and the Minnesota Department of Natural Resources (DNR) on the results of the first year of surveys, and on the approach, to conducting a second year of fatality monitoring in 2018. The 2018 PCM approach consisted of a modified curtailment program at approximately half of the turbines to provide a comparison to estimate the effect of extending the period when turbines were feathered below manufacturer's cut-in speed to start on April 1, as well as a higher cut-in speed in the late summer/fall period on bat mortality rates.

In 2018, turbines were split into two groups: a treatment group (20 turbines) and a control group (19 turbines), to assess the efficacy of the modified curtailment program. Treatment group turbines were operated under the modified curtailment program, which consisted of: feathered up to 3.0 m/s every night from April 1 through June 30, and were feathered up to 3.5 m/s from July 1 through September 30; these curtailment treatments occurred as long as the temperature during 10 minute rolling averages remained above 10 degrees Celsius (50 degrees Fahrenheit). Control group turbines were not feathered at all from April 1 through September 30. Due to a programming error, the treatment and control groups received the opposite treatments from October 1 through 31. During October the treatment group turbines were not feathered while the control group turbines were feathered up to 3.0 m/s. As described further in the Results section, the fatality estimates presented for the two treatment groups use the October data associated with the turbines assigned to each group (i.e., the bats found in October were kept with the turbines they were found with and not "switched" to a different control or treatment group).

Year 2 bird and bat mortality monitoring studies began on April 4, 2018, and continued through November 1. The objectives of the monitoring studies were to provide a summary of documented bird and bat fatalities, present estimates of searcher efficiency and carcass persistence, calculate annual fatality rates per turbine and per MW, and assess the effectiveness of the modified curtailment program. This report summarizes the methods and results of the second year of PCM conducted by Western EcoSystems Technology, Inc. (WEST) at the Project, and provides information on how the estimated fatality rates qualitatively

compare to the first year of PCM at the Project as well as other wind Projects in the state and region.

## STUDY AREA

The Project is located in Stearns County, Minnesota. The Project boundaries encompass approximately 14,719 acres (approximately 22 square miles), with all facilities on private lands. According to the US Geological Survey National Land Cover Database (USGS NLCD 2011, Homer et al. 2015), cropland (12,141.3 acres, or 82%) is the dominant land cover within the Project, followed by grassland (2,347.8 acres, or 16%). The breakout of land use by cover type within the Project is shown in Table 1 and Figure 2. Based on field observations, substantially less grassland exists within the Project area than suggested by the NLCD land cover map. Most of the mapped grassland areas have been converted to cropland, and the few parcels of grassland that exist within the Project consist of pasture or wetlands.

**Table 1. The land cover types, coverage, and composition within the Black Oak Getty Wind Project, Stearns County, Minnesota.**

| Habitat | Acres | % Composition |
|---|---|---|
| Cropland | 12,141.3 | 82.5% |
| Grassland | 2,347.8 | 16.0% |
| Marsh | 121.5 | 0.8% |
| Shrubland | 76.1 | 0.5% |
| Aquatic | 22.9 | 0.2% |
| Forested | 9.3 | <0.1% |
| **Total*** | **14,719.0** | **100** |

Data from US Geological Survey National Land Cover Database 2011, Homer et al. 2015.

* Totals may not equal values shown due to rounding.

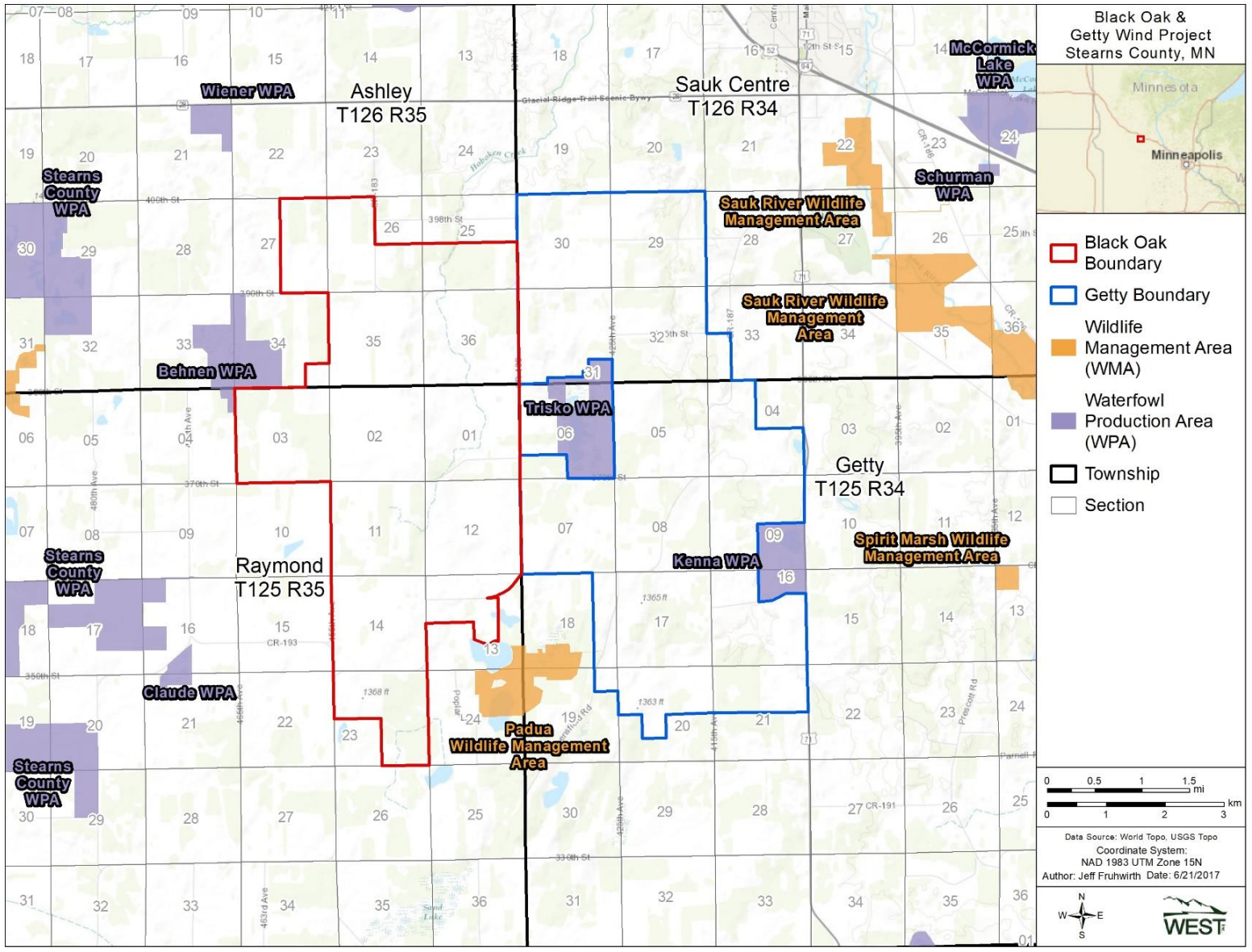


**Figure 1. Location of the Black Oak Getty Wind Project.**

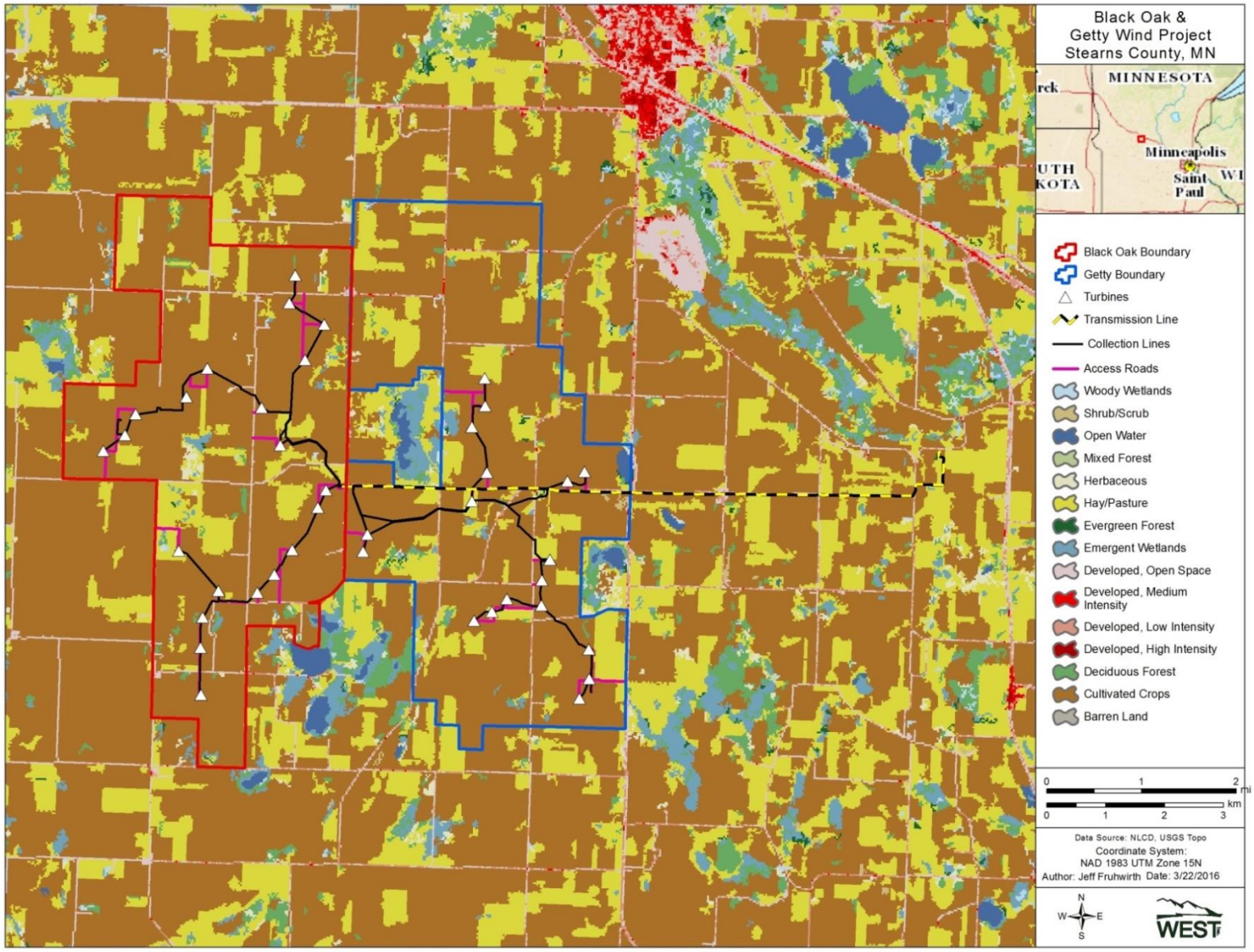


**Figure 2. Land cover map for the Black Oak Getty Wind Project.**

# METHODS

## Standardized Carcass Searches

Carcass searches were completed by WEST technicians trained in proper search techniques between April 4, 2018 and November 1, 2018. Data recorded during each carcass search included date, start and end time, observer, and weather data. When a dead bird or bat was found, the observer recorded the species, sex and age (when identifiable), observer name, measured distance from turbine, azimuth from turbine (including Universal Transverse Mercator coordinates), habitat surrounding carcass, condition of carcass (intact, scavenged, dismembered, injured, feather spot [for birds only]), and estimated time of death (e.g., less than one day, two days). Digital photographs were taken of the carcass, any visible injuries, and the surrounding habitat. All carcasses were collected, placed in a re-sealable plastic bag, labeled with a unique carcass identification number, and stored in an on-site freezer. WEST worked under the USFWS Migratory Bird Special Purpose Utility Permit held by Black Oak Wind LLC (Permit Number MB13133C-0) and the DNR Scientific Research – Salvage Special Permit (Number 19024, as amended) held by WEST.

The identification of all bird and bat carcasses was verified by biologists with experience identifying birds and bats to species. Due to the difficulty of identifying *Myotis* species, the identification of all bat carcasses was verified by WEST biologists permitted to identify and handle threatened and endangered bat species.

Casualties found in non-search areas (e.g., outside the designated search arear) were recorded as incidental discoveries and documented in a similar fashion as those found during standard searches. These casualties were not included in the estimation of fatality rates.

*Turbines Sampled, Turbine Groups, Search Frequency, and Search Area/Plot Size*

Vegetation was cleared within 120 x 120 m (394 x 394 ft) of four turbines (Table 2a, Figure 3). The gravel road and pad areas were searched within 60 m (197 ft) of the remaining 35 turbines (the searchable area around each turbine pad varied between 10–20 m [33-66 ft], with the roads searched out to a distance of 60 m; Table 2b, Figure 3). Turbines were split into two groups: a treatment group (20 turbines) and a control group (19 turbines), to assess the efficacy of the modified curtailment program. The treatment group consisted of two cleared plot turbines and 18 road and pad turbines and the control group consisted of two cleared plot turbines and 17 road and pad turbines (Table 2a, Table 2b, Figure 3).

Over the entire survey, the cleared plot turbines were searched twice a week. Road and pad turbines were searched once a week at the beginning of the survey period, but were increased to twice per week by early summer. Searchers walked at a casual walking rate of approximately 45-60 m (148-197 ft) per minute through the search area while scanning for carcasses. The searcher scanned the area on both sides of each search transect, spaced six m (20 ft) apart. For road and pad searches, searchers scanned the cleared area as delineated by the road and

pad; this was accomplished by parking on the access road, walking toward the turbine, walking around the pad surrounding the turbine and back to the vehicle, scanning for carcasses.

**Table 2a. Turbines searched as 120 x 120 meter cleared plots at the Black Oak Getty Wind Project.**

| Cleared Plot Search Turbines | |
|---|---|
| Treatment | Control |
| B13 | C28 |
| B20 | D38 |

**Table 2b. Road and Pad turbines searched within 60 meters at the Black Oak Getty Wind Project.**

| Road and Pad Search Turbines | | | |
|---|---|---|---|
| Treatment | | Control | |
| A02 | B18 | A01 | C24 |
| A04 | C21 | A03 | C29 |
| A07 | C23 | A05 | C30 |
| A08 | C25 | A06 | D31 |
| A10 | C26 | A09 | D32 |
| B12 | C27 | A11 | D35 |
| B14 | D33 | B16 | D36 |
| B15 | D34 | B19 | D39 |
| B17 | D37 | C22 | |

*Plotting of Search Plot Boundaries; Maintenance of Cleared Plots*

The boundaries of all cleared plots and roads and pads were recorded using Global Positioning System technology on handheld units in the field. All of the cleared plots were located within corn (*Zea mays*) or soybean (*Glycine max*) fields and were regularly mowed to maintain a height of 10 centimeters (four inches) or less, providing relatively uniform searching conditions across all cleared plots. Areas of roads and pads within cleared plots were also delineated.

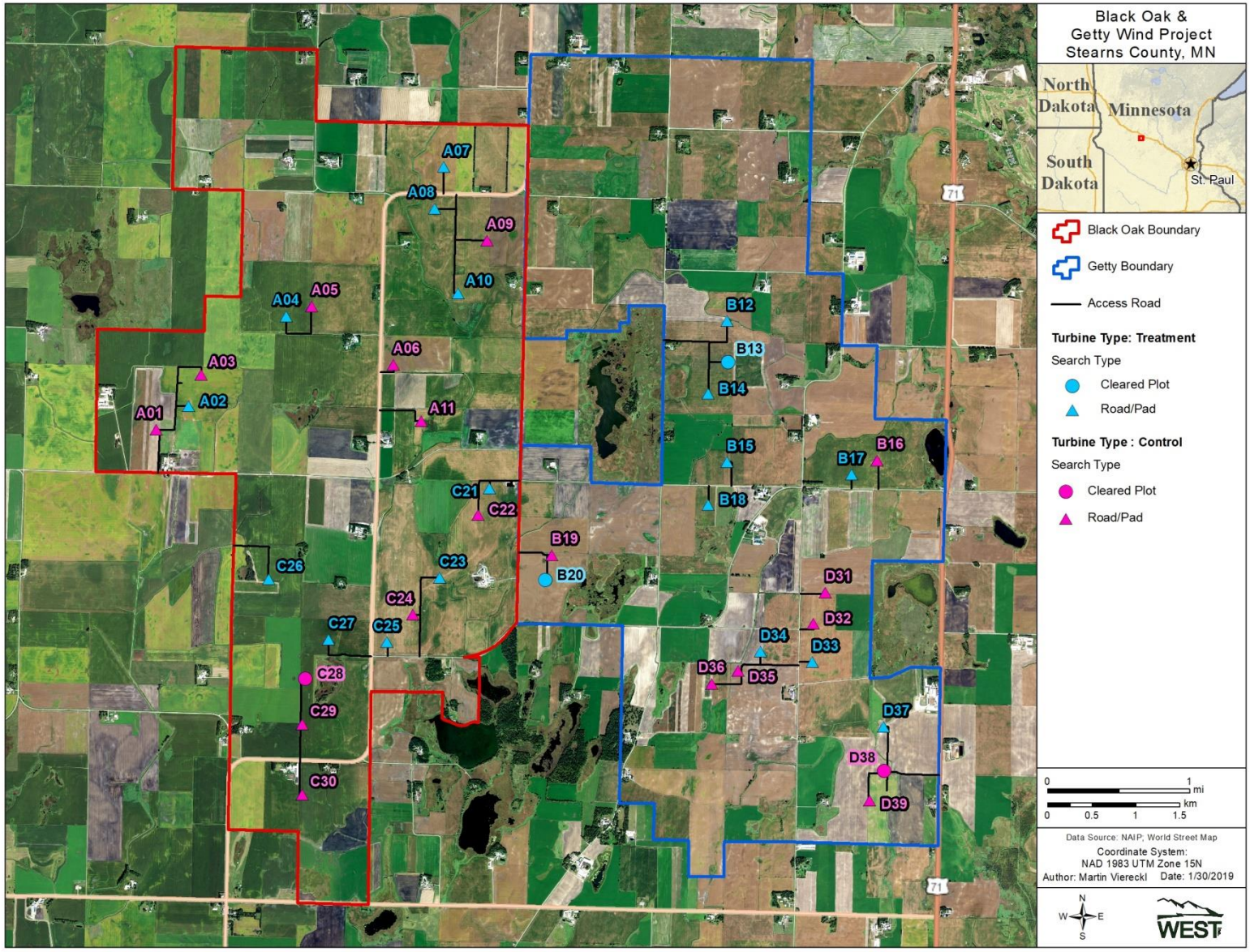


**Figure 3. Layout, Search Type, and Turbine Type for the Black Oak Getty Wind Project.**

## Bias Trials

*Searcher Efficiency Trials*

The objective of the searcher efficiency trials was to estimate the percentage of casualties found by searchers. Searcher efficiency trials were conducted in the same areas where carcass searches occurred, and separate trials were held for cleared plot turbines and road and pad turbines. Searcher efficiency was estimated by size of carcass (small bird, large bird, and bat). Multiple trials were conducted in each season of the study period in order to estimate searcher efficiency rates by season. Seasons were defined as spring (April 4 – May 13), summer (May 14 – August 2) and fall (August 3 – November 1). Estimates of searcher efficiency were used to adjust the total number of bird and bat carcasses found for those missed by technicians, accounting for detection bias in the fatality estimates.

Trial carcasses were placed by WEST personnel to ensure carcass searchers did not know when trials were conducted or the location of the detection carcasses. Adult coturnix quail (*Coturnix coturnix*) were used to represent large birds, juvenile coturnix quail carcasses were used for small birds, and brown/black mice carcasses represented bat carcasses. Raptor carcasses were also used in searcher efficiency trials separate from the large bird trials; raptors obtained from the University of Minnesota's Raptor Center (or other properly permitted facilities) were used. Red-tailed hawk (*Buteo jamaicensis*), snowy owl, barred owl, Cooper's hawk, great horned owl, and little eared owl carcasses were used to represent raptor carcasses. Bat and bird carcasses found during carcass searches (or birds obtained from properly permitted facilities) were also incorporated into the searcher efficiency trials.

Overall, a total of 93 mice/bat carcasses, 84 small bird carcasses, 82 large bird carcasses, and 26 raptor carcasses were used in the searcher efficiency trials (Table 3). Because the supply of raptor carcasses was relatively limited, searcher efficiency trials for those carcass types were concentrated on cleared plots with only two carcasses used in road/pad plots; trials for the other size classes were conducted on both road/pad and cleared plot turbines.

Each trial carcass was discreetly marked with a dark blue zip-tie around the leg for birds or upper arm for bats or mice prior to dropping so that it could be identified as a study carcass after it was found. All carcasses were placed at random locations within search plots by someone not conducting the search, and were placed on the same day of the search. Carcasses were dropped from waist height or higher and allowed to land in a random posture. The number and location of carcasses found during the subsequent carcass search was recorded, and the number of carcasses available for detection during each trial was determined immediately after the search by the person responsible for distributing the carcasses.

**Table 3. Distribution of carcasses used in searcher efficiency trials by size class and plot type at the Black Oak Getty Wind Project.**

| Size Class | Cleared Plots | Road/Pad Plots | Total |
|---|---|---|---|
| Bats | 48 | 45 | 93 |
| Small Birds | 42 | 42 | 84 |
| Large Birds | 43 | 39 | 82 |
| Raptors | 24 | 2 | 26 |
| **Total** | **157** | **128** | **285** |

*Carcass Persistence Trials*

The objective of carcass persistence trials was to estimate the average length of time (in days) a carcass persisted in the field (i.e., before a carcass was no longer available for detection). Carcasses could be removed by scavenging, or rendered undetectable by typical farming activities. Estimates of small bird, large bird, bat, and raptor carcass persistence were used to adjust the total number of carcasses found for those removed from the study area, accounting for persistence bias in the fatality estimates.

Trials were conducted during all seasons to incorporate the effects of varying weather, climatic conditions, and scavenger densities. Throughout the study period, 168 carcasses were monitored (Table 4). A subset of the same carcasses used for searcher efficiency trials were used for carcass persistence trials. Carcass persistence trials for raptors were only conducted on cleared plots due to a low overall sample size for raptors; trials for the other size classes were conducted on both road/pad and cleared plot turbines.

Technicians conducting carcass searches monitored the carcass persistence trial carcasses for bats, small birds and large birds 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, or until the carcass disappeared prior to 30 days, in which case no more checks occurred. For raptors, a 120-day monitoring period was used, with the same initial checked days through day 30 described above, then every 10 days after that. Carcasses were left at the location until the end of the carcass removal trial. At the end of the applicable monitoring period, any evidence of the remaining carcasses was removed from the search plot.

**Table 4. Distribution of carcasses used in carcass persistence trials by size class and plot type at the Black Oak Getty Wind Project.**

| Search Protocol | Cleared Plots | Road/Pad Plots | Total |
|---|---|---|---|
| Bats | 28 | 23 | 51 |
| Small Birds | 23 | 22 | 45 |
| Large Birds | 26 | 22 | 48 |
| Raptors | 24 | 0 | 24 |
| **Total** | **101** | **67** | **168** |

## Statistical Analysis

*Quality Assurance and Quality Control*

Quality assurance and quality control measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, technicians were responsible for making sure that all information entered into the tablet were successfully uploaded onto the cloud-based database. WEST database managers were responsible for downloading the data from the cloud-based database into WEST's Project-specific Microsoft® SQL database. Potentially erroneous data were identified using a series of database queries. Irregular codes or data suspected as questionable were discussed with the technician and/or Project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the original entries from the tablet, and appropriate changes were made in all affected steps.

*Data Compilation and Storage*

As stated above, a Microsoft® SQL database was developed to store, organize, and retrieve survey data. All electronic data files were retained for reference.

*Fatality Rate Estimation*

All carcasses located within surveyed areas were recorded. To determine the rate at which bird and bat fatalities occurred, the number of carcasses found in each search plot was tallied. However, carcasses persisted for variable amounts of time and could have been detected with varying levels of success based on carcass characteristics and ground cover (i.e., cleared plots versus roads and pads). To account for these variables, statistical analyses were used to adjust the observed count of bird and bat carcasses based on:

- Observed number of carcasses found during standardized searches during the monitoring period;
- Persistence rates, expressed as the estimated average probability a carcass remained in the search plot and was available for detection by the technician during carcass persistence trials;
- Searcher efficiency, expressed as the proportion of trial carcasses found by searchers during searcher efficiency trials; and
- Search area adjustment based on the plot size, shape and carcass density distribution.

Separate fatality estimates were calculated for each species type, and search type. For bats, fatality estimates were calculated separately for the treatment and control groups; for birds, due to the relatively low number of carcasses overall and the fact that the curtailment program is not expected to significantly affect avian fatality at the Project, fatality estimates were calculated for the overall Project (by search type) and not separated by treatment type. Both the Shoenfeld and Huso estimators were used to compare results.

*Huso Method Estimator*

Definition of Variables

The following variables were used in the equations below for the Huso estimator (Huso 2011; Huso et al. 2015):

- $c_i$ total number of carcasses in category *i* (e.g., combinations of carcass size [small bird, large bird, raptor and bat], search type [cleared plot and road/pad plot], and season [spring, summer and fall])
- $n$ number of turbines sampled at the Project
- $k$ number of carcass categories
- $\hat{a}_i$ area correction for category *i*
- $I_i$ time interval between the previous search and discovery for category *i*
- $\hat{\bar{I}}_i$ effective search interval for carcasses in category *i*
- $\hat{r}_i$ average probability of persistence for carcass in category *i*
- $\hat{p}_i$ probability of detection for carcass in category *i*
- $\hat{\pi}$ 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
- $\widehat{F}_i$ per turbine mortality for category *i*
- $\hat{m}$ total per turbine mortality

Censored Carcasses

The Huso method (Huso 2011; Huso et al. 2015) requires that carcasses of birds or bats that are estimated to have been killed in a time period longer than the search interval be censored. The time since death was used to determine if a carcass perished within the search interval. Carcasses were excluded if the estimated time of death was greater than the time since previous search.

Estimation of Searcher Efficiency Rates

Searcher efficiency rates, $\hat{p}_i$, were estimated separately for each size class using a logistic regression where plot type and season were included as potential covariates for large bird, small bird, and bat groups. Plot type was not included for raptors, due to the few raptor carcasses placed on road/pad plots. The logistic regression modeled the natural logarithm of the odds of finding an available carcass as a function of the above covariate. The model assumed that searchers had a single opportunity to discover a carcass. The best model was selected using corrected Akaike Information Criteria (AICc; Burnham and Anderson 2002). All models within two AICc values of the top model with the lowest AICc value were considered.

Estimation of Carcass Persistence Rates

Estimates of carcass persistence rates were used to adjust carcass counts for removal bias. Carcass persistence rates were modeled by carcass type (small bird, large bird, raptor, bat) as a function of season (spring, summer, and fall). The average probability of persistence of a carcass ($\hat{r}_i$) was estimated from an interval-censored carcass persistence model. Exponential, log-logistic, lognormal, and Weibull distributions were fit, and the best model was selected using an information theoretic approach known as corrected AICc (Burnham and White 2002).

Adjusted Facility-Related Fatality Rates

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

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

where $\hat{v}_i$ = min(1, $\hat{\hat{I}}_i / I_i$). The model assumed that searchers had a single opportunity to find each carcass, even though some carcasses persisted through multiple searches before being detected. If not statistically different across seasons or plot types, data for carcass persistence and searcher efficiency bias was pooled across the study. The total number of fatalities ($\hat{f}_i$) in category *i*, based on the number of carcasses found in category *I*, was calculated by:

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

The total per turbine fatality rate *($\hat{m}$)* was estimated by:

$$\hat{m} = \frac{\sum_{i=1}^{k} \hat{m}_i}{n}$$

The per-MW rate was estimated by dividing the per turbine fatality rate ($\hat{m}$) by the MW rating of the turbine. If the observed number of carcasses within a size category and season was less than five, a confidence interval (CI) was not reported for the season.

Overall fatality estimates were calculated ($\hat{f}_i$) for cleared plots and roads and pads. Overall estimates within a season, as well as overall study period fatality rates, were calculated using this method.

*Shoenfeld Method Estimator*

Definition of Variables

The following variables were used in the equations below for the Shoenfeld estimator (Shoenfeld 2004):

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

$n$ the number of search plots

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

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

$s$ the number of carcasses used in persistence trials

$s_c$ the number of carcasses in persistence trials that remained in the study area after 30 days (120 for raptors)

$t_j$ the time (in days) the carcass *j* persisted in the study area before it was removed, as determined by the persistence trials

$\bar{t}$ the average time (in days) a carcass remained in the study area before it was removed, as determined by the persistence 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 carcasses expected to land in searched area

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

$m$ the estimated annual average number of fatalities per turbine per year, adjusted for persistence and searcher efficiency bias

Observed Number of Carcasses

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

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

Estimation of Mean Carcass Persistence Time

Estimates of carcass persistence were used to adjust carcass counts for persistence bias. Mean carcass persistence time ($\bar{t}$) was the average number of days a bat carcass remained in the study area before it was removed:

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

Estimation of Searcher Efficiency Rates

Searcher efficiency rates were expressed as *p,* the proportion of trial carcasses that were detected by searchers in the searcher efficiency trials. These rates were estimated using the same methods as described above for the Huso estimator.

Estimation of Facility-Related Casualty Rates

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

$$m = \frac{\bar{c}}{\hat{\pi}}$$

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

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

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

*Confidence Interval Calculation*

The standard errors and 90% CI were calculated using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and CI for complicated test statistics. For each bootstrap sample, $\bar{c}$, $t$, $p$, $t$, and *m* were calculated. One thousand bootstrap samples were used. The standard deviation of the bootstrap estimates was the estimated standard error. The lower fifth and upper 95$^{th}$ percentiles of the 1,000 bootstrap estimates were estimates of the lower limit and upper limit of 90% CI.

*Adjustment for Searched Area*

The area searched underneath turbines represented a sample of the area in which carcasses could land, either as a result of searches restricted to roads and pads, or carcasses that could have fallen beyond the cleared plot boundaries. Models of carcass density (with respect to distance from the turbine base) can be used to calculate the density-weighted proportion (DWP) of area searched.

Bat and small bird carcass information found during this study were used to fit a density model. Models were fit separately for bats and small birds. For bats, WEST fit models for fatalities found at treatment and control turbines separately, in case their density distributions would vary across turbine curtailment regimens. For small birds, WEST incorporated fatality data from the 2017 survey to fit a more robust density distribution. Searched area was weighted as a function of distance from the turbine, because the areas near the turbine tend to have a higher density of bat and small bird carcasses than areas farther from the turbine (Huso and Dalthorp 2014). The

result was an estimate of the proportion of bat and small bird casualties expected to land within searched and unsearched areas around turbines.

The area adjustment for the estimate was calculated by estimating the proportion of carcasses expected to fall within searched areas:

$$a = \sum_{i=1}^{r} F(i) \times p(i)$$

where $a$ is the area adjustment factor, $i$ indexes a series of 1-m-wide (3-ft-wide) annuli centered on the turbine, $r$ is the maximum search radius, $p(i)$ is the fraction of the $i^{th}$ annulus that was searched (calculated in geographic information systems programs), and $F(i)$ is the proportion of all carcasses expected within the $i^{th}$ annulus. $F(i)$ is calculated from $f(i)$, the estimated density distribution of carcasses with respect to distance from turbines. The density distribution of carcasses was determined by fitting truncated Weibull, truncated normal, truncated Gompertz, truncated Rayleigh, and truncated gamma density distributions to carcass distances (from turbines) and choosing the best-supported distribution through AICc. Truncation bounds for the density distributions were set at zero m (carcasses cannot be negative distance from turbines) and at the maximum search radius from the turbine (100 m [328 ft], the distance at the corners of cleared plots). Fits were obtained using a weighted maximum likelihood approach (Khokan et al. 2013) where the weight for each observed carcass distance was the inverse of the fraction of area searched at the distance where the carcass was found, multiplied by the inverse of the probability of detection ($\hat{\pi}$) for that carcass, and the inverse of the proportion of plots searched as roads and pads versus cleared plots (e.g., the weight for a carcass found on a road and pad would include the inverse proportion of plots searched as roads and pads). This approach results in weighted maximum likelihood estimates of carcass detection probabilities that vary systematically with distance from turbines.

Due to low carcass counts for large birds, the Hull and Muir method was used to calculate area correction for road and pad as well as cleared plot searches for this size class (Hull and Muir 2010). Using this method, a physics-based model was developed to predict the maximum fall distance of animal carcasses around turbines. The model used turbine hub height, rotor diameter, and size of the carcass (bats, small and large birds) to determine the maximum theoretical fall distance relative to the turbine base. Carcass density was assumed to decrease linearly with increasing distance from the turbine. The density-weighted proportion of area searched was estimated based on the linear density and the proportion of area searched in each 1.0-m (3.28-ft) annulus from the turbine base out to the maximum predicted fall distance.

# RESULTS

### Avian and Bat Carcass Surveys

All 39 turbines were searched over 31 weeks throughout the spring, summer and fall for 2,068 turbine searches (each of the four cleared plot turbines were searched 61 times and each of the

34 road/pad turbines were searched 51 to 53 times). Three hundred and seventy-seven bat and 43 bird carcasses were found at the Project between April 4 and November 1, 2018, during surveys or incidentally (Table 5). The number, species, location, characteristics of the bird and bat carcasses, and the fatality estimates adjusted for searcher efficiency and carcass persistence biases are discussed below, and a full listing of carcasses is presented in Appendix A.

*Species Composition*

A total of 43 bird carcasses were found at the Project between April 4 and November 1, 2018; 21 were found on or near cleared plots during scheduled searches, 17 were found on or near road and pad plots during scheduled searches, and five were found incidentally (not during scheduled searches). Thirty-six bird carcasses were found on searched plots and included in the analysis, six were found off searched plots, and one was excluded from the Huso analysis (Table 5) because its estimated time of death was greater than the time since the previous search (this carcass was included in the Shoenfeld analysis). Twenty-four unique species of birds were found, with seven unidentified carcasses. Of the seven unidentified birds, one was an unidentified empidonax, one was an unidentified owl, one was an unidentified warbler, one was an unidentified grouse, one was an unidentified gull, and two were unidentified thrushes. Ruby-crowned kinglet (*Regulus calendula*) and sedge wren (*Cistothorus platensis*) were found most frequently, with four and three records, respectively, representing approximately 9.3% and 7.0%, respectively, of the overall composition. American white pelican (*Pelecanus erythrorhynchos*), brown creeper (*Certhia americana*), horned lark (*Eremophila alpestris*), house sparrow (*Passer domesticus*), house wren (*Troglodytes aedon*), least flycatcher (*Empidonax minimus*), and red-breasted nuthatch (*Sitta canadensis*) were each found two times (each approximately 4.7% of the overall composition). The remaining species were all documented only once. One raptor carcass, a Cooper's hawk (*Accipiter cooperii*), was found during a regular carcass search at a road/pad turbine site. No federally listed or state-threatened or endangered bird species were documented. One state-listed species of special concern, the American white pelican (*Pelecanus erythrorhynchos*; two found), was documented. Three avian species listed as Species of Greatest Conservation Need in Minnesota's Wildlife Action Plan 2015 – 2025 (DNR 2016) were documented: bobolink (*Dolichonyx oryzivorus*; one found), chimney swift (*Chaetura pelagica*; one found), and sedge wren (three found).

A total of 377 bat carcasses were found at the Project between April 4 and November 1, 2018; 140 were found on or near cleared plots during scheduled searches, 210 bats were found on or near road and pad plots during scheduled searches, and 27 were found incidentally (not during scheduled searches). Three hundred and fifty-one bat carcasses were found during scheduled searches and included in the analysis, 13 were found off searched plots, and 13 were excluded from the Huso analysis (Table 5) because their estimated time of death was greater than the time since the previous search (these 13 were included in the Shoenfeld analysis). Five species of bats were found: silver-haired bat (*Lasionycteris noctivagans*; 125 found, 54.3%), hoary bat (*Lasiurus cinereus*; 50 found, 21.7%), eastern red bat (*Lasiurus borealis*; 31 found, 13.5%), big brown bat (*Eptesicus fuscus*; 24 found, 10.4%), and little brown bat (*Myotis lucifugus;* one found, 0.3%). Two special status bat species were documented: the big brown bat and little

brown bat are state species of special concern in Minnesota. All five bat species found as carcasses at the Project are listed as Species of Greatest Conservation Need in the 2015 – 2025 Wildlife Action Plan (DNR 2016).

**Table 5. Total number of casualties and the composition of casualties discovered at the Black Oak Getty Wind Project, Stearns County, MN, from April 4 to November 1, 2018.**

| | Casualties Included | | Casualties Off Plot | | Clearing Search Casualties | | Casualties Censored | | Other Casualties Excluded | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Total** | **% Comp** | **Total** | **% Comp** | **Total** | **% Comp** | **Total** | **% Comp** | **Total** | **% Comp** | **Total** | **% Comp** |
| **Bat** | | | | | | | | | | | | |
| silver-haired bat | 164 | 46.7 | 3 | 23.1 | 0 | 0 | 9 | 69.2 | 0 | 0 | 176 | 46.7 |
| hoary bat | 110 | 31.3 | 6 | 46.2 | 0 | 0 | 2 | 15.4 | 0 | 0 | 118 | 31.3 |
| eastern red bat | 46 | 13.1 | 2 | 15.4 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 12.7 |
| big brown bat | 28 | 8.0 | 2 | 15.4 | 0 | 0 | 1 | 7.7 | 0 | 0 | 31 | 8.2 |
| unidentified bat | 2 | 0.6 | 0 | 0 | 0 | 0 | 1 | 7.7 | 0 | 0 | 3 | 0.8 |
| little brown bat | 1 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.3 |
| **Overall Bats** | **351** | **100** | **13** | **100** | **0** | **0** | **13** | **100** | **0** | **0** | **377** | **100** |
| **Bird** | | | | | | | | | | | | |
| ruby-crowned kinglet | 4 | 11.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 9.3 |
| sedge wren | 3 | 8.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 7.0 |
| brown creeper | 2 | 5.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4.7 |
| house sparrow | 2 | 5.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4.7 |
| house wren | 2 | 5.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4.7 |
| red-breasted nuthatch | 2 | 5.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4.7 |
| unidentified thrush | 2 | 5.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4.7 |
| American white pelican | 1 | 2.8 | 1 | 16.7 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4.7 |
| blackpoll warbler | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| chimney swift | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| Cooper’s hawk | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| golden-crowned kinglet | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| horned lark | 1 | 2.8 | 1 | 16.7 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4.7 |
| killdeer | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| least flycatcher | 1 | 2.8 | 1 | 16.7 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4.7 |
| mallard | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| magnolia warbler | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| marsh wren | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| red-eyed vireo | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| sora | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| Tennessee warbler | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |

**Table 5. Total number of casualties and the composition of casualties discovered at the Black Oak Getty Wind Project, Stearns County, MN, from April 4 to November 1, 2018.**

| | Casualties Included | | Casualties Off Plot | | Clearing Search Casualties | | Casualties Censored | | Other Casualties Excluded | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Total** | **% Comp** | **Total** | **% Comp** | **Total** | **% Comp** | **Total** | **% Comp** | **Total** | **% Comp** | **Total** | **% Comp** |
| tree swallow | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| unidentified empidonax | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| unidentified gull | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| unidentified warbler | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| yellow-throated vireo | 1 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| bobolink | 0 | 0 | 1 | 16.7 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| unidentified grouse | 0 | 0 | 1 | 16.7 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| unidentified owl | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 100 | 0 | 0 | 1 | 2.3 |
| white-throated sparrow | 0 | 0 | 1 | 16.7 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.3 |
| **Overall Birds** | **36** | **100** | **6** | **100** | **0** | **0** | **1** | **100** | **0** | **0** | **43** | **100** |

*Timing of Bird and Bat Carcasses*

Appendix A provides a complete list of fatalities found at the Project between April 4 and November 1, 2018, along with date and turbine/location information. There was no obvious temporal pattern for bird fatalities, with unadjusted rates (bird fatalities per turbine) remaining relatively low across most of the study period. The week of May 7 had the highest unadjusted rates of bird fatalities found, while no bird carcasses were found between June 8 and July 6 (Figure 4a).

For bats, there was a temporal pattern, with no carcasses found until late April; the number of unadjusted fatalities per turbine shows a moderate peak from April 30 to May 17, then fatalities stay relatively stable between mid-May and early July, followed by an increase in number of fatalities per turbine from July through late August, and a steady reduction in fatalities from early September through the end of October (Figure 4b). Overall, it appears that treatment group turbines (feathering below manufacturer's cut-in speed starting in April and feathering up to 3.5 m/s starting in July) did reduce bat fatalities compared to the treatment group turbines with no feathering, with the difference between treatment and control groups in unadjusted fatality rates most evident in the July through August timeframe (Figure 4c).

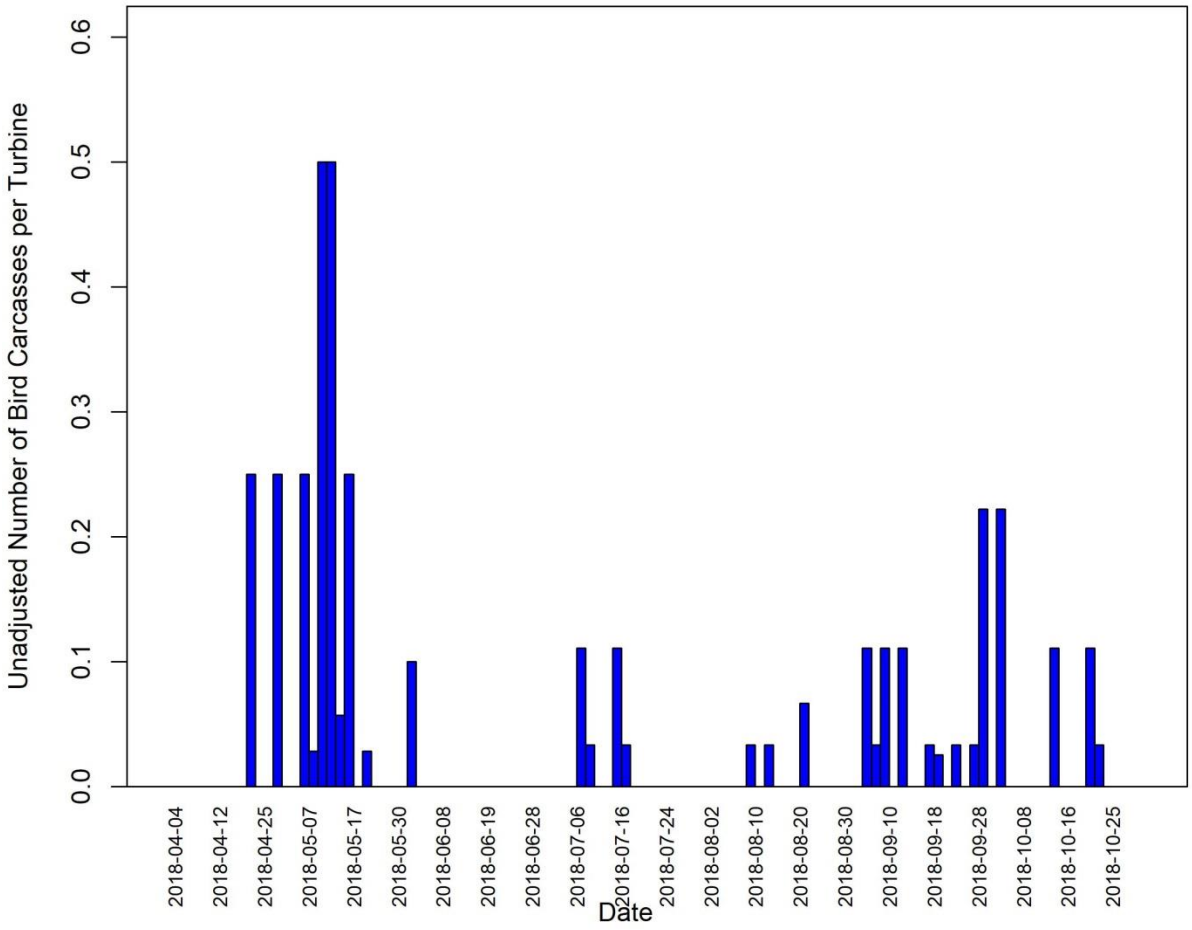


**Figure 4a. Timing of bird carcass discoveries found during scheduled searches or incidentally at the Black Oak Getty Wind Project on turbine search plots from April 4 to November 1, 2018.**

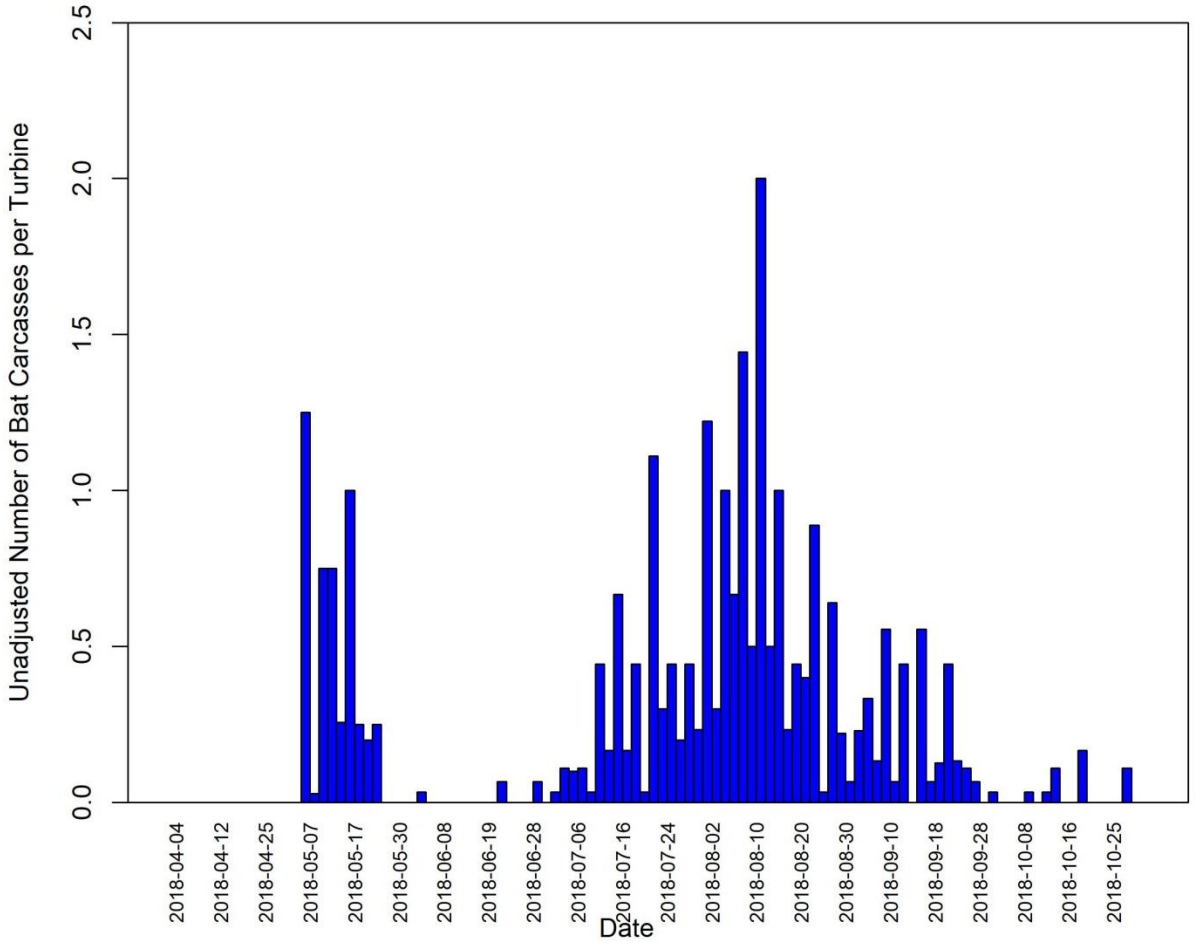


**Figure 4b. Timing of bat carcass discoveries found during scheduled searches or incidentally at the Black Oak Getty Wind Project on turbine search plots from April 4 to November 1, 2018.**

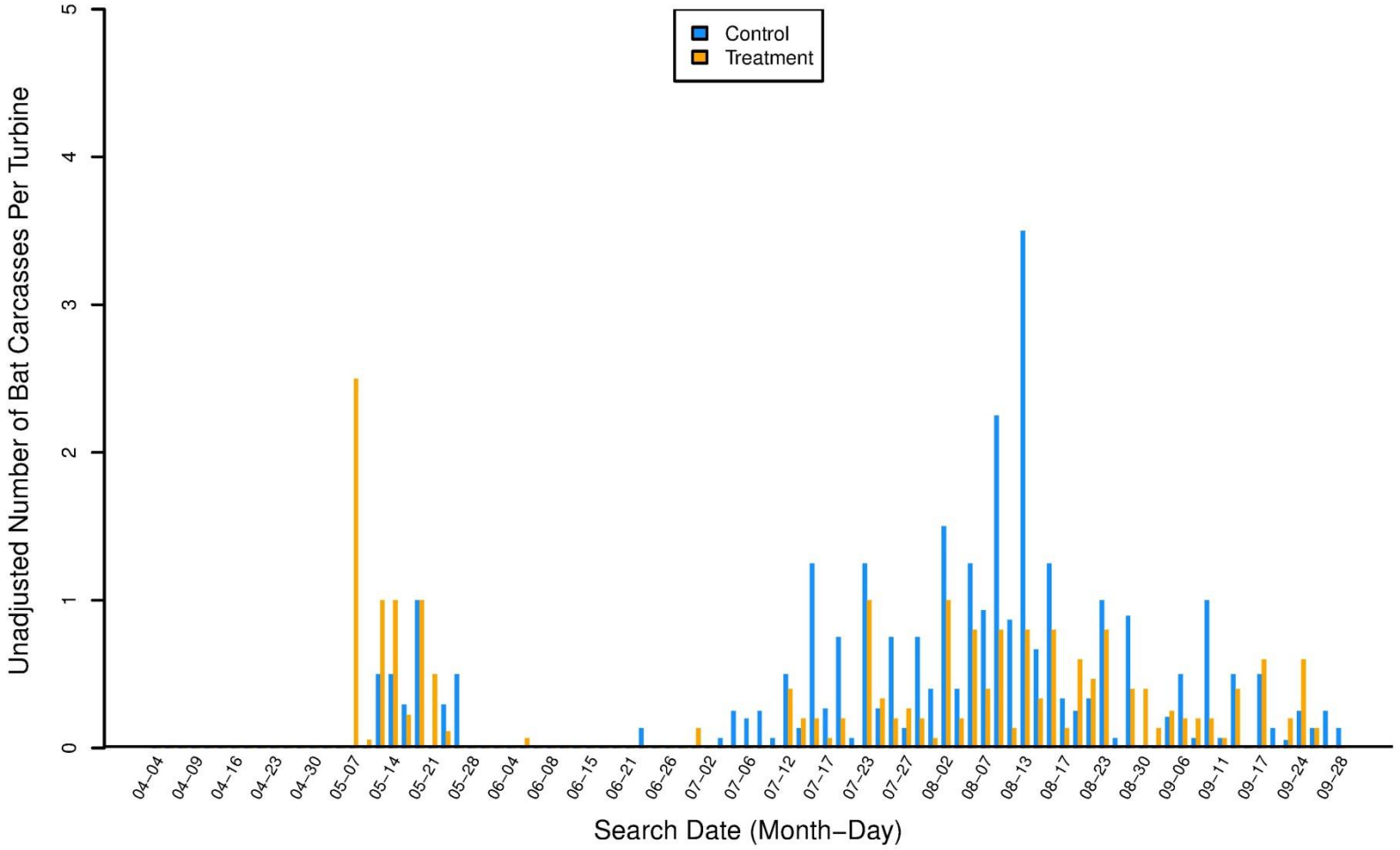


**Figure 4c. Timing of bat carcass discoveries included in the Huso analysis, and were found from April 4 to on or before September 30 (prior to the programming error that switched the treatment and control groups) during scheduled searches.**

*Distribution of Bird and Bat Carcasses within the Project*

Overall, fewer bird fatalities were documented in the northwest portion of the Project (Figure 5a). Turbines C28 and D38 both had the highest detections of bird carcasses (8 and 6 fatalities respectively) but are not located near one another and are different than the turbines that had relatively higher detections of bird carcasses in the 2017 study. Birds were found at all four of the cleared plots, and 12 of the 35 road and pad turbines.

Fewer bat carcasses were found per turbine in the northern portion of the Project compared to turbines in the other portions of the Project (Figure 5b). Bats were found at all four cleared plots, and all of the 35 road and pad turbines. Of the cleared plot turbines, turbine D38, which was in the control group, had the most detected bat fatalities overall (47); in 2018 this turbine had relatively lower detected bat fatalities than other cleared plot turbines. Turbine B16, also in the control group, had the highest recorded bat fatalities for road/pad searches with 14 fatalities. Overall, more bats were found per control group turbine than treatment group turbine, with ten out of 17 road and pad searched turbines having seven or more detected bat fatalities, compared to three out of 18 road and pad searched turbines having seven or more detected bat fatalities (Figure 5b).

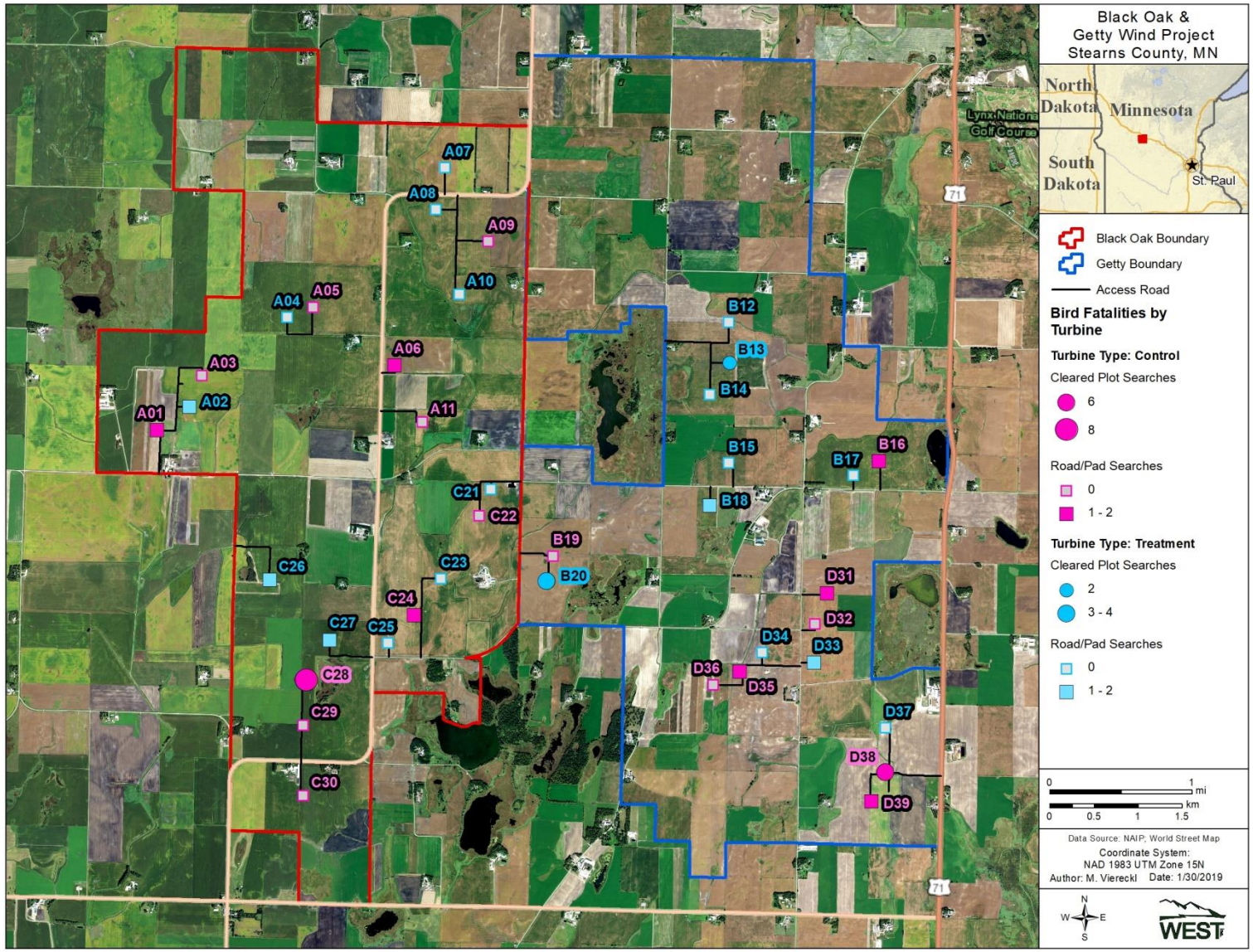


**Figure 5a. Bird fatalities by turbine and search type for treatment and control group turbines at the Black Oak Getty Wind Project, April 4 to November 1, 2018.**

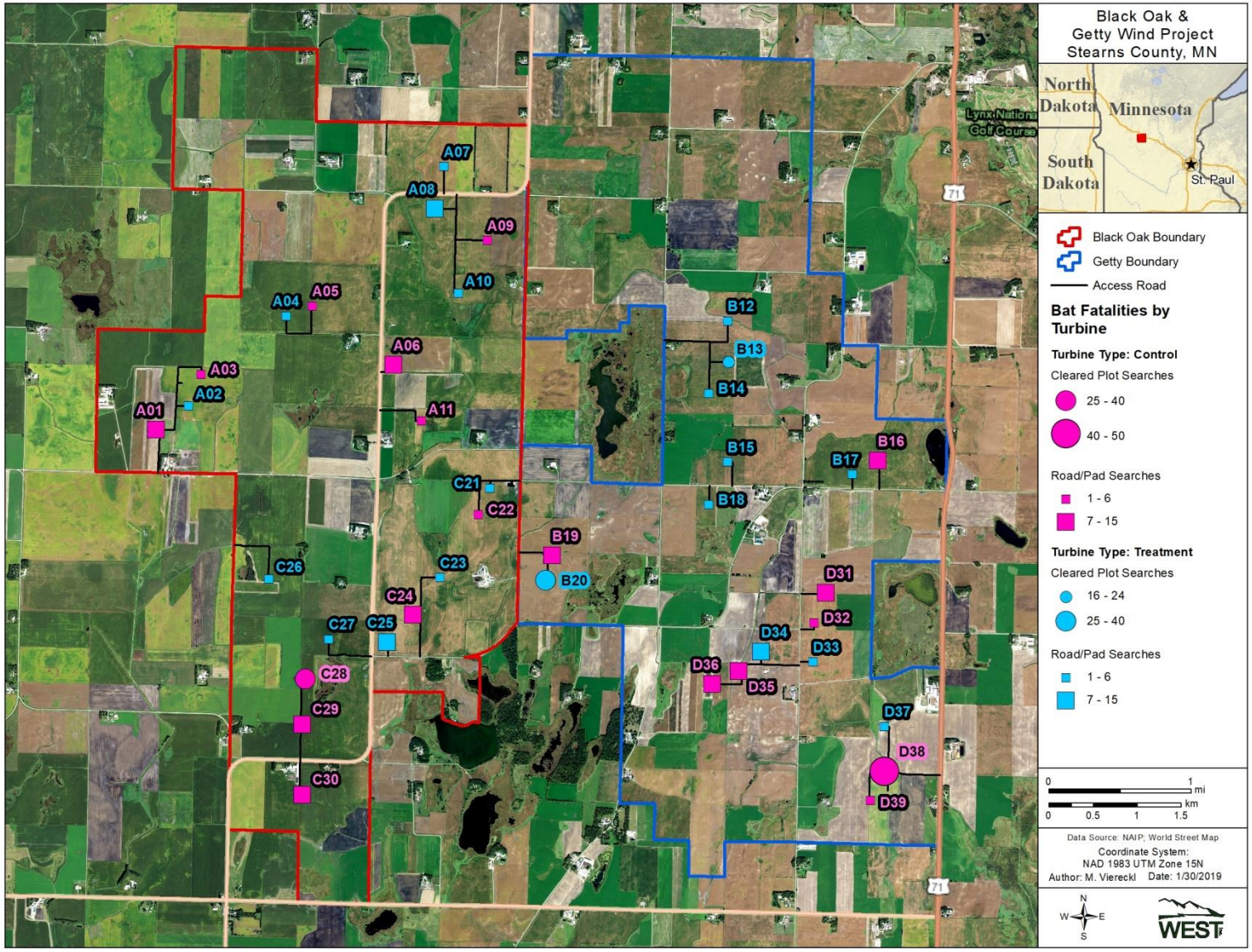


**Figure 5b. Bat fatalities by turbine and search type for treatment and control group turbines at the Black Oak Getty Wind Project, April 4 to November 1, 2018.**

*Distribution of Bird and Bat Carcasses—Distances from Turbines*

Bird carcasses were found out to 70 m from the turbine on cleared plots, and out to 100 m on road and pad searches, with the majority (80%) found within 50 m (Tables 6a and 6b). On road and pad searches, over 62% of bird carcasses were found within 30 m of turbines (Table 6b, Figure 6b); six carcasses were found farther than 30 m from turbines. The differences in distribution of carcasses between cleared plot and road and pad are due to the fact that a small amount of the area beyond 20 m was searched for road and pad searched turbines (i.e., it is expected that the distribution would be similar to cleared plots, but because a smaller amount of the area beyond 20 m was searched in road and pads – only that associated with the access road at this distance – a smaller number of carcasses were found).

Most (76.2%) bat carcasses were found within 40 m of turbines at cleared plots, with over half (55.3%) found within 30 m (Table 6a, Figure 6c). On road and pad searches, most (75.5%) of the bat carcasses were found within 30 m (Table 6b and Figure 6d). Similar to birds, it is expected that the actual distribution of bat carcasses would be similar no matter the search type, and the difference in percentages of distances is due to the fact that smaller percentages of the area beyond 20 m was searched in the road and pad turbines.

**Table 6a. Distribution of distances from turbines of all bird and bat carcasses found at cleared plots during scheduled searches on cleared plot turbines searched at the Black Oak Getty Wind Project.**

| Distance to Turbine (meters) | % Bird Casualties | % Bat Casualties |
|---|---|---|
| 0 to 10 | 5.0 | 8.6 |
| 10 to 20 | 15.0 | 23.7 |
| 20 to 30 | 0 | 23.0 |
| 30 to 40 | 20.0 | 20.9 |
| 40 to 50 | 40.0 | 12.2 |
| 50 to 60 | 15.0 | 10.1 |
| 60 to 70 | 5.0 | 1.4 |
| 70 to 80 | 0 | 0 |
| 80 to 90 | 0 | 0 |
| 90 to 100 | 0 | 0 |

**Table 6b. Distribution of distances from turbines of all bird and bat carcasses found at road and pads during scheduled searches on road and pad plot turbines searched at the Black Oak Getty Wind Project.**

| Distance to Turbine (meters) | % Bird Casualties | % Bat Casualties |
|---|---|---|
| 0 to 10 | 31.3 | 52.4 |
| 10 to 20 | 12.5 | 23.1 |
| 20 to 30 | 18.8 | 9.4 |
| 30 to 40 | 6.3 | 7.6 |
| 40 to 50 | 6.3 | 3.8 |
| 50 to 60 | 12.5 | 2.4 |
| 60 to 70 | 0 | 0.5 |
| 70 to 80 | 6.3 | 0.9 |
| 80 to 90 | 0 | 0 |
| 90 to 100 | 6.3 | 0 |

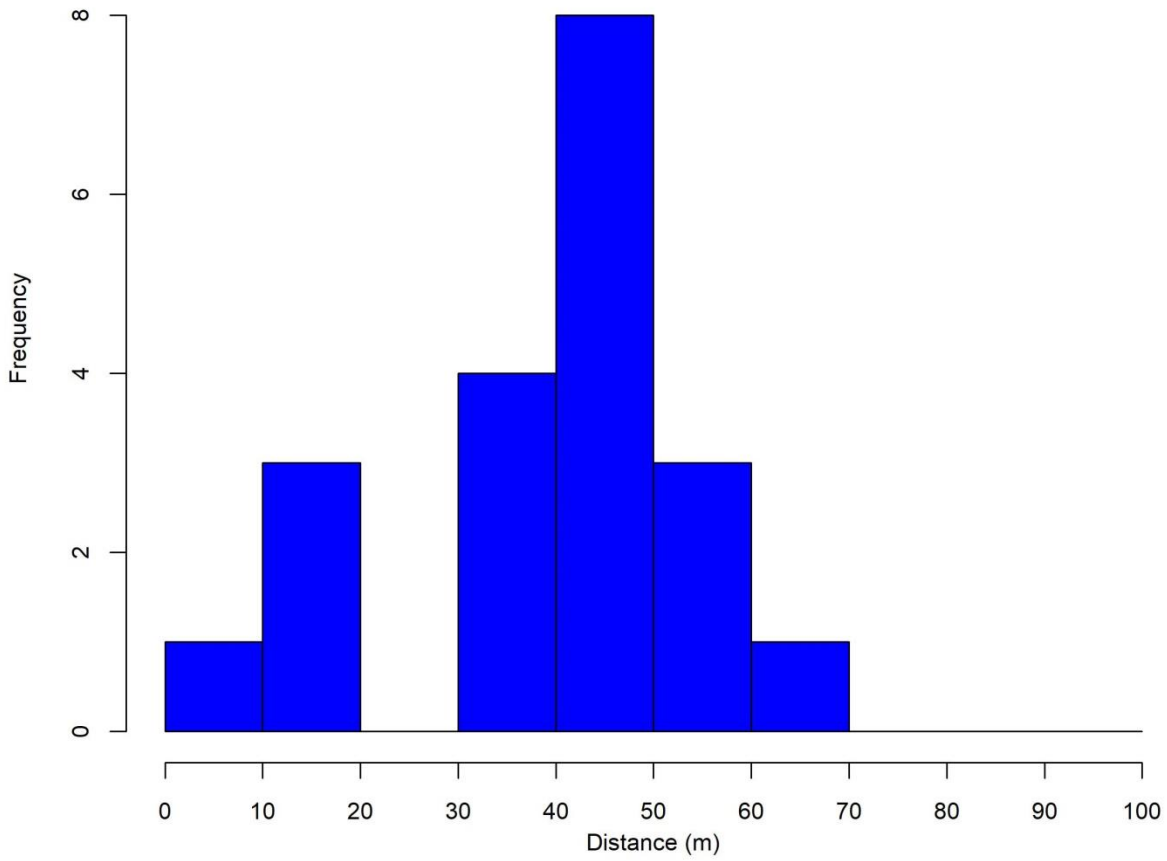


**Figure 6a. Distance of bird fatalities from the turbine found during scheduled cleared plot searches or incidentally on turbine search plots at the Black Oak Getty Wind Project.**

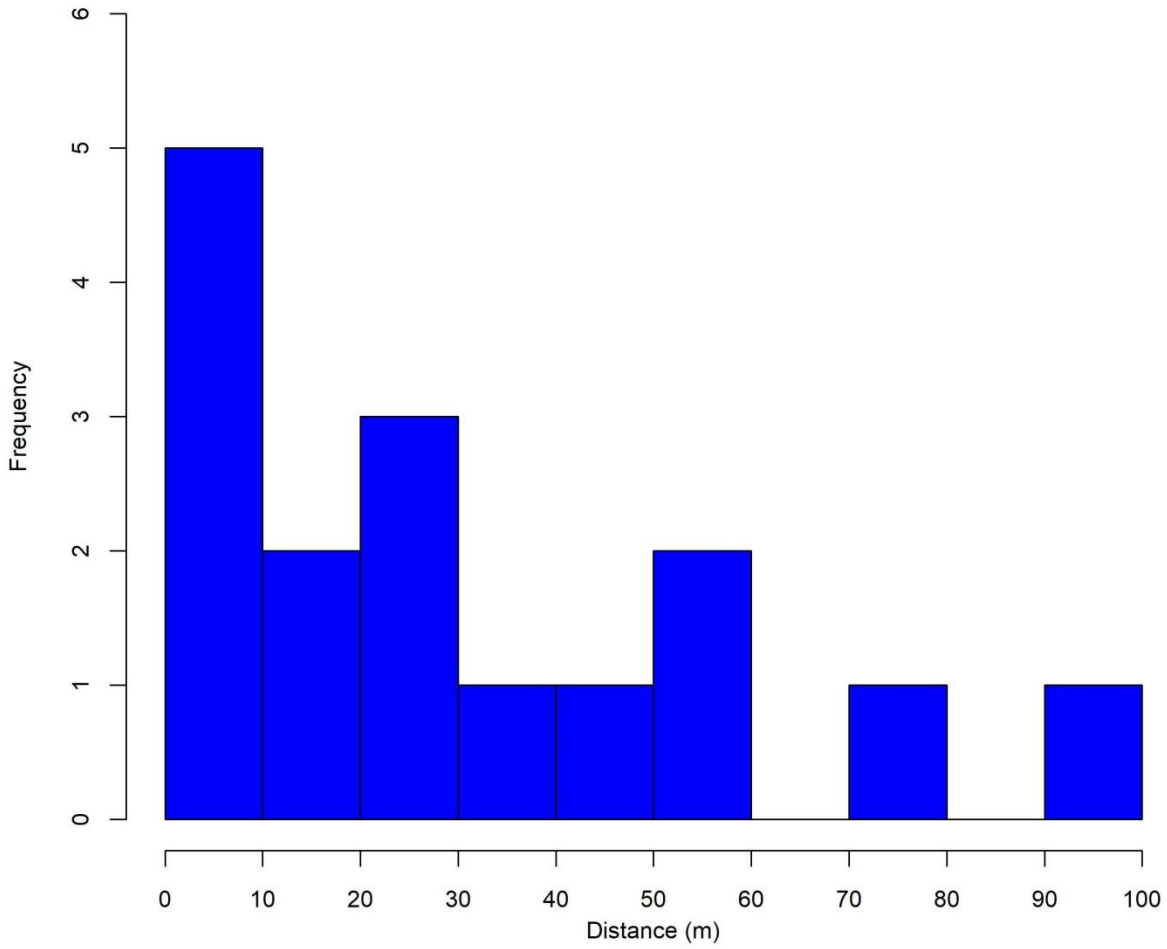


**Figure 6b. Distance of bird fatalities from the turbine found during scheduled road and pad searches or incidentally on turbine search plots at the Black Oak Getty Wind Project.**

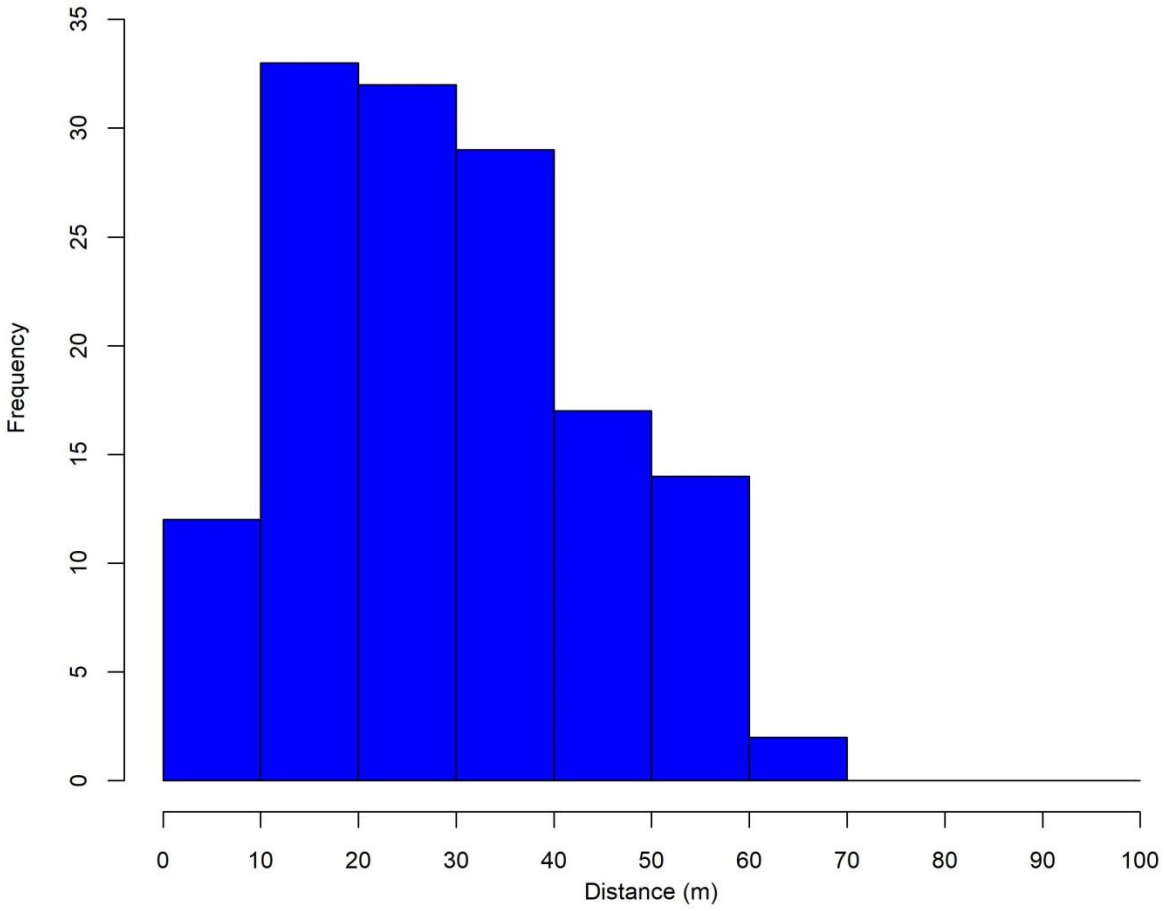


**Figure 6c. Distance of bat fatalities from the turbine found during scheduled cleared plot searches or incidentally on turbine search plots at the Black Oak Getty Wind Project.**

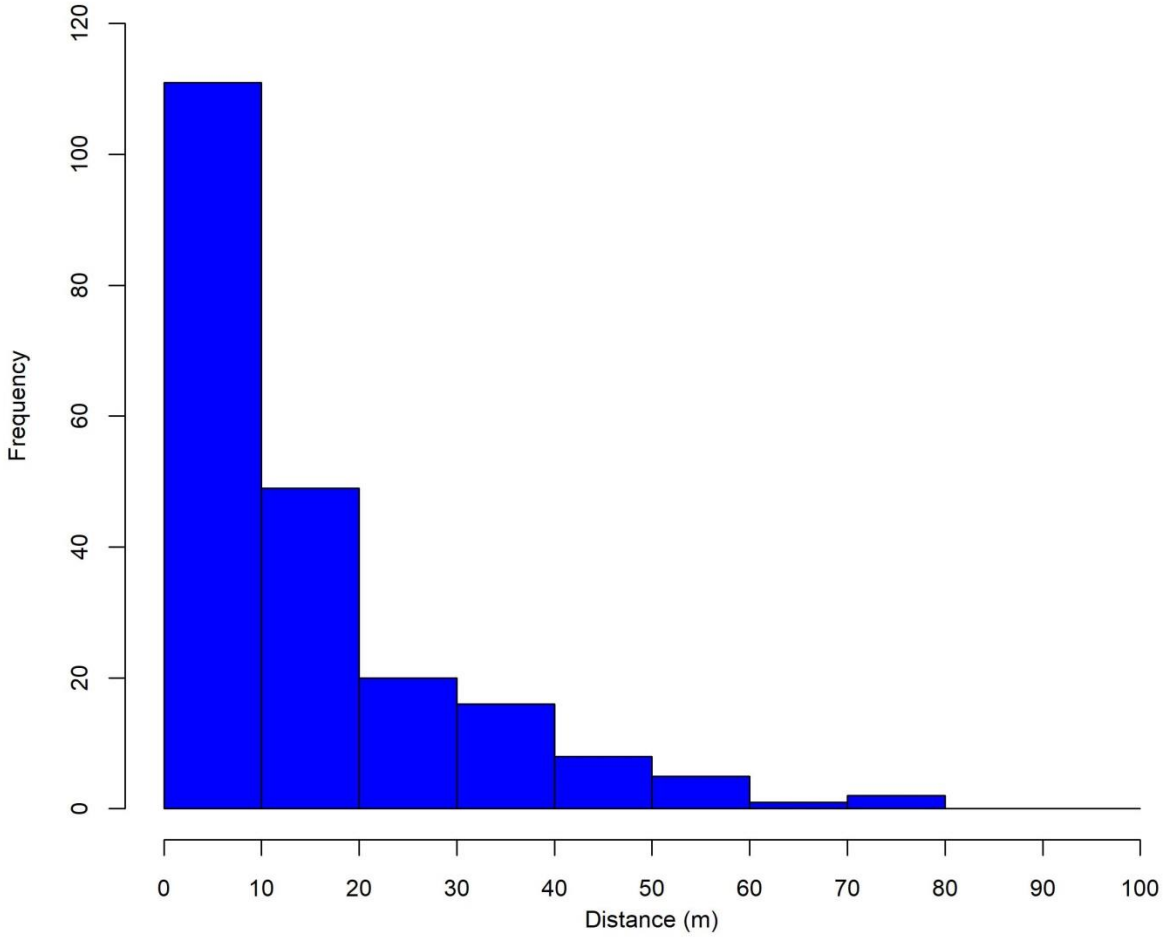


**Figure 6d. Distance of bat fatalities from the turbine found during scheduled road and pad searches or incidentally on turbine search plots at the Black Oak Getty Wind Project.**

*Searcher Efficiency Trials*

Searcher efficiency trials were conducted multiple times during the PCM study at the Project. At cleared plots, three trials were conducted in April, two in May, three in June, one in July, three in August, four in September, and two in October. At road and pad turbines, two trials were conducted in April, one in May, two in June, one in July, two in August, four in September, and two in October. Searchers found 69.4% of bats, 79.4% of small birds, 89.2% of large birds, and 96.2% of raptors that were available during trials. Searcher efficiency rates for bats, small birds, and large birds were statistically similar between cleared plot and road/pad search types (Tables 7b – 7d; Appendix B). Although there was some variation in searcher efficiency among seasons within a given size class (Table 7a), this difference was not statistically significant. Searcher efficiency regression models for the bat, small bird, large bird, and raptor trials are shown in Tables 7b – 7e.

**Table 7a. Searcher efficiency results at the Black Oak Getty Wind Project as a function of season and carcass size.**

| Size Class | Season | # Placed | # Available | # Found | % Found |
|---|---|---|---|---|---|
| **Bat** | Spring | 30 | 25 | 17 | 68.0 |
| | Summer | 24 | 22 | 13 | 59.1 |
| | Fall | 39 | 38 | 29 | 76.3 |
| | **Overall** | **93** | **85** | **59** | **69.4** |
| **Small Bird** | Spring | 23 | 16 | 11 | 68.8 |
| | Summer | 22 | 17 | 13 | 76.5 |
| | Fall | 39 | 35 | 30 | 85.7 |
| | **Overall** | **84** | **68** | **54** | **79.4** |
| **Large Bird** | Spring | 21 | 20 | 16 | 80.0 |
| | Summer | 21 | 20 | 19 | 95.0 |
| | Fall | 40 | 34 | 31 | 91.2 |
| | **Overall** | **82** | **74** | **66** | **89.2** |
| **Raptor** | Spring | 10 | 10 | 9 | 90.0 |
| | Summer | 8 | 8 | 8 | 100 |
| | Fall | 8 | 8 | 8 | 100 |
| | **Overall** | **26** | **26** | **25** | **96.2** |

**Table 7b. Searcher efficiency logistic regression models for bats from the Black Oak Getty Wind Project search efficiency trials. Selected models are denoted by an asterisk in the 'DeltaAICc' column.**

| Covariate | AICc | DeltaAICc |
|---|---|---|
| Null | 106.728 | 0.0* |
| -Null + PlotSearchType | 108.134 | 1.406 |
| -Null + Season | 109.010 | 2.282 |
| -Null + Season + PlotSearchType | 110.606 | 3.878 |
| -Null + Season + PlotSearchType + Season:PlotSearchType | 114.054 | 7.325 |

**Table 7c. Searcher efficiency logistic regression models for small birds from the Black Oak Getty Wind Project search efficiency trials. Selected models are denoted by an asterisk in the 'DeltaAICc' column.**

| Covariate | AICc | DeltaAICc |
|---|---|---|
| Null | 71.210 | 0.0* |
| -Null + PlotSearchType | 72.822 | 1.612 |
| -Null + Season | 73.508 | 2.298 |
| -Null + Season + PlotSearchType | 75.224 | 4.014 |
| -Null + Season + PlotSearchType + Season:PlotSearchType | 79.579 | 8.369 |

**Table 7d. Searcher efficiency logistic regression models for large birds from the Black Oak Getty Wind Project search efficiency trials. Selected models are denoted by an asterisk in the 'DeltaAICc' column.**

| Covariate | AICc | DeltaAICc |
|---|---|---|
| Null | 52.752 | 0.0* |
| -Null + PlotSearchType | 53.521 | 0.770 |
| -Null + Season | 54.593 | 1.841 |
| -Null + Season + PlotSearchType | 55.094 | 2.343 |
| -Null + Season + PlotSearchType + Season:PlotSearchType | 57.684 | 4.933 |

**Table 7e. Searcher efficiency logistic regression models for raptors from the Black Oak Getty Wind Project search efficiency trials. Selected models are denoted by an asterisk in the 'DeltaAICc' column.**

| Covariate | AICc | DeltaAICc |
|---|---|---|
| Null | 10.644 | 0.0* |
| -Null + Season | 13.593 | 2.949 |

*Carcass Persistence Trials*

One hundred sixty-eight carcasses were placed in the Project area for carcass persistence trials (Table 8). At cleared plots, two trials began in April, one in May, two in June, one in July, three in August, and two in September. At road and pad turbines, one trial was started in April, two in May, one each in June and July, and three in August and September. Models were fit for combinations of distribution (i.e., Weibull, exponential, loglogistic, and lognormal) and explanatory variable (i.e., season, or none) and AICc values were used to determine the best model for predicted carcass removal times. No covariate (intercept-only model) consistently had the lowest AICc value for small birds and large birds but for bats and raptors the seasonal covariate had the lowest AICc value; therefore, carcass removal rates were calculated based on size class and then based on season for bats and raptors (Table 9).

Mean removal time, $(\bar{t})$, for the Shoenfeld estimator was calculated using a survival regression model with an exponential distribution (the Shoenfeld model assumes exponentially distributed persistence times; Shoenfeld 2004). Due to the exponential model being the top distribution for bats and raptors, the persistence time was the same for Shoenfeld and Huso. Large birds had

seasonality come out as the top model when the exponential distribution was used (Appendix C).

Forty-eight large birds, 45 small birds, 51 mice/bats, and 24 raptors were used as trial carcasses. By Day 10 of the removal trials, roughly 35% of bat and small bird carcasses remained where they were placed and roughly 23% of large bird carcasses remained where they were placed; 100% of raptor carcasses remained where they were placed by Day 10 (Figures 7a and 7b). By Day 20, roughly 25% of small bird and bat carcasses and roughly 18% of large bird carcasses remained where they were placed (Figure 7a); roughly 90% of raptor carcasses remained where they were placed out to Day 40 (Figure 7b.

Mean removal time was 3.9 days for large birds and 5.4 days for small birds (Table 9). As Appendix B shows, there was no significant seasonal difference in persistence time for large birds and small birds, but there was a significant seasonal difference for bats and raptors (Appendix B1, B2, B4, and B5). Mean removal time for bats was 18.0, 22.5, and 8.6 days in spring, summer, and fall respectively (Table 9). Mean removal time for raptors was 901.0, 91.5, and 475.0 days in spring, summer, and fall respectively (Table 9).

**Table 8. Carcasses placed for persistence trials by size class and season at the Black Oak Wind Project.**

| Size Class | Season | # Placed |
|---|---|---|
| **Bat** | Spring | 16 |
| | Summer | 12 |
| | Fall | 23 |
| | **Overall** | **51** |
| **Small Bird** | Spring | 12 |
| | Summer | 10 |
| | Fall | 23 |
| | **Overall** | **45** |
| **Large Bird** | Spring | 12 |
| | Summer | 12 |
| | Fall | 24 |
| | **Overall** | **48** |
| **Raptor** | Spring | 8 |
| | Summer | 8 |
| | Fall | 8 |
| | **Overall** | **24** |

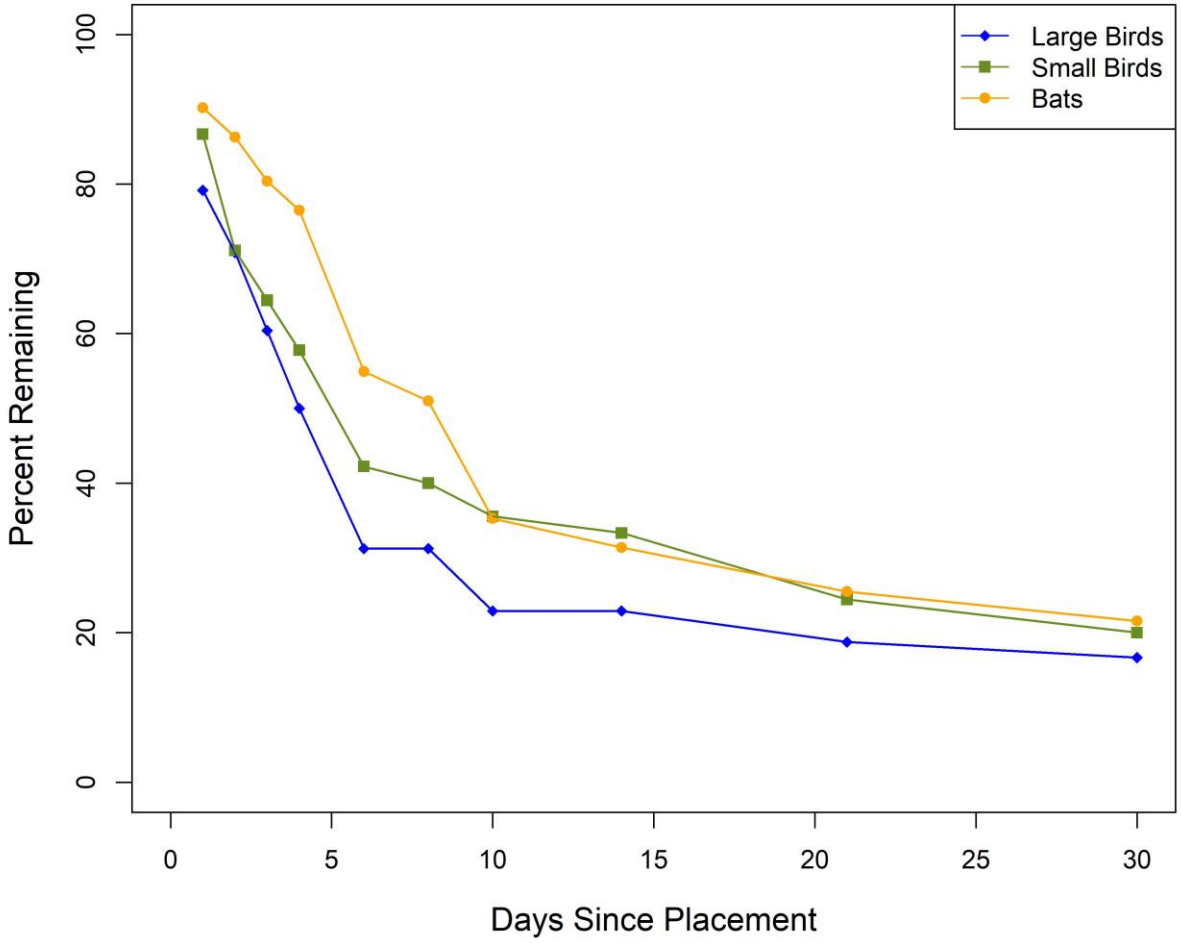


**Figure 7a. Persistence of non-raptor bird and bat carcasses though 30-day carcass persistence trials at the Black Oak Getty Wind Project from April 4 to November 1, 2018.**

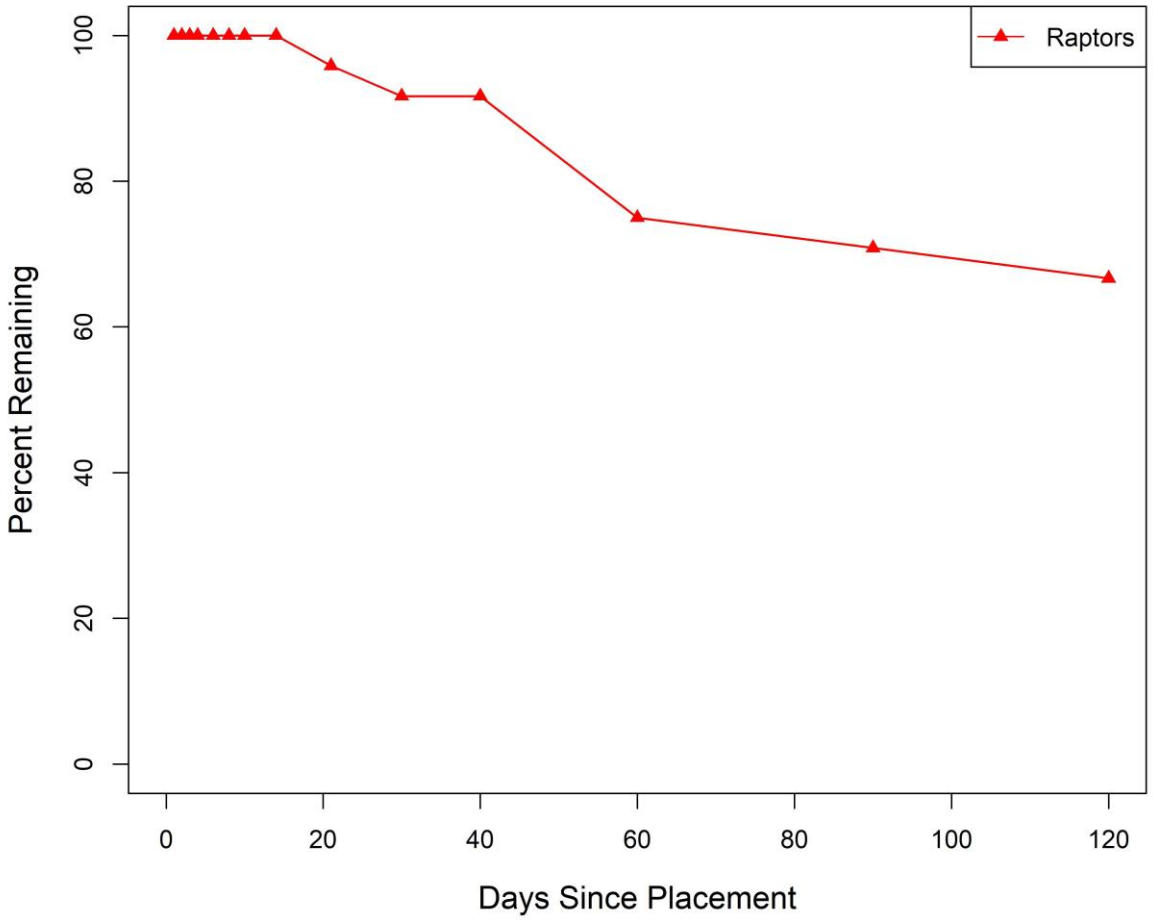


**Figure 7b. Persistence of raptor carcasses though 120-day carcass persistence trials at the Black Oak Getty Wind Project from April 4 to November 1, 2018.**

**Table 9. Carcass persistence top models with covariates, distributions, and model parameters for the Black Oak Getty Wind Project.**

| Size | Season | Distribution | predVals | Predicted Values | Scale |
|---|---|---|---|---|---|
| Bat | spring | Exponential | All | 17.956 | 1.0 |
| Bat | summer | Exponential | All | 22.457 | 1.0 |
| Bat | fall | Exponential | All | 8.576 | 1.0 |
| Small Bird | All | Lognormal | All | 5.411 | 1.580 |
| Large Bird | All | Lognormal | 3.8511 | 3.851 | 1.609 |
| Raptors | spring | Exponential | All | 900.991 | 1.0 |
| Raptors | summer | Exponential | All | 91.468 | 1.0 |
| Raptors | fall | Exponential | All | 474.982 | 1.0 |

*Adjustment for Searched Area Results*

Fatality data for small birds and bats were used to fit the density model separately for each size class. Fatality data for bats from the control group and the treatment group was analyzed separately. The chosen model distribution and parameter estimates are presented in Appendix E1, E2, and E3. Full DWP results are available in Appendix B. The best-fit distribution for bats in the control group was the Weibull distribution and the best-fit distribution for bats in the treatment group was the Gompertz distribution. The estimated DWP for bats on roads and pads was 0.18 for the control group and the treatment group; that is, road and pad searches captured an average of 18.0% of potential bat fatalities at both the control and treatment group turbines. The DWP for cleared plots was 0.93 for the control group and 0.98 for the treatment group, or 93-98% of potential bat carcasses were expected to fall on cleared plots.

The best-fit distribution for small birds was the gamma distribution. The estimated DWP for small birds on roads and pads was 0.09; that is, road and pad searches captured an average of 9.0% of potential small bird fatalities. The DWP for cleared plots was 0.78, or 78% of potential small bird carcasses were expected to fall on cleared plots. Small birds were found quite often at distances greater than 20 m, and as a result the road and pad area correction is quite large when compared to bats.

Large birds were modeled using Hull and Muir. The estimated DWP for large birds on roads and pads was 0.25; that is, road and pad searches captured an average of 25% of potential large bird fatalities. The DWP for cleared plots was 0.81, or 81% of potential large bird carcasses were expected to fall on cleared plots.

*Adjusted Fatality Estimates*

Estimates of mortality, standard errors, and confidence intervals were calculated for bats, small birds, large birds, and raptors using both the Shoenfeld and Huso estimators. Fatality estimates were adjusted based on the adjustments for carcass persistence, searcher efficiency, and the area adjustment values. Fatality estimates were calculated separately for the treatment and control groups for bats to assess the efficacy of the modified curtailment program implemented in 2018. Tables 10a and 10b provide the estimated fatality rates (rates/turbine/study period and rates/MW/study period), along with the 90% CI using Huso estimators for cleared plot and road and pad searches for small birds, large birds, and raptors. Tables 10c and 10d provide the adjusted fatality rates and 90% CI using the Huso estimators for cleared plot and road and pad searches for both the treatment and control groups for bats. Tables 10e and 10f provide the estimated fatality rates for cleared plot and road and pad searches using Shoenfeld estimators for small birds, large birds, and raptors. Tables 10g and 10h show the fatality rates for both search types for the treatment and control groups for bats. As noted above, due to a programming error the treatment turbines received no treatment starting on October 1 while the control turbines were feathered below manufacturer's cut-in speed (3.0 m/s) in this period. However, because only 10 bats were found in the month of October, they were distributed relatively evenly between treatment and control groups, and very little curtailment treatment occurred in this period due to the temperatures being below 10 degrees C at night (see below), it was determined that the treatment was not a significant factor on fatality rates in October and

the bats found in October were kept with the turbines they were found with and not “switched” to a different control or treatment group. Appendices B (Huso estimator) and C (Shoenfeld estimator) contain more details concerning the analyses, including correction factors. Overall, fatality estimates for birds and bats were similar between the two estimators (comparing Table 10a to Table 10e, Table 10b to Table 10f, Table 10c to Table 10g, and Table 10d to Table 10h).

Estimates for small birds, large birds, and raptors were roughly similar between the two search types and estimators. Small bird mortality estimates ranged from 3.11 birds/MW/study period at road and pads (Table 10b) to 4.96 birds/MW/study period at cleared plots (Table 10a) using the Huso estimator. Large bird fatality estimates ranged between 0.25 birds/MW/study period at cleared plots (Table 10a) and 0.38 birds/MW/study period at road and pads (Table 10b) using the Huso estimator. No raptors were documented at cleared plot turbines in the 2018 PCM study, so the fatality rate per turbine and per MW was estimated at zero. One raptor carcass was found at a road/pad turbine resulting in an estimated fatality rate of 0.06 raptors/MW/study period for both estimators (Tables 10b and 10f).

Overall, estimates for bat fatalities were roughly similar between the two search types and estimators (Tables 10c, 10d, 10g, and 10h). Estimated bat fatalities were higher for the control group than the treatment group for both the Huso estimator and the Shoenfeld estimator. Fatality estimates at cleared plots using the Huso estimator were 34.97 bats/MW/study period (90% CI of 1.82 – 83.02) for the control group and 26.67 bats/MW/study period (90% CI of 0.44-55.21) for the treatment group (Table 10c). Fatality estimates at road/pads using the Huso estimator were 37.59 bats/MW/study period (90% CI of 28.06 – 53.72) for the control group and 21.00 bats/MW/study period (90% CI of 12.90 – 26.64) for the treatment group (Table 10d).

**Table 10a. Overall adjusted bird mortality estimates using the Huso estimator for cleared plot surveys at the Black Oak Getty Wind Project, April 4 to November 1, 2018.**

| | Estimate #/turbine (90% CI) | Estimate #/MW (90% CI) |
|---|---|---|
| Small Birds | 9.93 (2.15 – 19.15) | 4.96 (1.08 – 9.58) |
| Large Birds | 0.50 (0 – 1.47) | 0.25 (0 – 0.73) |
| Raptors | 0 | 0 |
| **All Birds** | **10.43 (2.15 – 19.87)** | **5.22 (1.08 – 9.93)** |

Note: CI = Confidence Interval, MW = megawatt

**Table 10b. Overall adjusted bird mortality estimates using the Huso estimator for road/pad surveys at the Black Oak Getty Wind Project, April 4 to November 1, 2018.**

| | Estimate #/turbine (90% CI) | Estimate #/MW (90% CI) |
|---|---|---|
| Small Birds | 6.23 (3.19 – 9.83) | 3.11 (1.59 – 4.91) |
| Large Birds | 0.76 (0.22 – 1.58) | 0.38 (0.11 – 0.79) |
| Raptors | 0.12 | 0.06 |
| **All Birds** | **7.00 (3.89 – 10.93)** | **3.50 (1.95 – 5.46)** |

Note: CI = Confidence Interval, MW = megawatt

**Table 10c. Overall adjusted bat mortality estimates using the Huso estimator for cleared plot surveys at the Black Oak Getty Wind Project, April 4 to November 1, 2018.**

| | Turbine Treatment Group | Estimate #/turbine (90% CI) | Estimate #/MW (90% CI) |
|---|---|---|---|
| Bat | Control | 69.93 (3.64 – 166.03) | 34.97 (1.82 – 83.02) |
| | Treatment | 53.34 (0.90 – 110.41) | 26.67 (0.44 – 55.21) |

Note: CI = Confidence Interval, MW = megawatt

**Table 10d. Overall adjusted bat mortality estimates using the Huso estimator for road/pad plot surveys at the Black Oak Getty Wind Project, April 4 to November 1, 2018.**

| | Turbine Treatment Group | Estimate #/turbine (90% CI) | Estimate #/MW (90% CI) |
|---|---|---|---|
| Bat | Control | 75.19 (56.13 – 107.44) | 37.59 (28.06 – 53.72) |
| | Treatment | 42.00 (25.80 – 53.28) | 21.00 (12.90 – 26.64) |

Note: CI = Confidence Interval, MW = megawatt

**Table 10e. Overall adjusted bird mortality estimates using the Shoenfeld estimator for cleared plot surveys at the Black Oak Getty Wind Project, April 4 to November 1, 2018.**

| | Estimate #/turbine (90% CI) | Estimate #/MW (90% CI) |
|---|---|---|
| Small Birds | 7.43 (1.96 – 14.09) | 3.71 (0.98 – 7.04) |
| Large Birds | 0.70 (0 – 1.41) | 0.35 (0 – 0.71) |
| Raptors | 0 | 0 |
| **All Birds** | **8.14 (2.31 – 15.11)** | **4.07 (1.15 – 7.55)** |

Note: CI = Confidence Interval, MW = megawatt

**Table 10f. Overall adjusted bird mortality estimates using the Shoenfeld estimator for road/pad surveys at the Black Oak Getty Wind Project, April 4 to November 1, 2018.**

| | Estimate #/turbine (90% CI) | Estimate #/MW (90% CI) |
|---|---|---|
| Small Birds | 4.57 (2.62 – 6.88) | 2.28 (1.31 – 3.44) |
| Large Birds | 0.53 (0.14 – 0.97) | 0.27 (0.07 – 0.48) |
| Raptors | 0.12 | 0.06 |
| **All Birds** | **5.10 (3.03 – 7.54)** | **2.55 (1.51 – 3.77)** |

Note: CI = Confidence Interval, MW = megawatt

**Table 10g. Overall adjusted bat mortality estimates using the Shoenfeld estimator for cleared plot surveys at the Black Oak Getty Wind Project, April 4 to November 1, 2018.**

| | Turbine Treatment Group | Estimate #/turbine (90% CI) | Estimate #/MW (90% CI) |
|---|---|---|---|
| Bat | Control | 58.49 (0.75 – 127.51) | 29.24 (0.38 – 63.76) |
| | Treatment | 44.44 (0.71 – 101.88) | 22.22 (0.36 – 50.94) |

Note: CI = Confidence Interval, MW = megawatt

**Table 10h. Overall adjusted bat mortality estimates using the Shoenfeld estimator for road/pad plot surveys at the Black Oak Getty Wind Project, April 4 to November 1, 2018.**

| | Turbine Treatment Group | Estimate #/turbine (90% CI) | Estimate #/MW (90% CI) |
|---|---|---|---|
| Bat | Control | 59.20 (41.09 – 78.97) | 29.60 (20.54 – 39.49) |
| | Treatment | 32.64 (22.39 – 43.42) | 16.32 (11.20 – 21.71) |

Note: CI = Confidence Interval, MW = megawatt

*Comparison of Curtailment and Fatalities at Treatment and Control Turbines*

The SCADA data at the treatment and control turbines was examined in order to assess how much curtailment occurred at the Project during the 2018 PCM study period. Because the curtailment program involved feathering the blades of the treatment turbines below certain wind speeds (3.0 m/s April 1 – June 30 and October, and 3.5 m/s from July 1 – September 30),

periods of low rotor speed (defined as less than two rotations per minute) were evaluated and compared between treatment and control groups. Treatment turbines are feathered below the proscribed cut-in wind speeds when the temperature thresholds are met, prohibiting the turbines from spinning faster than two rotations per minute, and both treatment and control turbines may have low rotor speed periods due to low wind speeds or other conditions unrelated to the curtailment program. Figure 8 shows the cumulative proportion of 10 minute time intervals that had rotor speed measurements lower than two rotations per minute, separated by control turbines and treatment turbines. Treatment turbines are expected to have a higher cumulative proportion of low rotor speed intervals compared to control turbines because of the curtailment program, and Figure 8 shows this in how the treatment line diverges from the control line starting in June, with larger divergences in late July, August and early September. Note that in October, when the turbines undergoing the curtailment program were switched due to a programming error, there is very little difference in the cumulative amount of time when rotor speed was low between the two groups, indicating that the curtailment program was enacted a negligible amount of time during this month.

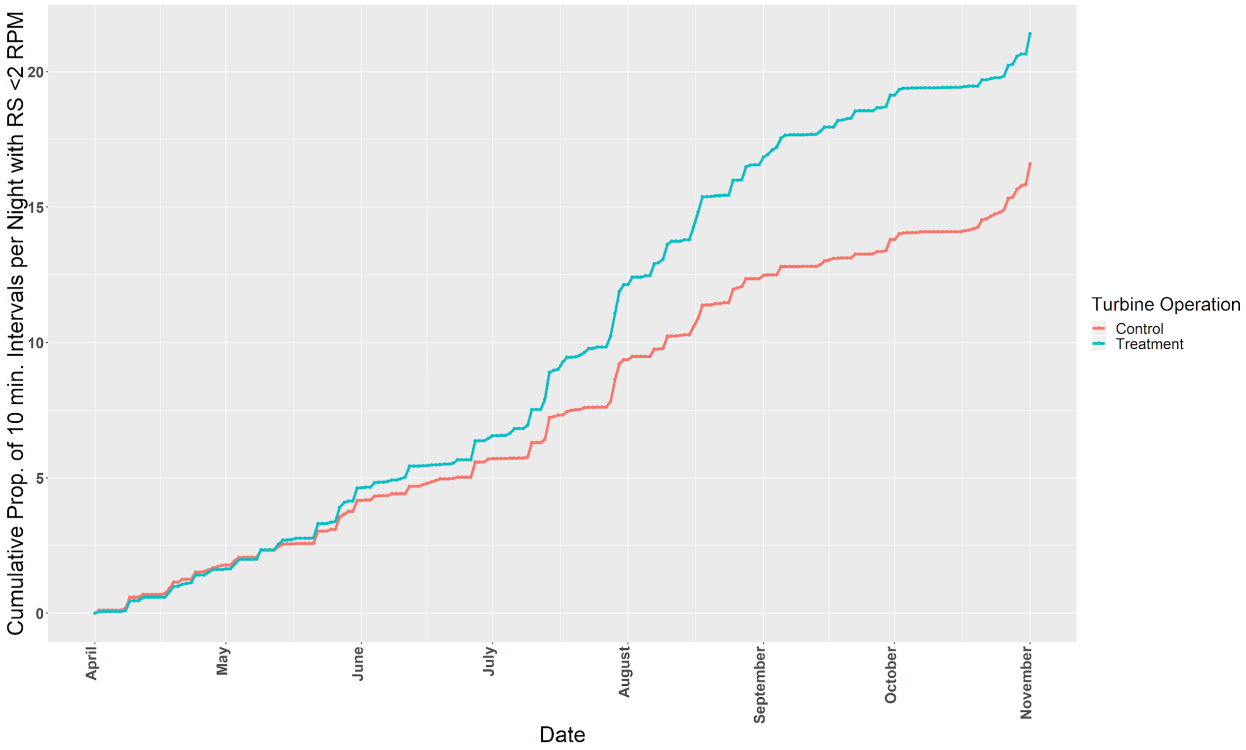


**Figure 8. Cumulative Proportion of 10 Minute Intervals with Low Rotor Speed.**

Figure 9 shows the proportion of 10 minute intervals per night for control and treatment turbines that had temperature measurements greater than 10 degrees C. As described above, the treatment turbines were not curtailed when temperatures were below 10 degrees C, even if the wind speed threshold was met. Each point on Figure 9 represents the proportion of 10 minute intervals that were above 10 degrees C across all turbines in each group (treatment points are orange, control points are blue) for each night. Lines were fitted with a Loess (short for "Local Regression") regression in R. Overall, Figure 9 shows that the temperature thresholds for the

curtailment program were not met (i.e., temperatures were below 10 degrees C at night) at the majority of turbines through April, but that starting in mid-May the majority of the nights met the temperature threshold through most of September. There was a period of time in mid-August when some nights had some 10 minute intervals when the temperature was below 10 degrees, but only four nights in August had less than 50 percent of the time not meeting the temperature threshold for curtailment, and the remaining nights in August had a majority of the 10 minute intervals meeting the temperature threshold. Starting in late September, the temperature thresholds were not met for the majority of nights through the end of the study period (Figure 9).

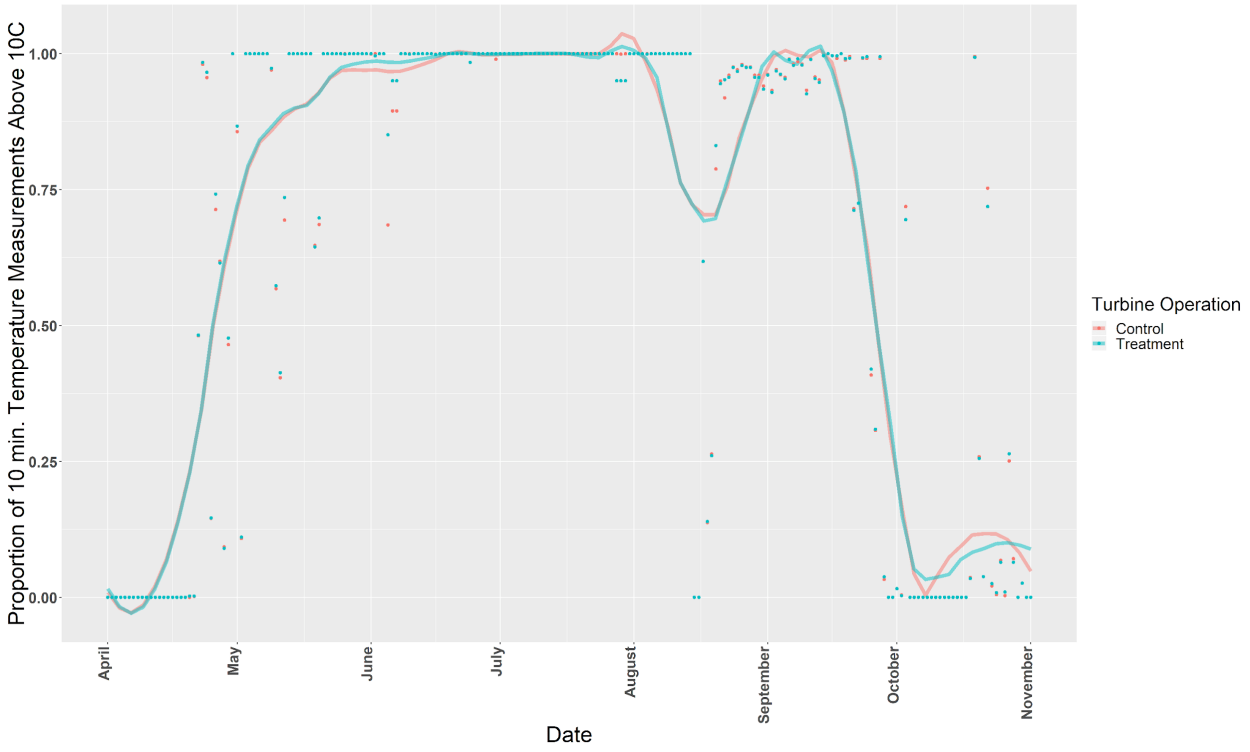


**Figure 9. Proportion of 10 Minute Intervals with Temperatures Above 10 Degrees Celsius.**

Figure 10 shows the 10 minute intervals with low rotor speed, along with documented bat fatalities, compared between treatment and control groups. The green lines in these panels are the proportion of 10 minute intervals per night where turbines demonstrated low rotor speeds, and the primary difference between the green lines on the left (control) versus the right (treatment) is active curtailment, particularly during the time when most of the bat fatalities occurred, because as discussed above and shown on Figure 9, the temperature threshold was met the majority of the study period from mid-May through late September. The black dots are the total fatalities found on those dates at each turbine group (control, treatment). All days where a carcass search did not occur have been assigned to 0 carcasses for plotting purposes. The purple line is a Loess regression line fitted to the fatality data. The comparison of treatment and control turbines in Figure 10 shows the overall effect of the curtailment program: namely that the increased amount of time with low rotor speed that occurred under the curtailment program, particularly in late July, August and early September, corresponded to a lower amount of bat fatality.

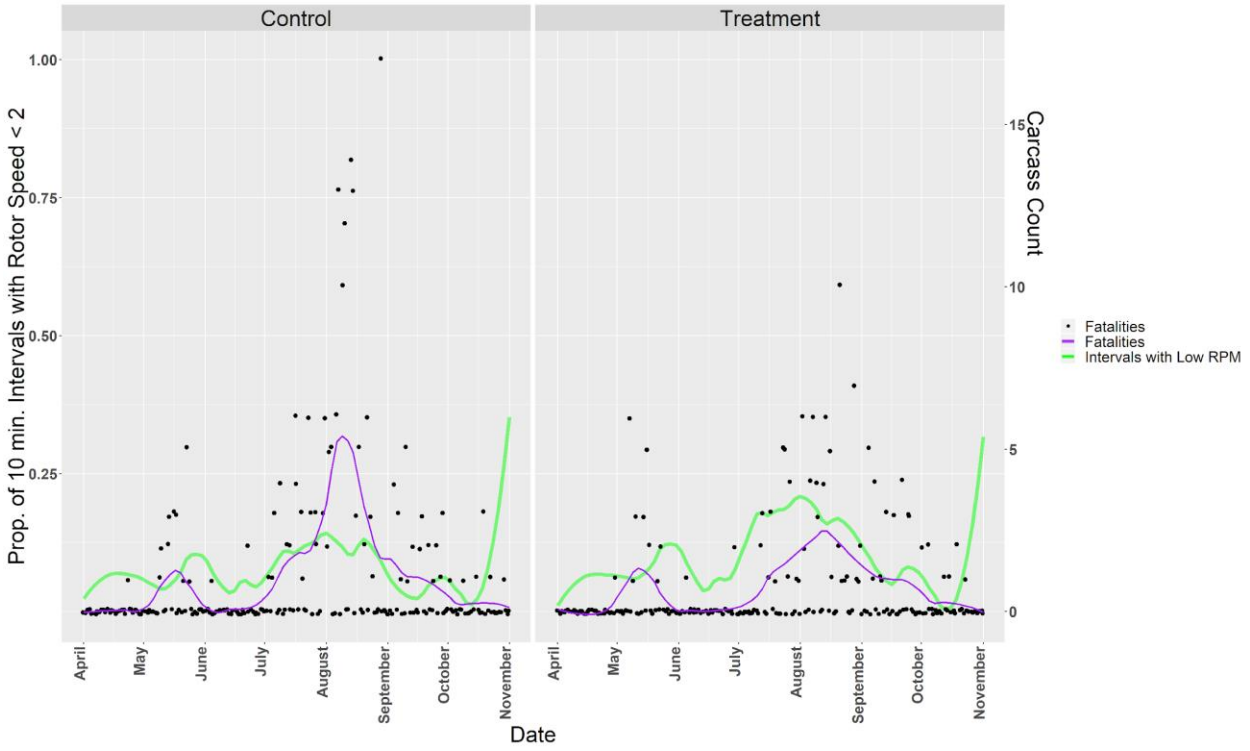


**Figure 10. Proportion of 10 Minute Intervals with Low Rotor Speed in Both Treatment and Control Turbines, with Bat Fatalities**

# DISCUSSION

The primary objective of the 2018 PCM survey was to estimate the overall bird and bat fatality rates at the Project, and to assess the efficacy of the modified curtailment program in reducing bat fatalities.

One raptor was found at a road and pad searched turbine during the 2018 study (no raptors were found at cleared plot surveys). The relatively low raptor fatality rate in 2018 (0 to 0.06 raptors/MW/study period, using the Huso estimator) is similar to the low raptor fatality rate (0 raptors/MW/study period) documented in the 2017 survey (Pickle et al. 2018). The 2018 adjusted all bird fatality rate estimate at the cleared plot turbines of 5.22 birds/MW/study period (90% CI of 1.08 - 9.93, using the Huso estimator) is within the range of other facilities in the Midwest and Minnesota (Appendix D), and is similar to the all bird fatality rate estimate documented at cleared plots in 2017 (4.37 birds/MW/study period; Pickle et al. 2018). Similarly, the all bird fatality rate estimate at the road and pad searches (3.50 birds/MW/study period with 90% CI of 1.95 - 5.46 using the Huso estimator) is also within the range of other facilities in Minnesota and the Midwest (Appendix D) and is lower than the rate documented at road and pad searched turbines in 2017 (8.15 birds/MW/study period). It should be noted that similar to 2017, the majority of the all bird fatality estimates for both search types was driven by the small bird estimates (4.96 birds/MW/study period with 90% CI of 1.08 - 9.58 for cleared plot searches and 3.11 birds/MW/study period with 90% CI of 1.59 - 4.91 for the road and pad searches using the Huso estimator). The large bird fatality estimate is relatively low and similar among search types (ranging between 0.25 and 0.38 birds/MW/study period using the Huso estimator), and the small birds documented as fatalities were spread among multiple species that are common in the region. American white pelican (a state species of Special Concern) were found as fatalities at the Project in both 2017 and 2018. In 2017, one American white pelican was found at turbine D39 on June 15; in 2018, an American white pelican was found at Turbine D36 on June 27 and a second pelican was found at Turbine B16 on July 9. Although June and July appear to potentially be higher risk time periods, there does not appear to be a specific turbine that is higher risk to pelicans based on these two years of data, and relatively low numbers of fatalities have been found each year compared to the numbers of pelicans that have been observed incidentally and during pre-construction use surveys to move through the Project. Therefore, significant impacts to particular avian species populations from the Project are not expected.

The main objective for the second year of monitoring was to assess the efficacy of the modified curtailment program to reduce bat fatalities at the Project. Estimated bat fatalities were higher for the control group than the treatment group for both search types, indicating that the additional feathering regime does reduce bat fatalities over no treatment. Fatality estimates at cleared plots using the Huso estimator were 34.97 bats/MW/study period (90% CI of 1.82 – 83.02) for the control group and 26.67 bats/MW/study period (90% CI of 0.44-55.21) for the treatment group (Table 10c). Fatality estimates at road/pads using the Huso estimator were 37.59 bats/MW/study period (90% CI of 28.06 – 53.72) for the control group and 21.00 bats/MW/study period (90% CI of 12.90 – 26.64) for the treatment group (Table 10d). The 90%

CIs for the treatment and control groups overlapped for cleared plot searches, indicating some uncertainty as to the level of effectiveness of the additional feathering. The cleared plot searches had confidence intervals that overlapped, likely due to the low sample size of cleared plot turbines (two turbines) searched in each group. However, no overlap of 90% CIs occurred for the road and pad searches, supporting the conclusion that the additional feathering is reducing the fatality rate for bats. These results are generally consistent with the results of other studies, which show that raising the cut-in speed (and feathering below the cut-in speed) reduces bat fatality rates at other projects (Arnett et al. 2013). An Indiana study showed that feathering turbines below 3.5 m/s reduced bat mortality by approximately 35% compared to no feathering (Good et al. 2012).

Bat fatality estimates in 2018 were generally similar to or higher than those reported in 2017, even for the treatment turbines. Using the Huso estimator, the cleared plot estimate in 2017 was 13.03 bats/MW/study period (90% CI of 10.46 - 16.15) (Pickle et al. 2018), compared to 26.67 bats/MW/study period for the 2018 treatment turbines searched as cleared plots and 34.97 bats/MW/study period for the 2018 control turbines searched as cleared plots. Using the Huso estimator, the road and pad estimate in 2017 was 29.88 bats/MW/study period (90% CI of 17.81 - 49.10) (Pickle et al. 2018), compared to 21.00 (90% CI of 0.44 - 55.21) bats/MW/study period for 2018 treatment turbines searched as road and pad and 37.59 (90% CI of 28.06 - 53.72) bats/MW/study period for the 2018 control turbines searched as road and pad. Therefore, although the 2018 treatment does appear to reduce bat fatality rates compared to no treatment (no feathering at any point), it appears possible that the overall bat fatality rate at the Project was higher in 2018 than in 2017.

As noted above, comparisons between fatality rates documented at other projects should be done qualitatively as different survey designs were likely used. All bird and raptor fatality rates documented at the Project in 2018 are within the range of others documented in both Minnesota and the Midwest Region (Appendix D1 and D2). Bat fatality estimates for both search types and treatment groups in 2018 are relatively high compared to other publicly available wind facilities in Minnesota (Appendix D3). When looking at publicly available data from projects in the Midwest, the Project's bat fatality estimates are still relatively high, although the bat fatality levels documented in 2017 and 2018 at the Project are more within the range of what has been found at other wind projects, particularly more recent studies. As Appendix D3 shows, the majority of the projects with fatality estimates of less than 5.0 bats/MW/study period occurred prior to 2005, while the majority of the publicly available studies that occurred after 2012 had estimated bat fatalities of greater than 10.0 bats/MW/study period; there are seven projects (four in Iowa, two in Wisconsin and one in Indiana) with bat fatality estimates of more than 20 bats/MW/study period. The reasons for this apparent trend of increasing bat fatality/MW associated with more recent studies are not known, but are likely related to one or more of the following: changing turbine technology (such as lowering the manufacturer's cut-in wind speed) potentially affecting bat fatality, updates to the statistical methodology used to estimate fatality rates, and changes to survey methodology (length of survey period, approach to bias trials, etc.) affecting how many bats are found.

Through coordination with Black Oak Wind, LLC, the DNR and the Department of Commerce, WEST is planning to conduct a third year of fatality monitoring at the Project in 2019. The third year of surveys is proposed to generally follow the same methodology as the second year, with the following changes in study design for the third year of PCM:

- All turbines will be searched as road and pad searches (no cleared plots)
    - As applicable the area correction/distribution data from road and pad analysis from Year 2 (treatment turbines) will be used to help inform the area correction for the third year
- All turbines will be feathered up to the manufacturer's cut-in speed of 3.0 m/s between April 1 and June 30
- All turbines will be feathered up to an adjusted cut-in speed of 3.5 m/s between July 1 and October 31

The main objective of the third year of survey is to estimate the fatality rate of bats at the Project, particularly to see if the modified curtailment program studied in Year 2 that will be in place at all turbines in Year 3 continues to reduce the number of bat fatalities at the Project.

# REFERENCES

ARCADIS U.S., Inc. 2013. Fall 2012 and Spring 2013 Avian and Bat Post-Construction Mortality Monitoring Report: Pioneer Trail Wind Farm. Prepared for E.On Climate & Renewables, North America. Prepared by ARCADIS U.S., Inc., Milwaukee, Wisconsin. August 2013.

Arnett, E. B., G. D. Johnson, W. P. Erickson, and C. D. Hein. 2013. A Synthesis of Operational Mitigation Studies to Reduce Bat Fatalities at Wind Energy Facilities in North America. A report submitted to the National Renewable Energy Laboratory (NREL), Golden Colorado. Bat Conservation International (BCI), Austin, Texas. March 2013.

Bay, K., E. Baumgartner, J. Studyvin, and R. McDonald. 2017a. 2015-2016 Post-Construction Fatality Monitoring: Bat Focused Surveys: MidAmerican Energy Company, Iowa Wind Energy Portfolio: Adams, Century, Charles City, Highland, Intrepid, Laurel, Lundgren, Macksburg, Pomeroy, Rolling Hills, Vienna I, Vienna II, and Wellsburg, November 2015 – November 2016. Prepared for MidAmerican Energy Company, Urbandale, Iowa. Prepared by WEST, Cheyenne, Wyoming.

Bay, K., E. Baumgartner, J. Studyvin, and A. Hoeing. 2017b. 2015-2017 Post-construction Fatality Monitoring: Eagle-focused Carcass Searches. MidAmerican Energy Company Iowa Wind Energy Portfolio: Adams, Century, Charles City, Highland, Intrepid, Laurel, Pomeroy, Vienna I, Vienna II, and Wellsburg. Final Report. November 2015-March 2017. Prepared for MidAmerican Energy Company, Prepared by WEST, Cheyenne, Wyoming.

BHE Environmental, Inc. (BHE). 2008. Investigations of Bat Activity and Bat Species Richness at the Proposed Cedar Ridge Wind Farm in Fond Du Lac County, Wisconsin. Interim Report prepared for Wisconsin Power and Light.

BHE Environmental, Inc. (BHE). 2010. Post-Construction Bird and Bat Mortality Study: Cedar Ridge Wind Farm, Fond Du Lac County, Wisconsin. Interim Report prepared for Wisconsin Power and Light, Madison, Wisconsin. Prepared by BHE Environmental, Inc. Cincinnati, Ohio. February 2010.

BHE Environmental, Inc. (BHE). 2011. Post-Construction Bird and Bat Mortality Study: Cedar Ridge Wind Farm, Fond Du Lac County, Wisconsin. Final Report. Prepared for Wisconsin Power and Light, Madison, Wisconsin. Prepared by BHE Environmental, Inc. Cincinnati, Ohio. February 2011.

Burnham, K. P. and G. C. White. 2002. Evaluation of Some Random Effects Methodology Applicable to Bird Ringing Data. Journal of Applied Statistics 29(1-4): 245-264.

Burnham, K. P. and D. R. Anderson. 2002. Model Selection and Multimodel Inference: A Practical Information-Theoretic Approach. 2nd Edition. Springer, New York, New York.

Chodachek, K., C. Derby, M. Sonnenberg, and T. Thorn. 2012. Post-Construction Fatality Surveys for the Pioneer Prairie Wind Farm I LLC Phase II, Mitchell County, Iowa: April 4, 2011 – March 31, 2012. Prepared for EDP Renewables, North America LLC, Houston, Texas. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. August 27, 2012.

Chodachek, K., C. Derby, K. Adachi, and T. Thorn. 2014. Post-Construction Fatality Surveys for the Pioneer Prairie II Wind Energy Facility, Mitchell County, Iowa. Final Report: July 1 - October 18, 2013. Prepared for EDP Renewables, North America LLC, Houston, Texas. Prepared by Western EcoSystems Technology Inc. (WEST), Bismarck, North Dakota. April 2014.

Chodachek, K., K. Adachi, and G. DiDonato. 2015. Post Construction Fatality Surveys for the Prairie Rose Wind Energy Facility, Rock County, Minnesota. Final Report: April 15 to June 13, 2014, and August 15 to October 29, 2014. Prepared for Enel Green Power, North America, San Diego, California. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. January 23, 2015.

Derby, C., A. Dahl, W. Erickson, K. Bay, and J. Hoban. 2007. Post-Construction Monitoring Report for Avian and Bat Mortality at the NPPD Ainsworth Wind Farm. Unpublished report prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming, for the Nebraska Public Power District.

Derby, C., A. Dahl, K. Taylor, K. Bay, and K. Seginak. 2008. Wildlife Baseline Studies for the Wessington Springs Wind Resource Area, Jerauld County, South Dakota, March 2007-November 2007. Technical report prepared for Power Engineers, Inc. and Babcock and Brown Renewable Holdings, Inc. by Western EcoSystems Technology, Inc. (WEST).

Derby, C., K. Bay, and J. Ritzert. 2009. Bird Use Monitoring, Grand Ridge Wind Resource Area, La Salle County, Illinois. Year One Final Report, March 2008 - February 2009. Prepared for Grand Ridge Energy LLC, Chicago, Illinois. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. July 29, 2009.

Derby, C., J. Ritzert, and K. Bay. 2010a. Bird and Bat Fatality Study, Grand Ridge Wind Resource Area, Lasalle County, Illinois. January 2009 - January 2010. Prepared for Grand Ridge Energy LLC, Chicago, Illinois. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. July 13, 2010. Revised January 2011.

Derby, C., K. Chodachek, and K. Bay. 2010b. Post-Construction Bat and Bird Fatality Study Crystal Lake II Wind Energy Center, Hancock and Winnebago Counties, Iowa. Final Report: April 2009-October 2009. Prepared for NextEra Energy Resources, Juno Beach, Florida. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. June 2, 2010.

Derby, C., A. Dahl, A. Merrill, and K. Bay. 2010d. 2009 Post-Construction Monitoring Results for the Wessington Springs Wind-Energy Facility, South Dakota. Final Report. Prepared for Wessington Wind Energy Center, LLC, Juno Beach, Florida. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. August 19, 2010.

Derby, C., K. Chodachek, K. Bay, and A. Merrill. 2010e. Post-Construction Fatality Survey for the Buffalo Ridge I Wind Project. May 2009 - May 2010. Prepared for Iberdrola Renewables, Inc., Portland, Oregon. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota.

Derby, C., K. Chodachek, K. Bay, and A. Merrill. 2010f. Post-Construction Fatality Surveys for the Elm Creek Wind Project: March 2009- February 2010. Prepared for Iberdrola Renewables, Inc. (IRI), Portland, Oregon. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota.

Derby, C., K. Chodachek, K. Bay, and A. Merrill. 2010g. Post-Construction Fatality Surveys for the Moraine II Wind Project: March - December 2009. Prepared for Iberdrola Renewables, Inc. (IRI), Portland, Oregon. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota.

Derby, C., K. Chodachek, K. Bay, and A. Merrill. 2010h. Post-Construction Fatality Surveys for the Winnebago Wind Project: March 2009- February 2010. Prepared for Iberdrola Renewables, Inc. (IRI), Portland, Oregon. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota.

Derby, C., A. Dahl, K. Bay, and L. McManus. 2011a. 2010 Post-Construction Monitoring Results for the Wessington Springs Wind Energy Facility, South Dakota. Final Report: March 9 – November 16, 2010. Prepared for Wessington Wind Energy Center, LLC, Juno Beach, Florida. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. November 22, 2011.

Derby, C., K. Chodachek, K. Bay, and S. Nomani. 2011b. Post-Construction Fatality Surveys for the Barton I and II Wind Project: Iri. March 2010 - February 2011. Prepared for Iberdrola Renewables, Inc. (IRI), Portland, Oregon. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. Version: September 28, 2011.

Derby, C., K. Chodachek, K. Bay, and S. Nomani. 2011c. Post-Construction Fatality Surveys for the Rugby Wind Project: Iberdrola Renewables, Inc. March 2010 - March 2011. Prepared for Iberdrola Renewables, Inc. (IRI), Portland, Oregon. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. Version: October 14, 2011.

Derby, C., K. Chodachek, T. Thorn, K. Bay, and S. Nomani. 2011d. Post-Construction Fatality Surveys for the PrairieWinds ND1 Wind Facility, Basin Electric Power Cooperative, March - November 2010. Prepared for Basin Electric Power Cooperative, Bismarck, North Dakota. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. August 2, 2011.

Derby, C., K. Chodachek, and M. Sonnenberg. 2012a. Post-Construction Casualty Surveys for the Buffalo Ridge II Wind Project. Iberdrola Renewables: March 2011- February 2012. Prepared for Iberdrola Renewables, LLC, Portland, Oregon. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. August 31, 2012.

Derby, C., K. Chodachek, and M. Sonnenberg. 2012b. Post-Construction Fatality Surveys for the Elm Creek II Wind Project. Iberdrola Renewables: March 2011-February 2012. Prepared for Iberdrola Renewables, LLC, Portland, Oregon. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. October 8, 2012.

Derby, C., A. Dahl, and A. Merrill. 2012c. Post-Construction Monitoring Results for the PrairieWinds SD1 Wind Energy Facility, South Dakota. Final Report: March 2011 - February 2012. Prepared for Basin Electric Power Cooperative, Bismarck, North Dakota. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. September 27, 2012.

Derby, C., K. Chodachek, T. Thorn, and A. Merrill. 2012d. Post-Construction Surveys for the PrairieWinds ND1 (2011) Wind Facility Basin Electric Power Cooperative: March - October 2011. Prepared for Basin Electric Power Cooperative, Bismarck, North Dakota. Prepared by Western Ecosystems Technology, Inc. (WEST), Bismarck, North Dakota. August 31, 2012.

Derby, C., A. Dahl, and D. Fox. 2013a. Post-Construction Fatality Monitoring Studies for the PrairieWinds SD1 Wind Energy Facility, South Dakota. Final Report: March 2012 - February 2013. Prepared for Basin Electric Power Cooperative, Bismarck, North Dakota. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. November 13, 2013.

Derby, C., A. Dahl, and G. DiDonato. 2014. Post-Construction Fatality Monitoring Studies for the PrairieWinds SD1 Wind Energy Facility, South Dakota. Final Report: March 2013 - February 2014. Prepared for Basin Electric Power Cooperative, Bismarck, North Dakota. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota.

ESRI. 2013. World Topographic Map. ArcGIS Resource Center. ESRI, producers of ArcGIS software. ESRI, Redlands, California. Last modified June 6, 2013. Accessed November 2016.

ESRI. 2017. World Street Map. ArcGIS Resource Center. ESRI, producers of ArcGIS software, Redlands, California. Data accessed January 2017. Information online: https://www.arcgis.com/home/item.html?id=3b93337983e9436f8db950e38a8629af

Fagen Engineering, LLC. 2014. 2013 Avian and Bat Monitoring Annual Report: Big Blue Wind Farm, Blue Earth, Minnesota. Prepared for Big Blue Wind Farm. Prepared by Fagen Engineering, LLC. May 2014.

Fagen Engineering, LLC. 2015. 2014 Avian and Bat Monitoring Annual Report: Big Blue Wind Farm, Blue Earth, Minnesota. Prepared for Big Blue Wind Farm. Prepared by Fagen Engineering, LLC.

Golder Associates. 2010. Report on Fall Post-Construction Monitoring, Ripley Wind Power Project, Acciona Wind. Report Number 09-1126-0029. Submitted to Suncor Energy Products Inc., Calgary, Alberta, and Acciona Wind Energy Canada, Toronto, Ontario. February 2010.

Good, R. E., W. P. Erickson, A. Merrill, S. Simon, K. Murray, K. Bay, and C. Fritchman. 2011. Bat Monitoring Studies at the Fowler Ridge Wind Energy Facility, Benton County, Indiana: April 13 - October 15, 2010. Prepared for Fowler Ridge Wind Farm. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. January 28, 2011.

Good, R. E., A. Merrill, S. Simon, K. Murray, and K. Bay. 2012. Bat Monitoring Studies at the Fowler Ridge Wind Farm, Benton County, Indiana: April 1 - October 31, 2011. Prepared for the Fowler Ridge Wind Farm. Prepared by Western EcoSystems Technology, Inc. (WEST), Bloomington, Indiana. January 31, 2012.

Good, R. E., M. Sonnenburg, and S. Simon. 2013a. Bat Evaluation Monitoring Studies at the Fowler Ridge Wind Farm, Benton County, Indiana: August 1 - October 15, 2012. Prepared for the Fowler Ridge Wind Farm. Prepared by Western EcoSystems Technology, Inc. (WEST), Bloomington, Indiana. January 31, 2013.

Good, R. E., M. L. Ritzert, and K. Adachi. 2013b. Post-Construction Monitoring at the Rail Splitter Wind Farm, Tazwell and Logan Counties, Illinois. Final Report: May 2012 - May 2013. Prepared for EDP Renewables, Houston, Texas. Prepared by Western EcoSystems Technology, Inc. (WEST), Bloomington, Indiana. October 22, 2013.

Good, R. E., J. P. Ritzert, and K. Adachi. 2013c. Post-Construction Monitoring at the Top Crop Wind Farm, Gundy and Lasalle Counties, Illinois. Final Report: May 2012 - May 2013. Prepared for EDP Renewables, Houston, Texas. Prepared by Western EcoSystems Technology, Inc. (WEST), Bloomington, Indiana. October 22, 2013.

Grodsky, S. M. and D. Drake. 2011. Assessing Bird and Bat Mortality at the Forward Energy Center. Final Report. Public Service Commission (PSC) of Wisconsin. PSC REF#:152052. Prepared for Forward Energy LLC. Prepared by Department of Forest and Wildlife Ecology, University of Wisconsin-Madison, Madison, Wisconsin. August 2011.

Gruver, J. 2008. Bat Acoustic Studies for the Blue Sky Green Field Wind Project, Fond Du Lac County, Wisconsin. Final Report: July 24 - October 29, 2007. Prepared for We Energies, Milwaukee, Wisconsin. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. February 26, 2008.

Gruver, J., M. Sonnenberg, K. Bay, and W. Erickson. 2009. Post-Construction Bat and Bird Fatality Study at the Blue Sky Green Field Wind Energy Center, Fond Du Lac County, Wisconsin July 21 - October 31, 2008 and March 15 - June 4, 2009. Unpublished report prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. December 17, 2009.

Hamer Environmental, L.P 2012. Acoustic Bat Studies for the Black Oak and Getty Wind Resource Area – Final Report. Prepared for Geronimo Wind Energy, LLC. Prepared by Matt Reed, Joshua Stumpf, and Thomas Hamer. December 17, 2012.

Homer, C. G., J. A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N. D. Herold, J. D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the Conterminous United States-Representing a Decade of Land Cover Change Information. Photogrammetric Engineering and Remote Sensing 81(5): 345-354. Available online: http://www.mrlc.gov/nlcd2011.php

Howe, R. W., W. Evans, and A. T. Wolf. 2002. Effects of Wind Turbines on Birds and Bats in Northeastern Wisconsin. Prepared by University of Wisconsin-Green Bay, for Wisconsin Public Service Corporation and Madison Gas and Electric Company, Madison, Wisconsin. November 21, 2002. 104 pp.

Hull, C. L. and S. Muir. 2010. Search Areas for Monitoring Bird and Bat Carcasses at Wind Farms Using a Monte-Carlo Model. Australian Journal of Environmental Management 17(2): 77-87.

Huso, M. 2011. An Estimator of Wildlife Fatality from Observed Carcasses. Environmetrics 22(3): 318-329. doi: 10.1002/env.1052.

Huso, M., N. Som, and L. Ladd. 2015. Fatality Estimator User's Guide. US Geological Survey (USGS) Data Series 729. Version 1.1. December 2015. Available online at: http://pubs.usgs.gov/ds/729/pdf/ds729.pdf

Huso, M. M. P. and D. Dalthorp. 2014. Accounting for Unsearched Areas in Estimating Wind Turbine-Caused Fatality. Journal of Wildlife Management 78(2): 347-358. doi: 10.1002/jwmg.663.

Jacques Whitford Stantec Limited (Jacques Whitford). 2009. Ripley Wind Power Project Postconstruction Monitoring Report. Project No. 1037529.01. Report to Suncor Energy Products Inc., Calgary, Alberta, and Acciona Energy Products Inc., Calgary, Alberta. Prepared for the Ripley Wind Power Project Post-Construction Monitoring Program. Prepared by Jacques Whitford, Markham, Ontario. April 30, 2009.

James, R. D. 2008. Erie Shores Wind Farm, Port Burwell, Ontario: Fieldwork Report for 2006 and 2007 During the First Two Years of Operation. Report to Environment Canada, Ontario Ministry of Natural Resources, Erie Shores Wind Farm LP - McQuarrie North American and AIM PowerGen Corporation. January 2008.

Johnson, G. D., W. P. Erickson, M. D. Strickland, M. F. Shepherd, and D. A. Shepherd. 2000a. Final Report: Avian Monitoring Studies at the Buffalo Ridge Wind Resource Area, Minnesota: Results of a 4-Year Study. Final report prepared for Northern States Power Company, Minneapolis, Minnesota, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. September 22, 2000. 212 pp.

Johnson, G. D., M. K. Perlik, W. P. Erickson, and M. D. Strickland. 2004. Bat Activity, Composition and Collision Mortality at a Large Wind Plant in Minnesota. Wildlife Society Bulletin 32(4): 1278-1288.

Johnson, G. D., M. Ritzert, S. Nomani, and K. Bay. 2010a. Bird and Bat Fatality Studies, Fowler Ridge I Wind-Energy Facility Benton County, Indiana. Unpublished report prepared for British Petroleum Wind Energy North America Inc. (BPWENA) by Western EcoSystems Technology, Inc. (WEST).

Johnson, G. D., M. Ritzert, S. Nomani, and K. Bay. 2010b. Bird and Bat Fatality Studies, Fowler Ridge III Wind-Energy Facility, Benton County, Indiana. April 2 - June 10, 2009. Prepared for BP Wind Energy North America. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming.

Kerlinger, P., J. Guarnaccia, R. Curry, and C. J. Vogel. 2014. Bird and Bat Fatality Study, Heritage Garden I Wind Farm, Delta County, Michigan: 2012-2014. Prepared for Heritage Sustainable Energy, LLC. Prepared by Curry and Kerlinger, LLC, McLean, Virginia. November 2014.

Khokan, M. R., W. Bari, and J. A. Khan. 2013. Weighted Maximum Likelihood Approach for Robust Estimation: Weibull Model. Dhaka University Journal of Science 61(2): 153-156.

Minnesota Department of Natural Resources (MN DNR). 2016. Minnesota's Wildlife Action Plan 2015-2025. Division of Ecological and Water Resources, Minnesota Department of Natural Resources. Available online at: http://www.dnr.state.mn.us/mnwap/index.html

Minnesota Public Utilities Commission (MPUC). 2012. Lakefield Wind Project Avian and Bat Fatality Monitoring. MPUC Site Permit Quarterly Report and USFWS Special Purpose – Utility (Avian Take Monitoring) 30-Day Report: April 1 – September 30, 2012. USFWS Permit No: MB70161A-0; MDNR Permit No: 17930; MPUC Permit No: IP-6829/WS-09-1239, Permit Special Condition VII.B. October 15, 2012.

Natural Resource Solutions Inc. (NRSI). 2011. Harrow Wind Farm 2010 Post-Construction Monitoring Report. Project No. 0953. Prepared for International Power Canada, Inc., Markham, Ontario. Prepared by NRSI. August 2011.

North American Datum (NAD). 1983. Nad83 Geodetic Datum.

Osborn, R. G., K. F. Higgins, C. D. Dieter, and R. E. Usgaard. 1996. Bat Collisions with Wind Turbines in Southwestern Minnesota. Bat Research News 37: 105-108.

Osborn, R. G., K. F. Higgins, R. E. Usgaard, C. D. Dieter, and R. G. Neiger. 2000. Bird Mortality Associated with Wind Turbines at the Buffalo Ridge Wind Resource Area, Minnesota. American Midland Naturalist 143: 41-52.

Pickle, J., J. Lombardi, J. Stucker, and M. Kauffman. 2018. 2017 Post-Construction Monitoring Study, Black Oak Getty Wind Project, Stearns County, Minnesota, March 15 – November 16, 2017. Prepared for Black Oak Wind, LLC. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. March 13, 2018.

Piorkowski, M. D. and T. J. O'Connell. 2010. Spatial Pattern of Summer Bat Mortality from Collisions with Wind Turbines in Mixed-Grass Prairie. American Midland Naturalist 164: 260-269.

Shoenfeld, P. 2004. Suggestions Regarding Avian Mortality Extrapolation. Technical memo provided to FPL Energy. West Virginia Highlands Conservancy, HC70, Box 553, Davis, West Virginia, 26260. Available online at: https://www.nationalwind.org/wp-content/uploads/2013/05/Shoenfeld-2004-Suggestions-Regarding-Avian-Mortality-Extrapolation.pdf

URS Corporation. 2010c. Final Marengo II Wind Project Year One Avian Mortality Monitoring Report. Prepared for PacifiCorp, Salt Lake City, Utah. Prepared by URS Corporation, Seattle, Washington. March 22, 2010.

US Department of Agriculture (USDA). 2017. Imagery Programs - National Agriculture Imagery Program (NAIP). USDA, Farm Service Agency (FSA), Aerial Photography Field Office (APFO), Salt Lake City, Utah. Accessed November 2017. Information online: https://www.fsa.usda.gov/programs-and-services/aerial-photography/imagery-programs/index

US Geological Survey (USGS). 2017. USGS Topographic Maps. Last updated January 17, 2017. Homepage available at: https://nationalmap.gov/ustopo/index.html

US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. National Land Cover Database 2011 (NLCD 2011). Multi-Resolution Land Characteristics Consortium (MRLC), National Land Cover Database (NLCD). USGS Earth Resources Observation and Science (EROS) Center, Sioux Falls, South Dakota. Available online: http://www.mrlc.gov/nlcd2011.php; Legend: http://www.mrlc.gov/nlcd11_leg.php

Watt, M. A. and D. Drake. 2011. Assessing Bat Use at the Forward Energy Center. Final Report. PSC REF#:152051. Public Service Commission of Wisconsin. Prepared for Forward Energy LLC. Prepared by Department of Forest and Wildlife Ecology, University of Wisconsin-Madison, Madison, Wisconsin. August 2011.

**Appendix A. Complete Fatality Listing for the Black Oak Getty Wind Project for Studies Conducted April 4 – November 1, 2018**

**Appendix A. Complete listing of carcasses found at the Black Oak Getty Wind Energy Project.**

| Date Found | Common Name | Search Location | Distance from Turbine | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 4/11/2018 | Horned lark | B16 | 53 | Carcass search | Single search | Intact |
| 4/19/2018 | Unidentified owl | B13 | 20 | Carcass search | Single search | Feather spot |
| 4/23/2018 | Brown creeper | C28 | 37 | Carcass search | Single search | Intact |
| 4/30/2018 | Unidentified bat | B13 | 34 | Carcass search | Single search | Intact |
| 4/30/2018 | Brown creeper | B20 | 47 | Carcass search | Single search | Intact |
| 5/7/2018 | Silver-haired bat | B20 | 19 | Carcass search | Single search | Intact |
| 5/7/2018 | Silver-haired bat | B20 | 47 | Carcass search | Single search | Dismembered |
| 5/7/2018 | Silver-haired bat | B20 | 32 | Carcass search | Single search | Intact |
| 5/7/2018 | Silver-haired bat | B20 | 19 | Carcass search | Single search | Dismembered |
| 5/7/2018 | Sedge wren | B20 | 34 | Carcass search | Single search | Intact |
| 5/7/2018 | Silver-haired bat | B20 | 27 | Carcass search | Single search | Scavenged |
| 5/9/2018 | Silver-haired bat | C23 | 11 | Carcass search | Single search | Intact |
| 5/9/2018 | Unidentified gull | D35 | 57 | Carcass search | Single search | Dismembered |
| 5/10/2018 | House wren | B13 | 43 | Carcass search | Single search | Intact |
| 5/10/2018 | Unidentified bat | B20 | 24 | Carcass search | Single search | Dismembered |
| 5/10/2018 | Silver-haired bat | B20 | 24 | Carcass search | Single search | Intact |
| 5/10/2018 | Silver-haired bat | C28 | 36 | Carcass search | Single search | Intact |
| 5/10/2018 | Blackpoll warbler | C28 | 8 | Carcass search | Single search | Dismembered |
| 5/13/2018 | Silver-haired bat | C22 | 7 | Incidental | Single search | Intact |
| 5/13/2018 | Big brown bat | D39 | 1 | Incidental | Single search | Intact |
| 5/14/2018 | Silver-haired bat | B13 | 7 | Carcass search | Single search | Intact |
| 5/14/2018 | Silver-haired bat | B13 | 40 | Carcass search | Single search | Intact |
| 5/14/2018 | Silver-haired bat | C25 | 19 | Incidental | Single search | Intact |
| 5/14/2018 | Unidentified thrush | C28 | 52 | Carcass search | Single search | Dismembered |
| 5/14/2018 | Sedge wren | C28 | 15 | Carcass search | Single search | Dismembered |
| 5/14/2018 | Silver-haired bat | D38 | 44 | Carcass search | Single search | Intact |
| 5/15/2018 | Least flycatcher | B16 | 27 | Incidental | Single search | Intact |
| 5/16/2018 | Big brown bat | A03 | 8 | Carcass search | Single search | Intact |
| 5/16/2018 | Silver-haired bat | B18 | 8 | Carcass search | Single search | Intact |
| 5/16/2018 | Silver-haired bat | B19 | 70 | Carcass search | Single search | Intact |
| 5/16/2018 | Silver-haired bat | C21 | 8 | Carcass search | Single search | Dismembered |

**Appendix A. Complete listing of carcasses found at the Black Oak Getty Wind Energy Project.**

| Date Found | Common Name | Search Location | Distance from Turbine | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 5/16/2018 | Silver-haired bat | C25 | 12 | Carcass search | Single search | Intact |
| 5/16/2018 | Unidentified thrush | C27 | 87 | Carcass search | Single search | Dismembered |
| 5/16/2018 | Least flycatcher | C27 | 5 | Carcass search | Single search | Intact |
| 5/16/2018 | Silver-haired bat | C29 | 11 | Carcass search | Single search | Intact |
| 5/17/2018 | Silver-haired bat | B13 | 20 | Carcass search | Single search | Intact |
| 5/17/2018 | Silver-haired bat | B20 | 20 | Carcass search | Single search | Intact |
| 5/17/2018 | Yellow-throated vireo | C28 | 54 | Carcass search | Single search | Intact |
| 5/17/2018 | Silver-haired bat | C28 | 30 | Carcass search | Single search | Intact |
| 5/17/2018 | Silver-haired bat | D38 | 39 | Carcass search | Single search | Intact |
| 5/21/2018 | Silver-haired bat | B20 | 48 | Carcass search | Single search | Intact |
| 5/21/2018 | Mallard | D39 | 11 | Incidental | Single search | Intact |
| 5/23/2018 | Silver-haired bat | A09 | 41 | Carcass search | Single search | Intact |
| 5/23/2018 | Silver-haired bat | B14 | 10 | Carcass search | Single search | Intact |
| 5/23/2018 | Silver-haired bat | C27 | 9 | Carcass search | Single search | Intact |
| 5/23/2018 | Silver-haired bat | C30 | 44 | Carcass search | Single search | Intact |
| 5/23/2018 | Hoary bat | D32 | 7 | Carcass search | Single search | Intact |
| 5/23/2018 | Silver-haired bat | D35 | 5 | Carcass search | Single search | Intact |
| 5/23/2018 | Silver-haired bat | D39 | 25 | Carcass search | Single search | Intact |
| 5/24/2018 | Silver-haired bat | D38 | 41 | Carcass search | Single search | Intact |
| 6/4/2018 | Magnolia warbler | C28 | 23 | Carcass search | Single search | Intact |
| 6/5/2018 | Hoary bat | C26 | 8 | Carcass search | Single search | Intact |
| 6/22/2018 | Silver-haired bat | B16 | 11 | Carcass search | Single search | Intact |
| 6/22/2018 | Silver-haired bat | D35 | 7 | Carcass search | Single search | Intact |
| 6/22/2018 | Hoary bat | D39 | 7 | Incidental | Single search | Intact |
| 6/27/2018 | American white pelican | D36 | 94 | Incidental | Single search | Intact |
| 6/29/2018 | Hoary bat | B15 | 40 | Carcass search | Single search | Intact |
| 6/29/2018 | Big brown bat | C23 | 50 | Carcass search | Single search | Intact |
| 7/3/2018 | Silver-haired bat | C24 | 21 | Carcass search | Single search | Intact |
| 7/5/2018 | Eastern red bat | D39 | 40 | Carcass search | Single search | Intact |
| 7/6/2018 | Unidentified bat | A03 | 7 | Carcass search | Single search | Intact |
| 7/6/2018 | Silver-haired bat | C24 | 1 | Carcass search | Single search | Injured |
| 7/6/2018 | Big brown bat | D31 | 4 | Carcass search | Single search | Intact |

**Appendix A. Complete listing of carcasses found at the Black Oak Getty Wind Energy Project.**

| Date Found | Common Name | Search Location | Distance from Turbine | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 7/9/2018 | American white pelican | B16 | 6 | Incidental | Single search | Intact |
| 7/9/2018 | Big brown bat | B16 | 9 | Incidental | Single search | Intact |
| 7/9/2018 | Hoary bat | D38 | 13 | Carcass search | Single search | Intact |
| 7/9/2018 | Killdeer | D38 | 36 | Carcass search | Single search | Intact |
| 7/12/2018 | Eastern red bat | B14 | 10 | Carcass search | Single search | Intact |
| 7/12/2018 | Eastern red bat | B20 | 53 | Carcass search | Single search | Intact |
| 7/12/2018 | Eastern red bat | C28 | 14 | Carcass search | Single search | Intact |
| 7/12/2018 | Silver-haired bat | D38 | 58 | Carcass search | Single search | Intact |
| 7/13/2018 | Bobolink | A05 | 17 | Carcass search | Single search | Intact |
| 7/13/2018 | Eastern red bat | A08 | 7 | Carcass search | Single search | Intact |
| 7/13/2018 | Hoary bat | B16 | 1 | Carcass search | Single search | Intact |
| 7/13/2018 | Silver-haired bat | C29 | 30 | Carcass search | Single search | Intact |
| 7/13/2018 | Hoary bat | D34 | 23 | Carcass search | Single search | Intact |
| 7/13/2018 | Silver-haired bat | D34 | 8 | Carcass search | Single search | Intact |
| 7/16/2018 | Eastern red bat | B13 | 39 | Carcass search | Single search | Intact |
| 7/16/2018 | Silver-haired bat | B19 | 13 | Carcass search | Single search | Intact |
| 7/16/2018 | Silver-haired bat | C28 | 10 | Carcass search | Single search | Intact |
| 7/16/2018 | Hoary bat | D38 | 65 | Carcass search | Single search | Intact |
| 7/16/2018 | Hoary bat | D38 | 30 | Carcass search | Single search | Intact |
| 7/16/2018 | Hoary bat | D38 | 2 | Carcass search | Single search | Injured |
| 7/16/2018 | Unidentified grouse | D39 | 116 | Incidental | Single search | Dismembered |
| 7/16/2018 | Chimney swift | D39 | 212 | Carcass search | Single search | Intact |
| 7/17/2018 | Hoary bat | A01 | 5 | Carcass search | Single search | Intact |
| 7/17/2018 | Cooper’s hawk | A02 | 56 | Carcass search | Single search | Intact |
| 7/17/2018 | Hoary bat | A02 | 18 | Carcass search | Single search | Intact |
| 7/17/2018 | Eastern red bat | A05 | 11 | Carcass search | Single search | Intact |
| 7/17/2018 | Silver-haired bat | A06 | 4 | Carcass search | Single search | Intact |
| 7/17/2018 | Silver-haired bat | D32 | 7 | Carcass search | Single search | Intact |
| 7/17/2018 | Hoary bat | D33 | 8 | Carcass search | Single search | Intact |
| 7/19/2018 | Silver-haired bat | B20 | 28 | Carcass search | Single search | Intact |
| 7/19/2018 | Silver-haired bat | C28 | 26 | Carcass search | Single search | Intact |
| 7/19/2018 | Silver-haired bat | D38 | 42 | Carcass search | Single search | Intact |

**Appendix A. Complete listing of carcasses found at the Black Oak Getty Wind Energy Project.**

| Date Found | Common Name | Search Location | Distance from Turbine | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 7/19/2018 | Hoary bat | D38 | 33 | Carcass search | Single search | Intact |
| 7/20/2018 | Hoary bat | C29 | 4 | Carcass search | Single search | Intact |
| 7/23/2018 | Silver-haired bat | B12 | 2 | Carcass search | Single search | Intact |
| 7/23/2018 | Hoary bat | B13 | 34 | Carcass search | Single search | Intact |
| 7/23/2018 | Silver-haired bat | B13 | 19 | Carcass search | Single search | Intact |
| 7/23/2018 | Silver-haired bat | B13 | 35 | Carcass search | Single search | Intact |
| 7/23/2018 | Silver-haired bat | B20 | 12 | Carcass search | Single search | Intact |
| 7/23/2018 | Hoary bat | C28 | 67 | Carcass search | Single search | Intact |
| 7/23/2018 | Eastern red bat | C28 | 57 | Carcass search | Single search | Intact |
| 7/23/2018 | Hoary bat | C28 | 32 | Carcass search | Single search | Intact |
| 7/23/2018 | Silver-haired bat | C29 | 20 | Incidental | Single search | Intact |
| 7/23/2018 | Silver-haired bat | D38 | 32 | Carcass search | Single search | Intact |
| 7/23/2018 | Hoary bat | D38 | 20 | Carcass search | Single search | Intact |
| 7/24/2018 | Silver-haired bat | A02 | 6 | Carcass search | Single search | Intact |
| 7/24/2018 | Hoary bat | A09 | 10 | Carcass search | Single search | Intact |
| 7/24/2018 | Eastern red bat | B13 | 216 | Incidental | Single search | Injured |
| 7/24/2018 | Silver-haired bat | B16 | 10 | Carcass search | Single search | Intact |
| 7/24/2018 | Silver-haired bat | C25 | 18 | Carcass search | Single search | Intact |
| 7/24/2018 | Silver-haired bat | C25 | 17 | Carcass search | Single search | Intact |
| 7/24/2018 | Silver-haired bat | D33 | 11 | Carcass search | Single search | Intact |
| 7/24/2018 | Eastern red bat | D34 | 27 | Carcass search | Single search | Intact |
| 7/24/2018 | Eastern red bat | D36 | 6 | Carcass search | Single search | Intact |
| 7/26/2018 | Silver-haired bat | B20 | 12 | Carcass search | Single search | Intact |
| 7/26/2018 | Silver-haired bat | C28 | 7 | Carcass search | Single search | Intact |
| 7/26/2018 | Silver-haired bat | C28 | 17 | Carcass search | Single search | Injured |
| 7/26/2018 | Silver-haired bat | D38 | 23 | Carcass search | Single search | Intact |
| 7/27/2018 | Eastern red bat | A02 | 16 | Carcass search | Single search | Intact |
| 7/27/2018 | Silver-haired bat | A10 | 5 | Carcass search | Single search | Intact |
| 7/27/2018 | Silver-haired bat | C21 | 16 | Carcass search | Single search | Intact |
| 7/27/2018 | Silver-haired bat | C24 | 12 | Carcass search | Single search | Intact |
| 7/27/2018 | Eastern red bat | C25 | 23 | Carcass search | Single search | Intact |
| 7/27/2018 | Hoary bat | C30 | 10 | Carcass search | Single search | Intact |

**Appendix A. Complete listing of carcasses found at the Black Oak Getty Wind Energy Project.**

| Date Found | Common Name | Search Location | Distance from Turbine | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 7/27/2018 | Hoary bat | D34 | 15 | Carcass search | Single search | Intact |
| 7/30/2018 | Hoary bat | B20 | 50 | Carcass search | Single search | Intact |
| 7/30/2018 | Silver-haired bat | D38 | 13 | Carcass search | Single search | Intact |
| 7/30/2018 | Hoary bat | D38 | 20 | Carcass search | Single search | Intact |
| 7/30/2018 | Silver-haired bat | D39 | 12 | Carcass search | Single search | Intact |
| 7/31/2018 | Silver-haired bat | A05 | 5 | Carcass search | Single search | Intact |
| 7/31/2018 | Silver-haired bat | A11 | 2 | Carcass search | Single search | Intact |
| 7/31/2018 | Eastern red bat | B16 | 12 | Carcass search | Single search | Intact |
| 7/31/2018 | Silver-haired bat | C22 | 9 | Carcass search | Single search | Intact |
| 7/31/2018 | Big brown bat | C25 | 15 | Carcass search | Single search | Intact |
| 7/31/2018 | Silver-haired bat | D31 | 9 | Carcass search | Single search | Intact |
| 7/31/2018 | Hoary bat | D36 | 6 | Carcass search | Single search | Intact |
| 8/1/2018 | Silver-haired bat | C28 | 51 | Incidental | Single search | Intact |
| 8/1/2018 | Silver-haired bat | D38 | 9 | Incidental | Single search | Intact |
| 8/2/2018 | Hoary bat | B13 | 16 | Carcass search | Single search | Intact |
| 8/2/2018 | Hoary bat | B13 | 14 | Carcass search | Single search | Intact |
| 8/2/2018 | Silver-haired bat | B13 | 14 | Carcass search | Single search | Intact |
| 8/2/2018 | Big brown bat | B16 | 4 | Incidental | Single search | Intact |
| 8/2/2018 | Big brown bat | B17 | 4 | Incidental | Single search | Intact |
| 8/2/2018 | Hoary bat | B19 | 6 | Carcass search | Single search | Intact |
| 8/2/2018 | Little brown bat | B20 | 55 | Carcass search | Single search | Intact |
| 8/2/2018 | Eastern red bat | B20 | 42 | Carcass search | Single search | Intact |
| 8/2/2018 | Big brown bat | C28 | 28 | Carcass search | Single search | Intact |
| 8/2/2018 | Hoary bat | D38 | 30 | Carcass search | Single search | Intact |
| 8/2/2018 | Silver-haired bat | D38 | 26 | Carcass search | Single search | Intact |
| 8/3/2018 | Silver-haired bat | A01 | 15 | Carcass search | Single search | Intact |
| 8/3/2018 | Eastern red bat | A01 | 14 | Carcass search | Single search | Intact |
| 8/3/2018 | Hoary bat | A05 | 14 | Carcass search | Single search | Intact |
| 8/3/2018 | Silver-haired bat | A08 | 29 | Carcass search | Single search | Intact |
| 8/3/2018 | Silver-haired bat | C25 | 14 | Carcass search | Single search | Dismembered |
| 8/3/2018 | Big brown bat | C30 | 10 | Carcass search | Single search | Intact |
| 8/3/2018 | Hoary bat | C30 | 12 | Carcass search | Single search | Intact |

**Appendix A. Complete listing of carcasses found at the Black Oak Getty Wind Energy Project.**

| Date Found | Common Name | Search Location | Distance from Turbine | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 8/3/2018 | Big brown bat | D31 | 2 | Carcass search | Single search | Intact |
| 8/3/2018 | Hoary bat | D33 | 20 | Carcass search | Single search | Intact |
| 8/6/2018 | Silver-haired bat | B12 | 1 | Carcass search | Single search | Intact |
| 8/6/2018 | Hoary bat | B19 | 3 | Carcass search | Single search | Dismembered |
| 8/6/2018 | Eastern red bat | B19 | 12 | Carcass search | Single search | Intact |
| 8/6/2018 | Hoary bat | B20 | 38 | Carcass search | Single search | Intact |
| 8/6/2018 | Eastern red bat | B20 | 32 | Carcass search | Single search | Intact |
| 8/6/2018 | Hoary bat | B20 | 20 | Carcass search | Single search | Intact |
| 8/6/2018 | Silver-haired bat | C29 | 13 | Incidental | Single search | Intact |
| 8/6/2018 | Silver-haired bat | D38 | 26 | Carcass search | Single search | Intact |
| 8/6/2018 | Eastern red bat | D38 | 14 | Carcass search | Single search | Intact |
| 8/6/2018 | Big brown bat | D38 | 8 | Carcass search | Single search | Intact |
| 8/7/2018 | Hoary bat | A03 | 80 | Carcass search | Single search | Injured |
| 8/7/2018 | Silver-haired bat | A03 | 50 | Carcass search | Single search | Intact |
| 8/7/2018 | Big brown bat | A06 | 14 | Carcass search | Single search | Intact |
| 8/7/2018 | Silver-haired bat | A08 | 13 | Carcass search | Single search | Intact |
| 8/7/2018 | Silver-haired bat | A09 | 11 | Carcass search | Single search | Intact |
| 8/7/2018 | Silver-haired bat | B15 | 53 | Carcass search | Single search | Intact |
| 8/7/2018 | Silver-haired bat | B16 | 13 | Carcass search | Single search | Injured |
| 8/7/2018 | Silver-haired bat | B16 | 27 | Carcass search | Single search | Intact |
| 8/7/2018 | Big brown bat | B18 | 7 | Carcass search | Single search | Intact |
| 8/7/2018 | Silver-haired bat | C24 | 20 | Carcass search | Single search | Intact |
| 8/7/2018 | Big brown bat | C26 | 15 | Carcass search | Single search | Dismembered |
| 8/7/2018 | Hoary bat | C27 | 16 | Carcass search | Single search | Intact |
| 8/7/2018 | Hoary bat | D31 | 11 | Carcass search | Single search | Intact |
| 8/7/2018 | Big brown bat | D31 | 11 | Carcass search | Single search | Intact |
| 8/7/2018 | Big brown bat | D31 | 11 | Carcass search | Single search | Intact |
| 8/7/2018 | Eastern red bat | D32 | 6 | Carcass search | Single search | Intact |
| 8/7/2018 | Eastern red bat | D34 | 40 | Carcass search | Single search | Intact |
| 8/7/2018 | Big brown bat | D35 | 7 | Carcass search | Single search | Intact |
| 8/7/2018 | Silver-haired bat | D36 | 37 | Carcass search | Single search | Intact |
| 8/7/2018 | Hoary bat | D36 | 16 | Carcass search | Single search | Dismembered |

**Appendix A. Complete listing of carcasses found at the Black Oak Getty Wind Energy Project.**

| Date Found | Common Name | Search Location | Distance from Turbine | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 8/9/2018 | Hoary bat | B19 | 12 | Carcass search | Single search | Intact |
| 8/9/2018 | Silver-haired bat | B19 | 19 | Carcass search | Single search | Injured |
| 8/9/2018 | Silver-haired bat | B19 | 18 | Carcass search | Single search | Intact |
| 8/9/2018 | Eastern red bat | B20 | 2 | Carcass search | Single search | Intact |
| 8/9/2018 | Eastern red bat | B20 | 30 | Carcass search | Single search | Intact |
| 8/9/2018 | Hoary bat | C28 | 36 | Carcass search | Single search | Intact |
| 8/9/2018 | Hoary bat | C28 | 51 | Carcass search | Single search | Intact |
| 8/9/2018 | Hoary bat | C28 | 12 | Carcass search | Single search | Intact |
| 8/9/2018 | Hoary bat | C28 | 24 | Carcass search | Single search | Intact |
| 8/9/2018 | Hoary bat | C29 | 7 | Incidental | Single search | Intact |
| 8/9/2018 | Hoary bat | D37 | 13 | Carcass search | Single search | Intact |
| 8/9/2018 | Hoary bat | D37 | 5 | Carcass search | Single search | Injured |
| 8/9/2018 | Hoary bat | D38 | 26 | Carcass search | Single search | Intact |
| 8/9/2018 | Hoary bat | D38 | 30 | Carcass search | Single search | Intact |
| 8/9/2018 | Silver-haired bat | D38 | 30 | Carcass search | Single search | Intact |
| 8/9/2018 | Hoary bat | D39 | 10 | Carcass search | Single search | Intact |
| 8/10/2018 | Hoary bat | A01 | 4 | Carcass search | Single search | Intact |
| 8/10/2018 | Hoary bat | A02 | 22 | Carcass search | Single search | Intact |
| 8/10/2018 | Big brown bat | A03 | 24 | Carcass search | Single search | Intact |
| 8/10/2018 | Silver-haired bat | A05 | 9 | Carcass search | Single search | Intact |
| 8/10/2018 | Silver-haired bat | A06 | 4 | Carcass search | Single search | Intact |
| 8/10/2018 | Hoary bat | A06 | 16 | Carcass search | Single search | Intact |
| 8/10/2018 | Silver-haired bat | A06 | 35 | Carcass search | Single search | Intact |
| 8/10/2018 | Hoary bat | A08 | 14 | Carcass search | Single search | Intact |
| 8/10/2018 | Hoary bat | A11 | 12 | Carcass search | Single search | Intact |
| 8/10/2018 | Marsh wren | B18 | 7 | Carcass search | Single search | Intact |
| 8/10/2018 | Big brown bat | C25 | 14 | Carcass search | Single search | Intact |
| 8/10/2018 | Big brown bat | C30 | 13 | Carcass search | Single search | Intact |
| 8/10/2018 | Big brown bat | C30 | 11 | Carcass search | Single search | Dismembered |
| 8/10/2018 | Hoary bat | D35 | 34 | Carcass search | Single search | Intact |
| 8/10/2018 | Silver-haired bat | D35 | 10 | Carcass search | Single search | Intact |
| 8/10/2018 | Hoary bat | D36 | 0 | Carcass search | Single search | Intact |

**Appendix A. Complete listing of carcasses found at the Black Oak Getty Wind Energy Project.**

| Date Found | Common Name | Search Location | Distance from Turbine | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 8/10/2018 | Hoary bat | D36 | 32 | Carcass search | Single search | Intact |
| 8/13/2018 | Eastern red bat | B13 | 49 | Carcass search | Single search | Intact |
| 8/13/2018 | Hoary bat | B20 | 47 | Carcass search | Single search | Intact |
| 8/13/2018 | Hoary bat | B20 | 36 | Carcass search | Single search | Intact |
| 8/13/2018 | Hoary bat | C28 | 18 | Carcass search | Single search | Dismembered |
| 8/13/2018 | Eastern red bat | D37 | 40 | Carcass search | Single search | Intact |
| 8/13/2018 | Big brown bat | D38 | 8 | Carcass search | Single search | Intact |
| 8/13/2018 | Hoary bat | D38 | 27 | Carcass search | Single search | Intact |
| 8/13/2018 | Hoary bat | D38 | 16 | Carcass search | Single search | Intact |
| 8/13/2018 | Hoary bat | D38 | 20 | Carcass search | Single search | Intact |
| 8/13/2018 | Hoary bat | D38 | 14 | Carcass search | Single search | Intact |
| 8/13/2018 | Hoary bat | D38 | 12 | Carcass search | Single search | Intact |
| 8/13/2018 | Hoary bat | D38 | 27 | Carcass search | Single search | Intact |
| 8/13/2018 | Hoary bat | D38 | 37 | Carcass search | Single search | Intact |
| 8/13/2018 | Hoary bat | D38 | 25 | Carcass search | Single search | Intact |
| 8/13/2018 | Silver-haired bat | D38 | 12 | Carcass search | Single search | Intact |
| 8/13/2018 | Hoary bat | D38 | 42 | Carcass search | Single search | Intact |
| 8/13/2018 | Hoary bat | D38 | 32 | Carcass search | Single search | Intact |
| 8/13/2018 | Hoary bat | D39 | 1 | Carcass search | Single search | Intact |
| 8/14/2018 | Hoary bat | B15 | 3 | Carcass search | Single search | Intact |
| 8/14/2018 | Hoary bat | B16 | 15 | Carcass search | Single search | Intact |
| 8/14/2018 | Hoary bat | B19 | 3 | Incidental | Single search | Injured |
| 8/14/2018 | Eastern red bat | B20 | 45 | Incidental | Single search | Intact |
| 8/14/2018 | Hoary bat | C21 | 22 | Carcass search | Single search | Intact |
| 8/14/2018 | Hoary bat | C22 | 19 | Carcass search | Single search | Intact |
| 8/14/2018 | Hoary bat | C22 | 9 | Carcass search | Single search | Dismembered |
| 8/14/2018 | Tree swallow | C24 | 33 | Carcass search | Single search | Intact |
| 8/14/2018 | Hoary bat | C26 | 8 | Carcass search | Single search | Intact |
| 8/14/2018 | Hoary bat | C28 | 18 | Incidental | Single search | Dismembered |
| 8/14/2018 | Hoary bat | C29 | 14 | Carcass search | Single search | Intact |
| 8/14/2018 | Hoary bat | C29 | 40 | Carcass search | Single search | Intact |
| 8/14/2018 | Hoary bat | C30 | 9 | Carcass search | Single search | Intact |

**Appendix A. Complete listing of carcasses found at the Black Oak Getty Wind Energy Project.**

| Date Found | Common Name | Search Location | Distance from Turbine | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 8/14/2018 | Silver-haired bat | C30 | 9 | Carcass search | Single search | Intact |
| 8/14/2018 | Hoary bat | C30 | 54 | Carcass search | Single search | Intact |
| 8/14/2018 | Big brown bat | D31 | 7 | Carcass search | Single search | Dismembered |
| 8/14/2018 | Hoary bat | D33 | 9 | Carcass search | Single search | Intact |
| 8/14/2018 | Big brown bat | D33 | 10 | Carcass search | Single search | Intact |
| 8/14/2018 | Hoary bat | D33 | 15 | Carcass search | Single search | Intact |
| 8/14/2018 | Hoary bat | D35 | 3 | Carcass search | Single search | Intact |
| 8/16/2018 | Hoary bat | A10 | 9 | Incidental | Single search | Intact |
| 8/16/2018 | Hoary bat | B19 | 4 | Carcass search | Single search | Intact |
| 8/16/2018 | Big brown bat | B20 | 31 | Carcass search | Single search | Intact |
| 8/16/2018 | Hoary bat | B20 | 34 | Carcass search | Single search | Intact |
| 8/16/2018 | Hoary bat | B20 | 13 | Carcass search | Single search | Intact |
| 8/16/2018 | Silver-haired bat | C25 | 5 | Incidental | Single search | Intact |
| 8/16/2018 | Hoary bat | D38 | 56 | Carcass search | Single search | Intact |
| 8/16/2018 | Silver-haired bat | D38 | 56 | Carcass search | Single search | Intact |
| 8/16/2018 | Hoary bat | D38 | 33 | Carcass search | Single search | Dismembered |
| 8/17/2018 | Hoary bat | B13 | 12 | Incidental | Single search | Intact |
| 8/17/2018 | Hoary bat | B16 | 12 | Carcass search | Single search | Intact |
| 8/17/2018 | Hoary bat | B16 | 24 | Carcass search | Single search | Intact |
| 8/17/2018 | Eastern red bat | C24 | 24 | Carcass search | Single search | Intact |
| 8/17/2018 | Hoary bat | C24 | 21 | Carcass search | Single search | Intact |
| 8/17/2018 | Hoary bat | D31 | 10 | Carcass search | Single search | Intact |
| 8/17/2018 | Hoary bat | D36 | 9 | Carcass search | Single search | Intact |
| 8/20/2018 | Silver-haired bat | B12 | 4 | Carcass search | Single search | Dismembered |
| 8/20/2018 | Hoary bat | B16 | 7 | Incidental | Single search | Intact |
| 8/20/2018 | Hoary bat | B20 | 18 | Carcass search | Single search | Intact |
| 8/20/2018 | Hoary bat | D38 | 37 | Carcass search | Single search | Intact |
| 8/21/2018 | Hoary bat | A04 | 8 | Carcass search | Single search | Intact |
| 8/21/2018 | Hoary bat | A04 | 21 | Carcass search | Single search | Intact |
| 8/21/2018 | Silver-haired bat | B12 | 8 | Incidental | Single search | Intact |
| 8/21/2018 | Silver-haired bat | B15 | 2 | Carcass search | Single search | Dismembered |
| 8/21/2018 | Eastern red bat | B15 | 11 | Carcass search | Single search | Intact |

**Appendix A. Complete listing of carcasses found at the Black Oak Getty Wind Energy Project.**

| Date Found | Common Name | Search Location | Distance from Turbine | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 8/21/2018 | Unidentified empidonax | B16 | 77 | Carcass search | Single search | Intact |
| 8/21/2018 | Hoary bat | B17 | 45 | Carcass search | Single search | Intact |
| 8/21/2018 | Hoary bat | B20 | 30 | Incidental | Single search | Injured |
| 8/21/2018 | Eastern red bat | C24 | 6 | Carcass search | Single search | Dismembered |
| 8/21/2018 | Silver-haired bat | D32 | 1 | Carcass search | Single search | Intact |
| 8/21/2018 | Red-eyed vireo | D33 | 5 | Carcass search | Single search | Intact |
| 8/21/2018 | Hoary bat | D34 | 10 | Carcass search | Single search | Intact |
| 8/21/2018 | Silver-haired bat | D34 | 8 | Carcass search | Single search | Intact |
| 8/21/2018 | Eastern red bat | D35 | 8 | Carcass search | Single search | Intact |
| 8/21/2018 | Big brown bat | D36 | 6 | Carcass search | Single search | Intact |
| 8/21/2018 | Silver-haired bat | D38 | 32 | Incidental | Single search | Intact |
| 8/22/2018 | Silver-haired bat | B20 | 35 | Incidental | Single search | Intact |
| 8/23/2018 | Silver-haired bat | B14 | 54 | Carcass search | Single search | Intact |
| 8/23/2018 | Hoary bat | C28 | 12 | Carcass search | Single search | Intact |
| 8/23/2018 | Eastern red bat | D38 | 21 | Carcass search | Single search | Intact |
| 8/23/2018 | Hoary bat | D38 | 41 | Carcass search | Single search | Intact |
| 8/24/2018 | Hoary bat | B13 | 28 | Incidental | Single search | Intact |
| 8/24/2018 | Big brown bat | C30 | 33 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | A01 | 10 | Carcass search | Single search | Dismembered |
| 8/28/2018 | Silver-haired bat | A01 | 6 | Carcass search | Single search | Dismembered |
| 8/28/2018 | Silver-haired bat | A04 | 1 | Carcass search | Single search | Injured |
| 8/28/2018 | Silver-haired bat | A06 | 67 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | A06 | 30 | Carcass search | Single search | Intact |
| 8/28/2018 | Eastern red bat | A06 | 38 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | A11 | 23 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | A11 | 17 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | B13 | 17 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | B16 | 25 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | B17 | 22 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | B19 | 20 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | B20 | 27 | Carcass search | Single search | Intact |
| 8/28/2018 | Hoary bat | B20 | 18 | Carcass search | Single search | Intact |

**Appendix A. Complete listing of carcasses found at the Black Oak Getty Wind Energy Project.**

| Date Found | Common Name | Search Location | Distance from Turbine | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 8/28/2018 | Silver-haired bat | B20 | 2 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | C21 | 14 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | C24 | 10 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | C28 | 16 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | C28 | 26 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | C28 | 40 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | C29 | 1 | Carcass search | Single search | Intact |
| 8/28/2018 | Eastern red bat | C30 | 14 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | D31 | 47 | Carcass search | Single search | Intact |
| 8/28/2018 | Silver-haired bat | D31 | 40 | Carcass search | Single search | Intact |
| 8/29/2018 | Hoary bat | B13 | 31 | Incidental | Single search | Intact |
| 8/30/2018 | Silver-haired bat | B13 | 36 | Carcass search | Single search | Intact |
| 8/30/2018 | Silver-haired bat | C28 | 62 | Carcass search | Single search | Intact |
| 8/30/2018 | Silver-haired bat | D38 | 27 | Carcass search | Single search | Intact |
| 8/31/2018 | Hoary bat | A08 | 8 | Carcass search | Single search | Intact |
| 8/31/2018 | Hoary bat | C26 | 17 | Carcass search | Single search | Intact |
| 9/4/2018 | Silver-haired bat | A01 | 0 | Carcass search | Single search | Injured |
| 9/4/2018 | Silver-haired bat | A06 | 11 | Carcass search | Single search | Intact |
| 9/4/2018 | Eastern red bat | A08 | 4 | Carcass search | Single search | Intact |
| 9/4/2018 | Silver-haired bat | B13 | 22 | Carcass search | Single search | Intact |
| 9/4/2018 | Eastern red bat | B13 | 9 | Carcass search | Single search | Intact |
| 9/4/2018 | Big brown bat | B18 | 26 | Carcass search | Single search | Intact |
| 9/4/2018 | Silver-haired bat | C24 | 6 | Carcass search | Single search | Intact |
| 9/4/2018 | Big brown bat | C25 | 0 | Carcass search | Single search | Injured |
| 9/4/2018 | Silver-haired bat | C28 | 40 | Carcass search | Single search | Intact |
| 9/4/2018 | Silver-haired bat | D32 | 3 | Carcass search | Single search | Intact |
| 9/6/2018 | Silver-haired bat | B20 | 12 | Carcass search | Single search | Intact |
| 9/6/2018 | Silver-haired bat | B20 | 19 | Carcass search | Single search | Intact |
| 9/6/2018 | Silver-haired bat | B20 | 10 | Carcass search | Single search | Intact |
| 9/6/2018 | Silver-haired bat | B20 | 12 | Carcass search | Single search | Intact |
| 9/6/2018 | Silver-haired bat | C28 | 37 | Carcass search | Single search | Intact |
| 9/6/2018 | Silver-haired bat | C28 | 35 | Carcass search | Single search | Intact |

**Appendix A. Complete listing of carcasses found at the Black Oak Getty Wind Energy Project.**

| Date Found | Common Name | Search Location | Distance from Turbine | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 9/6/2018 | Silver-haired bat | C28 | 26 | Carcass search | Single search | Intact |
| 9/6/2018 | Silver-haired bat | C28 | 5 | Carcass search | Single search | Intact |
| 9/6/2018 | House sparrow | D38 | 36 | Carcass search | Single search | Dismembered |
| 9/6/2018 | Silver-haired bat | D38 | 25 | Carcass search | Single search | Intact |
| 9/7/2018 | Silver-haired bat | A08 | 5 | Carcass search | Single search | Intact |
| 9/7/2018 | Silver-haired bat | C26 | 3 | Carcass search | Single search | Intact |
| 9/7/2018 | Silver-haired bat | C27 | 38 | Carcass search | Single search | Intact |
| 9/7/2018 | Hoary bat | C29 | 8 | Carcass search | Single search | Intact |
| 9/7/2018 | Sedge wren | D33 | 39 | Carcass search | Single search | Intact |
| 9/10/2018 | Eastern red bat | B13 | 58 | Carcass search | Single search | Intact |
| 9/10/2018 | Silver-haired bat | C28 | 39 | Carcass search | Single search | Intact |
| 9/10/2018 | Red-breasted nuthatch | C28 | 43 | Carcass search | Single search | Intact |
| 9/10/2018 | Silver-haired bat | D38 | 18 | Carcass search | Single search | Intact |
| 9/10/2018 | Silver-haired bat | D38 | 48 | Carcass search | Single search | Intact |
| 9/10/2018 | Silver-haired bat | D38 | 40 | Carcass search | Single search | Intact |
| 9/11/2018 | Hoary bat | B16 | 8 | Carcass search | Single search | Injured |
| 9/11/2018 | Silver-haired bat | C27 | 17 | Carcass search | Single search | Intact |
| 9/13/2018 | Eastern red bat | B13 | 23 | Carcass search | Single search | Dismembered |
| 9/13/2018 | Big brown bat | B13 | 41 | Carcass search | Single search | Dismembered |
| 9/13/2018 | Silver-haired bat | B13 | 37 | Carcass search | Single search | Intact |
| 9/13/2018 | House wren | B20 | 44 | Carcass search | Single search | Intact |
| 9/13/2018 | Eastern red bat | C28 | 45 | Carcass search | Single search | Intact |
| 9/13/2018 | Eastern red bat | C28 | 51 | Carcass search | Single search | Intact |
| 9/17/2018 | Eastern red bat | B13 | 28 | Carcass search | Single search | Intact |
| 9/17/2018 | Silver-haired bat | B14 | 13 | Carcass search | Single search | Intact |
| 9/17/2018 | Eastern red bat | B19 | 6 | Carcass search | Single search | Dismembered |
| 9/17/2018 | Silver-haired bat | B20 | 32 | Carcass search | Single search | Intact |
| 9/17/2018 | Silver-haired bat | C28 | 28 | Carcass search | Single search | Intact |
| 9/18/2018 | Silver-haired bat | A01 | 7 | Carcass search | Single search | Intact |
| 9/18/2018 | Ruby-crowned kinglet | A06 | 5 | Carcass search | Single search | Intact |
| 9/18/2018 | Silver-haired bat | A09 | 11 | Carcass search | Single search | Intact |
| 9/21/2018 | Eastern red bat | A07 | 43 | Carcass search | Single search | Intact |

**Appendix A. Complete listing of carcasses found at the Black Oak Getty Wind Energy Project.**

| Date Found | Common Name | Search Location | Distance from Turbine | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 9/21/2018 | Silver-haired bat | B19 | 13 | Carcass search | Single search | Intact |
| 9/21/2018 | Hoary bat | B20 | 20 | Carcass search | Single search | Intact |
| 9/21/2018 | Silver-haired bat | B20 | 18 | Carcass search | Single search | Intact |
| 9/21/2018 | Silver-haired bat | C26 | 6 | Carcass search | Single search | Intact |
| 9/21/2018 | Sora | C28 | 63 | Carcass search | Single search | Intact |
| 9/24/2018 | Silver-haired bat | B14 | 47 | Carcass search | Single search | Intact |
| 9/24/2018 | Silver-haired bat | B20 | 30 | Carcass search | Single search | Intact |
| 9/24/2018 | Eastern red bat | B20 | 43 | Carcass search | Single search | Intact |
| 9/24/2018 | Silver-haired bat | C28 | 14 | Carcass search | Single search | Intact |
| 9/25/2018 | Eastern red bat | A01 | 42 | Carcass search | Single search | Intact |
| 9/25/2018 | Silver-haired bat | A02 | 8 | Carcass search | Single search | Intact |
| 9/25/2018 | Eastern red bat | B18 | 8 | Carcass search | Single search | Intact |
| 9/25/2018 | Red-breasted nuthatch | C26 | 40 | Carcass search | Single search | Intact |
| 9/25/2018 | Silver-haired bat | C29 | 16 | Carcass search | Single search | Intact |
| 9/27/2018 | Silver-haired bat | D38 | 3 | Carcass search | Single search | Intact |
| 9/28/2018 | Silver-haired bat | C24 | 24 | Carcass search | Single search | Intact |
| 9/28/2018 | Horned lark | D31 | 22 | Carcass search | Single search | Intact |
| 9/28/2018 | Silver-haired bat | D35 | 28 | Carcass search | Single search | Intact |
| 10/1/2018 | Tennessee warbler | D38 | 35 | Carcass search | Single search | Intact |
| 10/1/2018 | Unidentified warbler | D38 | 50 | Carcass search | Single search | Dismembered |
| 10/2/2018 | Hoary bat | A05 | 10 | Incidental | Single search | Intact |
| 10/2/2018 | Eastern red bat | B17 | 8 | Carcass search | Single search | Intact |
| 10/4/2018 | White-throated sparrow | B12 | 117 | Carcass search | Single search | Intact |
| 10/4/2018 | Ruby-crowned kinglet | D38 | 49 | Carcass search | Single search | Intact |
| 10/4/2018 | Ruby-crowned kinglet | D38 | 49 | Carcass search | Single search | Dismembered |
| 10/9/2018 | Silver-haired bat | D34 | 205 | Carcass search | Single search | Intact |
| 10/12/2018 | Silver-haired bat | D36 | 6 | Carcass search | Single search | Intact |
| 10/15/2018 | Golden-crowned kinglet | B20 | 12 | Carcass search | Single search | Intact |
| 10/15/2018 | Silver-haired bat | C28 | 36 | Carcass search | Single search | Intact |
| 10/19/2018 | Eastern red bat | A08 | 10 | Carcass search | Single search | Intact |
| 10/19/2018 | Silver-haired bat | C21 | 7 | Carcass search | Single search | Injured |
| 10/19/2018 | Eastern red bat | D32 | 13 | Carcass search | Single search | Intact |

**Appendix A. Complete listing of carcasses found at the Black Oak Getty Wind Energy Project.**

| Date Found | Common Name | Search Location | Distance from Turbine | Type of Find | Search Type | Condition |
|---|---|---|---|---|---|---|
| 10/19/2018 | Silver-haired bat | D34 | 37 | Carcass search | Single search | Intact |
| 10/19/2018 | Silver-haired bat | D35 | 40 | Carcass search | Single search | Intact |
| 10/22/2018 | Ruby-crowned kinglet | B13 | 40 | Carcass search | Single search | Intact |
| 10/23/2018 | House sparrow | A01 | 60 | Carcass search | Single search | Intact |
| 10/29/2018 | Silver-haired bat | B13 | 33 | Carcass search | Single search | Intact |

# Appendix B. Huso Estimates for the 2018 Post-Construction Surveys at the Black Oak Getty Wind Project

**Appendix B1. Estimated fatality rates and correction factors, with 90% confidence intervals, for control group cleared plot studies conducted at the Black Oak Getty Wind Energy Project, Stearns County, MN, from April 4, 2018, to November 1, 2018.**

| | SPRING | | SUMMER1 | | SUMMER2 | | FALL1 | | FALL2 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** |
| **Search Area Adjustment** | | | | | | | | | | |
| A (Bats) | 0.927 | 0.870 - 0.979 | 0.927 | 0.870 - 0.979 | 0.927 | 0.870 - 0.979 | 0.927 | 0.870 - 0.979 | 0.927 | 0.870 - 0.979 |
| A (Large Birds) | 0.811 | 0.811 - 0.811 | 0.811 | 0.811 - 0.811 | 0.811 | 0.811 - 0.811 | 0.811 | 0.811 - 0.811 | 0.811 | 0.811 - 0.811 |
| A (Raptors) | 0.811 | 0.811 - 0.811 | 0.811 | 0.811 - 0.811 | 0.811 | 0.811 - 0.811 | 0.811 | 0.811 - 0.811 | 0.811 | 0.811 - 0.811 |
| A (Small Birds) | 0.776 | 0.588 - 0.943 | 0.776 | 0.588 - 0.943 | 0.776 | 0.588 - 0.943 | 0.776 | 0.588 - 0.943 | 0.776 | 0.588 - 0.943 |
| **Observer Detection Rate** | | | | | | | | | | |
| P (Bats) | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 |
| P (Large Birds) | 0.892 | 0.833 - 0.946 | 0.892 | 0.833 - 0.946 | 0.892 | 0.833 - 0.946 | 0.892 | 0.833 - 0.946 | 0.892 | 0.833 - 0.946 |
| P (Raptors) | 0.962 | 0.885 - 1.0 | 0.962 | 0.885 - 1.0 | 0.962 | 0.885 - 1.0 | 0.962 | 0.885 - 1.0 | 0.962 | 0.885 - 1.0 |
| P (Small Birds) | 0.794 | 0.716 - 0.873 | 0.794 | 0.716 - 0.873 | 0.794 | 0.716 - 0.873 | 0.794 | 0.716 - 0.873 | 0.794 | 0.716 - 0.873 |
| **Probability of a Carcass Persisting Through the Search Interval** | | | | | | | | | | |
| Bats | 0.909 | 0.862 - 0.934 | 0.926 | 0.869 - 0.960 | 0.926 | 0.869 - 0.960 | 0.822 | 0.727 - 0.879 | 0.822 | 0.727 - 0.879 |
| Large Birds | 0.716 | 0.636 - 0.793 | 0.716 | 0.636 - 0.793 | 0.716 | 0.636 - 0.793 | 0.716 | 0.636 - 0.793 | 0.716 | 0.636 - 0.793 |
| Raptors | 0.998 | 0.993 - 1.0 | 0.981 | 0.964 - 0.991 | 0.981 | 0.964 - 0.991 | 0.996 | 0.988 - 1.0 | 0.996 | 0.988 - 1.0 |
| Small Birds | 0.780 | 0.705 - 0.853 | 0.780 | 0.705 - 0.853 | 0.780 | 0.705 - 0.853 | 0.780 | 0.705 - 0.853 | 0.780 | 0.705 - 0.853 |
| **Probability of Available and Detected** | | | | | | | | | | |
| Bats | 0.631 | 0.548 - 0.701 | 0.643 | 0.555 - 0.722 | 0.643 | 0.555 - 0.722 | 0.570 | 0.472 - 0.654 | 0.570 | 0.472 - 0.654 |
| Large Birds | 0.638 | 0.559 - 0.725 | 0.638 | 0.559 - 0.725 | 0.638 | 0.559 - 0.725 | 0.638 | 0.559 - 0.725 | 0.638 | 0.559 - 0.725 |
| Raptors | 0.960 | 0.883 - 1.0 | 0.943 | 0.872 - 0.989 | 0.943 | 0.872 - 0.989 | 0.958 | 0.885 - 1.0 | 0.958 | 0.885 - 1.0 |
| Small Birds | 0.620 | 0.535 - 0.705 | 0.620 | 0.535 - 0.705 | 0.620 | 0.535 - 0.705 | 0.620 | 0.535 - 0.705 | 0.620 | 0.535 - 0.705 |
| **Unadjusted Number of Fatalities** | | | | | | | | | | |
| Bats | 1.0 | 0.0 - 4.0 | 4.0 | 0.0 - 10.0 | 25.0 | 1.0 - 58.0 | 46.0 | 2.0 - 109.0 | 1.0 | 0.0 - 3.0 |
| Large Birds | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 1.0 | 0.0 - 3.0 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |
| All Birds | 5.0 | 1.0 - 10.0 | 4.0 | 0.0 - 12.0 | 1.0 | 0.0 - 3.0 | 4.0 | 1.0 - 8.0 | 6.0 | 1.0 - 14.0 |
| Raptors | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |
| Small Birds | 5.0 | 1.0 - 10.0 | 4.0 | 0.0 - 12.0 | 0.0 | 0.0 - 0.0 | 4.0 | 1.0 - 8.0 | 6.0 | 1.0 - 14.0 |
| **Observed Fatality Rates (Fatalities/Turbine/Season(s))** | | | | | | | | | | |
| Bats | 0.500 | 0.0 - 2.0 | 2.0 | 0.0 - 5.0 | 12.500 | 0.500 - 29.0 | 23.0 | 1.0 - 54.500 | 0.500 | 0.0 - 1.500 |
| Large Birds | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.250 | 0.0 - 0.750 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |
| All Birds | 1.250 | 0.250 - 2.500 | 1.0 | 0.0 - 3.0 | 0.250 | 0.0 - 0.750 | 1.0 | 0.250 - 2.0 | 1.500 | 0.250 - 3.500 |
| Raptors | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |

**Appendix B1. Estimated fatality rates and correction factors, with 90% confidence intervals, for control group cleared plot studies conducted at the Black Oak Getty Wind Energy Project, Stearns County, MN, from April 4, 2018, to November 1, 2018.**

| | SPRING | | SUMMER1 | | SUMMER2 | | FALL1 | | FALL2 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** |
| Small Birds | 1.250 | 0.250 - 2.500 | 1.0 | 0.0 - 3.0 | 0.0 | 0.0 - 0.0 | 1.0 | 0.250 - 2.0 | 1.500 | 0.250 - 3.500 |
| **Adjusted Fatality Rates (Fatalities/Turbine/Seasons(s))** | | | | | | | | | | |
| Bats | 0.844 | 0.0 - 3.776 | 3.338 | 0.0 - 9.040 | 20.970 | 0.768 - 50.085 | 43.808 | 2.407 - 106.439 | 0.972 | 0.0 - 3.086 |
| Large Birds | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.502 | 0.0 - 1.507 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |
| All Birds | 2.617 | 0.496 - 5.519 | 2.113 | 0.0 - 6.298 | 0.502 | 0.0 - 1.507 | 2.046 | 0.451 - 4.308 | 3.153 | 0.478 - 7.132 |
| Raptors | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |
| Small Birds | 2.617 | 0.496 - 5.519 | 2.113 | 0.0 - 6.298 | 0.0 | 0.0 - 0.0 | 2.046 | 0.451 - 4.308 | 3.153 | 0.478 - 7.132 |
| **Adjusted Fatality Rates (Fatalities/MW/Seasons(s))** | | | | | | | | | | |
| Bats | 0.422 | 0.0 - 1.888 | 1.669 | 0.0 - 4.520 | 10.485 | 0.384 - 25.043 | 21.904 | 1.204 - 53.219 | 0.486 | 0.0 - 1.543 |
| Large Birds | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.251 | 0.0 - 0.754 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |
| All Birds | 1.308 | 0.248 - 2.760 | 1.057 | 0.0 - 3.149 | 0.251 | 0.0 - 0.754 | 1.023 | 0.225 - 2.154 | 1.577 | 0.239 - 3.566 |
| Raptors | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |
| Small Birds | 1.308 | 0.248 - 2.760 | 1.057 | 0.0 - 3.149 | 0.0 | 0.0 - 0.0 | 1.023 | 0.225 - 2.154 | 1.577 | 0.239 - 3.566 |

**Appendix B2. Estimated fatality rates and correction factors, with 90% confidence intervals, for treatment group cleared plot studies conducted at the Black Oak Getty Wind Energy Project, Stearns County, MN, from April 4, 2018, to November 1, 2018.**

| | SPRING | | SUMMER1 | | SUMMER2 | | FALL1 | | FALL2 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** |
| **Search Area Adjustment** | | | | | | | | | | |
| A (Bats) | 0.980 | 0.962 - 0.995 | 0.980 | 0.962 - 0.995 | 0.980 | 0.962 - 0.995 | 0.980 | 0.962 - 0.995 | 0.980 | 0.962 - 0.995 |
| **Observer Detection Rate** | | | | | | | | | | |
| P (Bats) | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 |
| **Probability of a Carcass Persisting Through the Search Interval** | | | | | | | | | | |
| Bats | 0.909 | 0.862 - 0.934 | 0.926 | 0.869 - 0.960 | 0.926 | 0.869 - 0.960 | 0.822 | 0.727 - 0.879 | 0.822 | 0.727 - 0.879 |
| **Probability of Available and Detected** | | | | | | | | | | |
| Bats | 0.631 | 0.548 - 0.701 | 0.643 | 0.555 - 0.722 | 0.643 | 0.555 - 0.722 | 0.570 | 0.472 - 0.654 | 0.570 | 0.472 - 0.654 |
| **Unadjusted Number of Fatalities** | | | | | | | | | | |
| Bats | 7.0 | 0.0 - 19.0 | 5.0 | 0.0 - 10.050 | 14.0 | 0.0 - 28.0 | 35.0 | 0.0 - 74.0 | 1.0 | 0.0 - 3.0 |
| **Observed Fatality Rates (Fatalities/Turbine/Season(s))** | | | | | | | | | | |
| Bats | 3.500 | 0.0 - 9.500 | 2.500 | 0.0 - 5.025 | 7.0 | 0.0 - 14.0 | 17.500 | 0.0 - 37.0 | 0.500 | 0.0 - 1.500 |
| **Adjusted Fatality Rates (Fatalities/Turbine/Seasons(s))** | | | | | | | | | | |

**Appendix B2. Estimated fatality rates and correction factors, with 90% confidence intervals, for treatment group cleared plot studies conducted at the Black Oak Getty Wind Energy Project, Stearns County, MN, from April 4, 2018, to November 1, 2018.**

| | SPRING | | SUMMER1 | | SUMMER2 | | FALL1 | | FALL2 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** |
| Bats | 5.694 | 0.0 - 15.396 | 3.976 | 0.0 - 8.500 | 11.093 | 0.0 - 23.492 | 31.660 | 0.0 - 71.306 | 0.919 | 0.0 - 2.614 |
| **Adjusted Fatality Rates (Fatalities/MW/Seasons(s))** | | | | | | | | | | |
| Bats | 2.847 | 0.0 - 7.698 | 1.988 | 0.0 - 4.250 | 5.546 | 0.0 - 11.746 | 15.830 | 0.0 - 35.653 | 0.460 | 0.0 - 1.307 |

**Appendix B3. Overall adjusted mortality estimates using the Huso estimator for surveys at the Black Oak Getty Wind Project, April 4 to November 1, 2018.**

| | Estimate #/turbine (90% CI) | Estimate #/MW (90% CI) |
|---|---|---|
| Small Birds | 6.61 (4.11 – 10.37) | 3.31 (2.05 – 5.19) |
| Large Birds | 0.74 (0.26 – 1.44) | 0.37 (0.13 – 0.72) |
| Raptors | 0.11 | 0.06 |
| **All Birds** | **7.35 (4.75 – 11.32)** | **3.68 (2.38 – 5.66)** |

Note: CI = Confidence Interval, MW = megawatt

**Appendix B4. Estimated fatality rates and correction factors, with 90% confidence intervals, for control group road and pad studies conducted at the Black Oak Getty Wind Energy Project, Stearns County, MN, from April 4, 2018, to November 1, 2018.**

| | SPRING | | SUMMER1 | | SUMMER2 | | FALL1 | | FALL2 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** |
| **Search Area Adjustment** | | | | | | | | | | |
| A (Bats) | 0.178 | 0.143 - 0.214 | 0.178 | 0.143 - 0.214 | 0.178 | 0.143 - 0.214 | 0.178 | 0.143 - 0.214 | 0.178 | 0.143 - 0.214 |
| A (Large Birds) | 0.247 | 0.247 - 0.247 | 0.247 | 0.247 - 0.247 | 0.247 | 0.247 - 0.247 | 0.247 | 0.247 - 0.247 | 0.247 | 0.247 - 0.247 |
| A (Raptors) | 0.247 | 0.247 - 0.247 | 0.247 | 0.247 - 0.247 | 0.247 | 0.247 - 0.247 | 0.247 | 0.247 - 0.247 | 0.247 | 0.247 - 0.247 |
| A (Small Birds) | 0.093 | 0.064 - 0.139 | 0.093 | 0.064 - 0.139 | 0.093 | 0.064 - 0.139 | 0.093 | 0.064 - 0.139 | 0.093 | 0.064 - 0.139 |
| **Observer Detection Rate** | | | | | | | | | | |
| P (Bats) | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 |
| P (Large Birds) | 0.892 | 0.833 - 0.946 | 0.892 | 0.833 - 0.946 | 0.892 | 0.833 - 0.946 | 0.892 | 0.833 - 0.946 | 0.892 | 0.833 - 0.946 |
| P (Raptors) | 0.962 | 0.885 - 1.0 | 0.962 | 0.885 - 1.0 | 0.962 | 0.885 - 1.0 | 0.962 | 0.885 - 1.0 | 0.962 | 0.885 - 1.0 |
| P (Small Birds) | 0.794 | 0.716 - 0.873 | 0.794 | 0.716 - 0.873 | 0.794 | 0.716 - 0.873 | 0.794 | 0.716 - 0.873 | 0.794 | 0.716 - 0.873 |
| **Probability of a Carcass Persisting Through the Search Interval** | | | | | | | | | | |
| Bats | 0.865 | 0.799 - 0.902 | 0.890 | 0.808 - 0.939 | 0.926 | 0.868 - 0.960 | 0.821 | 0.726 - 0.879 | 0.821 | 0.726 - 0.879 |
| Large Birds | 0.630 | 0.549 - 0.707 | 0.630 | 0.549 - 0.707 | 0.715 | 0.635 - 0.792 | 0.715 | 0.635 - 0.792 | 0.715 | 0.635 - 0.792 |
| Raptors | 0.997 | 0.989 - 1.0 | 0.971 | 0.945 - 0.986 | 0.981 | 0.964 - 0.991 | 0.996 | 0.988 - 1.0 | 0.996 | 0.988 - 1.0 |
| Small Birds | 0.702 | 0.620 - 0.782 | 0.702 | 0.620 - 0.782 | 0.780 | 0.704 - 0.852 | 0.780 | 0.704 - 0.852 | 0.780 | 0.704 - 0.852 |
| **Probability of Available and Detected** | | | | | | | | | | |
| Bats | 0.601 | 0.516 - 0.671 | 0.618 | 0.525 - 0.701 | 0.643 | 0.555 - 0.722 | 0.570 | 0.472 - 0.653 | 0.570 | 0.472 - 0.653 |
| Large Birds | 0.562 | 0.484 - 0.649 | 0.562 | 0.484 - 0.649 | 0.638 | 0.558 - 0.724 | 0.638 | 0.558 - 0.724 | 0.638 | 0.558 - 0.724 |
| Raptors | 0.959 | 0.882 - 1.0 | 0.934 | 0.863 - 0.984 | 0.943 | 0.872 - 0.989 | 0.958 | 0.885 - 1.0 | 0.958 | 0.885 - 1.0 |
| Small Birds | 0.557 | 0.478 - 0.644 | 0.557 | 0.478 - 0.644 | 0.619 | 0.534 - 0.705 | 0.619 | 0.534 - 0.705 | 0.619 | 0.534 - 0.705 |
| **Unadjusted Number of Fatalities** | | | | | | | | | | |
| Bats | 0.0 | 0.0 - 1.0 | 12.0 | 7.0 - 19.0 | 28.0 | 19.0 - 40.0 | 88.0 | 62.0 - 125.100 | 5.0 | 1.0 - 10.0 |
| Large Birds | 1.0 | 0.0 - 3.0 | 1.0 | 0.0 - 3.0 | 2.0 | 0.0 - 4.050 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |
| All Birds | 1.0 | 0.0 - 3.0 | 3.0 | 0.0 - 7.0 | 3.0 | 1.0 - 6.0 | 8.0 | 4.0 - 13.0 | 1.0 | 0.0 - 3.0 |
| Raptors | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 1.0 | 0.0 - 3.0 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |
| Small Birds | 0.0 | 0.0 - 0.0 | 2.0 | 0.0 - 6.0 | 1.0 | 0.0 - 3.0 | 8.0 | 4.0 - 13.0 | 1.0 | 0.0 - 3.0 |
| **Observed Fatality Rates (Fatalities/Turbine/Season(s))** | | | | | | | | | | |
| Bats | 0.0 | 0.0 - 0.059 | 0.706 | 0.412 - 1.118 | 1.647 | 1.118 - 2.353 | 5.176 | 3.647 - 7.359 | 0.278 | 0.056 - 0.556 |
| Large Birds | 0.029 | 0.0 - 0.086 | 0.029 | 0.0 - 0.086 | 0.057 | 0.0 - 0.116 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |
| All Birds | 0.029 | 0.0 - 0.086 | 0.086 | 0.0 - 0.200 | 0.086 | 0.029 - 0.171 | 0.229 | 0.114 - 0.371 | 0.029 | 0.0 - 0.086 |
| Raptors | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.029 | 0.0 - 0.086 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |

**Appendix B4. Estimated fatality rates and correction factors, with 90% confidence intervals, for control group road and pad studies conducted at the Black Oak Getty Wind Energy Project, Stearns County, MN, from April 4, 2018, to November 1, 2018.**

| | SPRING | | SUMMER1 | | SUMMER2 | | FALL1 | | FALL2 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** |
| Small Birds | 0.0 | 0.0 - 0.0 | 0.057 | 0.0 - 0.171 | 0.029 | 0.0 - 0.086 | 0.229 | 0.114 - 0.371 | 0.029 | 0.0 - 0.086 |
| **Adjusted Fatality Rates (Fatalities/Turbine/Seasons(s))** | | | | | | | | | | |
| Bats | 0.0 | 0.0 - 0.568 | 6.560 | 3.779 - 10.803 | 14.445 | 9.830 - 21.309 | 51.458 | 35.619 - 78.168 | 2.724 | 0.647 - 5.731 |
| Large Birds | 0.226 | 0.0 - 0.680 | 0.226 | 0.0 - 0.611 | 0.311 | 0.0 - 0.848 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |
| All Birds | 0.226 | 0.0 - 0.680 | 1.427 | 0.0 - 3.850 | 0.823 | 0.161 - 1.833 | 4.009 | 1.801 - 6.738 | 0.513 | 0.0 - 1.534 |
| Raptors | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.123 | 0.0 - 0.368 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |
| Small Birds | 0.0 | 0.0 - 0.0 | 1.200 | 0.0 - 3.625 | 0.513 | 0.0 - 1.412 | 4.009 | 1.801 - 6.738 | 0.513 | 0.0 - 1.534 |
| **Adjusted Fatality Rates (Fatalities/MW/Seasons(s))** | | | | | | | | | | |
| Bats | 0.0 | 0.0 - 0.284 | 3.280 | 1.889 - 5.401 | 7.222 | 4.915 - 10.654 | 25.729 | 17.810 - 39.084 | 1.362 | 0.323 - 2.865 |
| Large Birds | 0.113 | 0.0 - 0.340 | 0.113 | 0.0 - 0.306 | 0.155 | 0.0 - 0.424 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |
| All Birds | 0.113 | 0.0 - 0.340 | 0.713 | 0.0 - 1.925 | 0.412 | 0.080 - 0.917 | 2.004 | 0.900 - 3.369 | 0.256 | 0.0 - 0.767 |
| Raptors | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 | 0.061 | 0.0 - 0.184 | 0.0 | 0.0 - 0.0 | 0.0 | 0.0 - 0.0 |
| Small Birds | 0.0 | 0.0 - 0.0 | 0.600 | 0.0 - 1.812 | 0.256 | 0.0 - 0.706 | 2.004 | 0.900 - 3.369 | 0.256 | 0.0 - 0.767 |

**Appendix B5. Estimated fatality rates and correction factors, with 90% confidence intervals, for treatment group road and pad for studies conducted at the Black Oak Getty Wind Energy Project, Stearns County, MN, from April 4, 2018, to November 1, 2018.**

| | SPRING | | SUMMER1 | | SUMMER2 | | FALL1 | | FALL2 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** |
| **Search Area Adjustment** | | | | | | | | | | |
| A (Bats) | 0.179 | 0.133 - 0.238 | 0.179 | 0.133 - 0.238 | 0.179 | 0.133 - 0.238 | 0.179 | 0.133 - 0.238 | 0.179 | 0.133 - 0.238 |
| **Observer Detection Rate** | | | | | | | | | | |
| P (Bats) | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 | 0.694 | 0.607 - 0.773 |
| **Probability of a Carcass Persisting Through the Search Interval** | | | | | | | | | | |
| Bats | 0.865 | 0.799 - 0.902 | 0.890 | 0.808 - 0.939 | 0.926 | 0.868 - 0.960 | 0.821 | 0.726 - 0.879 | 0.821 | 0.726 - 0.879 |
| **Probability of Available and Detected** | | | | | | | | | | |
| Bats | 0.601 | 0.516 - 0.671 | 0.618 | 0.525 - 0.701 | 0.643 | 0.555 - 0.722 | 0.570 | 0.472 - 0.653 | 0.570 | 0.472 - 0.653 |
| **Unadjusted Number of Fatalities** | | | | | | | | | | |
| Bats | 1.0 | 0.0 - 3.0 | 9.0 | 4.0 - 13.0 | 16.0 | 7.0 - 24.0 | 50.0 | 29.0 - 63.0 | 3.0 | 0.0 - 5.0 |
| **Observed Fatality Rates (Fatalities/Turbine/Season(s))** | | | | | | | | | | |
| Bats | 0.056 | 0.0 - 0.167 | 0.500 | 0.222 - 0.722 | 0.889 | 0.389 - 1.333 | 2.778 | 1.611 - 3.500 | 0.176 | 0.0 - 0.294 |
| **Adjusted Fatality Rates (Fatalities/Turbine/Seasons(s))** | | | | | | | | | | |

**Appendix B5. Estimated fatality rates and correction factors, with 90% confidence intervals, for treatment group road and pad for studies conducted at the Black Oak Getty Wind Energy Project, Stearns County, MN, from April 4, 2018, to November 1, 2018.**

| | SPRING | | SUMMER1 | | SUMMER2 | | FALL1 | | FALL2 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** |
| Bats | 0.541 | 0.0 - 1.541 | 4.593 | 1.920 - 6.963 | 7.736 | 3.259 - 11.944 | 27.445 | 16.123 - 36.396 | 1.685 | 0.0 - 3.196 |
| **Adjusted Fatality Rates (Fatalities/MW/Seasons(s))** | | | | | | | | | | |
| Bats | 0.270 | 0.0 - 0.770 | 2.297 | 0.960 - 3.482 | 3.868 | 1.630 - 5.972 | 13.723 | 8.062 - 18.198 | 0.843 | 0.0 - 1.598 |

# Appendix C. Shoenfeld Estimates for the 2018 Post-Construction Surveys at the Black Oak Getty Wind Project

**Appendix C1. Estimated fatality rates and correction factors, with 90% confidence intervals (CI), for cleared plot studies conducted at the Black Oak Getty Wind Project from March 15 to November 16, 2017.**

| | SPRING – Cleared plot | | SUMMER – Cleared plot | | FALL – Cleared plot | |
|---|---|---|---|---|---|---|
| **Parameter** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** |
| Search Area Adjustment | | | | | | |
| A (Bat) | 1.00 | 1.00 - 1.00 | 1.00 | 1.00 - 1.00 | 1.00 | 1.00 - 1.00 |
| A (Large Birds) | 0.88 | 0.88 - 0.88 | 0.88 | 0.88 - 0.88 | 0.88 | 0.88 - 0.88 |
| A (Small Birds) | 0.99 | 0.99 - 1.00 | 0.99 | 0.99 - 1.00 | 0.99 | 0.99 - 1.00 |
| Observer Detection Rate | | | | | | |
| P (Bat) | 0.81 | 0.73 - 0.88 | 0.81 | 0.73 - 0.88 | 0.81 | 0.73 - 0.88 |
| P (Large Birds) | 0.94 | 0.89 - 0.98 | 0.94 | 0.89 - 0.98 | 0.94 | 0.89 - 0.98 |
| P (Small Birds) | 0.74 | 0.61 - 0.85 | 0.74 | 0.61 - 0.85 | 0.74 | 0.61 - 0.85 |
| Average Removal Time (days) | | | | | | |
| Bat | 7.85 | 5.75 - 10.14 | 7.85 | 5.75 - 10.14 | 7.85 | 5.75 - 10.14 |
| Large Birds | 18.34 | 9.69 - 35.31 | 8.41 | 4.88 - 12.55 | 6.68 | 3.84 - 9.50 |
| Small Birds | 7.46 | 5.67 - 9.54 | 7.46 | 5.67 - 9.54 | 7.46 | 5.67 - 9.54 |
| Probability of Available and Detected | | | | | | |
| Bat | 0.58 | 0.51 - 0.78 | 0.74 | 0.51 - 0.78 | 0.58 | 0.51 - 0.78 |
| Large Birds | 0.81 | 0.73 - 0.94 | 0.80 | 0.54 - 0.85 | 0.59 | 0.47 - 0.81 |
| Small Birds | 0.53 | 0.46 - 0.76 | 0.70 | 0.46 - 0.76 | 0.53 | 0.46 - 0.76 |
| Unadjusted Number of Fatalities | | | | | | |
| All Birds | 6.00 | 3.00 - 10.00 | 11.0 | 8.00 - 15.00 | 11.0 | 6.00 - 17.00 |
| Bat | 3.00 | - | 70.0 | 47.00 - 91.00 | 21.0 | 18.00 - 25.00 |
| Large Birds | 0 | - | 4.00 | - | 0 | - |
| Small Birds | 6.00 | 3.00 - 10.00 | 7.00 | 5.00 - 9.00 | 11.0 | 6.00 - 17.00 |
| Observed Fatality Rates (Fatalities/Turbine/Season(s)) | | | | | | |
| All Birds | 1.20 | 0.60 - 2.00 | 2.20 | 1.60 - 3.00 | 2.20 | 1.20 - 3.40 |
| Bat | 0.60 | - | 14.00 | 9.40 - 18.20 | 4.20 | 3.60 - 5.0 |
| Large Birds | 0 | - | 0.80 | - | 0 | - |
| Small Birds | 1.20 | 0.60 - 2.00 | 1.40 | 1.00 - 1.80 | 2.20 | 1.20 - 3.40 |
| Adjusted Fatality Rates (Fatalities/Turbine/Seasons(s)) | | | | | | |
| All Birds | 1.73 | 0.82 - 2.90 | 3.16 | 2.21 - 4.37 | 3.16 | 1.61 - 5.11 |
| Bat | 0.81 | - | 18.93 | 12.38 - 25.32 | 5.68 | 4.73 - 6.92 |
| Large Birds | 0 | - | 1.14 | - | 0 | - |
| Small Birds | 1.73 | 0.82 - 2.90 | 2.01 | 1.47 - 2.67 | 3.16 | 1.61 - 5.11 |
| Adjusted Fatality Rates (Fatalities/Megawatt/Seasons(s)) | | | | | | |
| All Birds | 0.86 | 0.41 - 1.45 | 1.58 | 1.11 - 2.18 | 1.58 | 0.80 - 2.56 |
| Bat | 0.41 | - | 9.47 | 6.19 - 12.66 | 2.84 | 2.36 - 3.46 |
| Large Birds | 0 | - | 0.57 | - | 0 | - |
| Small Birds | 0.86 | 0.41 - 1.45 | 1.01 | 0.74 - 1.34 | 1.58 | 0.80 - 2.56 |

**Appendix C2. Overall fatality rates per turbine for cleared plot studies conducted at the Black Oak Getty Wind Project from March 15 - November 16, 2017.**

| | OVERALL – Cleared plot/Turb | | OVERALL – Cleared plot/Megawatt | |
|---|---|---|---|---|
| | **Estimate** | **90% CI** | **Estimate** | **90% CI** |
| All Birds | 8.04 | 6.14 - 10.21 | 4.02 | 3.07 - 5.11 |
| Bat | 25.42 | 20.01 - 31.17 | 12.71 | 10.01 - 15.58 |
| Large Birds | 1.14 | - | 0.57 | - |
| Small Birds | 6.90 | 4.46 - 9.70 | 3.45 | 2.23 - 4.85 |

**Appendix C3. Estimated fatality rates and correction factors, with 90% confidence intervals (CI), for road & pad studies conducted at the Black Oak Getty Wind Project from March 15 to November 16, 2017.**

| | SPRING – Road & Pad | | SUMMER - Road & Pad | | FALL - Road & Pad | |
|---|---|---|---|---|---|---|
| **Parameter** | **Estimate** | **90% CI** | **Estimate** | **90% CI** | **Estimate** | **90% CI** |
| Search Area Adjustment | | | | | | |
| A (Bat) | 0.13 | 0.09 - 0.21 | 0.13 | 0.09 - 0.21 | 0.13 | 0.09 - 0.21 |
| A (Large Birds) | 0.18 | 0.18 - 0.18 | 0.18 | 0.18 - 0.18 | 0.18 | 0.18 - 0.18 |
| A (Small Birds) | 0.03 | 0.02 - 0.14 | 0.03 | 0.02 - 0.14 | 0.03 | 0.02 - 0.14 |
| Observer Detection Rate | | | | | | |
| P (Bat) | 0.81 | 0.73 - 0.88 | 0.81 | 0.73 - 0.88 | 0.81 | 0.73 - 0.88 |
| P (Large Birds) | 0.94 | 0.89 - 0.98 | 0.94 | 0.89 - 0.98 | 0.94 | 0.89 - 0.98 |
| P (Small Birds) | 0.92 | 0.83 - 0.97 | 0.92 | 0.83 - 0.97 | 0.92 | 0.83 - 0.97 |
| Average Removal Time (days) | | | | | | |
| Bat | 7.85 | 5.75 - 10.14 | 7.85 | 5.75 - 10.14 | 7.85 | 5.75 - 10.14 |
| Large Birds | 18.34 | 9.69 - 35.31 | 8.41 | 4.88 - 12.55 | 6.68 | 3.84 - 9.50 |
| Small Birds | 7.46 | 5.67 - 9.54 | 7.46 | 5.67 - 9.54 | 7.46 | 5.67 - 9.54 |
| Probability of Available and Detected | | | | | | |
| Bat | 0.58 | 0.51 - 0.78 | 0.74 | 0.51 - 0.78 | 0.74 | 0.51 - 0.78 |
| Large Birds | 0.81 | 0.73 - 0.94 | 0.80 | 0.54 - 0.85 | 0.59 | 0.47 - 0.81 |
| Small Birds | 0.61 | 0.55 - 0.81 | 0.77 | 0.55 - 0.81 | 0.77 | 0.55 - 0.81 |
| Unadjusted Number of Fatalities | | | | | | |
| All Birds | 2.00 | - | 6.00 | 3.00 - 10.00 | 7.00 | 3.00 - 12.00 |
| Bat | 6.00 | 3.00 - 10.00 | 117.00 | 94.0 - 141.0 | 12.00 | 8.00 - 16.05 |
| Large Birds | 2.00 | - | 1.00 | - | 1.00 | - |
| Small Birds | 0 | - | 5.00 | - | 6.00 | 2.00 - 11.00 |
| Observed Fatality Rates (Fatalities/Turbine/Season(s)) | | | | | | |
| All Birds | 0.06 | - | 0.18 | 0.09 - 0.29 | 0.21 | 0.09 - 0.35 |
| Bat | 0.18 | 0.09 - 0.29 | 3.44 | 2.76 - 4.15 | 0.35 | 0.24 - 0.47 |
| Large Birds | 0.06 | - | 0.03 | - | 0.03 | - |
| Small Birds | 0 | - | 0.15 | - | 0.18 | 0.06 - 0.32 |
| Adjusted Fatality Rates (Fatalities/Turbine/Seasons(s)) | | | | | | |
| All Birds | 0.41 | - | 8.14 | 1.99 - 17.10 | 9.74 | 2.30 - 20.97 |
| Bat | 2.31 | 0.84 - 4.40 | 44.99 | 27.42 - 71.62 | 4.61 | 2.43 - 7.98 |
| Large Birds | 0.41 | - | 0.25 | - | 0.28 | - |
| Small Birds | 0 | - | 7.89 | - | 9.46 | 2.04 - 20.55 |
| Adjusted Fatality Rates (Fatalities/Megawatt/Seasons(s)) | | | | | | |
| All Birds | 0.20 | - | 4.07 | 1.00 - 8.55 | 4.87 | 1.15 - 10.49 |
| Bat | 1.15 | 0.42 - 2.20 | 22.49 | 13.71 - 35.81 | 2.31 | 1.22 - 3.99 |
| Large Birds | 0.20 | - | 0.13 | - | 0.14 | - |
| Small Birds | 0 | - | 3.94 | - | 4.73 | 1.02 - 10.27 |

**Appendix C4. Overall fatality rates per turbine for road and pad studies conducted at the Black Oak Getty Wind Project from March 15 to November 16, 2017.**

| | OVERALL – Road & Pad/Turbine | | OVERALL – Road & Pad/Megawatt | |
|---|---|---|---|---|
| | **Estimate** | **90% CI** | **Estimate** | **90% CI** |
| All Birds | 18.29 | 5.70 - 35.65 | 9.14 | 2.85 - 17.83 |
| Bat | 51.91 | 31.60 - 82.18 | 25.95 | 15.80 - 41.09 |
| Large Birds | 0.94 | - | 0.47 | - |
| Small Birds | 17.35 | 4.61 - 34.70 | 8.68 | 2.30 - 17.35 |

# Appendix D. North American Fatality Summary Tables

**Appendix D1. Wind energy facilities in the Midwest with fatality data for all bird species, by geographic region.**

| Project Name | Fatality Estimate[A] | No. of Turbines | Total MW |
|---|---|---|---|
| **Black Oak Getty 2018** | **3.50 – 5.22** | **39** | **78** |
| Wellsburg, IA (2016) | 8.44 | 60 | 140.80 |
| Wessington Springs, SD (2009) | 8.25 | 34 | 51.00 |
| Blue Sky Green Field, WI (2008; 2009) | 7.17 | 88 | 145.00 |
| Cedar Ridge, WI (2009) | 6.55 | 41 | 67.60 |
| Buffalo Ridge, MN (Phase III; 1999) | 5.93 | 138 | 103.50 |
| Vienna I, IA (2016) | 5.7 | 45 | 105.60 |
| Moraine II, MN (2009) | 5.59 | 33 | 49.50 |
| Barton I & II, IA (2010-2011) | 5.5 | 80 | 160.00 |
| Buffalo Ridge I, SD (2009-2010) | 5.06 | 24 | 50.40 |
| Macksburg, IA (2014 - 2016) | 3.38 – 4.94 | 48 | 119.60 |
| Adair, IA (2015) | 4.64 | 76 | 174.80 |
| Black Oak Getty, MN (2017) | 4.37 | 39 | 78.00 |
| Buffalo Ridge, MN (Phase I; 1996) | 4.14 | 73 | 25.00 |
| Charles City, IA (2016) | 4.13 | 50 | 75.00 |
| Winnebago, IA (2009-2010) | 3.88 | 10 | 20.00 |
| Rugby, ND (2010-2011) | 3.82 | 71 | 149.00 |
| Cedar Ridge, WI (2010) | 3.72 | 41 | 68.00 |
| Elm Creek II, MN (2011-2012) | 3.64 | 62 | 148.80 |
| Vienna II, IA (2016) | 3.57 | 19 | 44.60 |
| Buffalo Ridge, MN (Phase II; 1999) | 3.57 | 143 | 107.25 |
| Carroll, IA (2015) | 3.55 | 100 | 150.00 |
| Century, IA (2016) | 3.54 | 145 | 200.00 |
| Lundgren, IA (2014 - 2016) | 2.91 – 3.37 | 107 | 251.00 |
| Rolling Hills, IA (2014 - 2016) | 1.79 – 3.48 | 193 | 443.90 |
| Buffalo Ridge, MN (Phase I; 1998) | 3.14 | 73 | 25.00 |
| Ripley, Ont (2008) | 3.09 | 38 | 76.00 |
| Laurel, IA (2016) | 2.96 | 52 | 119.60 |
| Intrepid, IA (2016) | 2.93 | 122 | 175.50 |
| Walnut, IA (2015) | 2.88 | 102 | 153.00 |
| Fowler I, IN (2009) | 2.83 | 162 | 301.00 |
| Pomeroy, IA (2016) | 2.76 | 184 | 286.40 |
| Buffalo Ridge, MN (Phase I; 1997) | 2.51 | 73 | 25.00 |
| Buffalo Ridge, MN (Phase II; 1998) | 2.47 | 143 | 107.25 |
| Morning Light, IA (2015) | 2.36 | 44 | 101.20 |
| Highland, IA (2016) | 2.25 | 217 | 502.00 |
| PrairieWinds SD1, SD (2012-2013) | 2.01 | 108 | 162.00 |
| Buffalo Ridge II, SD (2011-2012) | 1.99 | 105 | 210.00 |
| Kewaunee County, WI (1999-2001) | 1.95 | 31 | 20.46 |
| PrairieWinds SD1, SD (2013-2014) | 1.66 | 108 | 162.00 |
| NPPD Ainsworth, NE (2006) | 1.63 | 36 | 20.50 |
| Adams, IA (2016) | 1.56 | 64 | 154.30 |
| PrairieWinds ND1 (Minot), ND (2011) | 1.56 | 80 | 115.50 |
| Elm Creek, MN (2009-2010) | 1.55 | 67 | 100.00 |
| Victory, IA (2015) | 1.52 | 55 | 99.00 |

**Appendix D1. Wind energy facilities in the Midwest with fatality data for all bird species, by geographic region.**

| Project Name | Fatality Estimate[A] | No. of Turbines | Total MW |
|---|---|---|---|
| PrairieWinds ND1 (Minot), ND (2010) | 1.48 | 80 | 115.50 |
| Buffalo Ridge, MN (Phase I; 1999) | 1.43 | 73 | 25.00 |
| PrairieWinds SD1, SD (2011-2012) | 1.41 | 108 | 162.00 |
| Top Crop I & II (2012-2013) | 1.35 | 68 phase I, 132 phase II | 300 (102 phase I, 198 phase II) |
| Heritage Garden I, MI (2012-2014) | 1.3 | 14 | 28.00 |
| Wessington Springs, SD (2010) | 0.89 | 34 | 51.00 |
| Rail Splitter, IL (2012-2013) | 0.84 | 67 | 100.50 |
| Top of Iowa, IA (2004) | 0.81 | 89 | 80.00 |
| Big Blue, MN (2013) | 0.6 | 18 | 36.00 |
| Grand Ridge I, IL (2009-2010) | 0.48 | 66 | 99.00 |
| Top of Iowa, IA (2003) | 0.42 | 89 | 80.00 |
| Big Blue, MN (2014) | 0.37 | 18 | 36.00 |
| Pioneer Prairie I, IA (Phase II; 2011-2012) | 0.27 | 62 | 102.30 |

A=number of bird fatalities/MW/year

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

| Wind Energy Facility/Study | Fatality Estimate Citation | Wind Energy Facility/Study | Fatality Estimate Citation |
|---|---|---|---|
| Barton I & II, IA (2010-2011) | Derby et al. 2011b | Heritage Garden I, MI (2012-2014) | Kerlinger et al. 2014 |
| Big Blue, MN (2013) | Fagen Engineering 2014 | Kewaunee County, WI (1999-2001) | Howe et al. 2002 |
| Big Blue, MN (2014) | Fagen Engineering 2015 | Moraine II, MN (2009) | Derby et al. 2010f |
| Black Oak Getty, MN (2017) | Pickle et al. 2018 | NPPD Ainsworth, NE (2006) | Derby et al. 2007 |
| Blue Sky Green Field, WI (2008; 2009) | Gruver et al. 2009 | Pioneer Prairie I, IA (Phase II; 2011-2012) | Chodachek et al. 2012 |
| Buffalo Ridge I, SD (2009-2010) | Derby et al. 2010d | PrairieWinds ND1 (Minot), ND (2010) | Derby et al. 2011d |
| Buffalo Ridge II, SD (2011-2012) | Derby et al. 2012a | PrairieWinds ND1 (Minot), ND (2011) | Derby et al. 2012d |
| Buffalo Ridge, MN (Phase I; 1996) | Johnson et al. 2000 | PrairieWinds SD1, SD (2011-2012) | Derby et al. 2012c |
| Buffalo Ridge, MN (Phase I; 1997) | Johnson et al. 2000 | PrairieWinds SD1, SD (2012-2013) | Derby et al. 2013 |
| Buffalo Ridge, MN (Phase I; 1998) | Johnson et al. 2000 | PrairieWinds SD1, SD (2013-2014) | Derby et al. 2014 |
| Buffalo Ridge, MN (Phase I; 1999) | Johnson et al. 2000 | Rail Splitter, IL (2012-2013) | Good et al. 2013b |
| Buffalo Ridge, MN (Phase II; 1998) | Johnson et al. 2000 | Ripley, Ont (2008) | Jacques Whitford 2009 |
| Buffalo Ridge, MN (Phase II; 1999) | Johnson et al. 2000 | Rugby, ND (2010-2011) | Derby et al. 2011c |
| Buffalo Ridge, MN (Phase III; 1999) | Johnson et al. 2000 | Top Crop I & II (2012-2013) | Good et al. 2013c |
| Cedar Ridge, WI (2009) | | Top of Iowa, IA (2003) | Jain 2005 |
| Cedar Ridge, WI (2010) | BHE Environmental 2010 | Top of Iowa, IA (2004) | Jain 2005 |
| Elm Creek II, MN (2011-2012) | BHE Environmental 2011 | Wessington Springs, SD (2009) | Derby et al. 2010c |
| Elm Creek, MN (2009-2010) | Derby et al. 2010e | Wessington Springs, SD (2010) | Derby et al. 2011a |
| Fowler I, IN (2009) | Johnson et al. 2010a | Winnebago, IA (2009-2010) | Derby et al. 2010g |
| Grand Ridge I, IL (2009-2010) | Derby et al. 2010a | | |

**Appendix D2. Wind energy facilities in the Midwestern region of North America with fatality data for raptors.**

| Wind Energy Facility | Use Estimate[A] | Raptor Fatality Estimate[B] | No. of Turbines | Total MW |
|---|---|---|---|---|
| **Black Oak Getty, MN 2018** | **NA** | **0 – 0.6** | **39** | **78** |
| Buffalo Ridge, MN (Phase I; 1999) | NA | 0.47 | 73 | 25.00 |
| Moraine II, MN (2009) | NA | 0.37 | 33 | 49.50 |
| Winnebago, IA (2009-2010) | NA | 0.27 | 10 | 20.00 |
| Buffalo Ridge I, SD (2009-2010) | NA | 0.20 | 24 | 50.40 |
| Cedar Ridge, WI (2009) | NA | 0.18 | 41 | 67.60 |
| PrairieWinds SD1, SD (2013-2014) | NA | 0.17 | 108 | 162.00 |
| Top of Iowa, IA (2004) | NA | 0.17 | 89 | 80.00 |
| Cedar Ridge, WI (2010) | NA | 0.13 | 41 | 68.00 |
| Ripley, Ont (2008) | NA | 0.10 | 38 | 76.00 |
| Wessington Springs, SD (2010) | 0.232 | 0.07 | 34 | 51.00 |
| Rugby, ND (2010-2011) | NA | 0.06 | 71 | 149.00 |
| NPPD Ainsworth, NE (2006) | NA | 0.06 | 36 | 20.50 |
| Wessington Springs, SD (2009) | 0.232 | 0.06 | 34 | 51.00 |
| PrairieWinds ND1 (Minot), ND (2011) | NA | 0.05 | 80 | 115.50 |
| PrairieWinds ND1 (Minot), ND (2010) | NA | 0.05 | 80 | 115.50 |
| PrairieWinds SD1, SD (2012-2013) | NA | 0.03 | 108 | 162.00 |
| Black Oak Getty, MN (2017) | ? | 0 | 39 | 78.00 |
| Elm Creek, MN (2009-2010) | NA | 0 | 67 | 100 |
| Rail Splitter, IL (2012-2013) | NA | 0 | 67 | 100.50 |
| Pioneer Prairie I, IA (Phase II; 2011-2012) | NA | 0 | 62 | 102.30 |
| Buffalo Ridge, MN (Phase III; 1999) | NA | 0 | 138 | 103.50 |
| Buffalo Ridge, MN (Phase II; 1998) | NA | 0 | 143 | 107.25 |
| Buffalo Ridge, MN (Phase II; 1999) | NA | 0 | 143 | 107.25 |
| Blue Sky Green Field, WI (2008; 2009) | NA | 0 | 88 | 145.00 |
| Elm Creek II, MN (2011-2012) | NA | 0 | 62 | 148.80 |
| Barton I & II, IA (2010-2011) | NA | 0 | 80 | 160.00 |
| PrairieWinds SD1, SD (2011-2012) | NA | 0 | 108 | 162.00 |
| Kewaunee County, WI (1999-2001) | NA | 0 | 31 | 20.46 |
| Buffalo Ridge II, SD (2011-2012) | NA | 0 | 105 | 210.00 |
| Buffalo Ridge, MN (Phase I; 1996) | NA | 0 | 73 | 25.00 |
| Buffalo Ridge, MN (Phase I; 1997) | NA | 0 | 73 | 25.00 |
| Buffalo Ridge, MN (Phase I; 1998) | NA | 0 | 73 | 25.00 |
| Fowler I, IN (2009) | NA | 0 | 162 | 301.00 |
| Big Blue, MN (2013) | NA | 0 | 18 | 36.00 |
| Big Blue, MN (2014) | NA | 0 | 18 | 36.00 |
| Top of Iowa, IA (2003) | NA | 0 | 89 | 80.00 |
| Grand Ridge I, IL (2009-2010) | 0.195 | 0 | 66 | 99.00 |

A=number of raptors/plot/20-minute survey

B=number of fatalities/megawatt(MW)/year

**Appendix D2 (*continued*). Wind energy facilities in the Midwestern region of North America with fatality data for raptors. Data from the following sources:**

| Wind Energy Facility/Study | Use Estimate Report Citation | Facility Estimate Report Citation | Wind Energy Facility/Study | Use Estimate Report Citation | Facility Estimate Report Citation |
|---|---|---|---|---|---|
| Barton I & II, IA (2010-2011) | - | Derby et al. 2011b | Grand Ridge I, IL (2009-2010) | Derby et al. 2009 | Derby et al. 2010a |
| Big Blue, MN (2013) | - | Fagen Engineering 2014 | Kewaunee County, WI (1999-2001) | - | Howe et al. 2002 |
| Big Blue, MN (2014) | - | Fagen Engineering 2015 | Moraine II, MN (2009) | - | Derby et al. 2010f |
| Black Oak Getty, MN (2017) | - | Pickle et al. 2018 | NPPD Ainsworth, NE (2006) | - | Derby et al. 2007 |
| Blue Sky Green Field, WI (2008; 2009) | - | Gruver et al. 2009 | Pioneer Prairie I, IA (Phase II; 2011-2012) | - | Chodachek et al. 2012 |
| Buffalo Ridge I, SD (2009-2010) | - | Derby et al. 2010d | PrairieWinds ND1 (Minot), ND (2010) | - | Derby et al. 2011d |
| Buffalo Ridge II, SD (2011-2012) | - | Derby et al. 2012a | PrairieWinds ND1 (Minot), ND (2011) | - | Derby et al. 2012d |
| Buffalo Ridge, MN (Phase I; 1996) | - | Johnson et al. 2000 | PrairieWinds SD1, SD (2011-2012) | - | Derby et al. 2012c |
| Buffalo Ridge, MN (Phase I; 1997) | - | Johnson et al. 2000 | PrairieWinds SD1, SD (2012-2013) | - | Derby et al. 2013 |
| Buffalo Ridge, MN (Phase I; 1998) | - | Johnson et al. 2000 | PrairieWinds SD1, SD (2013-2014) | - | Derby et al. 2014 |
| Buffalo Ridge, MN (Phase I; 1999) | - | Johnson et al. 2000 | Rail Splitter, IL (2012-2013) | - | Good et al. 2013b |
| Buffalo Ridge, MN (Phase II; 1998) | - | Johnson et al. 2000 | Ripley, Ont (2008) | - | Jacques Whitford 2009 |
| Buffalo Ridge, MN (Phase II; 1999) | - | Johnson et al. 2000 | Rugby, ND (2010-2011) | - | Derby et al. 2011c |
| Buffalo Ridge, MN (Phase III; 1999) | - | Johnson et al. 2000 | Top of Iowa, IA (2003) | - | Jain 2005 |
| Cedar Ridge, WI (2009) | - | BHE Environmental 2010 | Top of Iowa, IA (2004) | - | Jain 2005 |
| Cedar Ridge, WI (2010) | - | BHE Environmental 2011 | Wessington Springs, SD (2009) | Derby et al. 2008 | Derby et al. 2010c |
| Elm Creek II, MN (2011-2012) | - | Derby et al. 2010e | Wessington Springs, SD (2010) | - | Derby et al. 2011a |
| Elm Creek, MN (2009-2010) | - | Derby et al. 2012b | Winnebago, IA (2009-2010) | - | Derby et al. 2010g |
| Fowler I, IN (2009) | - | Johnson et al. 2010a | | | |

**Appendix D3. Wind energy facilities in the Midwest with comparable activity and fatality data for bats.**

| Wind Energy Facility | Bat Activity Estimate[A] | Bat Activity Dates | Fatality Estimate[B] | No. of Turbines | Total MW |
|---|---|---|---|---|---|
| **Black Oak Getty, MN 2018** | **8.3** | **04/16/12 – 10/31/12** | **21.00 – 37.59** | **39** | **78** |
| | | ***Midwest*** | | | |
| Macksburg, IA (2015) | | | 73.08 | 48 | 119.6 |
| Cedar Ridge, WI (2009) | 10.0 [C,E,F] | 7/16/07-9/30/07 | 30.61 | 41 | 67.6 |
| Black Oak Getty, MN road/pads (2017) | 8.3 | 4/16/12-10/31/12 | 29.88 | 39 | 78 |
| Lundgren, IA (2015) | | | 28.74 | 107 | 251.0 |
| Blue Sky Green Field, WI | 7.7 [F] | 7/24/07-10/29/07 | 24.57 | 88 | 145 |
| Cedar Ridge, WI (2010) | 10.0 [C,E,F] | 7/16/07-09/30/07 | 24.12 | 41 | 68 |
| Walnut, IA (2015) | | | 21.69 | 102 | 153.0 |
| Morning Light, IA (2015) | | | 20.19 | 44 | 101.2 |
| Fowler I, II, III, IN (2011) | | | 20.19 | 355 | 600 |
| Fowler I, II, III, IN (2010) | | | 18.96 | 355 | 600 |
| Intrepid, IA (2016) | | | 18.37 | 122 | 175.5 |
| Forward Energy Center, WI | 6.97 | 8/5/08-11/08/08 | 18.17 | 86 | 129 |
| Laurel, IA (2016) | | | 14.22 | 52 | 119.6 |
| Adair, IA (2015) | | | 14.05 | 76 | 174.8 |
| Black Oak Getty, MN cleared plots (2018) | 8.3 | 4/16/12-10/31/12 | 13.03 | 39 | 78 |
| Top Crop I & II (2012-2013) | | | 12.55 | 68 phase I, 132 phase II | 300 (102 phase I, 198 phase II) |
| Wellsburg, IA (2016) | | | 12.3 | 60 | 140.8 |
| Carroll, IA (2015) | | | 11.71 | 100 | 150.0 |
| Rail Splitter, IL (2012-2013) | | | 11.21 | 67 | 100.5 |
| Harrow, Ont (2010) | | | 11.13 | 24 (four 6-turbine facilities) | 39.6 |
| Macksburg, IA (2016) | | | 10.79 | 48 | 119.6 |
| Charles City, IA (2016) | | | 10.41 | 50 | 75.0 |
| Vienna II, IA (2016) | | | 10.28 | 19 | 44.6 |
| Top of Iowa, IA (2004) | 35.7 | 5/26/04-9/24/04 | 10.27 | 89 | 80 |
| Adams, IA (2016) | | | 10.08 | 64 | 154.3 |
| Pioneer Prairie I, IA (Phase II; 2011-2012) | | | 10.06 | 62 | 102.3 |
| Eclipse, IA (2015) | | | 10.01 | 87 | 200.1 |
| Vienna I, IA (2016) | | | 9.09 | 45 | 105.6 |
| Century, IA (2016) | | | 9.07 | 145 | 200.0 |
| Lundgren, IA (2016) | | | 8.8 | 107 | 251.0 |
| Highland, IA (2016) | | | 8.63 | 217 | 502 |
| 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 |
| Victory, IA (2015) | | | 6.48 | 66 | 99.0 |
| Kewaunee County, WI | | | 6.45 | 31 | 20.46 |
| Rolling Hills, IA (2016) | | | 6.3 | 193 | 443.9 |
| Pomeroy, IA (2016) | | | 6.25 | 184 | 286.4 |
| Rolling Hills, IA (2015) | | | 6.13 | 193 | 443.9 |
| Ripley, Ont. (2008) | | | 4.67 | 38 | 76 |
| Winnebago, IA | | | 4.54 | 10 | 20 |

**Appendix D3. Wind energy facilities in the Midwest with comparable activity and fatality data for bats.**

| Wind Energy Facility | Bat Activity Estimate[A] | Bat Activity Dates | Fatality Estimate[B] | No. of Turbines | Total MW |
|---|---|---|---|---|---|
| Buffalo Ridge, MN (Phase II; 2001/Lake Benton I) | 2.2 [D] | 6/15/01-9/15/01 | 4.35 | 143 | 107.25 |
| Buffalo Ridge, MN (Phase III; 2001/Lake Benton II) | 2.2 [D] | 6/15/01-9/15/01 | 3.71 | 138 | 103.5 |
| Crescent Ridge, IL | | | 3.27 | 33 | 54.45 |
| 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 |
| Prairie Winds (Minot), ND | | | 2.13 | 80 | 115.5 |
| Grand Ridge, IL | | | 2.10 | 66 | 99 |
| Buffalo Ridge, MN (Phase III; 2002/Lake Benton II) | 1.9 [D] | 6/15/02-9/15/02 | 1.81 | 138 | 103.5 |
| Buffalo Ridge, MN (Phase II; 2002/Lake Benton I) | 1.9 [D] | 6/15/02-9/15/02 | 1.64 | 143 | 107.25 |
| Elm Creek, MN | | | 1.49 | 67 | 100 |
| Wessington Springs, SD | | | 1.48 | 34 | 51 |
| NPPD Ainsworth, NE | | | 1.16 | 36 | 20.5 |
| Buffalo Ridge, MN (Phase I; 1999) | | | 0.74 | 73 | 25 |
| Buffalo Ridge I, SD (2010) | | | 0.16 | 24 | 50.4 |

A = Bat passes per detector-night, from pre-construction surveys
B = Number of fatalities per megawatt per year, from post-construction fatality surveys
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 years
E = Activity rate calculated by WEST from data presented in referenced report
F= Activity rate based on pre-construction monitoring; data for all other activity and fatality rates were collected concurrently
G = The overall activity rate of 28.5 is from reference stations located along forest edges which may be attractive to bats; the activity rate of 0.3 is from one unit placed on a nacelle

**Appendix D3 (*continued*). Wind energy facilities in the Midwestern region of North America with comparable activity and fatality data for bats. Data from the following sources:**

| Wind Energy Facility/Study | Activity Estimate Report Citation | Fatality Estimate Report Citation | Wind Energy Facility/Study | Activity Estimate Report Citation | Fatality Estimate Report Citation |
|---|---|---|---|---|---|
| Adair, IA (2015) | NA | Bay et al. 2017a | Highland, IA (2016) | NA | Bay et al. 2017b |
| Adams, IA (2016) | NA | Bay et al. 2017b | Intrepid, IA (2016) | NA | Bay et al. 2017b |
| Barton I & II, IA (2010-2011) | NA | WEST 2011 | Kewaunee County, WI (1999-2001) | NA | Howe et al. 2002 |
| Big Blue, MN (2013) | NA | Fagen Engineering 2014 | Laurel, IA (2016) | NA | Bay et al. 2017b |
| Big Blue, MN (2014) | NA | Fagen Engineering 2015 | Lundgren, IA (2015) | NA | Bay et al. 2017a |
| Black Oak Getty, MN (2012, 2017) | Hamer Environmental 2012 | Pickle et al. 2018 | Lundgren, IA (2016) | NA | Bay et al. 2017b |
| Blue Sky Green Field, WI (2008; 2009) | Gruver 2008 | Gruver et al. 2009 | Macksburg, IA (2015) | NA | Bay et al. 2017a |
| Buffalo Ridge I, SD (2009-2010) | NA | Derby et al. 2010d | Macksburg, IA (2016) | NA | Bay et al. 2017b |
| Buffalo Ridge II, SD (2011-2012) | NA | Derby et al. 2012a | Moraine II, MN (2009) | NA | Derby et al. 2010f |
| Buffalo Ridge, MN (Phase I; 1999) | NA | Johnson et al. 2000 | Morning Light, IA (2015) | NA | Bay et al. 2017a |
| Buffalo Ridge, MN (Phase II; 1998) | NA | Johnson et al. 2000 | NPPD Ainsworth, NE (2006) | NA | Derby et al. 2007 |
| Buffalo Ridge, MN (Phase II; 1999) | NA | Johnson et al. 2000 | Pioneer Prairie I, IA (Phase II; 2011-2012) | NA | Chodachek et al. 2012 |
| Buffalo Ridge, MN (Phase II; 2001/Lake Benton I) | Johnson et al. 2004 | Johnson et al. 2004 | Pioneer Prairie II, IA (2013) | NA | Chodachek et al. 2014 |
| Buffalo Ridge, MN (Phase II; 2002/Lake Benton I) | Johnson et al. 2004 | Johnson et al. 2004 | Pomeroy, IA (2016) | NA | Bay et al. 2017b |
| Buffalo Ridge, MN (Phase III; 1999) | NA | Johnson et al. 2000 | PrairieWinds ND1 (Minot), ND (2010) | NA | Derby et al. 2011d |
| Buffalo Ridge, MN (Phase III; 2001/Lake Benton II) | Johnson et al. 2004 | Johnson et al. 2004 | PrairieWinds ND1 (Minot), ND (2011) | NA | Derby et al. 2012d |
| Buffalo Ridge, MN (Phase III; 2002/Lake Benton II) | Johnson et al. 2004 | Johnson et al. 2004 | PrairieWinds SD1, SD (2011-2012) | NA | Derby et al. 2012c |
| Carroll, IA (2015) | NA | Bay et al. 2017a | PrairieWinds SD1, SD (2012-2013) | NA | Derby et al. 2013 |
| Cedar Ridge, WI (2009) | BHE Environmental 2008 | BHE Environmental 2010 | PrairieWinds SD1, SD (2013-2014) | NA | Derby et al. 2014 |
| Cedar Ridge, WI (2010) | BHE Environmental 2008 | BHE Environmental 2011 | Rail Splitter, IL (2012-2013) | NA | Good et al. 2013b |
| Century, IA (2016) | NA | Bay et al. 2017b | Ripley, Ont (2008) | NA | Jacques Whitford |

**Appendix D3 (*continued*). Wind energy facilities in the Midwestern region of North America with comparable activity and fatality data for bats. Data from the following sources:**

| Wind Energy Facility/Study | Activity Estimate Report Citation | Fatality Estimate Report Citation | Wind Energy Facility/Study | Activity Estimate Report Citation | Fatality Estimate Report Citation |
|---|---|---|---|---|---|
| | | | | | 2009 |
| Charles City, IA (2016) | NA | Bay et al. 2017b | Rolling Hills, IA (2015) | NA | Bay et al. 2017a |
| Crescent Ridge, IL (2005-2006) | NA | Kerlinger et al. 2007 | Rolling Hills, IA (2016) | NA | Bay et al. 2017b |
| Crystal Lake II, IA (2009) | NA | Derby et al. 2010b | Rugby, ND (2010-2011) | NA | Derby et al. 2011c |
| Eclipse, IA (2015) | NA | Bay et al. 2017a | Top Crop I & II (2012-2013) | NA | Good et al. 2013c |
| Elm Creek II, MN (2011-2012) | NA | Derby et al. 2010e | Top of Iowa, IA (2003) | NA | Jain 2005 |
| Elm Creek, MN (2009-2010) | NA | Derby et al. 2012b | Top of Iowa, IA (2004) | Jain 2005 | Jain 2005 |
| Forward Energy Center, WI (2008-2010) | Watt and Drake 2011 | Grodsky and Drake 2011 | Victory, IA (2015) | NA | Bay et al. 2017a |
| Fowler I, II, III, IN (2010) | NA | Good et al. 2011 | Vienna I, IA (2016) | NA | Bay et al. 2017b |
| Fowler I, II, III, IN (2011) | NA | Good et al. 2012 | Vienna II, IA (2016) | NA | Bay et al. 2017b |
| Fowler I, II, III, IN (2012) | NA | Good et al. 2013a | Walnut, IA (2015) | NA | Bay et al. 2017a |
| Fowler I, IN (2009) | NA | Johnson et al. 2010a | Wellsburg, IA (2016) | NA | Bay et al. 2017b |
| Fowler III, IN (2009) | NA | Johnson et al. 2010b | Wessington Springs, SD (2009) | NA | Derby et al. 2010c |
| Grand Ridge I, IL (2009-2010) | NA | Derby et al. 2010a | Wessington Springs, SD (2010) | NA | Derby et al. 2011a |
| Harrow, Ont (2010) | NA | NRSI 2011 | Winnebago, IA (2009-2010) | NA | Derby et al. 2010g |
| Heritage Garden I, MI (2012-2014) | NA | Kerlinger et al. 2014 | | | |

**Appendix D4. Fatality estimates for wind-energy facilities in the Midwestern region of North America.**

| Wind Energy Facility | Bird Fatalities (bird/MW/year) | Raptor Fatalities (raptors/MW/year) | Bat Fatalities (bats/MW/year) | Predominant Habitat Type | Fatality Report Citation |
|---|---|---|---|---|---|
| Adair, IA (2015) | 4.64 | 0.07 | 14.05 | agriculture | Bay et al. 2017a |
| Adams, IA (2016) | 1.56 | NA | 10.08 | agriculture | Bay et al. 2017b |
| Barton I & II, IA (2010-2011) | 5.5 | 0 | 1.85 | agriculture | Derby et al. 2011b |
| Big Blue, MN (2013) | 0.6 | 0 | 2.04 | agriculture | Fagen Engineering 2014 |
| Big Blue, MN (2014) | 0.37 | 0 | 1.43 | agriculture | Fagen Engineering 2015 |
| Black Oak Getty, MN (2017) | 4.37 | 0 | 13.03 | agriculture, grassland | Pickle et al. 2018 |
| Blue Sky Green Field, WI (2008; 2009) | 7.17 | 0 | 24.57 | agriculture | Gruver et al. 2009 |
| Buffalo Ridge I, SD (2009-2010) | 5.06 | 0.2 | 0.16 | agriculture/grassland | Derby et al. 2010d |
| Buffalo Ridge II, SD (2011-2012) | 1.99 | 0 | 2.81 | agriculture, grassland | Derby et al. 2012a |
| Buffalo Ridge, MN (Phase I; 1996) | 4.14 | 0 | NA | agriculture | Johnson et al. 2000 |
| Buffalo Ridge, MN (Phase I; 1997) | 2.51 | 0 | NA | agriculture | Johnson et al. 2000 |
| Buffalo Ridge, MN (Phase I; 1998) | 3.14 | 0 | NA | agriculture | Johnson et al. 2000 |
| Buffalo Ridge, MN (Phase I; 1999) | 1.43 | 0.47 | 0.74 | agriculture | Johnson et al. 2000 |
| Buffalo Ridge, MN (Phase II; 1998) | 2.47 | 0 | 2.16 | agriculture | Johnson et al. 2000 |
| Buffalo Ridge, MN (Phase II; 1999) | 3.57 | 0 | 2.59 | agriculture | Johnson et al. 2000 |
| Buffalo Ridge, MN (Phase II; 2001/Lake Benton I) | NA | NA | 4.35 | agriculture | Johnson et al. 2004 |
| Buffalo Ridge, MN (Phase II; 2002/Lake Benton I) | NA | NA | 1.64 | agriculture | Johnson et al. 2004 |
| Buffalo Ridge, MN (Phase III; 1999) | 5.93 | 0 | 2.72 | agriculture | Johnson et al. 2000 |
| Buffalo Ridge, MN (Phase III; 2001/Lake Benton II) | NA | NA | 3.71 | agriculture | Johnson et al. 2004 |
| Buffalo Ridge, MN (Phase III; 2002/Lake Benton II) | NA | NA | 1.81 | agriculture | Johnson et al. 2004 |
| Carroll, IA (2015) | 3.55 | NA | 11.71 | agriculture | Bay et al. 2017a |
| 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 |
| Century, IA (2016) | 3.54 | 0.01 | 9.07 | agriculture | Bay et al. 2017b |
| Charles City, IA (2016) | 4.13 | NA | 10.41 | agriculture | Bay et al. 2017b |

**Appendix D4. Fatality estimates for wind-energy facilities in the Midwestern region of North America.**

| Wind Energy Facility | Bird Fatalities (bird/MW/year) | Raptor Fatalities (raptors/MW/year) | Bat Fatalities (bats/MW/year) | Predominant Habitat Type | Fatality Report Citation |
|---|---|---|---|---|---|
| Crescent Ridge, IL (2005-2006) | NA | NA | 3.27 | agriculture | Kerlinger et al. 2007 |
| Crystal Lake II, IA (2009) | NA | NA | 7.42 | agriculture | Derby et al. 2010b |
| Eclipse, IA (2015) | 3.62 | 0.12 | 10.01 | agriculture | Bay et al. 2017a |
| Elm Creek II, MN (2011-2012) | 3.64 | 0 | 2.81 | agriculture, grassland | Derby et al. 2010e |
| Elm Creek, MN (2009-2010) | 1.55 | 0 | 1.49 | agriculture | Derby et al. 2012b |
| Forward Energy Center, WI (2008-2010) | NA | NA | 18.17 | agriculture | Grodsky and Drake 2011 |
| Fowler I, II, III, IN (2010) | NA | NA | 18.96 | agriculture | Good et al. 2011 |
| Fowler I, II, III, IN (2011) | NA | NA | 20.19 | agriculture | Good et al. 2012 |
| Fowler I, II, III, IN (2012) | NA | NA | 2.96 | agriculture | Good et al. 2013a |
| Fowler I, IN (2009) | 2.83 | 0 | 8.09 | agriculture | Johnson et al. 2010a |
| Fowler III, IN (2009) | NA | NA | 1.84 | agriculture | Johnson et al. 2010b |
| Grand Ridge I, IL (2009-2010) | 0.48 | 0 | 2.1 | agriculture | Derby et al. 2010a |
| Harrow, Ont (2010) | NA | NA | 11.13 | agriculture | Natural Resource Solutions Inc. (NRSI) 2011 |
| Heritage Garden I, MI (2012-2014) | 1.3 | NA | 5.9 | agriculture | Kerlinger et al. 2014 |
| Highland, IA (2016) | 2.25 | NA | 8.63 | agriculture | Bay et al. 2017b |
| Intrepid, IA (2016) | 2.93 | 0.02 | 18.37 | agriculture | Bay et al. 2017b |
| Kewaunee County, WI (1999-2001) | 1.95 | 0 | 6.45 | agriculture | Howe et al. 2002 |
| Laurel, IA (2016) | 2.96 | NA | 14.22 | agriculture | Bay et al. 2017b |
| Lundgren, IA (2015) | 2.91 | NA | 28.74 | agriculture | Bay et al. 2017a |
| Lundgren, IA (2016) | 3.37 | NA | 8.08 | agriculture | Bay et al. 2017b |
| Macksburg, IA (2015) | 3.38 | NA | 73.08 | agriculture | Bay et al. 2017a |
| Macksburg, IA (2016) | 4.94 | 0.02 | 10.79 | agriculture | Bay et al. 2017b |
| Moraine II, MN (2009) | 5.59 | 0.37 | 2.42 | agriculture/grassland | Derby et al. 2010f |
| Morning Light, IA (2015) | 2.36 | NA | 20.19 | agriculture | Bay et al. 2017a |
| NPPD Ainsworth, NE (2006) | 1.63 | 0.06 | 1.16 | agriculture/grassland | Derby et al. 2007 |
| Pioneer Prairie I, IA (Phase II; 2011-2012) | 0.27 | 0 | 10.06 | agriculture, grassland | Chodachek et al. 2012 |
| Pioneer Prairie II, IA (2013) | NA | NA | 3.83 | agriculture | Chodachek et al. 2014 |

**Appendix D4. Fatality estimates for wind-energy facilities in the Midwestern region of North America.**

| Wind Energy Facility | Bird Fatalities (bird/MW/year) | Raptor Fatalities (raptors/MW/year) | Bat Fatalities (bats/MW/year) | Predominant Habitat Type | Fatality Report Citation |
|---|---|---|---|---|---|
| Pomeroy, IA (2016) | 2.76 | 0.19 | 6.25 | agriculture | Bay et al. 2017b |
| PrairieWinds ND1 (Minot), ND (2010) | 1.48 | 0.05 | 2.13 | agriculture | Derby et al. 2011d |
| PrairieWinds ND1 (Minot), ND (2011) | 1.56 | 0.05 | 1.39 | agriculture, grassland | Derby et al. 2012d |
| PrairieWinds SD1, SD (2011-2012) | 1.41 | 0 | 1.23 | grassland | Derby et al. 2012c |
| PrairieWinds SD1, SD (2012-2013) | 2.01 | 0.03 | 1.05 | grassland | Derby et al. 2013 |
| PrairieWinds SD1, SD (2013-2014) | 1.66 | 0.17 | 0.52 | grassland | Derby et al. 2014 |
| Rail Splitter, IL (2012-2013) | 0.84 | 0 | 11.21 | agriculture | Good et al. 2013b |
| Ripley, Ont (2008) | 3.09 | 0.1 | 4.67 | agriculture | Jacques Whitford 2009 |
| Rolling Hills, IA (2015) | 1.79 | 0.04 | 6.13 | agriculture | Bay et al. 2017a |
| Rolling Hills, IA (2016) | 3.48 | 0.08 | 6.30 | agriculture | Bay et al. 2017b |
| Rugby, ND (2010-2011) | 3.82 | 0.06 | 1.6 | agriculture | Derby et al. 2011c |
| Top Crop I & II (2012-2013) | 1.35 | NA | 12.55 | agriculture | Good et al. 2013c |
| 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 |
| Victory, IA (2015) | 1.52 | NA | 6.48 | agriculture | Bay et al. 2017a |
| Vienna I, IA (2016) | 5.70 | 0.03 | 9.09 | agriculture | Bay et al. 2017b |
| Vienna II, IA (2016) | 3.57 | 0.07 | 10.28 | agriculture | Bay et al. 2017b |
| Walnut, IA (2015) | 2.88 | NA | 21.69 | agriculture | Bay et al. 2017a |
| Wellsburg, IA (2016) | 8.44 | NA | 12.30 | agriculture | Bay et al. 2017b |
| Wessington Springs, SD (2009) | 8.25 | 0.06 | 1.48 | grassland | Derby et al. 2010c |
| Wessington Springs, SD (2010) | 0.89 | 0.07 | 0.41 | grassland | Derby et al. 2011a |
| Winnebago, IA (2009-2010) | 3.88 | 0.27 | 4.54 | agriculture/grassland | Derby et al. 2010g |

MW = megawatt

**Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology for wind-power plants in the Midwest region of North America.**

| Wind Energy Facility/Study | Total # of Turbines | Total MW | Tower Size (m) | Number Turbines Searched | Plot Size | Length of Study | Survey frequency |
|---|---|---|---|---|---|---|---|
| Adair, IA (2015) | 76 | 174.8 | 2.3 | 76 | Road/pad with 100m radius | 1 year | Bimonthly (winter) and weekly (spring, summer, and fall) |
| Adams, IA (2016) | 64 | 154.3 | 2.3/2.4 | 50 road/pad, 14 cleared plots (7 60x60m and 7 100x1100m) | 60x60m and 100x100m (cleared plot), 100m radius (road/pad) | 1 year | bimonthly (winter) and biweekly (spring, summer, and fall) |
| Barton I & II, IA (2010-2011) | 80(35 (9 turbines were dropped in June 2010 due to landowner issues) 26 turbines were searched for the remainder of the study) | 160 | 100 | 30 | 200 m x 200 m | 1 year | weekly (spring, fall; migratory turbines), monthly (summer, winter; non-migratory turbines) |
| Big Blue, MN (2013) | 18(18) | 36 | 78 or 90 (according to Gamesa website) | 18 | 200m diameter | NA | weekly, monthly (Nov and Dec) |
| Big Blue, MN (2014) | 18(18) | 36 | 78 or 90 (according to Gamesa website) | 18 | 200m diameter | NA | weekly, monthly (Nov and Dec) |
| Black Oak Getty, MN (2017) | 39 | 78 | 80 | 5 cleared plots, 34 road/pad | 120 m x 120 m (cleared plot), 60 m radius (road/pad) | 9 months (March 15, 2017 – November 16, 2017) | Cleared plots twice weekly, road/pads once weekly. |
| Blue Sky Green Field, WI (2008; 2009) | 88(30) | 145 | 80 | 30 | 160 m x 160 m | fall, spring | daily(10 turbines), weekly (20 turbines) |
| Buffalo Ridge, MN (1994-1995) | 73(1994:10 plots (3 turbines/plot), 20 addition plots in Sept | 25 | 37 | 1994:10 plots (3 turbines/plot), 20 addition plots in Sept | 100 x 100m | 20 months | varies. See number turbines searched or page 44 of report |

**Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology for wind-power plants in the Midwest region of North America.**

| Wind Energy Facility/Study | Total # of Turbines | Total MW | Tower Size (m) | Number Turbines Searched | Plot Size | Length of Study | Survey frequency |
|---|---|---|---|---|---|---|---|
| | & Oct 1994, 1995: 30 turbines search every other week (Jan-Mar), 60 searched weekly (Apr, July, Aug) 73 searched weekly (May-June and Sept-Oct), 30 searched weekly (Nov-Dec)) | | | & Oct 1994, 1995: 30 turbines search every other week (Jan-Mar), 60 searched weekly (Apr, July, Aug) 73 searched weekly (May-June and Sept-Oct), 30 searched weekly (Nov-Dec) | | | |
| Buffalo Ridge, MN (Phase I; 1996) | 73(21) | 25 | 36 | 21 | 126 m x 126 m | 1 year | bi-monthly (spring, summer, and fall) |
| Buffalo Ridge, MN (Phase I; 1997) | 73(21) | 25 | 36 | 21 | 126 m x 126 m | 1 year | bi-monthly (spring, summer, and fall) |
| Buffalo Ridge, MN (Phase I; 1998) | 73(21) | 25 | 36 | 21 | 126 m x 126 m | 1 year | bi-monthly (spring, summer, and fall) |
| Buffalo Ridge, MN (Phase I; 1999) | 73(21) | 25 | 36 | 21 | 126 m x 126 m | 1 year | bi-monthly (spring, summer, and fall) |
| Buffalo Ridge, MN (Phase II; 1998) | 143(40) | 107.25 | 50 | 40 | 126 m x 126 m | 1 year | bi-monthly (spring, summer, and fall) |
| Buffalo Ridge, MN (Phase II; 1999) | 143(40) | 107.25 | 50 | 40 | 126 m x 126 m | 1 year | bi-monthly (spring, summer, and fall) |
| Buffalo Ridge, MN (Phase II; 2001/Lake Benton I) | 143(83) | 107.25 | 50 | 83 | 60 m x 60 m | summer, fall | bi-monthly |
| Buffalo Ridge, MN (Phase II; 2002/Lake Benton I) | 143(103) | 107.25 | 50 | 103 | 60 m x 60 m | summer, fall | bi-monthly |
| Buffalo Ridge, MN (Phase III; 1999) | 138(30) | 103.5 | 50 | 30 | 126 m x 126 m | 1 year | bi-monthly (spring, summer, and fall) |
| Buffalo Ridge, MN (Phase III; 2001/Lake Benton II) | 138(83) | 103.5 | 50 | 83 | 60 m x 60 m | summer, fall | bi-monthly |

**Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology for wind-power plants in the Midwest region of North America.**

| Wind Energy Facility/Study | Total # of Turbines | Total MW | Tower Size (m) | Number Turbines Searched | Plot Size | Length of Study | Survey frequency |
|---|---|---|---|---|---|---|---|
| Buffalo Ridge, MN (Phase III; 2002/Lake Benton II) | 138(103) | 103.5 | 50 | 103 | 60 m x 60 m | summer, fall | bi-monthly |
| Buffalo Ridge I, SD (2009-2010) | 24(24) | 50.4 | 79 | 24 | 200 m x 200 m | 1 year | weekly (migratory), monthly (non-migratory) |
| Buffalo Ridge II, SD (2011-2012) | 105(65 (60 road and pad, 5 turbine plots)) | 210 | 78 | 65 (60 road and pad, 5 turbine plots) | 100 x 100 m | 1 year | weekly (spring, summer, fall), monthly (winter) |
| Carroll, IA (2015) | 100 | 150.0 | 1.5 | 100 | Road/pad with 100m radius | 1 year | Bimonthly (winter) and weekly (spring, summer, and fall) |
| Cedar Ridge, WI (2009) | 41(20) | 67.6 | 80 | 20 | 160 m x 160 m | spring, summer, fall | daily, every 4 days; late fall searched every 3 days |
| Cedar Ridge, WI (2010) | 41(20) | 68 | 80 | 20 | 160 m x 160 m | 1 year | Five turbines were surveyed daily, 15 turbines surveyed every 4 days in rotating groups each day. All 20 surveyed every three days during late fall |
| Century, IA (2016) | 145 | 200.0 | 1.5/1.0 | 115 road/pad, 30 cleared plots (14 60x60m and 14 100x1100m) | 60x60m and 100x100m (cleared plot), 100m radius (road/pad) | 1 year | bimonthly (winter) and biweekly (spring, summer, and fall) |
| Charles City, IA (2016) | 50 | 75.0 | 1.5 | 40 road/pad, 10 cleared 200x200m plot | 200x200m (cleared plot), 100m radius (road/pad) | 1 year | bimonthly (winter) and biweekly (spring, summer, and fall) |
| Crescent Ridge, IL (2005-2006) | 33(33) | 49.5 | 80 | 33 | 70-m radius | 1 year | weekly (fall, spring) |

**Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology for wind-power plants in the Midwest region of North America.**

| Wind Energy Facility/Study | Total # of Turbines | Total MW | Tower Size (m) | Number Turbines Searched | Plot Size | Length of Study | Survey frequency |
|---|---|---|---|---|---|---|---|
| Crystal Lake II, IA (2009) | 80(16 turbines through week 6, and then 15 for duration of study) | 200 | 80 | 16 turbines through week 6, and then 15 for duration of study | 100 m x 100 m | spring, summer, fall | 3 times per week for 26 weeks |
| Eclipse, IA (2015) | 87 | 200.1 | 2.3 | 87 | Road/pad with 100m radius | 1 year | Bimonthly (winter) and weekly (spring, summer, and fall) |
| Elm Creek, MN (2009-2010) | 67(29) | 100 | 80 | 29 | 200 m x 200 m | 1 year | weekly, monthly |
| Elm Creek II, MN (2011-2012) | 62(30) | 148.8 | 80 | 30 | 200 x 200m (2 random migration search areas 100 x 100m) | 1 year | 20 searched every 28 days, 10 turbines every 7 days during migration) |
| Erie Shores, Ont (2006) | 66(66) | 99 | 80 | 66 | 40-m radius | 2 years | weekly, bi-monthly, 2-3 times weekly (migration) |
| Forward Energy Center, WI (2008-2010) | 86(29) | 129 | 80 | 29 | 160 m x 160 m | 2 years | 11 turbines daily, 9 every 3 days, 9 every 5 days |
| Fowler I, IN (2009) | 162(25) | 301 | 78 (Vestas), 80 (Clipper) | 25 | 160 m x 160 m | spring, summer, fall | weekly, bi-weekly |
| Fowler I, II, III, IN (2010) | 355(36 turbines, 100 road and pads) | 600 | Vestas = 80, Clipper = 80, GE = 80 | 36 turbines, 100 road and pads | 80 m x 80 m for turbines ; 40-m radius for roads and pads | spring, fall | daily, weekly |
| Fowler I, II, III, IN (2011) | 355(177 road and pads (spring), 9 turbines & 168 roads and pads (fall)) | 600 | Vestas = 80, Clipper = 80, GE = 80 | 177 road and pads (spring), 9 turbines & 168 roads and pads (fall) | turbines (80 m circular plot), roads and pads (out to 80 m) | spring, fall | daily, weekly |
| Fowler I, II, III, IN (2012) | 355(118 roads and pads) | 600 | Vestas = 80, Clipper = 80, GE = | 118 roads and pads | roads and pads (out to 80 m) | 2.5 months | weekly |

**Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology for wind-power plants in the Midwest region of North America.**

| Wind Energy Facility/Study | Total # of Turbines | Total MW | Tower Size (m) | Number Turbines Searched | Plot Size | Length of Study | Survey frequency |
|---|---|---|---|---|---|---|---|
| | | | 80 | | | | |
| Fowler III, IN (2009) | 60(12) | 99 | 78 | 12 | 160 m x 160 m | 10 weeks | weekly, bi-weekly |
| Grand Ridge I, IL (2009-2010) | 66(30) | 99 | 80 | 30 | 160 m x 160 m | 1 year | weekly, monthly |
| Harrow, Ont (2010) | 24 (four 6-turb facilities)(12 in July, 24 Aug-Oct) | 39.6 | NA | 12 in July, 24 Aug-Oct | 50-m radius from turbine base | 4 months | twice-weekly |
| Heritage Garden I, MI (2012-2014) | 14(14) | 28 | 90 | 14 | 120x120 m except one plot that was 280x280 m | 1 years | weekly (spring, summer, and fall) and bi-weekly (winter) |
| Highland, IA (2016) | 214 | 502 | 2.3 | 170 road/pad, 44 cleared plots (22 60x60m and 22 100x1100m) | 60x60m and 100x100m (cleared plot), 100m radius (road/pad) | 1 year | bimonthly (winter) and biweekly (spring, summer, and fall) |
| Intrepid, IA (2016) | 122 | 175.5 | 1.5/1.0 | 96 road/pad, 26 cleared plots (13 60x60m and 13 100x1100m) | 60x60m and 100x100m (cleared plot), 100m radius (road/pad) | 1 year | bimonthly (winter) and biweekly (spring, summer, and fall) |
| Kewaunee County, WI (1999-2001) | 31(31) | 20.46 | 65 | 31 | 60 m x 60 m | 2 years | bi-weekly (spring, summer), daily (spring, fall migration), weekly (fall, winter) |
| Lakefield Wind, MN (2012) | 137(26) | 205.5 | 80 | 26 | 100 m x 100 m | 7.5 months | 3 times per week |
| Laurel, IA (2016) | 52 | 119.6 | 2.3 | 40 road/pad, 12 cleared plots (6 60x60m and 6 100x1100m) | 60x60m and 100x100m (cleared plot), 100m | 1 year | bimonthly (winter) and biweekly (spring, summer, and fall) |

**Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology for wind-power plants in the Midwest region of North America.**

| Wind Energy Facility/Study | Total # of Turbines | Total MW | Tower Size (m) | Number Turbines Searched | Plot Size | Length of Study | Survey frequency |
|---|---|---|---|---|---|---|---|
| | | | | | radius (road/pad) | | |
| Lundgren, IA (2015) | 107 | 251 | 2.3 | 107 | Road/pad with 100m radius | 1 year | Bimonthly (winter) and weekly (spring, summer, and fall) |
| Lundgren, IA (2016) | 107 | 251 | 2.3 | 86 road/pad, 10 cleared 200x200m plots | 200x200m (cleared plot), 100m radius (road/pad) | 1 year | bimonthly (winter) and biweekly (spring, summer, and fall) |
| Macksburg, IA (2015) | 51 | 119.6 | 2.3 | 51 | Road/pad with 100m radius | 1 year | Bimonthly (winter) and weekly (spring, summer, and fall) |
| Macksburg, IA (2016) | 51 | 119.6 | 2.3 | 41 road/pad, 10 cleared 200x200m plots | 200x200m (cleared plot), 100m radius (road/pad) | 1 year | bimonthly (winter) and biweekly (spring, summer, and fall) |
| Melancthon, Ont (Phase I; 2007) | 45(45) | NA | NA | 45 | 35m radius | 5 months | weekly, twice weekly |
| Moraine II, MN (2009) | 33(30) | 49.5 | 82.5 | 30 | 200 m x 200 m | 1 year | weekly (migratory), monthly (non-migratory) |
| Morning Light, IA (2015) | 44 | 101.2 | 2.3 | 44 | Road/pad with 100m radius | 1 year | Bimonthly (winter) and weekly (spring, summer, and fall) |
| NPPD Ainsworth, NE (2006) | 36(36) | 20.5 | 70 | 36 | 220 m x 220 m | spring, summer, fall | bi-monthly |
| Pioneer Prairie II, IA (2013) | 62(62) | 102.3 | 80 | 62 | 80x80 m (5 turbines), road and pad within 100 m of turbine (57 turbines) | NA | weekly |
| Pioneer Prairie I, IA | 62(62 (57 road/pad) 5 | 102.3 | 80 | 62 (57 road/pad) 5 | 80 x 80m | 1 year | weekly (spring and fall), |

**Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology for wind-power plants in the Midwest region of North America.**

| Wind Energy Facility/Study | Total # of Turbines | Total MW | Tower Size (m) | Number Turbines Searched | Plot Size | Length of Study | Survey frequency |
|---|---|---|---|---|---|---|---|
| (Phase II; 2011-2012) | cleared search plots) | | | cleared search plots | | | every two weeks (summer), monthly (winter) |
| Pioneer Trail, IL (2012-2013) | 94(50) | 150.5 | NA | 50 | 80x80m | fall, spring | weekly |
| Pomeroy, IA (2016) | 184 | 286.4 | 1.5/2.3 | 146 road/pad, 38 cleared plots (19 60x60m and 19 100x1100m) | 60x60m and 100x100m (cleared plot), 100m radius (road/pad) | 1 year | bimonthly (winter) and biweekly (spring, summer, and fall) |
| Prairie Rose, MN (2014) | 119(10) | 200 | 80 | 10 | 100x100m | 6 months | weekly |
| PrairieWinds SD1, SD (2012-2013) | 108(50) | 162 | 80 | 50 | 200 x 200m | 1 year | bi-weekly |
| PrairieWinds SD1, SD (2013-2014) | 108(45) | 162 | 80 | 45 | 200 x 200m | 1 year | twice monthly (spring, summer, fall), monthly (winter) |
| PrairieWinds ND1 (Minot), ND (2010) | 80(35) | 115.5 | 89 | 35 | minimum of 100 m x 100 m | 3 seasons | bi-monthly |
| PrairieWinds ND1 (Minot), ND (2011) | 80(35) | 115.5 | 80 | 35 | minimum 100 x 100m | 3 season | twice monthly |
| PrairieWinds SD1, SD (2011-2012) | 108(50) | 162 | 80 | 50 | 200 x 200m | 1 year | twice monthly (spring, summer, fall), monthly (winter) |
| Rail Splitter, IL (2012-2013) | 67(34) | 100.5 | 80 | 34 | 60 m radius | 1 year | weekly (spring, summer, and fall) and bi-weekly (winter) |
| Ripley, Ont (2008) | 38(38) | 76 | 64 | 38 | 80 m x 80 m | spring, fall | twice weekly for odd turbines; weekly for even turbines. |

**Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology for wind-power plants in the Midwest region of North America.**

| Wind Energy Facility/Study | Total # of Turbines | Total MW | Tower Size (m) | Number Turbines Searched | Plot Size | Length of Study | Survey frequency |
|---|---|---|---|---|---|---|---|
| Ripley, Ont (2008-2009) | 38(38) | 76 | 64 | 38 | 80 m x 80 m | 6 weeks | twice weekly for odd turbines; weekly for even turbines. |
| Rolling Hills, IA (2015) | 193 | 443.9 | 2.3 | 193 | Road/pad with 100m radius | 1 year | Bimonthly (winter) and weekly (spring, summer, and fall) |
| Rolling Hills, IA (2016) | 193 | 443.9 | 2.3 | 153 road/pad, 40 cleared plots (20 60x60m and 20 100x1100m) | 60x60m and 100x100m (cleared plot), 100m radius (road/pad) | 1 year | bimonthly (winter) and biweekly (spring, summer, and fall) |
| Rugby, ND (2010-2011) | 71(32) | 149 | 78 | 32 | 200 m x 200 m | 1 year | weekly (spring, fall; migratory turbines), monthly ( non-migratory turbines) |
| Top Crop I & II (2012-2013) | 68 (phase I) 132 (phase (II)(100) | 300 (102 phase I, 198 phase II) | 65 (phase I) 80 (phase II) | 100 | 61 m radius | 1 year | weekly (spring, summer, and fall) and bi-weekly (winter) |
| Top of Iowa, IA (2003) | 89(26) | 80 | 71.6 | 26 | 76 m x 76 m | spring, summer, fall | once every 2 to 3 days |
| Top of Iowa, IA (2004) | 89(26) | 80 | 71.6 | 26 | 76 m x 76 m | spring, summer, fall | once every 2 to 3 days |
| Victory, IA (2015) | 66 | 99.0 | 1.5 | 66 | Road/pad with 100m radius | 1 year | Bimonthly (winter) and weekly (spring, summer, and fall) |
| Vienna, IA (2016) | 45 | 105.6 | 2.3 | 35 road/pad, 10 cleared plots (5 60x60m and 5 100x1100m) | 60x60m and 100x100m (cleared plot), 100m radius (road/pad) | 1 year | bimonthly (winter) and biweekly (spring, summer, and fall) |
| Vienna II, IA (2016) | 19 | 44.6 | 2.3 | 15 road/pad, 4 | 60x60m and | 1 year | bimonthly (winter) and |

**Appendix D5. All post-construction monitoring studies, project characteristics, and select study methodology for wind-power plants in the Midwest region of North America.**

| Wind Energy Facility/Study | Total # of Turbines | Total MW | Tower Size (m) | Number Turbines Searched | Plot Size | Length of Study | Survey frequency |
|---|---|---|---|---|---|---|---|
| | | | | cleared plots (2 60x60m and 2 100x1100m) | 100x100m (cleared plot), 100m radius (road/pad) | | biweekly (spring, summer, and fall) |
| Walnut, IA (2015) | 102 | 153.0 | 1.5 | 102 | Road/pad with 100m radius | 1 year | Bimonthly (winter) and weekly (spring, summer, and fall) |
| Wellsburg, IA (2016) | 60 | 140.8 | 2.3 | 48 road/pad, 12 cleared plots (6 60x60m and 6 100x1100m) | 60x60m and 100x100m (cleared plot), 100m radius (road/pad) | 1 year | bimonthly (winter) and biweekly (spring, summer, and fall) |
| Wessington Springs, SD (2009) | 34(20) | 51 | 80 | 20 | 200 m x 200 m | spring, summer, fall | bi-monthly |
| Wessington Springs, SD (2010) | 34(20) | 51 | 80 | 20 | 200 m x 200 m | 8 months | bi-weekly (spring, summer, fall) |
| Winnebago, IA (2009-2010) | 10(10) | 20 | 78 | 10 | 200 m x 200 m | 1 year | weekly (migratory), monthly (non-migratory) |

**Appendix D5 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology for wind-energy facilities in the Midwestern region of North America. Data from the following sources:**

| Project Name | Reference | Project Name | Reference |
|---|---|---|---|
| Adair, IA (2015) | Bay et al. 2017a | Crystal Lake II, IA (2009) | Derby et al. 2010b |
| Adams, IA (2016) | Bay et al. 2017b | Eclipse, IA (2015) | Bay et al. 2017a |
| Barton I & II, IA (2010-2011) | Derby et al. 2011b | Elm Creek, MN (2009-2010) | Derby et al. 2010e |
| Big Blue, MN (2013) | Fagen Engineering 2014 | Elm Creek II, MN (2011-2012) | Derby et al. 2012b |
| Big Blue, MN (2014) | Fagen Engineering 2015 | Erie Shores, Ont (2006) | James 2008 |
| Black Oak Getty, MN (2017) | Pickle et al. 2018 | Forward Energy Center, WI (2008-2010) | Grodsky and Drake 2011 |
| Blue Sky Green Field, WI (2008; 2009) | Gruver et al. 2009 | Fowler I, IN (2009) | Johnson et al. 2010a |
| Buffalo Ridge, MN (1994-1995) | Osborn et al. 1996, 2000 | Fowler I, II, III, IN (2010) | Good et al. 2011 |
| Buffalo Ridge, MN (Phase I; 1996) | Johnson et al. 2000 | Fowler I, II, III, IN (2011) | Good et al. 2012 |
| Buffalo Ridge, MN (Phase I; 1997) | Johnson et al. 2000 | Fowler I, II, III, IN (2012) | Good et al. 2013a |
| Buffalo Ridge, MN (Phase I; 1998) | Johnson et al. 2000 | Fowler III, IN (2009) | Johnson et al. 2010b |
| Buffalo Ridge, MN (Phase I; 1999) | Johnson et al. 2000 | Grand Ridge I, IL (2009-2010) | Derby et al. 2010a |
| Buffalo Ridge, MN (Phase II; 1998) | Johnson et al. 2000 | Harrow, Ont (2010) | Natural Resource Solutions 2011 |
| Buffalo Ridge, MN (Phase II; 1999) | Johnson et al. 2000 | Heritage Garden I, MI (2012-2014) | Kerlinger et al. 2014 |
| Buffalo Ridge, MN (Phase II; 2001/Lake Benton I) | Johnson et al. 2004 | Highland, IA (2016) | Bay et al. 2017b |
| Buffalo Ridge, MN (Phase II; 2002/Lake Benton I) | Johnson et al. 2004 | Intrepid, IA (2016) | Bay et al. 2017b |
| Buffalo Ridge, MN (Phase III; 1999) | Johnson et al. 2000 | Kewaunee County, WI (1999-2001) | Howe et al. 2002 |
| Buffalo Ridge, MN (Phase III; 2001/Lake Benton II) | Johnson et al. 2004 | Lakefield Wind, MN (2012) | MPUC 2012 |
| Buffalo Ridge, MN (Phase III; 2002/Lake Benton II) | Johnson et al. 2004 | Laurel, IA (2016) | Bay et al. 2017b |
| Buffalo Ridge I, SD (2009-2010) | Derby et al. 2010d | Lundgren, IA (2015) | Bay et al. 2017a |
| Buffalo Ridge II, SD (2011-2012) | Derby et al. 2012a | Lundgren, IA (2016) | Bay et al. 2017b |
| Carroll, IA (2015) | Bay et al. 2017a | Macksburg, IA (2015) | Bay et al. 2017a |
| Cedar Ridge, WI (2009) | BHE Environmental 2010 | Macksburg, IA (2016) | Bay et al. 2017b |
| Cedar Ridge, WI (2010) | BHE Environmental 2011 | Melancthon, Ont (Phase I; 2007) | Stantec Ltd. 2008 |
| Crescent Ridge, IL (2005-2006) | Kerlinger et al. 2007 | Moraine II, MN (2009) | Derby et al. 2010f |
| Century, IA (2016) | Bay et al. 2017b | Morning Light, IA (2015) | Bay et al. 2017a |
| Charles City, IA (2016) | Bay et al. 2017b | NPPD Ainsworth, NE (2006) | Derby et al. 2007 |
| Pioneer Prairie II, IA (2013) | Chodachek et al. 2014 | Rolling Hills, IA (2016) | Bay et al. 2017b |

**Appendix D5 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology for wind-energy facilities in the Midwestern region of North America. Data from the following sources:**

| Project Name | Reference | Project Name | Reference |
|---|---|---|---|
| Pioneer Prairie I, IA (Phase II; 2011-2012) | Chodachek et al. 2012 | Rugby, ND (2010-2011) | Derby et al. 2011c |
| Pioneer Trail, IL (2012-2013) | ARCADIS 2013 | | |
| Pomeroy, IA (2016) | Bay et al. 2017b | Top Crop I & II (2012-2013) | Good et al. 2013c |
| Prairie Rose, MN (2014) | Chodachek et al. 2015 | Top of Iowa, IA (2003) | Jain 2005 |
| PrairieWinds SD1, SD (2012-2013) | Derby et al. 2013 | Top of Iowa, IA (2004) | Jain 2005 |
| PrairieWinds SD1, SD (2013-2014) | Derby et al. 2014 | Victory, IA (2015) | Bay et al. 2017a |
| PrairieWinds ND1 (Minot), ND (2010) | Derby et al. 2011d | Vienna I, IA (2016) | Bay et al. 2017b |
| PrairieWinds ND1 (Minot), ND (2011) | Derby et al. 2012d | Vienna II, IA (2016) | Bay et al. 2017b |
| PrairieWinds SD1, SD (2011-2012) | Derby et al. 2012c | Walnut, IA (2015) | Bay et al. 2017a |
| Rail Splitter, IL (2012-2013) | Good et al. 2013b | Wellsburg, IA (2016) | Bay et al. 2017b |
| Ripley, Ont (2008) | Jacques Whitford 2009 | Wessington Springs, SD (2009) | Derby et al. 2010c |
| Ripley, Ont (2008-2009) | Golder Associates 2010 | Wessington Springs, SD (2010) | Derby et al. 2011a |
| Rolling Hills, IA (2015) | Bay et al. 2017a | Winnebago, IA (2009-2010) | Derby et al. 2010g |

# Appendix E. Distributions, Model Parameter and AIC Values for Small Bird and Bat Density Models

**Appendix E1. Area correction models for bats–Control from the Black Oak Getty Wind Energy Project. Selected models are denoted by an asterisk in the 'Delta AICc' column.**

| Distribution | AICc | Delta AICc |
|---|---|---|
| weibull | 11754.470 | 0* |
| rayleigh | 11764.600 | 10.1298889765749 |
| norm | 11772.027 | 17.5567752636744 |
| gamma | 11797.307 | 42.8371684912181 |
| gompertz | 11826.219 | 71.7491798020983 |

**Appendix E2. Area correction models for bats–Treatment from the Black Oak Getty Wind Energy Project. Selected models are denoted by an asterisk in the 'Delta AICc' column.**

| Distribution | AICc | Delta AICc |
|---|---|---|
| gompertz | 6872.204 | 0* |
| norm | 6915.697 | 43.4925326503653 |
| weibull | 6939.183 | 66.9787906683823 |
| rayleigh | 6942.204 | 69.9999474020469 |
| gamma | 7016.116 | 143.912335056836 |

**Appendix E3. Area correction models for small birds from the Black Oak Getty Wind Energy Project. Selected models are denoted by an asterisk in the 'Delta AICc' column.**

| Distribution | AICc | Delta AICc |
|---|---|---|
| gamma | 5218.193 | 0* |
| rayleigh | 5222.943 | 4.74977351555754 |
| weibull | 5225.068 | 6.87512149798658 |
| norm | 5251.759 | 33.5658238239394 |
| gompertz | 5304.134 | 85.9411981639651 |