Post-Construction Bird and Bat Fatality Monitoring Study

Dakota Range I and II Wind Project

Grant and Codington Counties, South Dakota

March – December 2022

Prepared for:

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WEST

EXECUTIVE SUMMARY

Northern States Power, a Minnesota corporation, d/b/a Xcel Energy contracted Western EcoSystems Technology, Inc. to conduct a post-construction fatality monitoring (PCM) study at the Dakota Range I and II Wind Project (Project). The study was developed and implemented to estimate bird and bat fatality rates resulting from Project operations. This report presents the results of one year of PCM conducted from March 16 – December 11, 2022.

The primary objectives of PCM were to 1) document species occurring as fatalities, 2) estimate bird and bat fatality rates for the study period, 3) qualitatively evaluate spatial and temporal patterns of bird and bat fatalities, 4) qualitatively compare data from PCM studies conducted at other wind energy facilities in South Dakota and neighboring states, and 5) document fatalities of sensitive species as a result of collisions with wind turbines at the Project.

Twenty-two turbines were initially selected for carcass searches at the Project, with seasons defined as spring (March 15 – June 17), summer (June 18 – September 12) and fall (September 13 – December 15). Twenty-two turbines were searched as square plots until vegetation obstructed visibility, at which time turbines were searched as road and pad plots. Searches at turbines located in land cover with relatively low vegetation that allowed for unobstructed search visibility remained as square plots. After vegetation (i.e., crops) was cleared in fall and plot visibility became unobstructed, technicians searched all survey turbines as square plots through the end of the study except Turbine 13. Turbine 13 was searched as a road and pad plot through the end of the study due to a fence bisecting the square plot. Square plots consisted of a 150- x 150-meter (m; 492- x 492-foot [ft]) square centered on the turbine, and road and pad plots included all area on the gravel pads and access roads out to 100 m (328 ft) from the turbine.

During the study, 68 bird carcasses and 52 bat carcasses were found during searches or incidentally. Of these, 13 bird carcasses and ten bat carcasses were found outside of search areas, and three bird carcasses were found outside of the study period. Thirty-nine identifiable bird species and four bat species were found as fatalities during the study. Two raptor species were found as fatalities, including one bald eagle and one sharp-shinned hawk. Both raptor fatalities were outside of search areas, and they were therefore excluded from analysis. No federally or state-listed threatened or endangered species were found as fatalities. Seven sensitive species were found during the study (considered Species of Greatest Conservation Need), including American white pelican (nine carcasses), bald eagle (one), bobolink (one), Le Conte's sparrow (one), eastern red bat (15), hoary bat (17), and silver-haired bat (15). The bald eagle is also protected by the Bald and Golden Eagle Protection Act.

Fifty-two bird carcasses and 42 bat carcasses were included in analysis. The overall estimated bird fatality rate was 2.30 bird fatalities/megawatt (MW)/study period and the overall estimated bat fatality rate was 14.19 bat fatalities/MW/study period. The estimated bird fatality rate by season was 0.98 bird fatalities/MW in spring, 1.12 in summer, and 0.18 in fall. The estimated bat fatality rate by season was 0.26 bat fatalities/MW in spring, 13.84 in summer, and 0.06 in fall.

STUDY PARTICIPANTS

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REPORT REFERENCE

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ACRONYMS AND ABBREVIATIONS

AICc	corrected Akaike Information Criterion
AWWI	American Wind Wildlife Institute
BGEPA	Bald and Golden Eagle Protection Act
cm	centimeter(s)
CI	confidence interval
CP	carcass persistence
CPT	carcass persistence trial
ft	feet or foot
GenEst	generalized estimator of fatality
in	inch(es)
k	detection reduction factor
km	kilometer(s)
m	meter(s)
MCP	minimum convex polygon
mi	mile(s)
MW	megawatt(s)
PCM	post-construction fatality monitoring
Project	Dakota Range I and II Wind Project
QA/QC	quality assurance/quality control
SDGFP	South Dakota Game, Fish, and Parks
SEEF	searcher efficiency
SEEF carcasses	SEEF trial carcasses
SGCN	Species of Greatest Conservation Need
TWL	truncated weighted maximum likelihood
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
WEST	Western EcoSystems Technology, Inc.
Xcel Energy	Northern States Power, a Minnesota corporation, d/b/a Xcel Energy

INTRODUCTION

Northern States Power, a Minnesota corporation, d/b/a Xcel Energy (Xcel Energy) owns and operates the Dakota Range I and II Wind Project (Project), located in Grant and Codington counties, South Dakota (Figure 1). The Project became operational in 2022 with an installed nameplate capacity of 304 megawatts (MW). The Project consists of 72 wind turbines: one Vestas V120 2.2-MW turbine with an 80-meter (m; 262-feet [ft]) hub height and 120-m (394-ft) rotor diameter, seven Vestas V136 3.8-MW turbines, and 64 Vestas V136 4.3-MW turbines. All Vestas V136 turbines at the Project have an 82-m (269-ft) hub height and 136-m (446-ft) rotor diameter.

Xcel Energy contracted Western EcoSystems Technology, Inc. (WEST) to conduct post-construction fatality monitoring (PCM) at the Project to estimate bird and bat fatality rates resulting from Project operations. The Project's South Dakota Public Utilities Commission site permit (number EL18-003) requires two years of PCM to be conducted at the Project. The PCM follows guidance described in Tier 4 of the US Fish and Wildlife Service (USFWS) *Land-Based Wind Energy Guidelines* (USFWS 2012).

The primary objectives of PCM were to 1) document species occurring as fatalities, 2) estimate bird and bat fatality rates for the study period, 3) qualitatively evaluate spatial and temporal patterns of bird and bat fatalities, 4) qualitatively compare data from PCM studies conducted at other wind energy facilities in South Dakota and neighboring states, and 5) document fatalities of sensitive species (defined in the *Methods* section) as a result of collisions with turbines at the Project. This report presents the results of the study conducted within the Project from March 16 – December 11, 2022.

PROJECT LOCATION

The Project is located in northeast South Dakota within the Big Sioux Basin and Prairie Coteau Level IV ecoregions of the Northern Glaciated Plains Level III Ecoregion (US Environmental Protection Agency 2013). The Prairie Coteau and Big Sioux Basin Level IV ecoregions encompass the majority of northeast South Dakota and into southwest Minnesota. The landscape in this ecoregion is composed of glacial drift and contains numerous seasonal and temporary prairie pothole wetlands that provide nesting and foraging habitat for waterfowl (Bryce et al. 1998). Historically, this ecoregion supported both tall- and short-grass prairies; however, these native grasslands have been extensively converted to agriculture (Bryce et al. 1998). Topography is flat to gently rolling; elevations within a minimum convex polygon (MCP; Figure 2) of the turbine layout range from 567–629 m (1,860–2,064 ft; US Geological Survey [USGS] 2023).

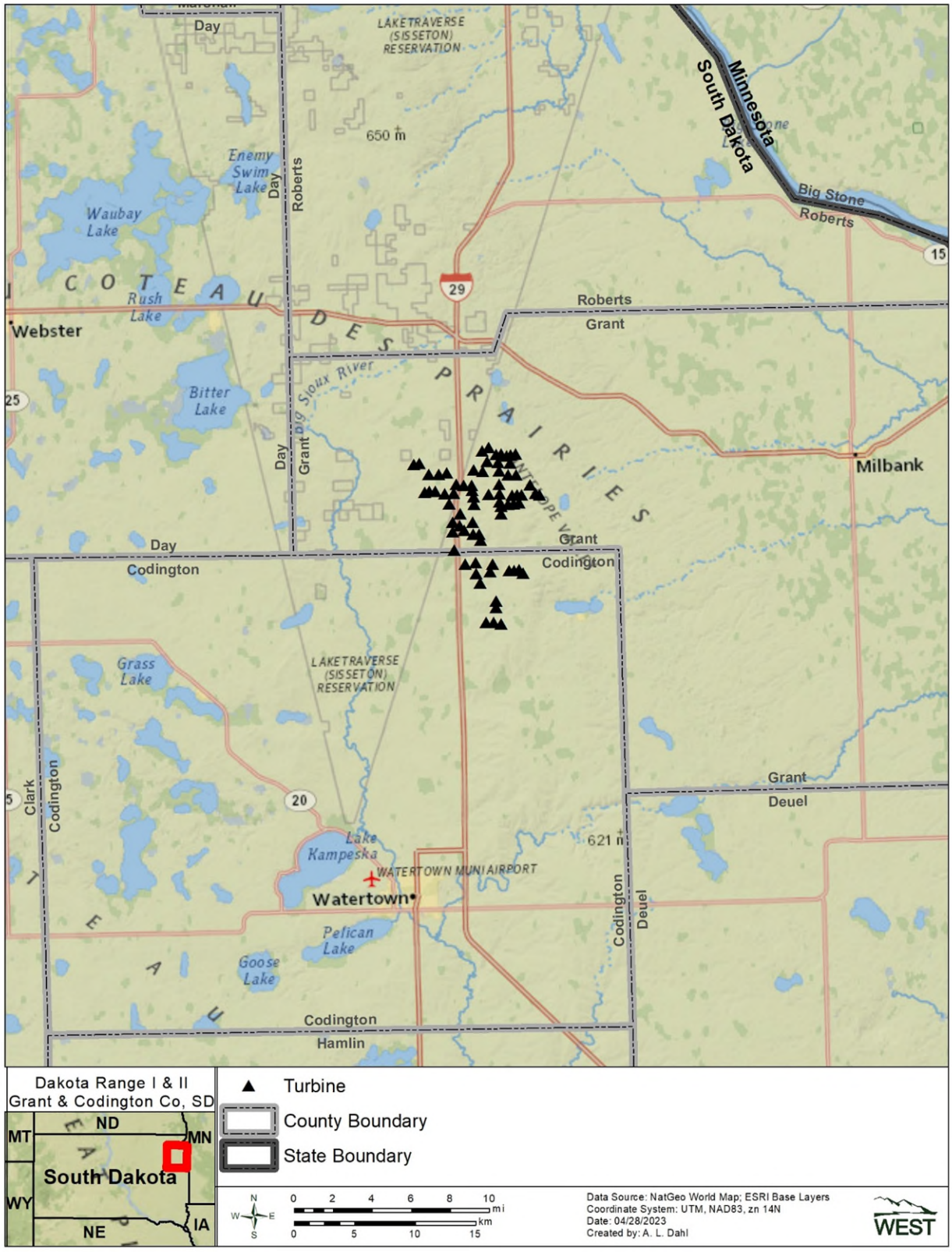

Figure 1. Location of the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota.

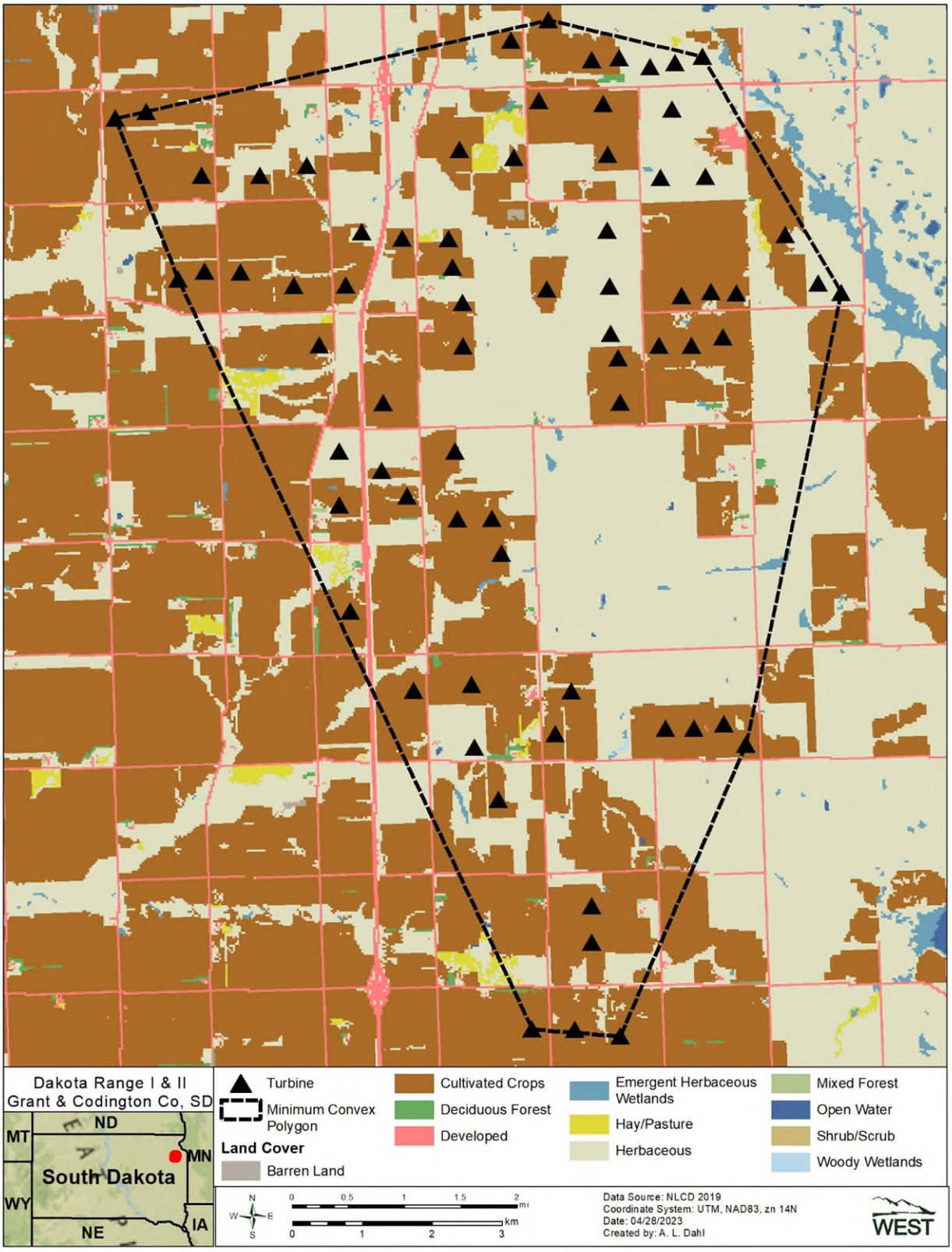

Figure 2. Land cover types within and adjacent to the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota.

The dominant land cover type in the MCP is herbaceous (48.2%), followed by cultivated crops (45.9%) and developed land (4.0%; National Land Cover Database 2019; Figure 2, Table 1). The cultivated crops consist mainly of soybeans (*Glycine max)* and corn (*Zea mays;* US Department of Agriculture 2022). Remaining land cover types each account for less than 1.0% of the MCP. Wetlands are relatively sparse but evenly distributed within the MCP and consist mainly of freshwater emergent and riverine wetlands (USFWS National Wetlands Inventory 2023).

Table 1. Land cover types, coverage, and percent (%) composition within the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota.[1]

Land Cover Type	Coverage (hectares)	Coverage (acres)	% Composition
Herbaceous	4,305.3	10,638.7	48.2
Cultivated Crops	4,099.1	10,129.2	45.9
Developed Land	354.8	876.8	4.0
Hay/Pasture	79.0	195.1	0.9
Emergent Herbaceous Wetlands	38.7	95.6	0.4
Deciduous Forest	34.2	84.4	0.4
Mixed Forest	7.8	19.3	<0.1
Barren Land	3.7	9.1	<0.1
Open Water	3.6	8.9	<0.1
Woody Wetlands	1.8	4.4	<0.1
Shrub/Scrub	0.5	1.3	<0.1
Total[2]	**8,928.6**	**22,063.0**	**100**

1. Land cover composition within minimum convex polygon of turbines.

2. Sums can differ from total values shown due to rounding.

Source: National Land Cover Database 2019.

METHODS

PCM consisted of three primary survey components: 1) standardized carcass searches (carcass searches) of turbines, 2) searcher efficiency (SEEF) trials to estimate the probability technicians found a carcass, and 3) carcass persistence (CP) trials (CPTs) to estimate the average length of time a carcass remained in the search area for possible detection. In addition, the searched areas were delineated to provide the basis for an area adjustment, which accounts for carcasses that fell outside of search areas. The methods for each of these survey components and associated analysis are described below. An overview of the study design and search methods are presented in Appendix A.

Sensitive species for the Project are defined as bird or bat species protected under the Endangered Species Act (1973) or Bald and Golden Eagle Protection Act (BGEPA; 1940), state-listed as endangered or threatened (South Dakota Game, Fish, and Parks [SDGFP] 2023a), or Species of Greatest Conservation Need (SGCN; SDGFP 2014, 2023b).

Bird fatalities were classified based on size. Large birds generally included groups of species with a total length greater than 23 centimeters (cm; nine inches [in]) in length and a wingspan greater than 46 cm (18 in). Small birds generally included groups of species equal to or less than 23 cm in total length, with a wingspan less than 46 cm.

Survey Design

Search Turbines

Twenty-two turbines (about 30% of total turbines) were initially selected for carcass searches at the Project. Due to turbine access issues (i.e., long-term maintenance), searches were discontinued at Turbine 24 in August; Turbine 38 was substituted as a searched turbine (Figure 3). At the start of the study, the 22 selected turbines were searched as square plots (discussed in *Search Areas*, below) until vegetation obstructed visibility (mid-June; "crop-in period"). Four turbines located in land cover with relatively low vegetation (e.g., grazed pasture) that allowed for unobstructed search visibility remained as square plots throughout the entire crop-in period. The other 18 turbines had only the access roads and turbine pads searched during the crop-in period. After vegetation (i.e., crops) was cleared in fall and plot visibility became unobstructed (late October), all survey turbines except Turbine 13 were searched as square plots through the end of the study. Turbine 13 was searched as a road and pad plot through the end of the study due to a fence bisecting the square plot.

Search Areas

Search areas consisted of square plots and road and pad plots. Square plots measured 150 x 150 m (492 x 492 ft) as a square area centered on the turbine (Figure 4). Road and pad plots included all area on the gravel pads and access roads out to 100 m (328 ft) from the turbine (Figure 4).

Search Frequency

Carcass searches occurred between March 16 and December 11, 2022. Seasons were defined as: spring (March 15 – June 17), summer (June 18 – September 12) and fall (September 13 – December 15). Searches were conducted once every two weeks for the duration of the study. Searches were missed on occasion due to site access issues that created unsafe working conditions (e.g., turbine maintenance, extreme weather, or impassable roads).

Search Area Delineations

Technicians delineated road and pad plots by walking along the perimeter of each plot and collecting a digital boundary file with a handheld GPS. The digital file was then converted to an ArcGIS layer. Square plot boundaries were created via desktop using ArcGIS.

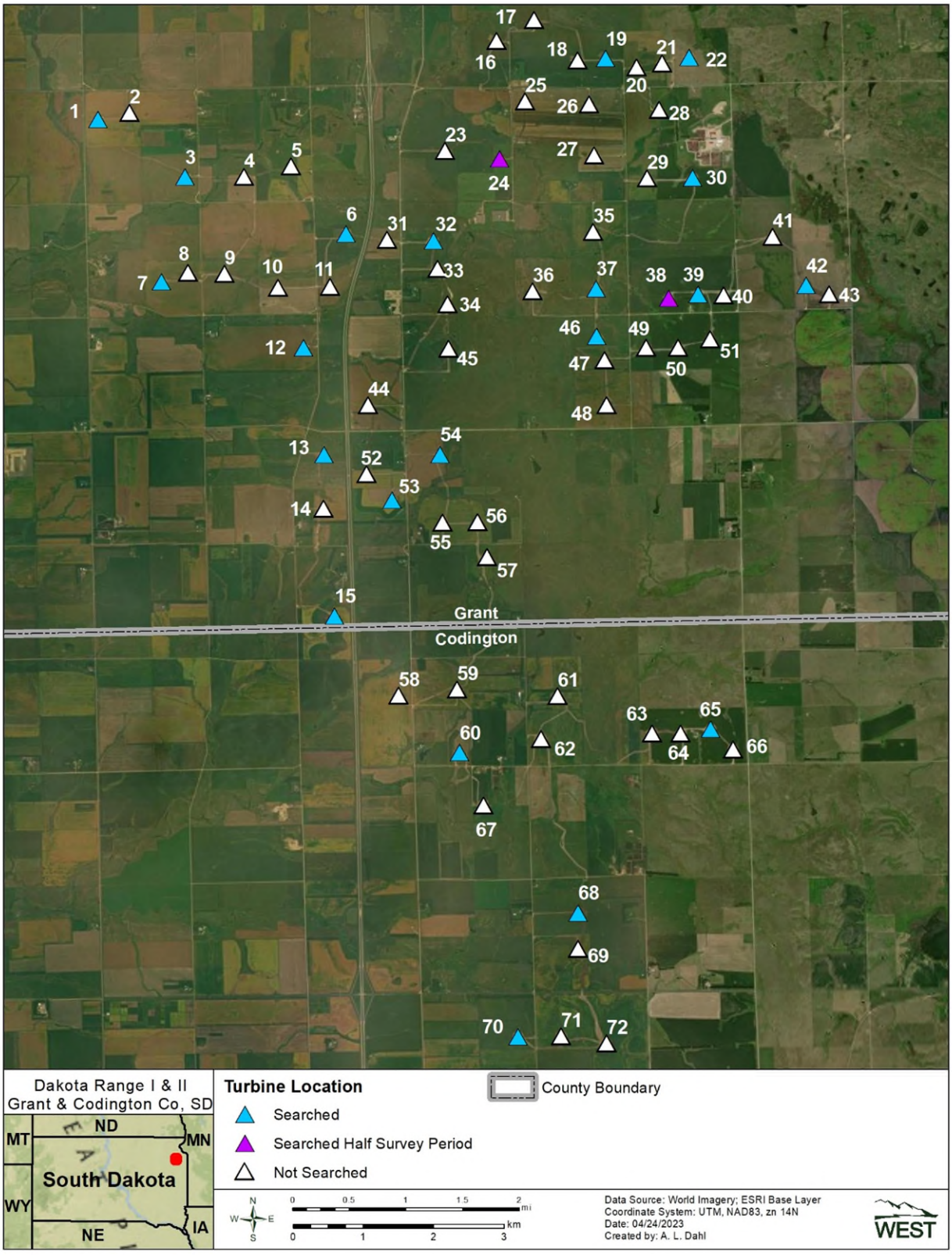

Figure 3. Location of turbines and search areas at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Figure 4. Schematic illustrating both search area types at an example turbine. The solid line outlines a 150-meter (492-foot) square area centered on the turbine used for square plot searches. Road and pad plot searches occurred within the turbine pad and access roads out to 100 meters (328 feet) from the center of the turbine.

Standardized Carcass Searches

Technicians looked for carcasses while walking transects spaced up to six m (20 ft) apart at a pace of approximately 45–60 m (148–197 ft) per minute within square plots and road and pad plots. During the first search of the study at each turbine, any carcasses found were recorded and included in the overall reported fatalities (Appendices B and C); however, these carcasses were excluded from the fatality rate estimation analysis.

All bird and bat carcasses found were recorded and cause of death was assumed to be from collision with turbines. Furthermore, any injured bird or bats observed within search areas or elsewhere in the Project were recorded and considered as fatalities for the analysis. Data recorded for all carcasses included:

- an identification code
- species, sex, and age (when identifiable)
- date and time
- location (i.e., coordinates in decimal degrees)
- distance from turbine measured using a handheld rangefinder
- bearing from turbine determined using a handheld compass
- estimated time of death
- any comments that indicated possible cause of death
- photograph(s) of carcass as found
- condition (i.e., intact, scavenged, dismembered, feather spot, injured)
    - Intact—a completely intact carcass, not badly decomposed, and shows no sign of being fed upon by a predator or scavenger
    - Scavenged—an entire carcass that shows signs of scavenging or is heavily infested by insects, or portion(s) of a carcass in one location (e.g., wings)
    - Dismembered—a carcass that has any major part of its body missing with no evidence of scavenging, or portions of the carcass are distributed in different locations
    - Feather Spot—10 or more body feathers (or two or more primary feathers) at one location indicating predation or scavenging
    - Injured—a live bird or bat that is harmed, damaged, or impaired in some way

Bird and bat carcasses were collected under the SDGFP Scientific Collector's Permit (permit number 21), and collection of bird carcasses was authorized under a Federal Migratory Bird Special Purpose – Utility Permit (permit number MBPER0021440). All bird and bat carcasses

were placed in individual re-sealable plastic bags, labeled with a unique carcass identification number, turbine number, and date, and stored in a freezer on site. Leather and nitrile gloves were worn to process all carcasses to reduce the risk of possible injury or transmission of rabies or other diseases.

Biologists with experience identifying birds and bats to species verified identification of all bird and bat carcasses. Permitted bat biologists (Kristina Hammond [USFWS permit number ES03495B-3] and Brenna Hyzy [ES26854C-2]) verified the identification of all sensitive bat species or suspected sensitive bat species.

Searcher Efficiency Trials

The objective of SEEF trials was to estimate the probability that technicians detected bird and bat carcasses. This effort accounted for biases associated with changes in conditions such as vegetation, topography, weather (e.g., rain, cloud cover, muddy plots), and technician variability that could have affected SEEF. Estimates of SEEF were used to adjust the total number of carcasses found to account for those missed by technicians.

SEEF trials commenced with the start of carcass searches and were conducted in the same search areas throughout the study period. SEEF trials were stratified by the type and size of carcass (large bird, small bird, or bat), by search area (road and pad plot or square plot), and by season (spring, summer, or fall). A bias trial administrator placed SEEF trial carcasses (SEEF carcasses) in search areas; technicians were unaware of when and where the SEEF carcasses were placed. Bird carcasses used for the trials included non-protected, commercially available species (i.e., rock pigeons [*Columba livia*] for large birds, and 6- to 8-day old northern bobwhite [*Colinus virginianus*] for small birds). Bat carcasses found during carcass searches were used for bat SEEF trials. Commercially available brown-colored house mice (*Mus musculus*) were also used as surrogates for bats.

The bias trial administrator placed SEEF carcasses in search areas at predetermined random locations before that day's scheduled search. Prior to placement, each SEEF carcass was discreetly marked (e.g., beak or foot of carcass was marked with a small amount of nail polish) so it could be identified as a SEEF carcass. The administrator dropped SEEF carcasses from waist height or higher and allowed them to land in a random posture. To avoid attracting scavengers, no more than two SEEF carcasses were placed at a single road and pad plot turbine and no more than three SEEF carcasses were placed at a single square plot turbine during an individual trial. Technicians conducting carcass searches recorded the location of any SEEF carcasses found. Immediately following the trial, the searcher confirmed with the bias trial administrator whether any missed trial carcasses were available for detection.

Carcass Persistence Trials

The objective of CPTs was to estimate the probability that a bird or bat carcass remained available to be found during the search interval. The data collected were used to adjust for the potential bias of carcasses being removed between carcass searches. CPTs were conducted throughout the study period to incorporate the effects of varying weather, climatic conditions, and scavenger

densities. Possible means of carcass removal included predators, scavengers, insects, or agricultural practices, such as being plowed into a field.

The same species of large and small bird carcasses used for SEEF trials were used for CPTs, including non-protected, commercially available species. Large bird carcasses found during carcass searches were also used for large bird CPTs. Brown-colored house mice (bat surrogates) were used for bat CPTs. Square plot CPT were placed at both search and non-searched turbines for the study period. During periods of high vegetation height, square plot CPTs were placed at searched turbines. Road and pad plot CPTs were placed at non-searched turbines throughout the study period. Trial carcasses were placed randomly (random distance and direction from a turbine). Carcasses were discreetly marked (e.g., beak or foot of carcass was marked with a small amount of nail polish) for recognition by technicians and other personnel, and then dropped from waist height or higher and allowed to land in a random posture.

CPT carcasses were monitored over a 30-day period according to the following schedule: every day for the first four days, then on days 7, 10, 14, 21, and 30. The condition of carcasses was recorded each time the CPT carcasses were checked. The schedule varied slightly depending on weather and coordination with other survey work. Following the 30-day period, any remaining evidence of carcasses was removed.

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. All WEST field staff were trained in proper survey techniques and tablet data entry procedures. All data collected were recorded on a tablet data form. Following field surveys, technicians were responsible for inspecting data forms for completeness and accuracy. If errors or anomalies were found, follow-up measures were implemented including discussions and review of field data with technicians and/or project managers.

System controls were implemented to ensure correct data were entered; however, if any errors, omissions, or problems were identified in later stages of analysis, they were traced back to the raw data where appropriate changes and measures were implemented. Data were incorporated into a Microsoft® SQL Server database and underwent QA/QC procedures throughout the course of the study. Statisticians provided an additional level of QA/QC to ensure proper protocols were followed and data collected were congruent with the objectives of the study.

WEST's reporting and review process included project management review, technical editing and content review, senior technical review, and a final review by the project manager before delivery to the client.

Statistical Analysis

Fatality Rate Estimation

Carcasses included in fatality rate estimation were found within the search areas and had an estimated time of death within the study period. Fatality estimates were calculated for all categories (all birds, large birds, small birds, and bats) by season and for the study period using GenEst (a generalized estimator of fatality; Dalthorp et al. 2018, Simonis et al. 2018).

To obtain an overall estimate of fatality, each carcass included in the analysis was adjusted for SEEF, CP, a detection reduction factor (also referred to as "*k*"; see below), and a search area adjustment. Estimates and confidence intervals (CIs) were calculated using a parametric bootstrap (Dalthorp et al. 2018) if five or more fatalities were detected. CIs were not calculated when the observed number of carcasses in a class was less than five because CIs from Horvitz-Thompson estimators can be unreliable when carcass counts are low (Korner-Nievergelt et al. 2011).

Searcher Efficiency Estimation

Data collected during SEEF trials were used to estimate the probability technicians detected bird and bat carcasses. Estimates of SEEF were used to adjust carcass counts for detection bias. SEEF estimated the probability of a searcher detecting a carcass given the carcass was available to be found. Estimates were obtained for each size class separately using a logit regression model (Dalthorp et al. 2018). Season and search area type were used as potential explanatory variables (covariates) for the logit regression models. Model selection was completed using an information theoretic approach known as AICc, or corrected Akaike Information Criterion (Burnham and Anderson 2002). Models with lower AICc values were considered to have a better fit. The most parsimonious model (the model with the fewest variables) within two AICc units of the model with the lowest AICc value was selected as the best model.

Carcass Persistence Estimation

Data collected during CPTs were used to estimate the amount of time, in days, that carcasses remained available to be located by the searcher. Estimates of CP were used to adjust carcass counts for removal bias. The CP adjustment estimated the average probability a carcass persisted through the search interval (i.e., the time between scheduled searches). The persistence of a carcass was modeled using an interval-censored survival regression for each size class using exponential, log-logistic, lognormal, and Weibull distributions (Kalbfleisch and Prentice 2002, Dalthorp et al. 2018). Season and search area type were used as potential covariates. Covariates were fit to each of the parameters of the distributions. The most parsimonious model within two AICc units of the model with the lowest AICc value was selected as the best model.

Detection Reduction Factor

The change in SEEF between successive searches was defined by a parameter called the detection reduction factor (*k*) that ranged from zero to one. When *k* is zero, it implied that a carcass missed on the first search would never be found on subsequent searches. A *k* of one implies SEEF remained constant no matter how many times a carcass is missed (i.e., a carcass missed

on the first search would have an equal chance of being found on a subsequent search as any other newly available carcass). The detection reduction factor was a required parameter for GenEst; however, data were not collected to estimate *k*. A value for *k* of 0.67 has been found to be a reliable estimate for bats (Huso et al. 2017), and this value was assumed in this study for birds and bats.

Search Area Adjustment Estimate

The search area adjustment accounted for unsearched areas beneath turbines and was calculated as a probability that ranged from zero to one. For example, an area adjustment of 0.75 meant that an estimated 75% of carcasses fell within the search area. Areas could be unsearchable due to survey obstacles such as ground cover (e.g., tall crops) or terrain, or there could be areas where carcasses fell outside the search area (e.g., a carcass landed 80 m (262 ft) away from the turbine on a square plot searched out to 75 m [246 ft] from the turbine base). The area adjustment was estimated as the product of the unsearched area around each turbine and a carcass-density distribution. The carcass-density distribution predicts the likelihood a carcass fell a given distance from the turbine base. Separate area adjustments were estimated for large birds, small birds, and bats.

A number of analysis methods exist to calculate the search area adjustment. The number of carcasses found during surveys determined the method used. In general, at least 30 carcasses are required to use the truncated weighted maximum likelihood (TWL) modeling approach (Khokan et al. 2013). In this study, the TWL approach was used for bats. Large bird and small bird area adjustments were estimated using a physics-based model (Hull and Muir 2013). Using the Hull and Muir method, the relative carcass-density distribution for a given turbine height and rotor diameter was assumed to decrease linearly from the turbine base out to the maximum predicted fall distance (Huso and Dalthorp 2014).

RESULTS

The number, species, location, and other characteristics of bird and bat carcasses that were found during the study and were included in analysis for fatality estimates are discussed below. A full list of species (including common and scientific names) found during the study period is presented in Appendix B, all carcasses found are presented in Appendix C, SEEF model selection is presented in Appendix D, CP data are presented in Appendix E, search area adjustment models are presented in Appendix F, and fatality estimates by season and plot type are presented in Appendix G.

Standardized Carcass Searches

In total, 422 carcass searches were conducted from March 16 – December 11, 2022 at 23 turbines in the Project. At square plots, 244 searches were conducted (during spring, summer, and fall), and at road and pad plots, 178 carcass searches were conducted (only during summer and fall). The average search interval was 14.9 days at both search area types across the study period.

During the study, 68 bird carcasses and 52 bat carcasses were found (Table 2). Of these, 13 bird carcasses and 10 bat carcasses were found outside of search areas, and three bird carcasses were found outside of the study period; these 26 carcasses were excluded from the fatality estimate analyses. Fifty-two bird carcasses and 42 bat carcasses were included in analysis.

Table 2. Number and percent (%) of carcasses by species included and excluded from analysis at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

	Included in Analysis		Outside Search Area[1]		Outside Study Period[1]		Total	
Type/Species	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
Birds								
American white pelican	4	7.7	5	38.5	0	0	9	13.2
unidentified wren	4	7.7	0	0	0	0	4	5.9
American coot	3	5.8	0	0	0	0	3	4.4
cliff swallow	3	5.8	0	0	0	0	3	4.4
yellow warbler	3	5.8	0	0	0	0	3	4.4
mallard	2	3.9	1	7.7	0	0	3	4.4
killdeer	2	3.9	0	0	0	0	2	2.9
horned lark	1	1.9	0	0	1	33.3	2	2.9
turkey vulture	1	1.9	0	0	1	33.3	2	2.9
American redstart	1	1.9	0	0	0	0	1	1.5
American robin	1	1.9	0	0	0	0	1	1.5
barn swallow	1	1.9	0	0	0	0	1	1.5
brown-headed cowbird	1	1.9	0	0	0	0	1	1.5
blue jay	1	1.9	0	0	0	0	1	1.5
bobolink	1	1.9	0	0	0	0	1	1.5
Caspian tern	1	1.9	0	0	0	0	1	1.5
Canada warbler	1	1.9	0	0	0	0	1	1.5
clay-colored sparrow	1	1.9	0	0	0	0	1	1.5
chipping sparrow	1	1.9	0	0	0	0	1	1.5
golden-crowned kinglet	1	1.9	0	0	0	0	1	1.5
greater scaup	1	1.9	0	0	0	0	1	1.5
house wren	1	1.9	0	0	0	0	1	1.5
Lapland longspur	1	1.9	0	0	0	0	1	1.5
Le Conte’s sparrow	1	1.9	0	0	0	0	1	1.5
least flycatcher	1	1.9	0	0	0	0	1	1.5
lesser yellowlegs	1	1.9	0	0	0	0	1	1.5
marsh wren	1	1.9	0	0	0	0	1	1.5
orchard oriole	1	1.9	0	0	0	0	1	1.5
ring-billed gull	1	1.9	0	0	0	0	1	1.5
ring-necked duck	1	1.9	0	0	0	0	1	1.5
red-winged blackbird	1	1.9	0	0	0	0	1	1.5
swamp sparrow	1	1.9	0	0	0	0	1	1.5
Swainson’s thrush	1	1.9	0	0	0	0	1	1.5
unidentified duck	1	1.9	0	0	0	0	1	1.5
unidentified large bird	1	1.9	0	0	0	0	1	1.5
unidentified passerine	1	1.9	0	0	0	0	1	1.5
unidentified thrush	1	1.9	0	0	0	0	1	1.5
unidentified vireo	1	1.9	0	0	0	0	1	1.5
bald eagle	0	0	1	7.7	0	0	1	1.5
Brewer’s blackbird	0	0	1	7.7	0	0	1	1.5
Lincoln’s sparrow	0	0	1	7.7	0	0	1	1.5
sedge wren	0	0	1	7.7	0	0	1	1.5

Table 2. Number and percent (%) of carcasses by species included and excluded from analysis at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

	Included in Analysis		Outside Search Area[1]		Outside Study Period[1]		Total	
Type/Species	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
song sparrow	0	0	1	7.7	0	0	1	1.5
sharp-shinned hawk	0	0	1	7.7	0	0	1	1.5
unidentified grebe	0	0	1	7.7	0	0	1	1.5
long-eared owl	0	0	0	0	1	33.3	1	1.5
Overall Birds[2]	**52**	**100**	**13**	**100**	**3**	**100**	**68**	**100**
Bats								
hoary bat	13	31.0	4	40.0	0	0	17	32.7
silver-haired bat	14	33.3	1	10.0	0	0	15	28.9
eastern red bat	11	26.2	4	40.0	0	0	15	28.9
big brown bat	4	9.5	1	10.0	0	0	5	9.6
Overall Bats[2]	**42**	**100**	**10**	**100**	**0**	**0**	**52**	**100**

1. Carcasses not included in analysis.
2. Sums can differ from total values shown due to rounding.

Sensitive Species

No federally or state-listed threatened or endangered species were found as fatalities. Sensitive species found as fatalities included four bird species and three bat species (considered SGCN). Sensitive species included American white pelican (nine carcasses), bald eagle (one), bobolink (one), Le Conte's sparrow (one), eastern red bat (15), hoary bat (17), and silver-haired bat (15; Table 3, Appendix B). The bald eagle is also protected by the BGEPA.

The nine American white pelican fatalities were found between late April and late November. Five of the nine American white pelicans were found incidentally throughout the Project (at turbines 15, 23, 64, 67, and 68; Appendix B). The bald eagle fatality was found incidentally at Turbine 56 in late October. The one bobolink was found at turbine 46 on May 24, 2022 and the one Le Conte's sparrow was found on August 1, 2022 at turbine 22. Seasonal and spatial trends in bat fatalities, including the three SGCN bat species, are included in the results and discussion below.

Table 3. Sensitive species found during post-construction fatality monitoring at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Type/Common Name	Scientific Name	Status	Number of Fatalities
Birds			
American white pelican	*Pelecanus erythrorhynchos*	SGCN	9
bobolink	*Dolichonyx oryzivorus*	SGCN	1
Le Conte's sparrow	*Ammodramus leconteii*	SGCN	1
bald eagle	*Haliaeetus leucocephalus*	SGCN; BGEPA	1
Bats			
eastern red bat	*Lasiurus borealis*	SGCN	15
hoary bat	*Lasiurus cinereus*	SGCN	17
silver-haired bat	*Lasionycteris noctivagans*	SGCN	15

SGCN = Species of Greatest Conservation Need, as designated in the South Dakota Wildlife Action Plan (SDGFP 2014, 2023b); BGEPA = Bald and Golden Eagle Protection Act (1940).

Bird Carcasses

Thirty-nine identifiable bird species were found as fatalities during the study; carcasses of 33 species were included in the analysis (Table 2, Appendix B). Among bird species found as fatalities, American white pelican was the most common (nine carcasses, 13.2% of total bird carcasses), followed by unidentified wren (four, 5.9%; Table 2). The next four most common species found as fatalities included American coot, cliff swallow, yellow warbler, and mallard (three carcasses each; 4.4% each), followed by killdeer, horned lark, and turkey vulture (two carcasses each; 2.9% each). One fatality of each of the remaining identifiable bird species was found (Table 2). Two species of raptors were found as fatalities: one bald eagle and one sharp-shinned hawk. Both raptor fatalities were outside of search plots, and the bald eagle was found incidentally outside of a carcass search.

Bird carcasses included in analysis were located at 91.3% of searched turbines (Figure 5). Bird carcasses were generally found throughout the Project (Figure 5). The highest number of bird carcasses were found at Turbine 15 (eight carcasses) and Turbine 46 (five carcasses) in the central and northern portions of the Project, respectively (Figure 5, Appendix C).

The first bird carcass included in the analysis was found during the March 28 – April 5 visit (at a square plot; Figure 6a). After searches switched to road and pad plots at most turbines during summer, the first bird carcass that was included in the analysis was found during the July 6 – July 14 visit (Figure 6b). Bird carcasses were generally found more often during spring compared to summer and fall, specifically from April 26 to June 3 (Figures 6a and 6b). The highest bird carcass count per searched turbine was for square plots in the fall from September 6 to 7 (Figure 6a).

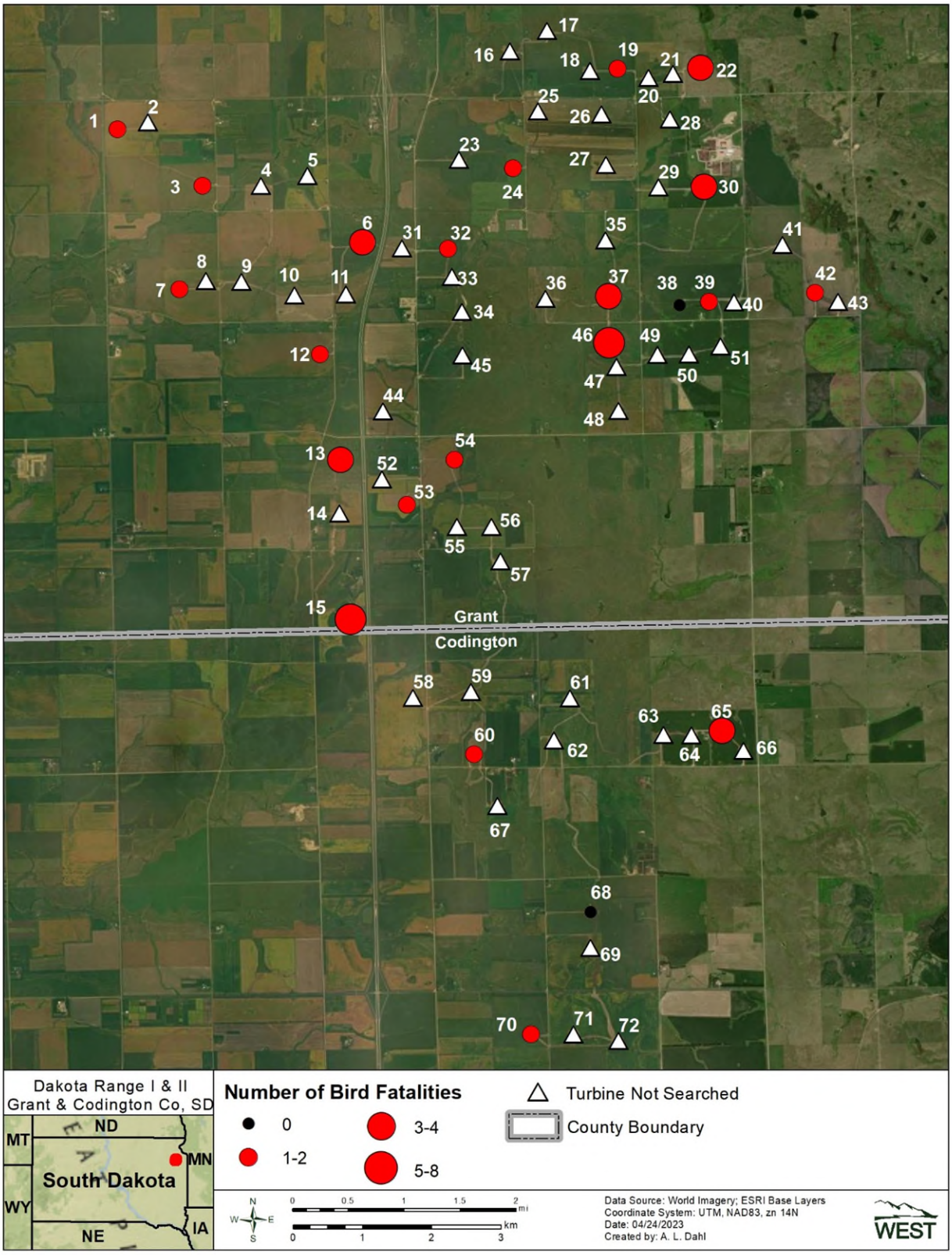

Figure 5. Location of all bird carcasses included in GenEst analysis found at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

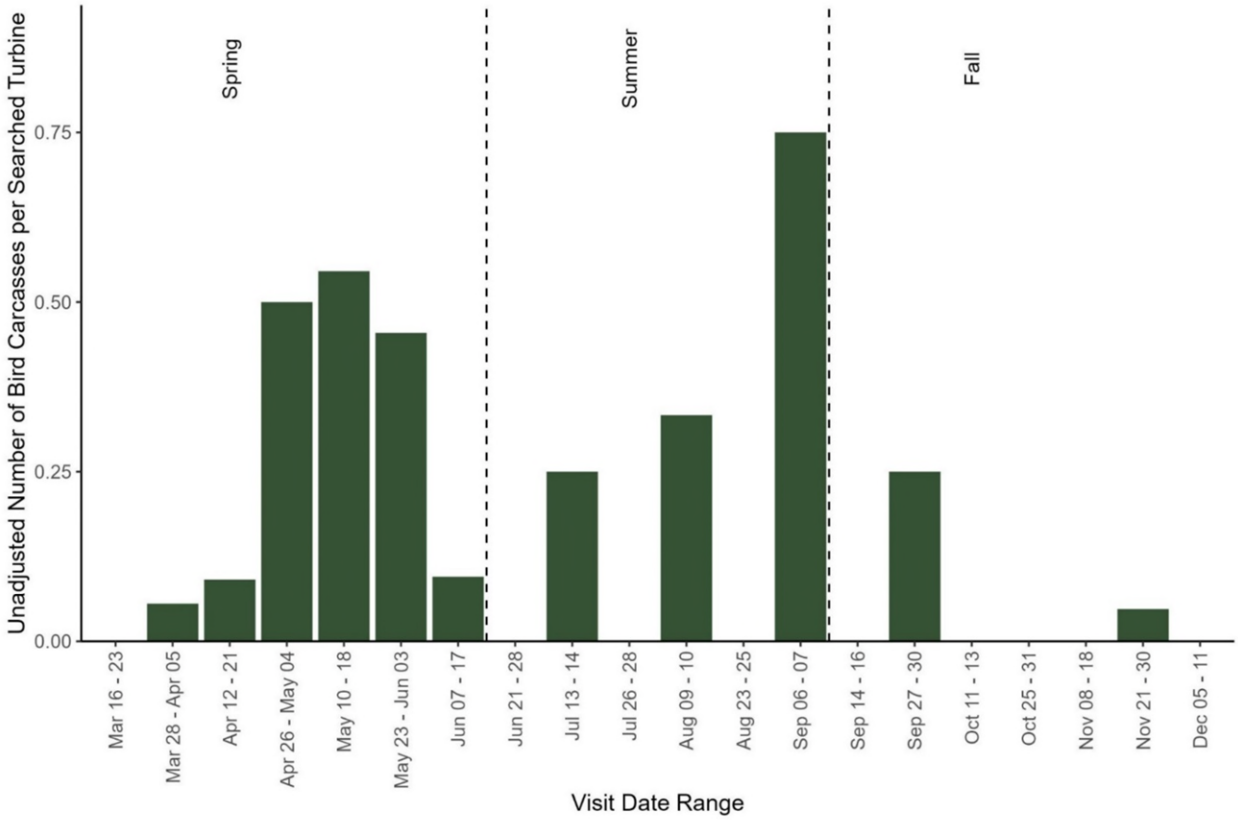

Figure 6a. Temporal distribution of bird carcasses per turbine searched included in GenEst analysis at square plots (unadjusted for searcher efficiency and carcass persistence) at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

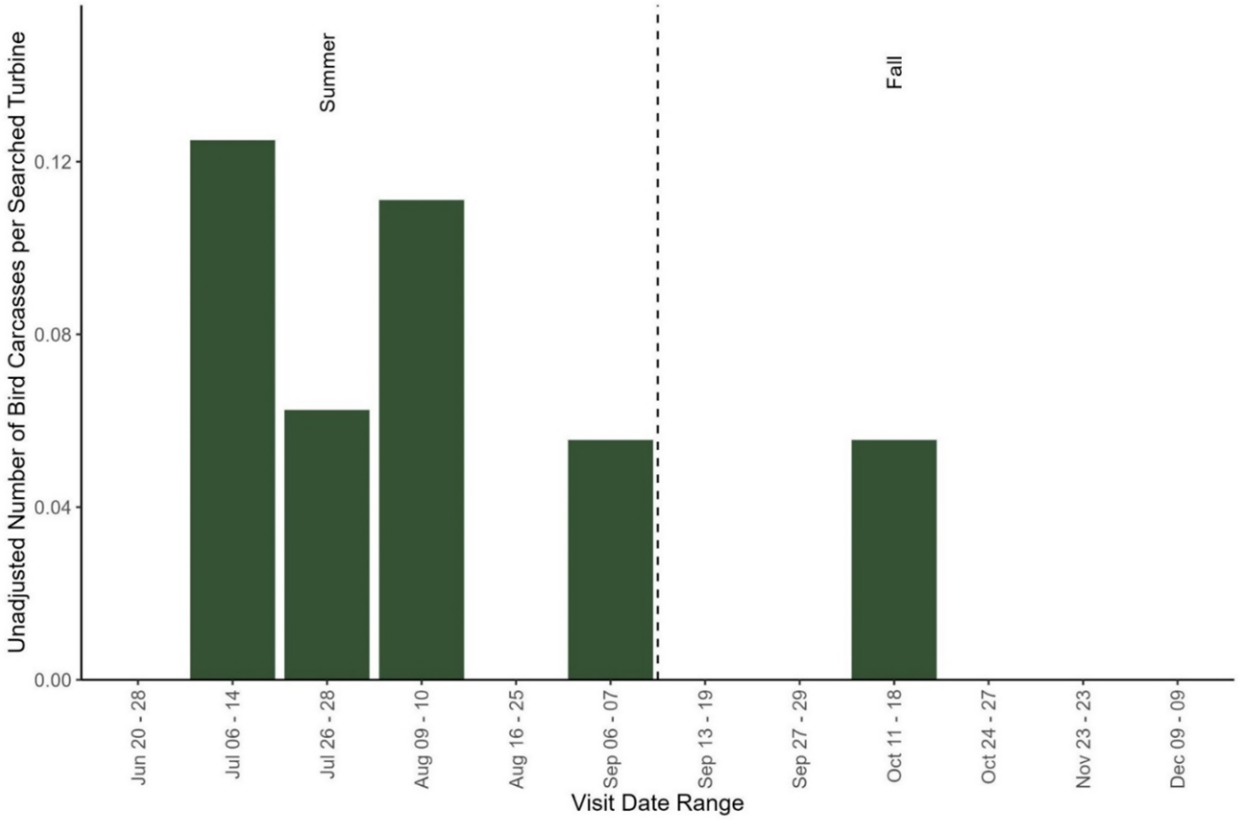

Figure 6b. Temporal distribution of bird carcasses per turbine searched (unadjusted for searcher efficiency and carcass persistence) included in GenEst analysis found at road and pad plots during the crop-in period at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from June 20 – October 31, 2022.

Bat Carcasses

Four identifiable bat species were found as fatalities during the study and were included in analysis (Table 2, Appendix B). Hoary bat was the most common (17 carcasses, 32.7% of total bat carcasses), followed by silver-haired bat and eastern red bat (15 each, 28.9% each), and big brown bat (five, 9.6%; Table 2).

Bat carcasses included in analysis were found at 78.2% of searched turbines (Figure 7). The most bat carcasses were found at Turbine 46 (six carcasses), followed by Turbine 3 (five), and Turbine 30 (four). All of these turbines are located in the northern portion of the Project (Figure 7; Appendix C).

Most bat carcasses found in square plots included in analysis were found in the latter part of what the study defined as the summer season (June 18 – September 12), with the highest number found during the September 6 and 7 visit (Figure 8a). For road and pad plots, bat carcasses were only found during the latter part of summer season (later July through early September; Figure 8b). At road and pad plots, the most bat carcasses were found during the two visits that occurred from August 9 – 25 (Figure 8b).

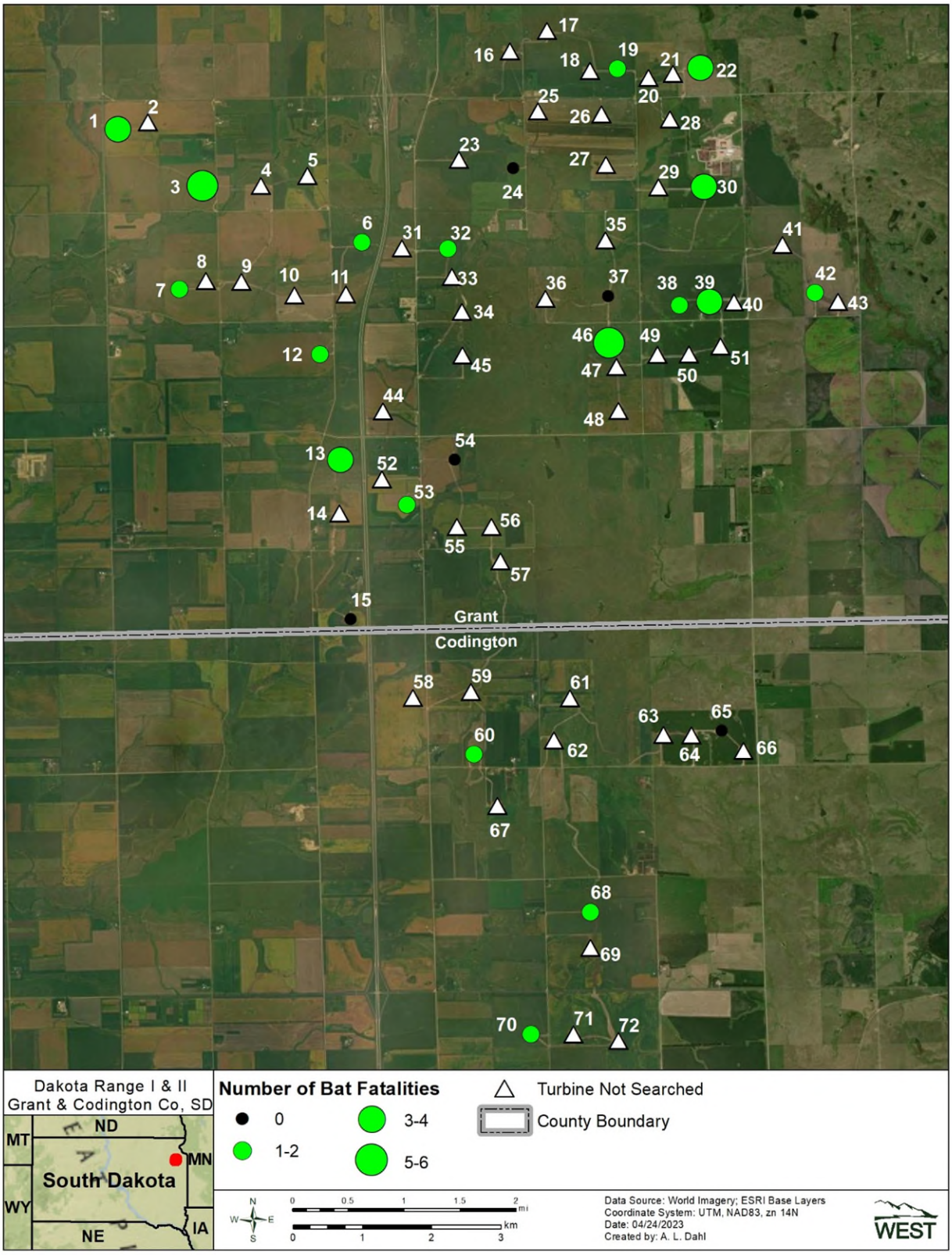

Figure 7. Location of all bat carcasses included in GenEst analysis found at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

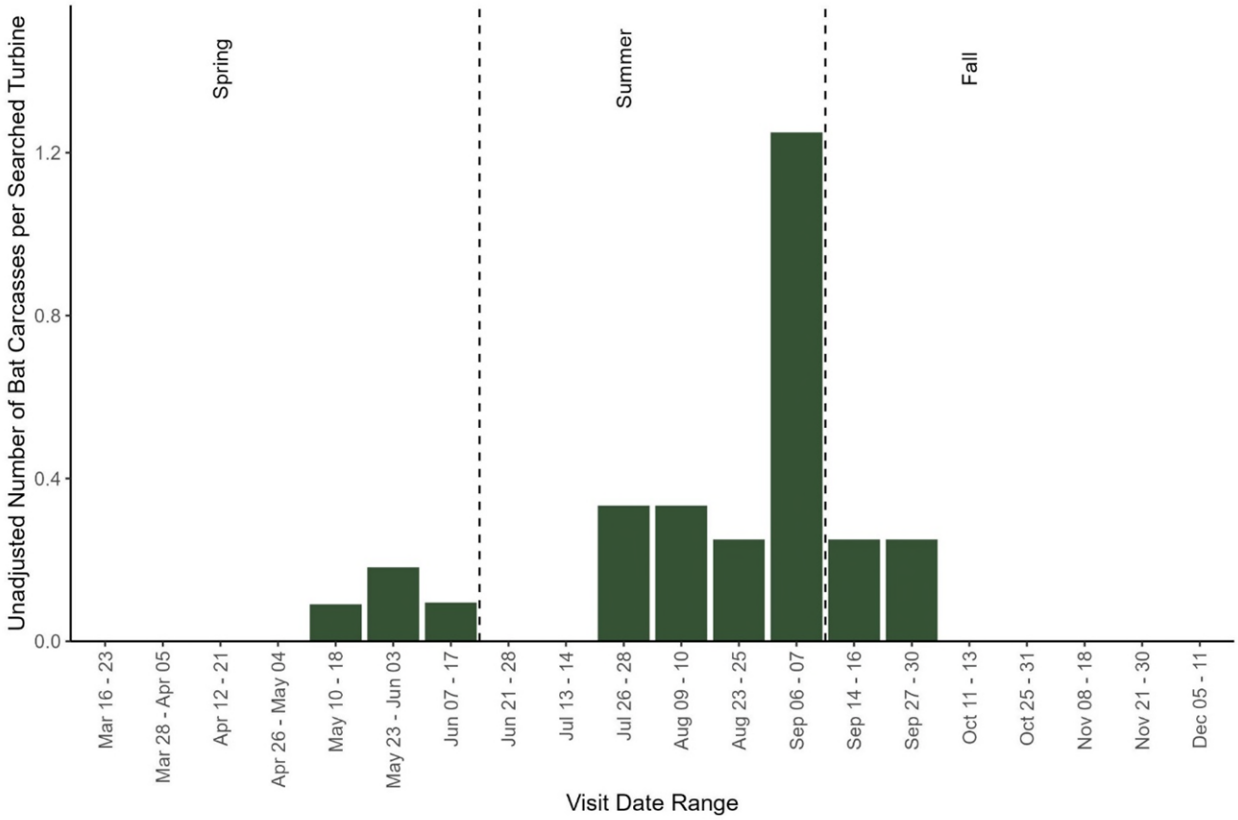

Figure 8a. Temporal distribution of bat carcasses per turbine searched included in GenEst analysis at square plots (unadjusted for searcher efficiency and carcass persistence) at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

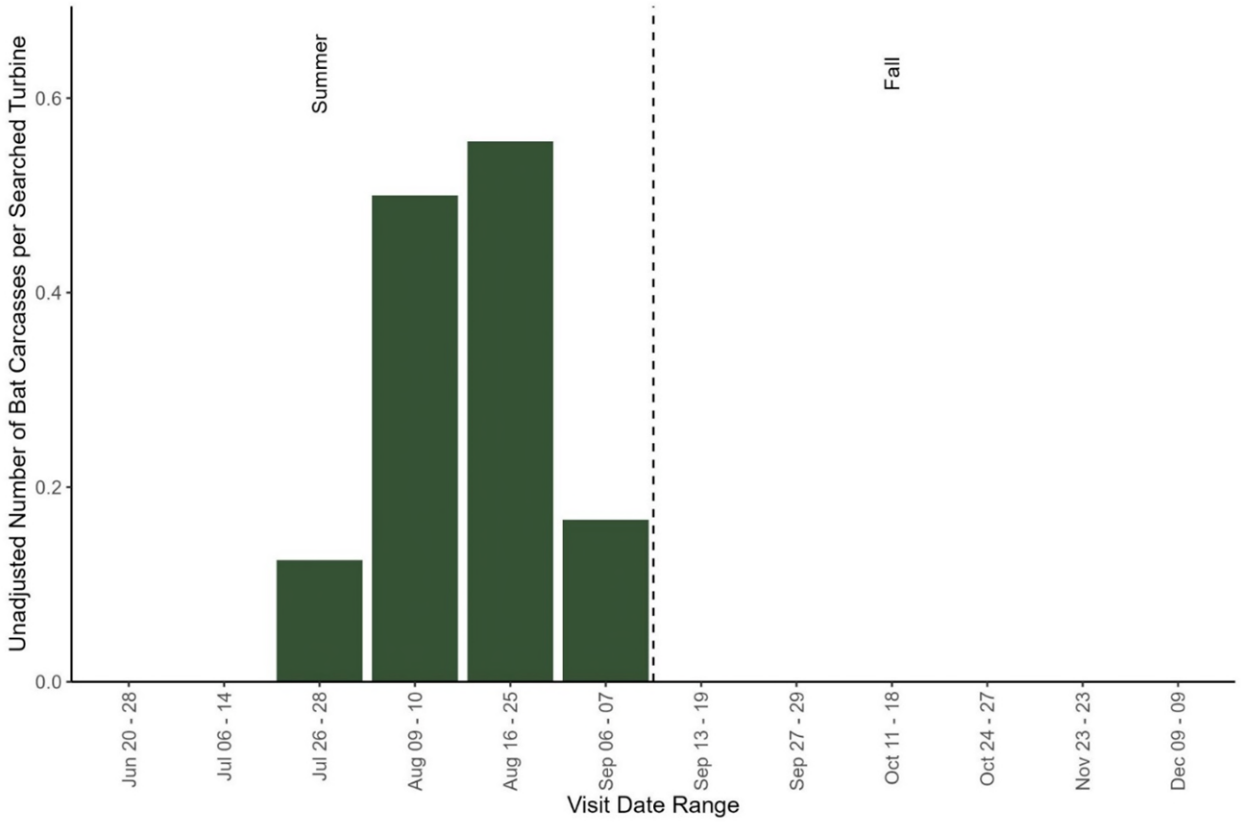

Figure 8b. Temporal distribution of bat carcasses per turbine searched (unadjusted for searcher efficiency and carcass persistence) found at road and pad plots during crop-in period at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from June 20 – October 31, 2022.

Searcher Efficiency Trials

One hundred and eight carcasses (32 large birds, 38 small birds, and 38 bats [and mice as bat surrogates]) were placed for SEEF trials in square plots. Eighty-seven of those carcasses (30 large birds, 31 small birds, and 26 bats) remained available for the technician to find during scheduled searches (Table 4a). The technician found 80.0% of large bird carcasses, 64.5% of small bird carcasses, and 61.5% of bat carcasses.

At road and pad plots, 60 carcasses (20 large birds, 20 small birds, and 20 bats [and mice as bat surrogates]) were placed for SEEF trials. Fifty-nine carcasses (20 large birds, 20 small birds, and 19 mice) remained available for the technician to find during scheduled searches (Table 4b). The technician found 100% of large bird carcasses, 90.0% of small bird carcasses, and 73.7% of bat carcasses.

Table 4a. Searcher efficiency results for square plots as a function of season and carcass size at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Size Class	Season[1]	Number Placed	Number Available	Number Found	Percent Found
Large Bird	Spring	12	10	10	100
	Summer	10	10	6	60.0
	Fall	10	10	8	80.0
	Overall	**32**	**30**	**24**	**80.0**
Small Bird	Spring	12	10	8	80.0
	Summer	10	9	5	55.6
	Fall	16	12	7	58.3
	Overall	**38**	**31**	**20**	**64.5**
Bat	Spring	12	6	6	100
	Summer	10	8	4	50.0
	Fall	16	12	6	50.0
	Overall	**38**	**26**	**16**	**61.5**

[1] Spring = March 15 – June 17; Summer = June 18 – September 12; Fall = September 13 – December 15.

Table 4b. Searcher efficiency results for road and pad plots as a function of season and carcass size at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Size Class	Season[1]	Number Placed	Number Available	Number Found	Percent Found
Large Bird	Summer	10	10	10	100
	Fall	10	10	10	100
	Overall	**20**	**20**	**20**	**100**
Small Bird	Summer	10	10	9	90.0
	Fall	10	10	9	90.0
	Overall	**20**	**20**	**18**	**90.0**
Bat	Summer	10	9	7	77.8
	Fall	10	10	7	70.0
	Overall	**20**	**19**	**14**	**73.7**

[1] Summer = June 18 – September 12; Fall = September 13 – December 15.

Models were fit for each size class to determine whether season or plot type covariates provided the best model for estimating SEEF rates based on AICc values. A model with a plot type covariate provided the best fit for modeling large bird and small bird SEEF (Appendices D1 and D2). An intercept-only model provided the best fit for modeling bat SEEF (Appendix D3).

Estimated annual SEEF rates in square plots were 0.80 (90% CI: 0.65–0.89) for large birds and 0.65 (90% CI: 0.50–0.77) for small birds (Appendix G1). On road and pad plots, SEEF rates were 0.97 (90% CI: 0.88–1.00) for large birds and 0.90 (90% CI: 0.73–0.97) for small birds (Appendix G2). SEEF rates for bats were 0.67 (90% CI: 0.54–0.77) across both plot types.

Carcass Persistence

In total, 150 carcasses (50 carcasses each of large bird, small bird, and bat surrogates) were placed for CPTs throughout the duration of the study (Appendix E). Large bird CP was best modeled using plot type and season as covariates, with a Weibull distribution (Appendix E), meaning the median removal

time for large birds varied based by season and plot type. A model with a plot type covariate provided the best fit for estimating small bird CP, using an exponential distribution. Bat CP was best estimated using an intercept-only model with a Weibull distribution. Large bird median removal time on square plots ranged from 13.14 days in summer to 19.53 days in fall. On road and pad plots, large bird median removal times ranged from 6.16 days in summer to 17.48 in fall (Appendix E). The median removal time was 8.98 days for small birds on square plots and 3.62 days on road and pad plots. The median removal time was 4.53 days for bats (Appendix E).

The average probability that a large bird carcass persisted through the search interval (once every two weeks) on square plots in spring was 0.71 (90% CI: 0.61–0.79), 0.67 (90% CI: 0.57–0.77) in summer, and 0.98 (90% CI: 0.91–1.00) in fall (Figure 9a, Appendix G). Large bird CP was relatively lower on road and pad plots: 0.51 (90% CI: 0.46–0.58) in summer, and 0.86 (90% CI: 0.77–0.92) in fall (Figure 9b, Appendix G).

The average probability that a small bird carcass persisted through the search interval on cleared plots was 0.59 (90% CI: 0.50–0.68), and on road and pad plots was 0.33 (90% CI: 0.24–0.43; Figure 9c, Appendix G). The average probability that a bat carcass persisted through the search interval was 0.42 (90% CI: 0.33–0.50; Figure 9d, Appendix G).

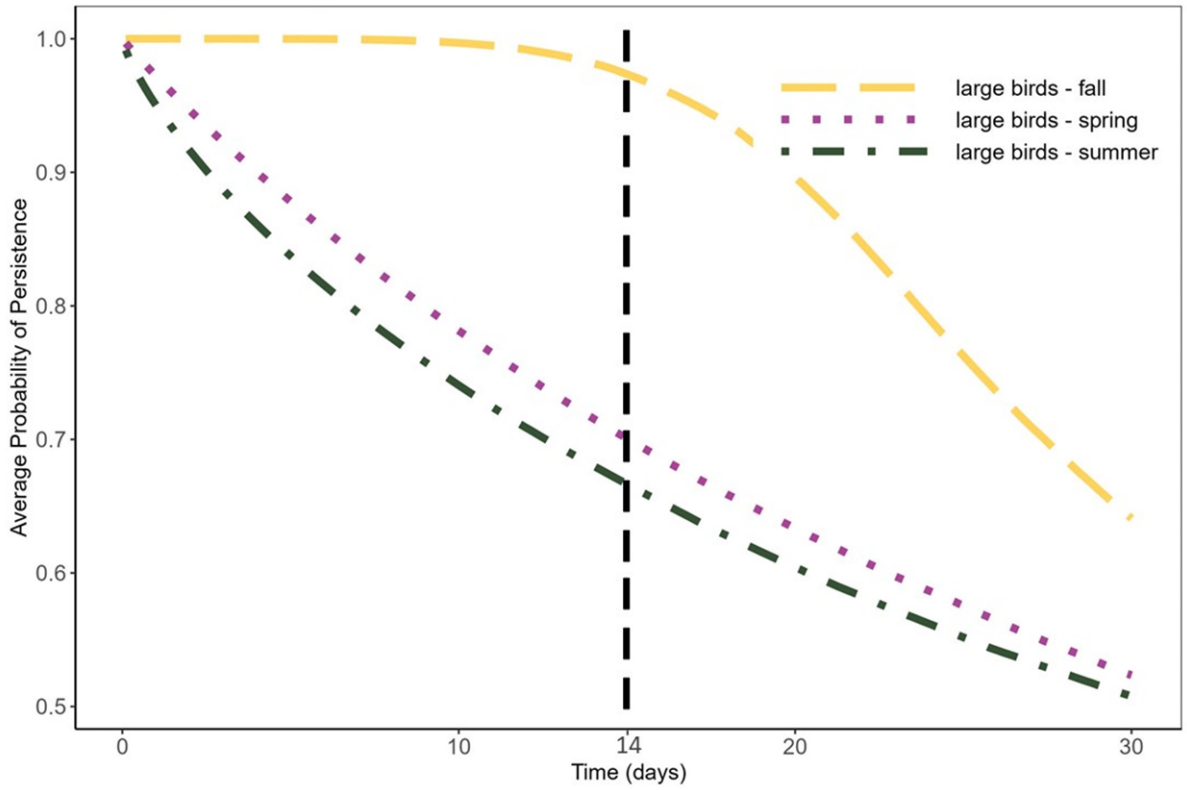

Figure 9a. Average probability of carcass persistence by season as a function of time (days) for large birds at square plots at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022. The vertical black dashed line denotes the search interval (once every two weeks).

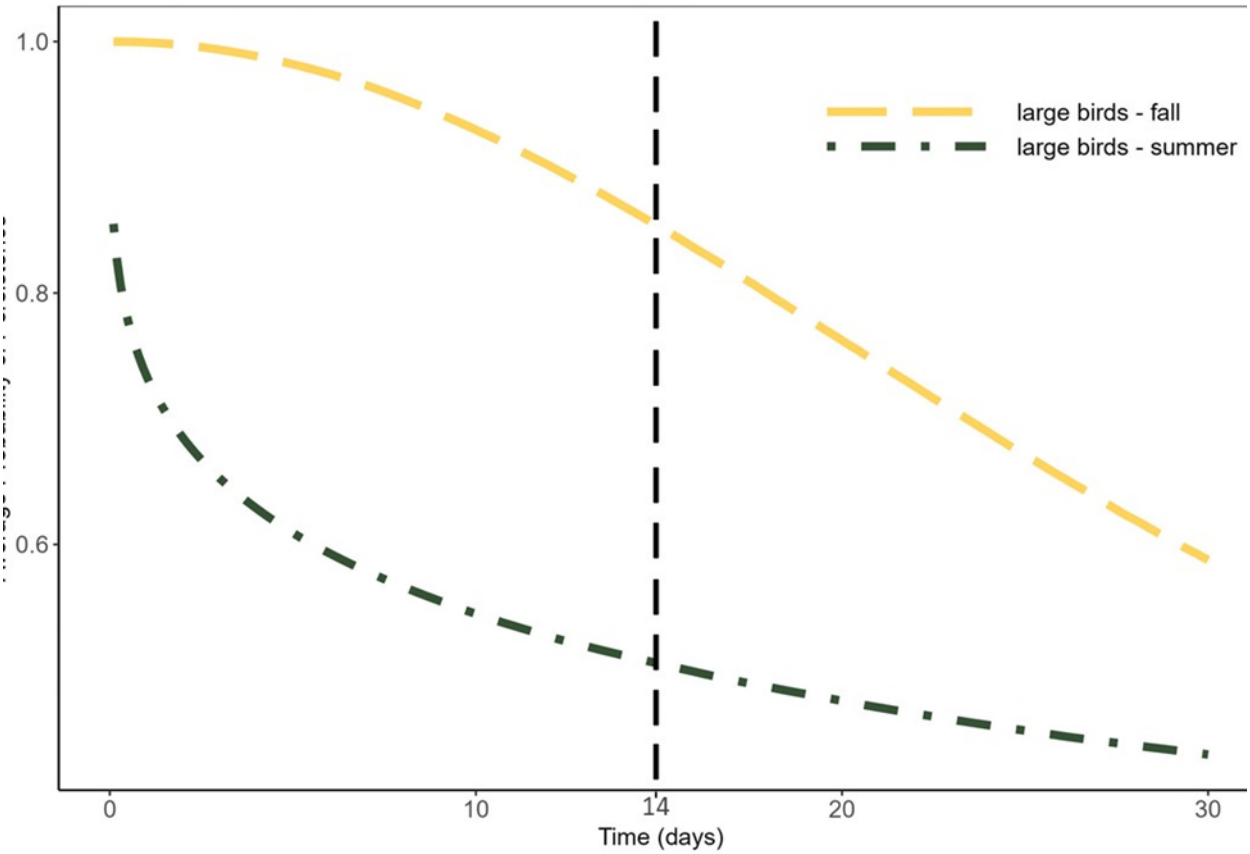

Figure 9b. Average probability of carcass persistence by season as a function of time (days) for large birds at road and pad plots at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022. The vertical black dashed line denotes the search interval (once every two weeks).

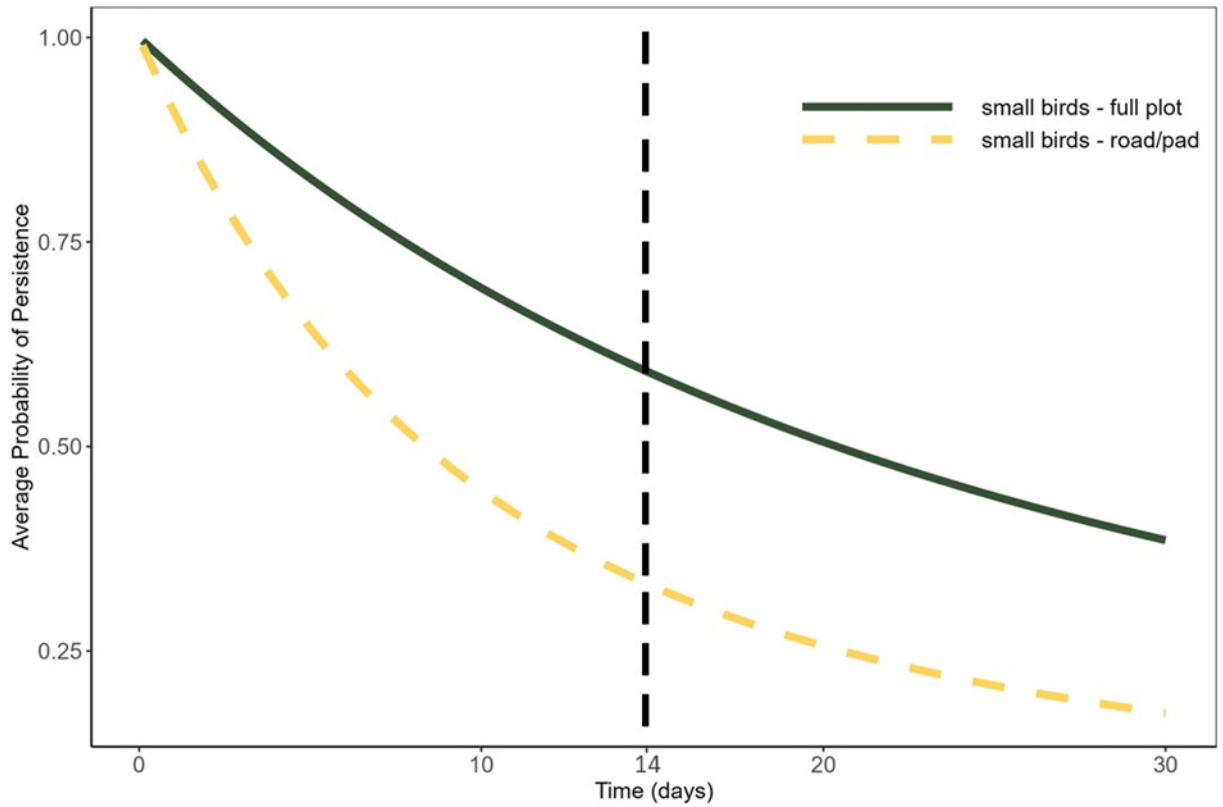

Figure 9c. Average probability of carcass persistence by plot type as a function of time (days) for small birds placed at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022. The vertical black dashed line denotes the search interval (once every two weeks).

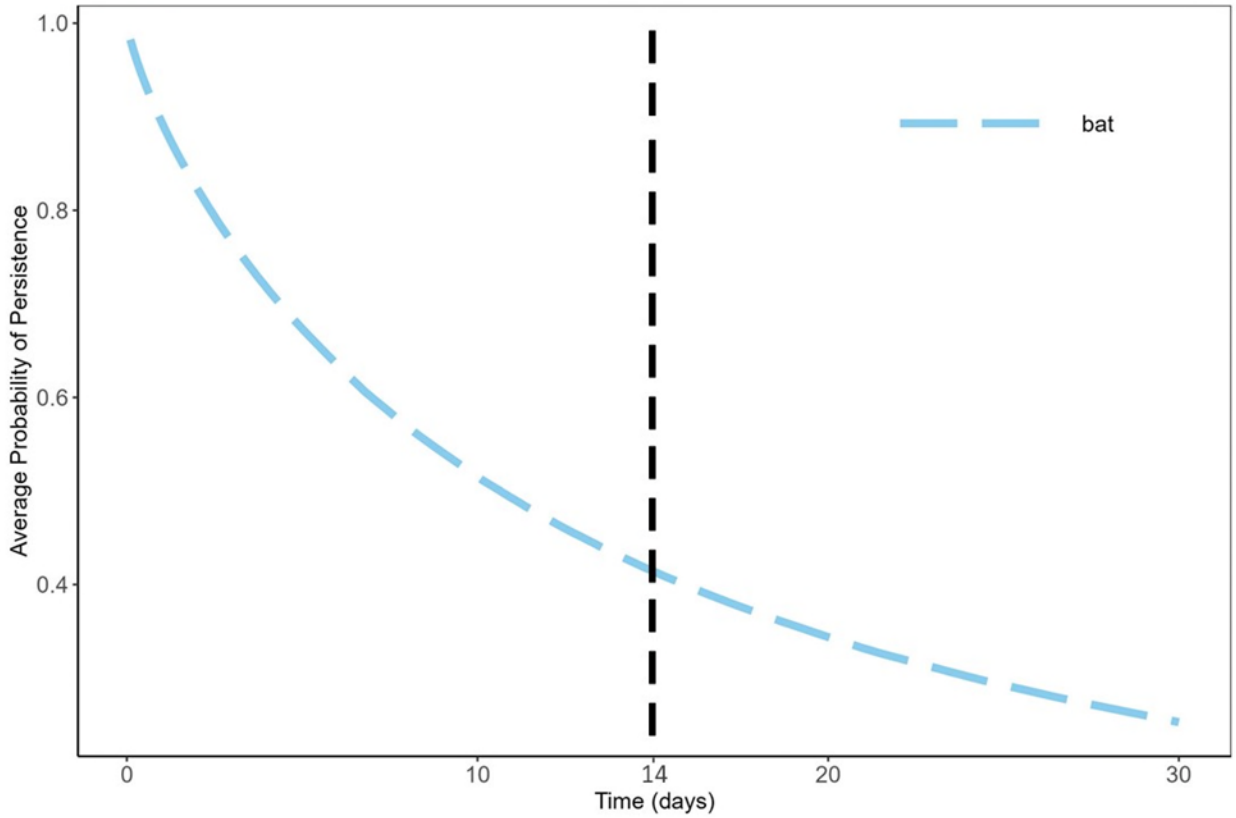

Figure 9d. Average probability of carcass persistence as a function of time (days) for bats at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022. The vertical black dashed line denotes the search interval (once every two weeks).

Search Area Adjustment

The search area adjustment model for large birds and small birds was calculated using the Hull and Muir (2013) method (Appendix F). The large bird and small bird carcass-density distributions were estimated using the maximum fall distance of carcasses for a 82-m turbine tower height and a 136-m rotor diameter (Hull and Muir 2013) where the relative carcass-density distribution was assumed to follow a linear decrease from the turbine base out to the maximum estimated fall distance (Huso and Dalthorp 2014; Figure 10).

The search area adjustment for bats was calculated using the TWL modeling approach (Figure 11; Appendix F). A normal distribution was the best fit for modeling the bat carcass-density distribution.

The search area adjustment for square plots was 0.86 (90% CI: 0.86–0.86) for large birds, 0.98 (90% CI: 0.98–0.98) for small birds, and 1.00 (90% CI: 1.00–1.00) for bats (Appendix G1). The search area adjustment for road and pad plots was 0.15 (90% CI: 0.15–0.15) for large birds, 0.21 (90% CI: 0.21–0.21) for small birds, and 0.07 (90% CI: 0.04–0.12) for bats (Appendix G2).

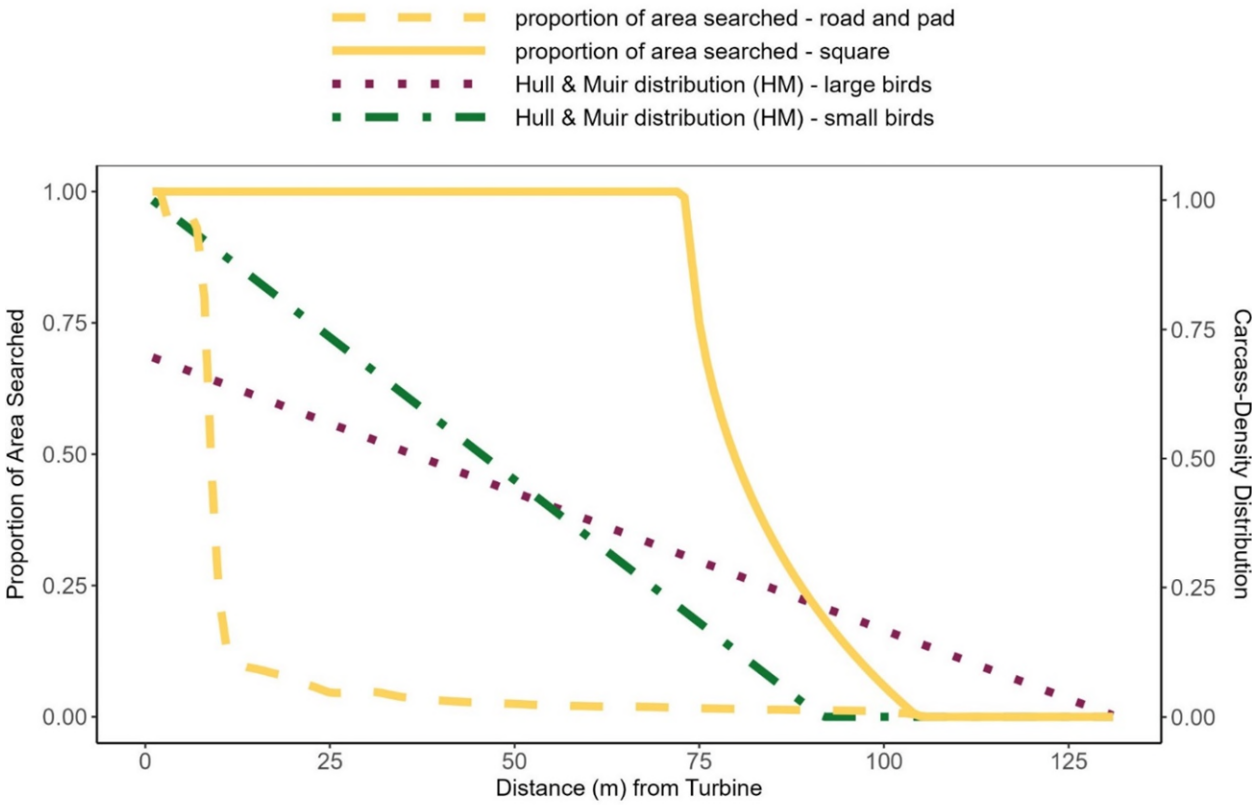

Figure 10. Estimated large and small bird carcass-density distributions, and proportion of area searched by distance from turbine for road and pad plots and square plots at Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

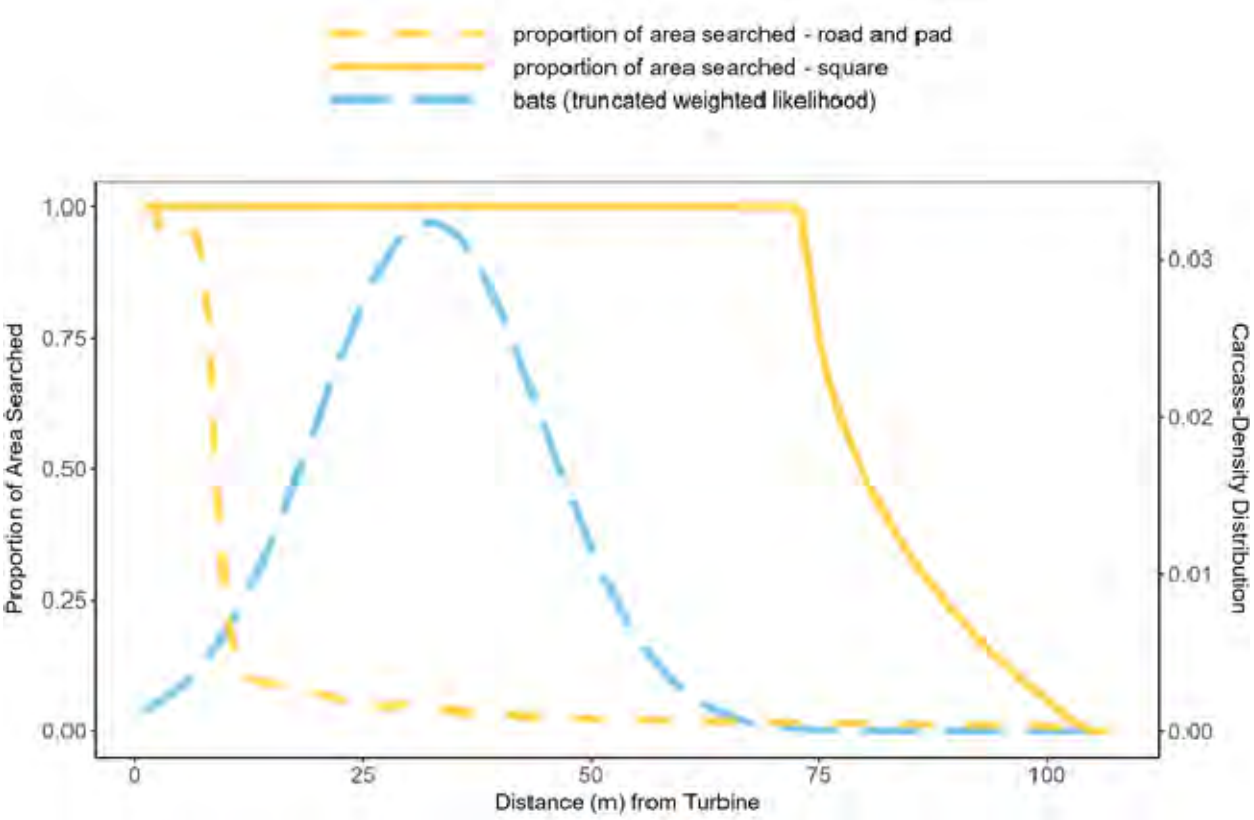

Figure 11. Estimated bat carcass-density distribution and proportion of area searched by distance from turbine for road and pad plots and square plots at Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Estimated Fatality Rates

Estimated fatality rates and 90% CI were calculated on a per-MW and per-turbine basis for all birds, large bird, small birds, and bats using GenEst (Table 5). The average probability a carcass remained in the search area and was found by technicians is listed in Appendix G.

Table 5. GenEst estimated overall fatality rates per megawatt (MW) and per turbine at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

	Per MW Estimates		Per Turbine Estimates	
	Estimate	90% CI	Estimate	90% CI
All Bird	2.30	1.59–3.37	9.51	6.44–14.01
Large Bird	0.78	0.40–1.35	3.21	1.66–5.58
Small Bird	1.47	0.88–2.39	6.04	3.61–10.02
Bat	14.19	6.83–25.56	59.84	28.71–108.62

CI = confidence interval.

All Birds

The overall estimated bird fatality rate was 2.30 bird fatalities/MW/study period (9.51 bird fatalities/turbine/study period), driven primarily by the small bird estimated fatality rate (1.47 fatalities/MW/study period [6.04 fatalities/turbine/study period]; Table 5).

Bird fatalities included in analysis were documented during spring, summer and fall. Estimated bird fatality rates for spring were 0.98 bird fatalities/MW (3.94 bird fatalities/turbine), in summer were 1.12 bird fatalities/MW (4.71 bird fatalities/turbine), and in fall were 0.18 bird fatalities/MW (0.77 bird fatalities/turbine; Appendix G5). Both raptor fatalities found at the Project were outside of search plots; therefore, they were excluded from analysis and a raptor fatality estimate was not calculated.

Bats

The overall estimated bat fatality rate was 14.19 bat fatalities/MW/study period (59.84 bat fatalities/turbine/study period; Table 5). Estimated bat fatality rates were calculated during spring (0.26 bat fatalities/MW [1.09 bat fatalities/turbine]), summer (13.84 bat fatalities/MW [58.44 bat fatalities/turbine] and fall (0.06 bat fatalities/MW [0.23 bat fatalities/turbine]; Appendix G5).

DISCUSSION

The overall goal for this study was to estimate the number of bird and bat fatalities within the Project attributable to collisions with turbines. The primary objectives of PCM were to 1) document bird and bat species occurring as fatalities, 2) estimate bird and bat fatality rates for the study period, 3) qualitatively evaluate spatial and temporal patterns of bird and bat fatalities, 4) qualitatively compare data from PCM studies conducted at other wind energy facilities in South Dakota and neighboring states, and 5) document bird and bat fatalities of sensitive species as a result of collisions with turbines at the Project.

Birds

Species Composition

Thirty-nine identifiable bird species were documented as fatalities during the study. Among identifiable bird species documented during PCM, American white pelican was the most abundant (nine fatalities, 13.2% of overall bird fatalities), followed by American coot, cliff swallow, yellow warbler, and mallard (three fatalities each; 4.4% each).

No federally or state-listed threatened or endangered bird species were observed during surveys. One bald eagle fatality (a species protected by BGEPA) was found incidentally outside of the search area on October 20, 2022. Because it was found outside of the search area, it was not included in analysis. The eagle was found near Turbine 56 which is located in the central portion of the Project. American white pelican, a SGCN, was the most common sensitive bird species documented as a fatality at the Project. American white pelicans are a relatively common species to find as a fatality at other wind energy facilities in the region (WEST 2021).

American white pelicans primarily breed along the shorelines of inland lakes, often on islands, and can fly up to 100 kilometers (km; 62 miles [mi]) to forage in emergent wetlands, rivers, and marshlands (Knopf and Evans 2020). American white pelicans are relatively common in the region during the summer breeding season (eBird 2023). In South Dakota, there are two known main breeding colonies of American white pelicans: Bitter Lake and LaCreek National Wildlife Refuge (Sovada et al. 2013). Bitter Lake, approximately 18 km (11 mi) northwest of the Project, is the closest large colony to the Project, with approximately 15,400 nests (Sovada et al. 2013). While pelicans in the Dakotas are known to spend up to three days away from the colony during the incubation period, not all breeding-aged individuals nest every year (Sovada et al. 2013), thereby increasing the distribution of pelicans across the region during and after nesting. The nine American white pelican fatalities were found across seasons (discussed in *Spatial and Temporal Patterns*, below) at the Project, with most fatalities documented in the southern portion of the Project.

Spatial and Temporal Patterns

Bird fatalities included in analysis were found throughout the study period at many turbines throughout the Project with no apparent spatial pattern. The highest number of bird carcasses were found at Turbine 15 (eight carcasses) but reasons for that are unclear, since the habitat at this turbine is similar to the surrounding turbines (i.e., agriculture; Figure 3) and there are no features at the turbine that would be expected to attract birds. The nine American white pelican fatalities were found throughout the study period (two in spring, five in summer, and two in fall) and mainly in the southern portion of the Project (Appendix C). Nearby Bitter Lake is a known pelican breeding colony to the northwest of the Project (discussed in *Species Composition*, above).

The estimated overall bird fatality rate was higher in spring and summer compared to fall (Appendix G5). This could suggest that bird species found as fatalities are at greatest risk of colliding with turbines during spring migration and the summer breeding season and lower during fall migration period.

Comparison Data from Other Post-construction Fatality Monitoring Studies

Comparison figures to provide context for understanding the estimated bird fatality rates for this Project compared with other recent PCM projects at wind energy facilities in South Dakota, North Dakota, and Minnesota are provided below.

The estimated overall bird fatality rate of 2.30 bird fatalities/MW/study period (90% CI: 1.59–3.37) is mid- to lower range in fatality rates seen at other facilities in neighboring states with recently conducted PCM studies and publicly available data (Figure 12). Among other PCM studies in neighboring states, fatality rate estimates range from 0.51 (Oak Glen, Minnesota [Chodachek et al. 2014]) to 12.18 (Blazing Star, Minnesota [Stucker et al. 2021]). The references for the comparison projects shown in the Figures 12 and 13, and referenced in the following text can be found in Appendix H.

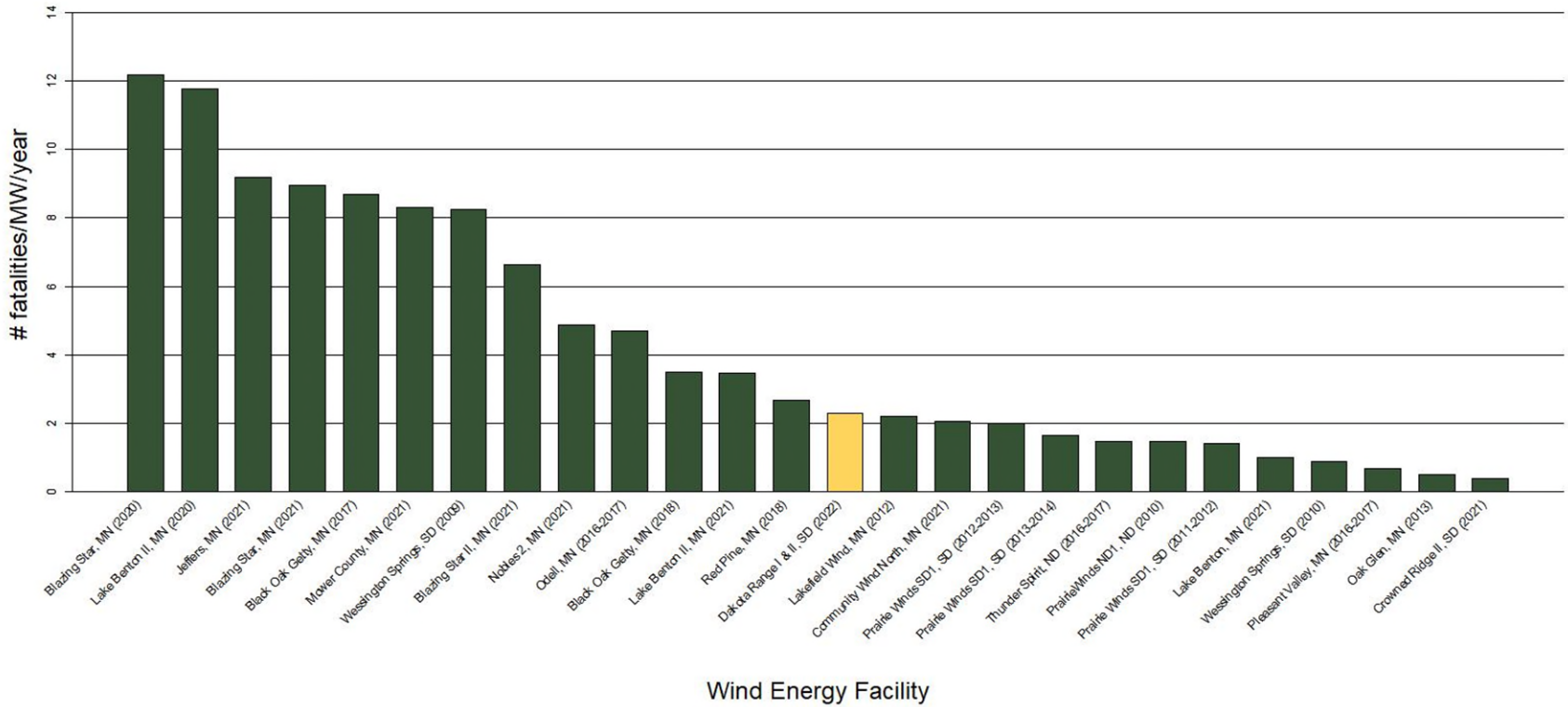

Figure 12. Estimated fatality rates for all birds (number of birds per megawatt [MW] per year) from recently conducted post-construction fatality monitoring studies at wind energy facilities in South Dakota, North Dakota, and Minnesota with publicly available data.

Bats

Species Composition

Four bat species were found as fatalities during the study. Hoary bat was the most common (17 carcasses, 32.7% of total bat carcasses), followed by silver-haired bat and eastern red bat (15 each, 28.9% each), and big brown bat (five, 9.6%). Among other wind energy facilities in the region, eastern red bat, hoary bat, and silver-haired bat are the top three most common bat species found as fatalities, respectively (WEST 2021). Each of these three species are designated as SGCN in South Dakota.

Spatial and Temporal Patterns

Although bat fatalities were generally found throughout the Project, the three turbines with the most bat fatalities (turbines 46, 3, and 30, respectively) each occur in the northern portion of the Project. Habitat features near these three turbines appears to be similar to other areas within the Project. Although turbine blade strikes have been suggested to be the likely cause of most bat fatalities at wind farms (Lawson et al. 2020), the reason for their apparent attraction to wind turbines is unknown (USGS 2016). Possible reasons for attraction include insect concentrations that act as a food source, mistaking the turbine for a potential roost location, or attraction to the sound produced by wind turbines (National Wind Coordinating Collaborative 2010).

Temporally, the estimated overall bat fatality rate was highest during the latter part of the study's summer season, although bat fatalities were documented from May to September. During this study, the summer season was defined as June 18 – September 12, 2022, hence the relatively higher bat fatality rate during summer at the Project compared to other seasons. The timing of bat fatalities at the Project (primarily documented from late July through early September) was generally similar to the timing of bat fatalities found elsewhere in the Midwest region and the Mountain Prairie region, where most fatalities occurred in August and September during fall migration (American Wind Wildlife Institute [AWWI] 2020).

Comparison Data from Other Post-construction Fatality Monitoring Studies

The estimated overall bat fatality rate of 14.19 bat fatalities/MW/study period (90% CI: 6.83–25.56) is within the mid-range of bat fatality rates at other wind energy facilities in neighboring states with recently conducted PCM studies and publicly available data (Figure 13). Fatality rates at the facilities shown in Figure 13 range from 0.41 (Wessington Springs, South Dakota [Derby et al. 2011]) to 37.59 (Black Oak Getty, Minnesota [Pickle et al. 2019]).

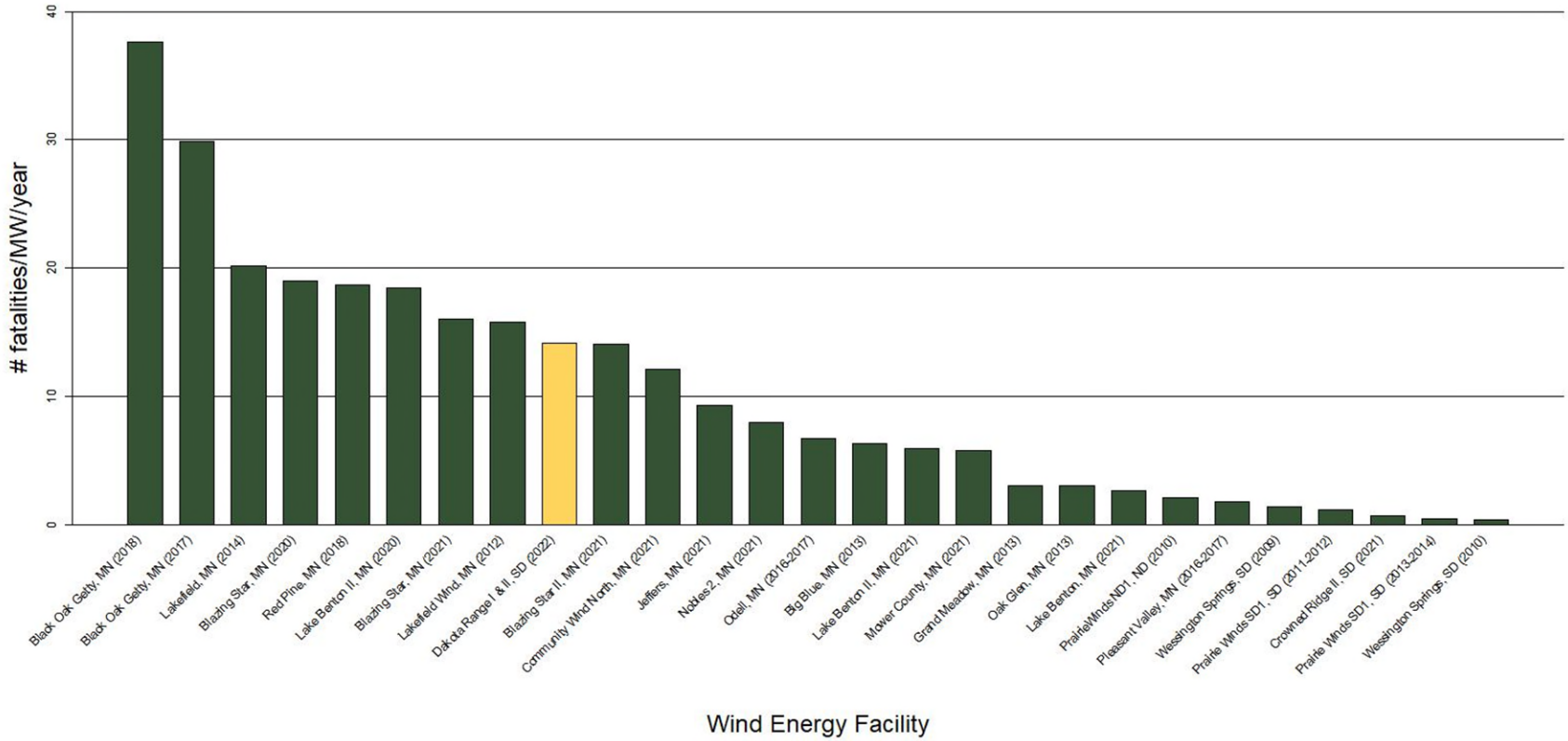

Figure 13. Estimated fatality rates for bats (number of bats per megawatt [MW] per year) from recently conducted post-construction fatality monitoring studies at wind energy facilities in South Dakota, North Dakota, and Minnesota with publicly available data.

Estimated Fatality Rates

Numerous factors may contribute to both positive and negative biases in estimating fatality rates (Erickson 2006), and there are several potential sources of inherent bias that exist in field-based fatality monitoring studies. First, all carcasses found within search areas during a study are used in the analysis, including those found outside of scheduled search times. If these carcasses do not persist until the next carcass search, or are missed by searchers, this bias would result in an overestimate of fatality rates. Second, it is assumed all carcasses found during the study are due to collisions with wind turbines, even though some could have occurred from natural causes (background fatality), resulting in a potential overestimate of fatality rates. Third, experimental carcasses used in SEEF trials and CPT are assumed to be representative of the actual species found as fatalities, but if the types of birds or bats used are larger or smaller, or are more or less cryptic than the actual carcasses found during the course of the study, this could lead to a positive or negative bias. In order to minimize this bias, representative bat carcasses found during the study were used for SEEF trials and CPT when their body condition was relatively intact.

In this study, the potential sources of bias noted above were either not thought to be highly influential or were unknown because 1) background fatality rates are unknown or expected to be minimal for both birds and bats, 2) the species used for SEEF trials and CPT are thought to be representative of the size range and physical characteristics of the bird and bat carcasses expected to be found as fatalities at the Project, and 3) the *k* value was not influential in this study. In general, an analysis is sensitive to k when persistence times are long relative to the search interval and SEEF values are low. This study demonstrated relatively high SEEF rates and persistence times that were near or shorter than the search intervals. In this situation, the influence of *k* is minimal.

Increased fatality estimates and associated confidence intervals for bats on road and pad searches may be attributed to the area correction factor, as there is both a larger correction (bigger increase) and a higher degree of uncertainty in the fatality rates compared to a full plot search, due to the small proportion of area under the turbine that is searched. Approximately half of all the bat carcasses included in the analysis were found on road and pad plots, which contributed to a larger than expected bat fatality rate.

REFERENCES

American Wind Wildlife Institute (AWWI). 2020. AWWI Technical Report 2nd Edition: Summary of Bat Fatality Monitoring Data Contained in AWWIC. American Wind Wildlife Information Center (AWWIC) database. AWWI, Washington, D.C. November 24, 2020. Available online: https://rewi.org/resources/awwic-bat-technical-report/

Bald and Golden Eagle Protection Act (BGEPA). 1940. 16 United States Code (USC) Sections (§§) 668-668d. Bald Eagle Protection Act of 1940, June 8, 1940, Chapter 278, § 2, 54 Statute (Stat.) 250; Expanded to include the related species of the golden eagle October 24, 1962, Public Law (PL) 87-884, 76 Stat. 1246. [as amended: October 23, 1972, PL 92-535, § 2, 86 Stat. 1065; November 8, 1978, PL 95-616, § 9, 92 Stat. 3114.].

Bryce, S., J. M. Omernik, D. E. Pater, M. Ulmer, J. Schaar, J. Freeouf, R. Johnson, P. Kuck, and S. H. Azevedo. 1998. Ecoregions of North Dakota and South Dakota. Color poster with map, descriptive text, summary tables, and photographs. US Geological Survey (USGS) map (map scale 1:1,500,000). USGS, Reston, Virginia. US Environmental Protection Agency (USEPA). Available online: https://store.usgs.gov/assets/MOD/StoreFiles/Ecoregion/21629_nd_sd_front.pdf

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

Chodachek, K., C. Derby, D. Bruns Stockrahm, P. Rabie, K. Adachi, and T. Thorn. 2014. Bat Fatality Rates and Effects of Changes in Operational Cut-in Speeds at Commercial Wind Farms in Southern Minnesota - Year 1: July 9 - October 31, 2013. Prepared for Minnesota Department of Commerce, St. Paul, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota, and Minnesota State University Moorhead, Moorhead, Minnesota. May 23, 2014. Available online: http://mn.gov/commerce/energyfacilities/documents/MNDOC,%20Bat%20Fatality%20Study%20Year%201,%205.23.14.pdf

Dalthorp, D. H., L. Madsen, M. M. Huso, P. Rabie, R. Wolpert, J. Studyvin, J. Simonis, and J. M. Mintz. 2018. GenEst Statistical Models—a Generalized Estimator of Mortality. US Geological Survey Techniques and Methods, Volume 7, Chapter A2. 13 pp. doi: 10.3133/tm7A2. Available online: https://pubs.usgs.gov/tm/7a2/tm7a2.pdf

Derby, C., A. Dahl, K. Bay, and L. McManus. 2011. 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.

eBird. 2023. eBird: An Online Database of Bird Distribution and Abundance [Web Application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. Accessed April 2023. Available online: https://ebird.org/

Endangered Species Act (ESA). 1973. 16 United States Code (USC) Sections (§§) 1531-1544, Public Law (PL) 93-205, December 28, 1973, as amended, PL 100-478 [16 USC 1531 et seq.]; 50 Code of Federal Regulations (CFR) 402.

Erickson, W. P. 2006. Objectives, Uncertainties and Biases in Mortality Studies at Wind Facilities. Paper presented at the NWCC Research Meeting VI, November 2006. San Antonio, Texas.

Esri. 2023. World Imagery and Aerial Photos (World Topo). ArcGIS Resource Center. Environmental Systems Research Institute (Esri), producers of ArcGIS software, Redlands, California. Accessed April 2023. Available online: https://www.arcgis.com/home/webmap/viewer.html?useExisting=1&layers=10df2279f9684e4a9f6a7f08febac2a9

Hull, C. L. and S. C. Muir. 2013. Behavior and Turbine Avoidance Rates of Eagles at Two Wind Farms in Tasmania, Australia. Wildlife Society Bulletin 37(1): 49-58. doi: 10.1002/wsb.254.

Huso, M., D. Dalthorp, and F. Korner-Nievergelt. 2017. Statistical Principles of Post-Construction Fatality Monitoring Design. In: M. Perrow, ed. Wildlife and Wind Farms, Conflicts and Solutions. Pelagic Publishing, Exeter, United Kingdom. Vol. 2, Onshore: Monitoring and Mitigation.

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.

Kalbfleisch, J. D. and R. L. Prentice. 2002. The Statistical Analysis of Failure Time Data. John Wiley & Sons, Hoboken, New Jersey.

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.

Knopf, F. L. and R. M. Evans. 2020. American White Pelican (*Pelecanus erythrorhynchos*), Version 1.0. In: A. F. Poole, ed. Birds of the World. Cornell Lab of Ornithology, Ithaca, New York. doi: 10.2173/bow.amwpel.01. Available online: http://birdsoftheworld.org/bow/species/amwpel/1.0/

Korner-Nievergelt, F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann, and B. Hellriegel. 2011. A New Method to Determine Bird and Bat Fatality at Wind Energy Turbines from Carcass Searches. Wildlife Biology 17: 350-363. doi: 10.2981/10-121.

Lawson, M., D. Jenne, R. Thresher, D. Houck, J. Wimsatt, and B. Straw. 2020. An Investigation into the Potential for Wind Turbines to Cause Barotrauma in Bats. PLoS ONE 15(12): e0242485. doi: 10.1371/journal.pone.0242485.

National Geographic Society (National Geographic). 2023. World Maps. Digital topographic map. PDF topographic map quads. Accessed April 2023. Available online: http://www.natgeo maps.com/trail-maps/pdf-quads

National Land Cover Database (NLCD). 2019. National Land Cover Database 2019 - Landcover & Imperviousness (NLCD2019). Available online: https://www.mrlc.gov/data. As cited includes:

Dewitz, J., and U.S. Geological Survey. 2021. National Land Cover Database (NLCD) 2019 Products (ver. 2.0, June 2021): U.S. Geological Survey data release. doi: 10.5066/P9KZCM54.

Homer, C., J. Dewitz, S. Jin, G. Xian, C. Costello, P. Danielson, L. Gass, M. Funk, J. Wickham, S. Stehman, R. Auch, and K. Riitters. 2020. Conterminous United States Land Cover Change Patterns 2001–2016 from the 2016 National Land Cover Database. ISPRS Journal of Photogrammetry and Remote Sensing 162(5): 184-199. doi: 10.1016/j.isprsjprs.2020.02.019.

Jin, S., C. Homer, L. Yang, P. Danielson, J. Dewitz, C. Li, Z. Zhu, G. Xian, and D. Howard. 2019. Overall Methodology Design for the United States National Land Cover Database 2016 Products. Remote Sensing. 2971. doi: 10.3390/rs11242971.

Wickham, J., S. V. Stehman, D. G. Sorenson, L. Gass, and J. A. Dewitz. 2021, Thematic Accuracy Assessment of the NLCD 2016 Land Cover for the Conterminous United States: Remote Sensing of Environment 257: 112357. doi: 10.1016/j.rse.2021.112357.

and

Yang, L., S. Jin, P. Danielson, C. Homer, L. Gass, S. M. Bender, A. Case, C. Costello, J. Dewitz, J. Fry, M. Funk, B. Granneman, G. C. Liknes, M. Rigge, and G. Xian. 2018. A New Generation of the United States National Land Cover Database: Requirements, Research Priorities, Design, and Implementation Strategies. ISPRS Journal of Photogrammetry and Remote Sensing 146: 108-123. doi: 10.1016/j.isprsjprs.2018.09.006.

National Wind Coordinating Collaborative (NWCC). 2010. Wind Turbine Interactions with Birds, Bats, and Their Habitats: A Summary of Research Results and Priority Questions. NWCC c/o RESOLVE, Washington, D. C. Spring 2010. Available online: https://www1.eere.energy.gov/wind/pdfs/birds_and_bats_fact_sheet.pdf

North American Datum (NAD). 1983. NAD83 Geodetic Datum.

Pickle, J., J. Lombardi, J. Stucker, and G. DiDonato. 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. Available online: https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId=%7B80398269-0000-CD12-876A-A85CEB339B7A%7D&documentTitle=20193-151123-01

Simonis, J., D. H. Dalthorp, M. M. Huso, J. M. Mintz, L. Madsen, P. Rabie, and J. Studyvin. 2018. Genest User Guide—Software for a Generalized Estimator of Mortality. US Geological Survey Techniques and Methods, Volume 7, Chapter C19, 72 pp. doi: 10.3133/tm7C19. Available online: https://pubs.usgs.gov/tm/7c19/tm7c19.pdf

South Dakota Game, Fish and Parks (SDGFP). 2014. Species of Greatest Conservation Need. Pp. 8-23. In: South Dakota Wildlife Action Plan. SDGFP, Pierre, South Dakota.

South Dakota Game Fish and Parks (SDGFP). 2023a. Threatened and Endangered Species. SDGFP, Pierre, South Dakota. Accessed April 2023. Available online: https://gfp.sd.gov/threatened-endangered/

South Dakota Game Fish and Parks (SDGFP). 2023b. List of Species of Greatest Conservation Need in South Dakota Wildlife Action Plan as of 1 March 2023. SDGFP, Pierre, South Dakota. March 1, 2023. 10 pp. Available online: https://gfp.sd.gov/UserDocs/nav/SD_SGCN_list_as_of_1_March_2023.pdf

Sovada, M. A., P. J. Pietz, R. O. Woodward, A. J. Bartos, D. A. Buhl, and M. J. Assenmacher. 2013. American White Pelicans Breeding in the Northern Plains: Productivity, Behavior, Movements, and Migration. Scientific Investigations Report 2013-5105. US Geological Survey (USGS) Northern Prairie Wildlife Research Center, Reston, Virginia. Available online: https://pubs.er.usgs.gov/publication/sir20135105

Stucker, J., A. Suehring, and R. Clark. 2021. Post-Construction Bird and Bat Fatality Monitoring Study. Blazing Star Wind Farm, Lincoln County, Minnesota. Final: March - November 2020. Prepared for Northern States Power, Minneapolis, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. January 28, 2021.

US Department of Agriculture (USDA) National Agricultural Statistics Service (NASS). 2022. Cropscape - Cropland Data Layer. USDA NASS, Washington, D.C. 2021 Cropland Data Layer released February 14, 2022. Accessed April 2023. Available online: https://nassgeodata.gmu.edu/CropScape/

US Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS). 2022. NAIP 2021 Mosaics. National Agriculture Imagery Program (NAIP) data, Geospatial Data Gateway, USDA NRCS, Washington, D.C. Updated October 30, 2022. Available online: https://datagateway.nrcs.usda.gov/

US Environmental Protection Agency (USEPA). 2013. Level III and Level IV Ecoregions of the Continental United States. Ecosystems Research, USEPA. April 16, 2013. Accessed April 2023. Available online: https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states

US Fish and Wildlife Service (USFWS). 2012. Land-Based Wind Energy Guidelines. March 23, 2012. 82 pp. Available online: https://www.fws.gov/sites/default/files/documents/WEG_final.pdf

US Fish and Wildlife Service (USFWS). 2013. Eagle Conservation Plan Guidance: Module 1 - Land-Based Wind Energy, Version 2. US Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management. April 2013. Frontmatter + 103 pp. Available online: https://www.fws.gov/sites/default/files/documents/eagle-conservation-plan-guidance.pdf

US Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI). 2023. Wetlands Mapper, Nwi: Surface Waters and Wetlands. USFWS NWI, Baileys Crossroads, Virginia. Accessed April 2023. Available online: https://fwsprimary.wim.usgs.gov/wetlands/apps/wetlands-mapper/

US Geological Survey (USGS). 2016. Bat Fatalities at Wind Turbines- Investigating the Causes and Consequences. USGS, Fort Collins Science Center, Fort Collins, Colorado. July 21, 2016. Accessed April 2023. Available online: https://www.usgs.gov/centers/fort/science/bat-fatalities-wind-turbines-investigating-causes-and-consequences?qt-science_center_objects=0#qt-science_center_objects

US Geological Survey (USGS). 2023. The National Map. TNM Download V2.0. Topo Map data, 3DEP products, Lidar, IfSAR, NHD (Hydrography Dataset), NAIP Plus Imagery, National Structures Dataset. Accessed April 2023. Available online: https://apps.nationalmap.gov/downloader/#/

Western EcoSystems Technology, Inc. (WEST). 2021. Regional Summaries of Wildlife Fatalities at Wind Facilities in the United States and Canada. 2020 Report from the Renew Database. WEST, Cheyenne, Wyoming. June 30, 2021. Available online: https://west-inc.com/wp-content/uploads/2021/07/WEST_2020_RenewWildlifeFatalitySummaries.pdf

Appendix A. Overview of Study Design and Search Methods for Post-construction Fatality Monitoring at the Dakota Range I and II Wind Project, Grant and Codington Counties, South Dakota, from March 16 – December 11, 2022

Appendix A. Overview of study design and search methods for post-construction fatality monitoring at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

	Sampling Unit	
Design Component	**Square Plot[1]**	**Road and Pad Plot[1]**
Number of Plots (percent [%] of all turbines)	22 (30%) in spring 4 (6%) in summer 21 (29%) in fall	0 (0%) in spring 18 (25%) in summer 1 (1%) in fall
Size/Shape	150-m x 150-m square centered on turbine	100-m radius from turbine on gravel road and pad
Search Interval	Once every two weeks	Once every two weeks
Search Period	March 16 – December 11, 2022	June 20 – December 11, 2022
Searcher efficiency – seasons	spring, summer, fall	summer, fall
Searcher efficiency – carcass sizes	bat (surrogate), small bird, large bird	bat (surrogate), small bird, large bird
Carcass persistence trials – seasons	spring, summer, fall	summer, fall
Carcass persistence trials – carcass sizes	bat (surrogate), small bird, large bird	bat (surrogate), small bird, large bird
Turbine Specifications		
Turbine Model	Vestas V120 2.2-MW (1 turbine); Vestas V136 3.8-MW (7); Vestas V136 4.3-MW (64)	
Hub Height	80 m (Vestas V120); 82 m (Vestas V136)	
Rotor Diameter	120 m (Vestas V120); 136 m (Vestas 136)	
Blade serrations (Yes/No)	Yes	

[1] Twenty-two turbines were initially selected for searches. All 22 turbines were initially searched as square plots. When vegetation obstructed visibility (beginning in summer), 18 square plots switched to road and pad plots until crops were harvested in fall; square plot searches continued at four turbines. After crops were harvested, searches switched back to cleared plots at 21 turbines. One turbine remained as a road and pad plot through the end of the study due to a fence that bisected the square plot.

m = meters; s = second; MW = megawatt

Appendix B. Common and Scientific Names of Species Found During Post-construction Fatality Monitoring at the Dakota Range I and II Wind Project, Grant and Codington Counties, South Dakota, from March 16 – December 11, 2022

Appendix B. Species found during post-construction fatality monitoring at Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Common Name	Scientific Name
American coot	*Fulica americana*
American redstart	*Setophaga ruticilla*
American robin	*Turdus migratorius*
American white pelican	*Pelecanus erythrorhynchos*
bald eagle	*Haliaeetus leucocephalus*
barn swallow	*Hirundo rustica*
blue jay	*Cyanocitta cristata*
bobolink	*Dolichonyx oryzivorus*
Brewer's blackbird	*Euphagus cyanocephalus*
brown-headed cowbird	*Molothrus ater*
Canada warbler	*Cardellina canadensis*
Caspian tern	*Hydroprogne caspia*
chipping sparrow	*Spizella passerina*
clay-colored sparrow	*Spizella pallida*
cliff swallow	*Petrochelidon pyrrhonota*
golden-crowned kinglet	*Regulus satrapa*
greater scaup	*Aythya marila*
horned lark	*Eremophila alpestris*
house wren	*Troglodytes aedon*
killdeer	*Charadrius vociferus*
Lapland longspur	*Calcarius lapponicus*
Le Conte's sparrow	*Ammodramus leconteii*
least flycatcher	*Empidonax minimus*
lesser yellowlegs	*Tringa flavipes*
Lincoln's sparrow	*Melospiza lincolnii*
long-eared owl	*Asio otus*
mallard	*Anas platyrhynchos*
marsh wren	*Cistothorus palustris*
orchard oriole	*Icterus spurius*
red-winged blackbird	*Agelaius phoeniceus*
ring-billed gull	*Larus delawarensis*
ring-necked duck	*Aythya collaris*
sedge wren	*Cistothorus platensis*
sharp-shinned hawk	*Accipiter striatus*
song sparrow	*Melospiza melodia*
Swainson's thrush	*Catharus ustulatus*
swamp sparrow	*Melospiza georgiana*
turkey vulture	*Cathartes aura*
yellow warbler	*Setophaga petechia*
big brown bat	*Eptesicus fuscus*
eastern red bat	*Lasiurus borealis*
hoary bat	*Lasiurus cinereus*
silver-haired bat	*Lasionycteris noctivagans*

Appendix C. Complete Listing of Bird and Bat Carcasses Found During Post-construction Fatality Monitoring at the Dakota Range I and II Wind Project, Grant and Codington Counties, South Dakota, from March 16 – December 11, 2022

Appendix C. Complete listing of carcasses found at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Found Date	Species	Distance from Turbine (meters)	Turbine	Search Type	Plot Type	Physical Condition
03/17/2022	horned lark	33	39	carcass search	square	scavenged
03/29/2022	Lapland longspur	82	46	carcass search	square	intact
04/19/2022	unidentified large bird	58	6	carcass search	square	feather spot
04/21/2022	American robin	63	54	carcass search	square	scavenged
04/26/2022	American coot	22	37	carcass search	square	scavenged
04/28/2022	American white pelican**	35	42	carcass search	square	intact
04/28/2022	brown-headed cowbird	36	30	carcass search	square	intact
05/02/2022	greater scaup	66	6	carcass search	square	intact
05/03/2022	American coot	18	13	carcass search	square	scavenged
05/03/2022	American coot	21	15	carcass search	square	dismembered
05/03/2022	ring-necked duck	40	15	carcass search	square	scavenged
05/03/2022	unidentified wren	54	15	carcass search	square	scavenged
05/04/2022	blue jay	9	65	carcass search	square	intact
05/04/2022	Swainson's thrush	73	65	carcass search	square	scavenged
05/04/2022	swamp sparrow	84	65	carcass search	square	scavenged
05/10/2022	mallard	61	30	carcass search	square	scavenged
05/11/2022	least flycatcher	60	13	carcass search	square	scavenged
05/11/2022	lesser yellowlegs	70	12	carcass search	square	scavenged
05/11/2022	mallard	8	23	incidental*	square	dismembered
05/11/2022	silver-haired bat**	73	1	carcass search	square	scavenged
05/16/2022	Caspian tern	51	46	carcass search	square	scavenged
05/17/2022	horned lark	46	24	carcass search	square	dismembered
05/17/2022	silver-haired bat**	73	7	carcass search	square	scavenged
05/17/2022	unidentified thrush	52	65	carcass search	square	scavenged
05/17/2022	yellow warbler	82	7	carcass search	square	scavenged
05/18/2022	clay-colored sparrow	68	32	carcass search	square	scavenged
05/18/2022	orchard oriole	68	15	carcass search	square	scavenged
05/18/2022	unidentified wren	13	15	carcass search	square	scavenged
05/18/2022	unidentified wren	62	15	carcass search	square	scavenged
05/18/2022	yellow warbler	80	15	carcass search	square	scavenged
05/23/2022	barn swallow	37	37	carcass search	square	scavenged
05/23/2022	red-winged blackbird	21	1	carcass search	square	scavenged
05/23/2022	unidentified passerine	46	1	carcass search	square	scavenged
05/24/2022	Le Conte's sparrow**	73	46	carcass search	square	scavenged
05/24/2022	mallard	48	30	carcass search	square	scavenged
05/24/2022	marsh wren	39	42	carcass search	square	scavenged
05/24/2022	silver-haired bat**	41	3	carcass search	square	scavenged
05/24/2022	silver-haired bat**	27	46	carcass search	square	intact
05/25/2022	American redstart	42	13	carcass search	square	scavenged
05/25/2022	Canada warbler	67	70	carcass search	square	scavenged
05/25/2022	silver-haired bat**	40	60	carcass search	square	scavenged
05/25/2022	silver-haired bat**	38	60	carcass search	square	scavenged
06/02/2022	cliff swallow	24	53	carcass search	square	scavenged
06/02/2022	cliff swallow	47	54	carcass search	square	scavenged
06/15/2022	silver-haired bat**	34	39	carcass search	square	scavenged
06/16/2022	cliff swallow	83	53	carcass search	square	intact
06/16/2022	unidentified duck	68	6	carcass search	square	feather spot
06/17/2022	American white pelican**	97	64	incidental*	n/a	scavenged
06/17/2022	hoary bat**	14	46	carcass search	square	scavenged

Appendix C. Complete listing of carcasses found at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Found Date	Species	Distance from Turbine (meters)	Turbine	Search Type	Plot Type	Physical Condition
06/21/2022	American white pelican**	92	65	carcass search*	square	dismembered
06/22/2022	American white pelican**	63	15	incidental	road and pad	scavenged
06/27/2022	American white pelican**	61	68	incidental*	road and pad	scavenged
06/29/2022	Brewer's blackbird	40	21	incidental*	n/a	scavenged
07/01/2022	unidentified grebe	47	27	incidental*	n/a	dismembered
07/13/2022	American white pelican**	72	60	carcass search	road and pad	dismembered
07/14/2022	turkey vulture	68	22	carcass search	square	scavenged
07/22/2022	American white pelican**	5	23	incidental*	n/a	scavenged
07/22/2022	hoary bat**	4	23	incidental*	n/a	scavenged
07/26/2022	big brown bat	20	19	carcass search	road and pad	intact
07/26/2022	unidentified wren	56	19	carcass search	road and pad	scavenged
07/28/2022	big brown bat	8	68	carcass search	road and pad	scavenged
07/28/2022	hoary bat**	14	46	carcass search	square	intact
07/29/2022	hoary bat**	4	38	incidental*	square	intact
08/01/2022	bobolink**	3	22	incidental	square	intact
08/09/2022	eastern red bat**	26	19	carcass search	road and pad	scavenged
08/09/2022	hoary bat**	5	3	carcass search	road and pad	scavenged
08/09/2022	hoary bat**	1	39	carcass search	road and pad	scavenged
08/09/2022	hoary bat**	5	42	carcass search	road and pad	scavenged
08/09/2022	house wren	66	32	carcass search	road and pad	scavenged
08/09/2022	silver-haired bat**	5	53	carcass search	road and pad	scavenged
08/10/2022	eastern red bat**	3	12	carcass search	road and pad	scavenged
08/10/2022	hoary bat**	1	13	carcass search	road and pad	injured
08/10/2022	hoary bat**	6	30	carcass search	road and pad	scavenged
08/10/2022	hoary bat**	5	30	carcass search	road and pad	scavenged
08/10/2022	hoary bat**	31	46	carcass search	square	intact
08/10/2022	ring-billed gull	68	60	carcass search	road and pad	scavenged
08/16/2022	eastern red bat**	113	15	carcass search*	road and pad	scavenged
08/16/2022	eastern red bat**	31	26	incidental*	n/a	scavenged
08/16/2022	hoary bat**	9	11	incidental*	n/a	scavenged
08/18/2022	eastern red bat**	37	10	incidental*	n/a	scavenged
08/22/2022	big brown bat	1	49	incidental*	n/a	scavenged
08/22/2022	eastern red bat**	43	12	carcass search	road and pad	scavenged
08/22/2022	eastern red bat**	30	30	carcass search	road and pad	scavenged
08/22/2022	hoary bat**	33	11	incidental*	n/a	scavenged
08/22/2022	hoary bat**	40	30	carcass search	road and pad	scavenged
08/22/2022	silver-haired bat**	45	32	carcass search	road and pad	scavenged
08/23/2022	big brown bat	2	3	carcass search	road and pad	scavenged
08/23/2022	eastern red bat**	4	3	carcass search	road and pad	scavenged
08/23/2022	eastern red bat**	56	22	carcass search	square	scavenged
08/23/2022	hoary bat**	1	1	carcass search	road and pad	scavenged
08/23/2022	silver-haired bat**	2	1	carcass search	road and pad	scavenged
08/23/2022	silver-haired bat**	19	70	carcass search	road and pad	scavenged
08/25/2022	hoary bat**	6	39	carcass search	road and pad	injured
09/06/2022	hoary bat**	19	46	carcass search	square	scavenged
09/06/2022	killdeer	13	22	carcass search	square	scavenged
09/06/2022	killdeer	50	46	carcass search	square	scavenged
09/06/2022	silver-haired bat**	39	22	carcass search	square	scavenged
09/06/2022	unidentified vireo	8	37	carcass search	road and pad	scavenged

Appendix C. Complete listing of carcasses found at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Found Date	Species	Distance from Turbine (meters)	Turbine	Search Type	Plot Type	Physical Condition
09/06/2022	yellow warbler	11	22	carcass search	square	scavenged
09/07/2022	big brown bat	79	38	carcass search	square	scavenged
09/07/2022	eastern red bat**	27	3	carcass search	road and pad	scavenged
09/07/2022	eastern red bat**	4	6	carcass search	square	scavenged
09/07/2022	eastern red bat**	7	13	carcass search	road and pad	scavenged
09/07/2022	eastern red bat**	82	40	incidental*	n/a	scavenged
09/07/2022	silver-haired bat**	26	6	carcass search	square	scavenged
09/07/2022	silver-haired bat**	32	13	carcass search	road and pad	scavenged
09/13/2022	American white pelican**	27	67	incidental*	n/a	scavenged
09/14/2022	silver-haired bat**	27	29	incidental*	n/a	scavenged
09/16/2022	eastern red bat**	11	46	carcass search	square	scavenged
09/27/2022	eastern red bat**	13	22	carcass search	square	scavenged
09/30/2022	golden-crowned kinglet	58	46	carcass search	square	scavenged
10/04/2022	song sparrow	46	58	incidental*	n/a	scavenged
10/10/2022	sedge wren	6	2	incidental*	n/a	scavenged
10/11/2022	chipping sparrow	44	39	carcass search	road and pad	scavenged
10/11/2022	Lincoln's sparrow	110	8	incidental*	n/a	scavenged
10/20/2022	bald eagle**	38	56	incidental*	n/a	scavenged
11/21/2022	turkey vulture	56	32	carcass search	square	scavenged
11/29/2022	American white pelican**	78	3	carcass search	square	dismembered
11/29/2022	long-eared owl	62	1	carcass search	square	scavenged
12/05/2022	sharp-shinned hawk	91	32	carcass search*	square	scavenged

* Carcass was found outside the search area

** Species of Greatest Conservation Need, as designated in the South Dakota Wildlife Action Plan (South Dakota Game, Fish and Parks 2014, revised 2023).

n/a = not applicable.

Appendix D. Searcher Efficiency Model Selection for the Dakota Range I and II Wind Project, Grant and Codington Counties, South Dakota, from March 16 – December 11, 2022

Appendix D1. GenEst estimated searcher efficiency models for large birds (n = 50 searcher efficiency trial carcasses) from the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Covariates	k Value	AICc	Delta AICc
Plot Search Type	k fixed at 0.67	35.29	0*
No Covariates	k fixed at 0.67	38.78	3.49
Season	k fixed at 0.67	40.57	5.28

* Selected model.

k = detection reduction factor; AICc = corrected Akaike Information Criterion; Delta AICc = change in AICc.

Appendix D2. GenEst estimated searcher efficiency models for small birds (n = 51 searcher efficiency trial carcasses) from the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Covariates	k Value	AICc	Delta AICc
Plot Search Type	k fixed at 0.67	57.58	0*
No Covariates	k fixed at 0.67	59.98	2.40
Season + Plot Search Type	k fixed at 0.67	60.55	2.97
Season	k fixed at 0.67	64.20	6.62

* Selected model.

k = detection reduction factor; AICc = corrected Akaike Information Criterion; Delta AICc = change in AICc.

Appendix D3. GenEst estimated searcher efficiency models for bats (n = 45 searcher efficiency trial carcasses) from the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Covariates	k Value	AICc	Delta AICc
No Covariates	k fixed at 0.67	59.38	0*
Season	k fixed at 0.67	59.47	0.09
Plot Search Type	k fixed at 0.67	60.83	1.45

* Selected model.

k = detection reduction factor; AICc = corrected Akaike Information Criterion; Delta AICc = change in AICc.

Appendix E. Carcass Persistence Trial Information for the Dakota Range I and II Wind Project, Grant and Codington Counties, South Dakota, from March 16 – December 11, 2022

Appendix E1. All carcasses placed for carcass persistence trials by date, season, species, and turbine at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Date Placed	Season	Common Name	Turbine	Before Removal*	After Removal**
04/11/2022	Spring	northern bobwhite	2	04/12/2022	04/12/2022
04/11/2022	Spring	northern bobwhite	34	04/11/2022	04/11/2022
04/11/2022	Spring	northern bobwhite	40	04/24/2022	05/02/2022
04/11/2022	Spring	northern bobwhite	61	04/12/2022	04/12/2022
04/11/2022	Spring	northern bobwhite	71	04/11/2022	04/12/2022
04/11/2022	Spring	rock pigeon	2	04/17/2022	04/26/2022
04/11/2022	Spring	rock pigeon	34	04/17/2022	04/17/2022
04/11/2022	Spring	rock pigeon	34	04/24/2022	05/02/2022
04/11/2022	Spring	rock pigeon	61	04/12/2022	04/12/2022
04/11/2022	Spring	rock pigeon	61	04/12/2022	04/12/2022
04/11/2022	Spring	unidentified mouse	2	04/12/2022	04/12/2022
04/11/2022	Spring	unidentified mouse	40	05/02/2022	05/11/2022
04/11/2022	Spring	unidentified mouse	40	04/15/2022	04/17/2022
04/11/2022	Spring	unidentified mouse	71	04/15/2022	04/18/2022
04/11/2022	Spring	unidentified mouse	71	04/18/2022	04/25/2022
05/16/2022	Spring	northern bobwhite	49	05/19/2022	05/22/2022
05/16/2022	Spring	northern bobwhite	52	05/22/2022	05/29/2022
05/16/2022	Spring	northern bobwhite	52	06/13/2022	06/13/2022
05/16/2022	Spring	northern bobwhite	72	05/17/2022	05/19/2022
05/16/2022	Spring	northern bobwhite	8	05/20/2022	05/23/2022
05/16/2022	Spring	rock pigeon	18	05/19/2022	05/23/2022
05/16/2022	Spring	rock pigeon	49	05/19/2022	05/22/2022
05/16/2022	Spring	rock pigeon	49	05/19/2022	05/22/2022
05/16/2022	Spring	rock pigeon	72	06/06/2022	06/13/2022
05/16/2022	Spring	rock pigeon	8	05/18/2022	05/19/2022
05/16/2022	Spring	unidentified mouse	18	05/20/2022	05/23/2022
05/16/2022	Spring	unidentified mouse	18	05/19/2022	05/23/2022
05/16/2022	Spring	unidentified mouse	52	05/18/2022	05/19/2022
05/16/2022	Spring	unidentified mouse	72	05/16/2022	05/16/2022
05/16/2022	Spring	unidentified mouse	8	05/18/2022	05/19/2022
06/27/2022	Summer	American white pelican	2	07/24/2022	07/24/2022
06/27/2022	Summer	American white pelican	25	07/25/2022	07/25/2022
06/27/2022	Summer	northern bobwhite	16	06/27/2022	06/27/2022
06/27/2022	Summer	northern bobwhite	16	06/27/2022	06/28/2022
06/27/2022	Summer	northern bobwhite	2	07/25/2022	07/25/2022
06/27/2022	Summer	northern bobwhite	21	06/28/2022	06/29/2022
06/27/2022	Summer	northern bobwhite	25	07/24/2022	07/24/2022
06/27/2022	Summer	northern bobwhite	25	06/30/2022	07/05/2022
06/27/2022	Summer	northern bobwhite	29	07/10/2022	07/25/2022
06/27/2022	Summer	northern bobwhite	29	06/30/2022	07/05/2022
06/27/2022	Summer	northern bobwhite	50	06/28/2022	06/28/2022
06/27/2022	Summer	northern bobwhite	50	06/28/2022	06/28/2022
06/27/2022	Summer	northern bobwhite	8	06/27/2022	06/27/2022
06/27/2022	Summer	northern bobwhite	9	07/10/2022	07/24/2022
06/27/2022	Summer	rock pigeon	21	06/28/2022	06/29/2022
06/27/2022	Summer	rock pigeon	27	06/28/2022	06/29/2022
06/27/2022	Summer	rock pigeon	27	06/27/2022	06/28/2022
06/27/2022	Summer	rock pigeon	29	07/24/2022	07/24/2022
06/27/2022	Summer	rock pigeon	8	06/27/2022	06/27/2022
06/27/2022	Summer	rock pigeon	9	07/06/2022	07/10/2022
06/27/2022	Summer	rock pigeon	9	06/27/2022	06/28/2022

Appendix E1. All carcasses placed for carcass persistence trials by date, season, species, and turbine at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Date Placed	Season	Common Name	Turbine	Before Removal*	After Removal**
06/27/2022	Summer	unidentified mouse	17	06/27/2022	06/27/2022
06/27/2022	Summer	unidentified mouse	17	06/30/2022	07/05/2022
06/27/2022	Summer	unidentified mouse	18	06/27/2022	06/27/2022
06/27/2022	Summer	unidentified mouse	18	06/27/2022	06/27/2022
06/27/2022	Summer	unidentified mouse	18	06/27/2022	06/27/2022
06/27/2022	Summer	unidentified mouse	2	06/30/2022	07/05/2022
06/27/2022	Summer	unidentified mouse	27	07/24/2022	07/24/2022
06/27/2022	Summer	unidentified mouse	47	07/06/2022	07/10/2022
06/27/2022	Summer	unidentified mouse	47	07/25/2022	07/25/2022
08/01/2022	Summer	American white pelican	22	08/28/2022	08/28/2022
08/01/2022	Summer	northern bobwhite	22	08/01/2022	08/01/2022
08/01/2022	Summer	northern bobwhite	52	08/04/2022	08/07/2022
08/01/2022	Summer	northern bobwhite	61	08/01/2022	08/02/2022
08/01/2022	Summer	northern bobwhite	64	08/07/2022	08/10/2022
08/01/2022	Summer	northern bobwhite	71	08/03/2022	08/04/2022
08/01/2022	Summer	rock pigeon	33	08/07/2022	08/10/2022
08/01/2022	Summer	rock pigeon	33	08/01/2022	08/01/2022
08/01/2022	Summer	rock pigeon	37	08/14/2022	08/21/2022
08/01/2022	Summer	rock pigeon	37	08/04/2022	08/07/2022
08/01/2022	Summer	unidentified mouse	22	08/04/2022	08/07/2022
08/01/2022	Summer	unidentified mouse	37	08/02/2022	08/03/2022
08/01/2022	Summer	unidentified mouse	52	08/04/2022	08/07/2022
08/01/2022	Summer	unidentified mouse	61	08/01/2022	08/02/2022
08/01/2022	Summer	unidentified mouse	71	08/02/2022	08/03/2022
08/15/2022	Summer	northern bobwhite	10	08/18/2022	08/21/2022
08/15/2022	Summer	northern bobwhite	26	08/28/2022	09/05/2022
08/15/2022	Summer	northern bobwhite	31	08/16/2022	08/17/2022
08/15/2022	Summer	rock pigeon	11	08/15/2022	08/15/2022
08/15/2022	Summer	rock pigeon	11	08/24/2022	08/28/2022
08/15/2022	Summer	rock pigeon	31	08/16/2022	08/17/2022
08/15/2022	Summer	rock pigeon	49	09/13/2022	09/13/2022
08/15/2022	Summer	rock pigeon	58	08/16/2022	08/17/2022
08/15/2022	Summer	rock pigeon	69	08/15/2022	08/15/2022
08/15/2022	Summer	unidentified mouse	10	08/21/2022	08/24/2022
08/15/2022	Summer	unidentified mouse	26	08/15/2022	08/15/2022
08/15/2022	Summer	unidentified mouse	48	08/24/2022	08/28/2022
08/15/2022	Summer	unidentified mouse	49	08/18/2022	08/21/2022
08/15/2022	Summer	unidentified mouse	58	08/16/2022	08/16/2022
08/15/2022	Summer	unidentified mouse	69	08/15/2022	08/15/2022
10/03/2022	Fall	northern bobwhite	2	10/09/2022	10/13/2022
10/03/2022	Fall	northern bobwhite	21	10/06/2022	10/09/2022
10/03/2022	Fall	northern bobwhite	21	10/06/2022	10/06/2022
10/03/2022	Fall	northern bobwhite	23	10/04/2022	10/05/2022
10/03/2022	Fall	northern bobwhite	26	10/18/2022	10/24/2022
10/03/2022	Fall	northern bobwhite	52	10/05/2022	10/06/2022
10/03/2022	Fall	northern bobwhite	58	10/16/2022	10/23/2022
10/03/2022	Fall	rock pigeon	14	10/09/2022	10/13/2022
10/03/2022	Fall	rock pigeon	18	10/17/2022	10/23/2022
10/03/2022	Fall	rock pigeon	26	10/24/2022	11/01/2022
10/03/2022	Fall	rock pigeon	43	10/13/2022	10/18/2022
10/03/2022	Fall	rock pigeon	43	10/24/2022	11/01/2022

Appendix E1. All carcasses placed for carcass persistence trials by date, season, species, and turbine at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Date Placed	Season	Common Name	Turbine	Before Removal*	After Removal**
10/03/2022	Fall	rock pigeon	58	10/23/2022	10/31/2022
10/03/2022	Fall	rock pigeon	58	10/23/2022	10/31/2022
10/03/2022	Fall	unidentified mouse	14	10/23/2022	10/31/2022
10/03/2022	Fall	unidentified mouse	18	10/04/2022	10/05/2022
10/03/2022	Fall	unidentified mouse	2	10/09/2022	10/13/2022
10/03/2022	Fall	unidentified mouse	23	10/03/2022	10/03/2022
10/03/2022	Fall	unidentified mouse	52	10/04/2022	10/05/2022
10/03/2022	Fall	unidentified mouse	52	10/04/2022	10/05/2022
10/17/2022	Fall	northern bobwhite	34	10/17/2022	10/18/2022
10/17/2022	Fall	northern bobwhite	66	10/30/2022	11/06/2022
10/17/2022	Fall	northern bobwhite	66	10/26/2022	10/30/2022
10/17/2022	Fall	rock pigeon	11	11/06/2022	11/15/2022
10/17/2022	Fall	rock pigeon	34	10/19/2022	10/20/2022
10/17/2022	Fall	unidentified mouse	11	10/19/2022	10/20/2022
10/17/2022	Fall	unidentified mouse	69	10/18/2022	10/19/2022
10/17/2022	Fall	unidentified mouse	69	10/18/2022	10/19/2022
11/07/2022	Fall	northern bobwhite	16	11/08/2022	11/15/2022
11/07/2022	Fall	northern bobwhite	17	11/20/2022	11/28/2022
11/07/2022	Fall	northern bobwhite	17	11/24/2022	11/28/2022
11/07/2022	Fall	northern bobwhite	29	11/08/2022	11/16/2022
11/07/2022	Fall	northern bobwhite	33	11/24/2022	11/28/2022
11/07/2022	Fall	northern bobwhite	40	11/08/2022	11/24/2022
11/07/2022	Fall	northern bobwhite	44	11/28/2022	12/06/2022
11/07/2022	Fall	northern bobwhite	44	11/08/2022	11/28/2022
11/07/2022	Fall	northern bobwhite	47	11/21/2022	11/28/2022
11/07/2022	Fall	northern bobwhite	71	11/08/2022	11/28/2022
11/07/2022	Fall	rock pigeon	16	11/24/2022	11/28/2022
11/07/2022	Fall	rock pigeon	17	11/28/2022	12/06/2022
11/07/2022	Fall	rock pigeon	25	11/17/2022	11/20/2022
11/07/2022	Fall	rock pigeon	33	11/24/2022	11/28/2022
11/07/2022	Fall	rock pigeon	33	11/24/2022	11/28/2022
11/07/2022	Fall	rock pigeon	47	11/21/2022	11/28/2022
11/07/2022	Fall	rock pigeon	51	12/06/2022	12/06/2022
11/07/2022	Fall	rock pigeon	72	11/20/2022	11/28/2022
11/07/2022	Fall	rock pigeon	72	11/20/2022	11/28/2022
11/07/2022	Fall	rock pigeon	8	11/20/2022	11/28/2022
11/07/2022	Fall	rock pigeon	9	11/08/2022	11/15/2022
11/07/2022	Fall	unidentified mouse	10	11/08/2022	11/28/2022
11/07/2022	Fall	unidentified mouse	10	11/16/2022	11/20/2022
11/07/2022	Fall	unidentified mouse	25	11/08/2022	11/17/2022
11/07/2022	Fall	unidentified mouse	25	11/20/2022	11/28/2022
11/07/2022	Fall	unidentified mouse	29	11/17/2022	11/21/2022
11/07/2022	Fall	unidentified mouse	40	11/08/2022	11/16/2022
11/07/2022	Fall	unidentified mouse	44	11/08/2022	11/20/2022
11/07/2022	Fall	unidentified mouse	51	12/06/2022	12/06/2022
11/07/2022	Fall	unidentified mouse	71	11/16/2022	11/20/2022
11/07/2022	Fall	unidentified mouse	8	11/20/2022	11/28/2022
11/07/2022	Fall	unidentified mouse	9	11/08/2022	11/15/2022

* Last date checked before removal

** Date checked after removal

Appendix E2. Carcass persistence models with covariates and distributions for large birds (n = 50 carcass persistence trial carcasses) at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Location Covariates	Scale Covariates	Distribution	AICc	Delta AICc
Season	Season + PlotSearchType	Weibull	201.75	0
No Covariates	Season + PlotSearchType	Weibull	203.39	1.64*
Season + PlotSearchType	Season + PlotSearchType	Weibull	203.99	2.24
Season + PlotSearchType	Season + PlotSearchType	lognormal	205.21	3.46
Season	Season + PlotSearchType	lognormal	205.23	3.48
PlotSearchType	Season + PlotSearchType	Weibull	205.58	3.83
Season	Season + PlotSearchType	log-logistic	206.11	4.36
Season + PlotSearchType	Season + PlotSearchType	log-logistic	206.53	4.78
Season	Season	Weibull	207.12	5.37
No Covariates	Season	Weibull	209.30	7.55
Season + PlotSearchType	Season	Weibull	209.53	7.78
Season	Season	log-logistic	210.46	8.71
Season + PlotSearchType	Season	log-logistic	210.66	8.91
No Covariates	Season + PlotSearchType	lognormal	211.28	9.53
Season + PlotSearchType	Season	lognormal	211.31	9.56
PlotSearchType	Season + PlotSearchType	lognormal	211.67	9.92
Season	Season	lognormal	212.07	10.32
No Covariates	Season + PlotSearchType	log-logistic	212.64	10.89
PlotSearchType	Season + PlotSearchType	log-logistic	213.41	11.66
No Covariates	Season	log-logistic	218.24	16.49
No Covariates	Season	lognormal	218.40	16.65
Season + PlotSearchType	–	exponential	228.30	26.55
Season + PlotSearchType	No Covariates	log-logistic	228.95	27.20
Season + PlotSearchType	No Covariates	lognormal	229.13	27.38
No Covariates	–	exponential	229.36	27.61
Season + PlotSearchType	PlotSearchType	Weibull	229.45	27.70
Season	–	exponential	229.58	27.83
Season + PlotSearchType	PlotSearchType	log-logistic	230.11	28.36
Season + PlotSearchType	PlotSearchType	lognormal	230.17	28.42
No Covariates	PlotSearchType	Weibull	230.34	28.59
PlotSearchType	–	exponential	230.47	28.72
Season + PlotSearchType	No Covariates	Weibull	230.78	29.03
No Covariates	No Covariates	Weibull	231.24	29.49
PlotSearchType	PlotSearchType	Weibull	231.31	29.56
Season	No Covariates	log-logistic	231.74	29.99
Season	No Covariates	Weibull	231.90	30.15
PlotSearchType	No Covariates	Weibull	232.48	30.73
Season	No Covariates	lognormal	233.09	31.34
No Covariates	PlotSearchType	lognormal	236.60	34.85
PlotSearchType	PlotSearchType	lognormal	236.70	34.95
PlotSearchType	No Covariates	lognormal	237.23	35.48
No Covariates	PlotSearchType	log-logistic	237.30	35.55
PlotSearchType	PlotSearchType	log-logistic	237.54	35.79
No Covariates	No Covariates	log-logistic	237.79	36.04
No Covariates	No Covariates	lognormal	237.81	36.06
PlotSearchType	No Covariates	log-logistic	237.87	36.12

* Selected model.

Location covariates = covariates that affect the shape of the distribution.

Scale covariates = covariates that affect the spread of the distribution.

AICc = corrected Akaike Information Criterion; Delta AICc = change in AICc.

Appendix E3. Carcass persistence models with covariates and distributions for small birds (n = 50 carcass persistence trial carcasses) at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Location Covariates	Scale Covariates	Distribution	AICc	Delta AICc
Season + PlotSearchType	–	exponential	200.79	0
PlotSearchType	–	exponential	200.84	0.05*
Season + PlotSearchType	Season	Weibull	201.40	0.61
PlotSearchType	No Covariates	Weibull	202.92	2.13
PlotSearchType	Season + PlotSearchType	Weibull	202.99	2.20
Season + PlotSearchType	No Covariates	Weibull	203.27	2.48
No Covariates	Season	Weibull	203.66	2.87
Season + PlotSearchType	No Covariates	lognormal	203.75	2.96
Season + PlotSearchType	Season	lognormal	203.93	3.14
Season + PlotSearchType	Season + PlotSearchType	Weibull	204.12	3.33
Season + PlotSearchType	No Covariates	log-logistic	204.13	3.34
Season + PlotSearchType	Season	log-logistic	204.35	3.56
Season + PlotSearchType	PlotSearchType	lognormal	205.18	4.39
PlotSearchType	PlotSearchType	Weibull	205.28	4.49
Season + PlotSearchType	PlotSearchType	Weibull	205.43	4.64
Season	Season	Weibull	205.95	5.16
Season + PlotSearchType	PlotSearchType	log-logistic	206.06	5.27
No Covariates	Season + PlotSearchType	Weibull	206.08	5.29
Season + PlotSearchType	Season + PlotSearchType	lognormal	206.43	5.64
PlotSearchType	No Covariates	lognormal	206.85	6.06
Season + PlotSearchType	Season + PlotSearchType	log-logistic	207.08	6.29
No Covariates	–	exponential	207.10	6.31
Season	Season	lognormal	207.49	6.70
No Covariates	Season	lognormal	207.56	6.77
No Covariates	No Covariates	Weibull	207.95	7.16
PlotSearchType	No Covariates	log-logistic	208.08	7.29
Season	Season + PlotSearchType	Weibull	208.61	7.82
Season	Season	log-logistic	209.00	8.21
PlotSearchType	PlotSearchType	lognormal	209.10	8.31
PlotSearchType	Season + PlotSearchType	lognormal	209.25	8.46
Season	Season + PlotSearchType	lognormal	209.61	8.82
No Covariates	Season	log-logistic	209.65	8.86
No Covariates	Season + PlotSearchType	lognormal	210.03	9.24
No Covariates	PlotSearchType	Weibull	210.18	9.39
PlotSearchType	PlotSearchType	log-logistic	210.36	9.57
No Covariates	No Covariates	lognormal	210.37	9.58
Season	No Covariates	lognormal	210.59	9.80
Season	–	exponential	210.71	9.92
Season	No Covariates	log-logistic	210.90	10.11
Season	Season + PlotSearchType	log-logistic	211.01	10.22
PlotSearchType	Season + PlotSearchType	log-logistic	211.14	10.35
No Covariates	No Covariates	log-logistic	211.17	10.38
Season	No Covariates	Weibull	211.81	11.02
No Covariates	Season + PlotSearchType	log-logistic	212.09	11.30
No Covariates	PlotSearchType	lognormal	212.60	11.81
No Covariates	PlotSearchType	log-logistic	213.39	12.60

* Selected model.

Location covariates = covariates that affect the shape of the distribution.

Scale covariates = covariates that affect the spread of the distribution.

AICc = corrected Akaike Information Criterion; Delta AICc = change in AICc.

Appendix E4. GenEst estimated carcass persistence models with covariates and distributions for bats (n = 50 carcass persistence trial carcasses) at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Location Covariates	Scale Covariates	Distribution	AICc	Delta AICc
No Covariates	Season	log-logistic	206.83	0
No Covariates	Season	Weibull	206.95	0.12
No Covariates	Season	lognormal	207.81	0.98
No Covariates	No Covariates	Weibull	208.08	1.25*
PlotSearchType	No Covariates	Weibull	208.63	1.80
No Covariates	No Covariates	log-logistic	209.06	2.23
Season	Season	log-logistic	209.07	2.24
PlotSearchType	–	exponential	209.08	2.25
No Covariates	Season + PlotSearchType	log-logistic	209.17	2.34
No Covariates	–	exponential	209.19	2.36
No Covariates	Season + PlotSearchType	Weibull	209.43	2.60
Season + PlotSearchType	Season	log-logistic	209.51	2.68
PlotSearchType	Season + PlotSearchType	Weibull	209.57	2.74
Season	Season	lognormal	209.64	2.81
PlotSearchType	No Covariates	log-logistic	209.84	3.01
Season + PlotSearchType	Season	lognormal	209.92	3.09
No Covariates	No Covariates	lognormal	209.98	3.15
PlotSearchType	Season + PlotSearchType	log-logistic	210.06	3.23
Season	Season	Weibull	210.08	3.25
No Covariates	Season + PlotSearchType	lognormal	210.22	3.39
No Covariates	PlotSearchType	Weibull	210.25	3.42
Season	No Covariates	log-logistic	210.50	3.67
Season + PlotSearchType	No Covariates	log-logistic	210.53	3.70
PlotSearchType	Season + PlotSearchType	lognormal	210.66	3.83
PlotSearchType	No Covariates	lognormal	210.73	3.90
Season + PlotSearchType	Season	Weibull	210.74	3.91
PlotSearchType	PlotSearchType	Weibull	210.99	4.16
Season	No Covariates	lognormal	211.18	4.35
No Covariates	PlotSearchType	log-logistic	211.27	4.44
Season + PlotSearchType	No Covariates	lognormal	211.39	4.56
Season	Season + PlotSearchType	log-logistic	211.67	4.84
Season	No Covariates	Weibull	211.76	4.93
No Covariates	PlotSearchType	lognormal	212.16	5.33
Season + PlotSearchType	Season + PlotSearchType	log-logistic	212.20	5.37
PlotSearchType	PlotSearchType	log-logistic	212.20	5.37
Season	Season + PlotSearchType	lognormal	212.24	5.41
Season	–	exponential	212.45	5.62
Season + PlotSearchType	Season + PlotSearchType	lognormal	212.57	5.74
Season + PlotSearchType	No Covariates	Weibull	212.72	5.89
Season	Season + PlotSearchType	Weibull	212.77	5.94
Season + PlotSearchType	–	exponential	212.95	6.12
Season + PlotSearchType	PlotSearchType	log-logistic	213.08	6.25
PlotSearchType	PlotSearchType	lognormal	213.08	6.25
Season + PlotSearchType	Season + PlotSearchType	Weibull	213.31	6.48
Season + PlotSearchType	PlotSearchType	lognormal	213.97	7.14
Season + PlotSearchType	PlotSearchType	Weibull	215.27	8.44

* Selected model.

Location covariates = covariates that affect the shape of the distribution.

Scale covariates = covariates that affect the spread of the distribution.

AICc = corrected Akaike Information Criterion; Delta AICc = change in AICc.

Appendix E5. Carcass persistence top models with covariates, distributions, and model parameters using GenEst for the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

Size Class	Season	Plot Type	Distribution	Predicted Median Removal Times (days)	Parameter 1	Parameter 2
Large Bird	Fall	Square	Weibull*	19.53	shape = 5.3763	scale = 20.9052
		Road And Pad	Weibull*	17.48	shape = 2.045	scale = 20.9052
	Spring	Square	Weibull*	14.25	shape = 0.956	scale = 20.9052
		Road And Pad	Weibull*	7.64	shape = 0.3638	scale = 20.9052
	Summer	Square	Weibull*	13.14	shape = 0.7886	scale = 20.9052
		Road And Pad	Weibull*	6.16	shape = 0.3002	scale = 20.9052
Small Bird	All	Square	exponential*	8.98	rate = 0.0772	–
		Road And Pad	exponential*	3.62	rate = 0.1917	–
Bat	All	All	Weibull*	4.53	shape = 0.8026	scale = 7.1421

* Parameterization follows the base R parameterization for this distribution.

Appendix F. Search Area Adjustment Models for the Dakota Range I and II Wind Project, Grant and Codington Counties, South Dakota, from March 16 – December 11, 2022

Appendix F1. GenEst estimated search area adjustment models for bats at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota from March 16 – December 11, 2022.

Distribution	AICc	Delta AICc
normal	7,478.21	0*
Weibull	7,591.30	113.09
Gompertz	7,602.07	123.86
gamma	7,835.27	357.06

* Selected model.

AICc = corrected Akaike Information Criterion; Delta AIC = change in AICc.

Appendix F2. GenEst estimated Truncated Weighted Maximum Likelihood search area adjustment estimates for bats at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota from March 16 – December 11, 2022 (n = 42 bat carcasses).

Plot Type	Distribution	Parameter 1	Parameter 2	Area Adjustment
road and pad	normal	32.3212	12.3820	0.07
square	normal	32.3212	12.3820	1.00

Appendix F3. Search area adjustment estimates for the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022. Estimates were calculated using the maximum fall distance of carcasses for a given turbine height (82 meters [m]) and rotor diameter (136 m) estimated using a physics-based model (Hull and Muir 2013). The relative carcass-density distribution was assumed to follow a linear decrease from the turbine base out to the maximum predicted fall distance (Huso and Dalthorp 2014).

Size Class	Plot Type	Area Adjustment
Large Bird	road and pad	0.15
	square	0.86
Small Bird	road and pad	0.21
	square	0.98

Appendix G. Bird and Bat Fatality Rates and Adjustment Factors for the Dakota Range I and II Wind Project, Grant and Codington Counties, South Dakota, from March 16 – December 11, 2022

Appendix G1. GenEst estimated fatality rates and adjustment factors with 90% confidence intervals (CI) for square plots during post-construction fatality monitoring at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

	Spring 22 turbines searched		Summer 8 turbines searched		Fall 21 turbines searched	
	Estimate	**90% CI**	**Estimate**	**90% CI**	**Estimate**	**90% CI**
Search Area Adjustment						
Large Bird	0.86	0.86–0.86	0.86	0.86–0.86	0.86	0.86–0.86
Small Bird	0.98	0.98–0.98	0.98	0.98–0.98	0.98	0.98–0.98
Bat	1.00	1.00–1.00	1.00	1.00–1.00	1.00	1.00–1.00
Searcher Efficiency						
Large Bird	0.80	0.65–0.89	0.80	0.65–0.89	0.80	0.65–0.89
Small Bird	0.65	0.50–0.77	0.65	0.50–0.77	0.65	0.50–0.77
Bat	0.67	0.54–0.77	0.67	0.54–0.77	0.67	0.54–0.77
Average Probability of a Carcass Persisting Through the Search Interval[1]						
Large Bird	0.71	0.61–0.79	0.67	0.57–0.77	0.98	0.91–1.00
Small Bird	0.59	0.50–0.68	0.59	0.50–0.68	0.59	0.51–0.68
Bat	0.42	0.34–0.50	0.42	0.34–0.50	0.42	0.34–0.50
Probability of Available and Detected						
Large Bird	0.61	0.52–0.72	0.59	0.49–0.68	0.82	0.69–0.90
Small Bird	0.42	0.32–0.53	0.42	0.32–0.53	0.42	0.32–0.53
Bat	0.31	0.24–0.38	0.31	0.24–0.38	0.31	0.24–0.38
Estimated Fatality Rates (Fatalities/Turbine/Season)						
All Bird	3.94	2.85–5.45	2.52	0.86–4.37	0.61	n/a[2]
Large Bird	1.03	0.60–1.59	1.35	n/a[2]	0.06	n/a[2]
Small Bird	2.91	1.93–4.28	1.12	n/a[2]	0.55	n/a[2]
Bat	1.09	0.52–1.92	6.34	3.06–11.01	1.26	n/a[2]
Estimated Fatality Rates (Fatalities/Megawatt/Season)						
All Bird	0.98	0.69–1.36	0.65	0.22–1.13	0.14	n/a[2]
Large Bird	0.24	0.14–0.38	0.34	n/a[2]	0.01	n/a[2]
Small Bird	0.73	0.48–1.09	0.29	n/a[2]	0.13	n/a[2]
Bat	0.26	0.13–0.46	1.52	0.74–2.65	0.31	n/a[2]

1. The search interval was twice per month.

2. Confidence interval not calculated because the observed carcass count is less than five.

n/a = not applicable.

Appendix G2. GenEst estimated fatality rates and adjustment factors with 90% confidence intervals (CI) for road and pad plots during post-construction fatality monitoring at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

	Summer 20 turbines searched		Fall 18 turbines searched	
	Estimate	**90% CI**	**Estimate**	**90% CI**
Search Area Adjustment				
Large Bird	0.15	0.15–0.15	0.15	0.15–0.15
Small Bird	0.21	0.21–0.21	0.21	0.21–0.21
Bat	0.07	0.04–0.12	0.07	0.04–0.12
Searcher Efficiency				
Large Bird	0.97	0.88–1.00	0.97	0.88–1.00
Small Bird	0.90	0.73–0.97	0.90	0.73–0.97
Bat	0.67	0.54–0.77	0.67	0.54–0.77
Average Probability of a Carcass Persisting Through the Search Interval[1]				
Large Bird	0.51	0.46–0.58	0.86	0.77–0.92
Small Bird	0.33	0.24–0.43	0.33	0.23–0.44
Bat	0.42	0.34–0.50	0.42	0.34–0.50
Probability of Available and Detected				
Large Bird	0.50	0.45–0.58	0.85	0.75–0.93
Small Bird	0.31	0.21–0.41	0.31	0.21–0.41
Bat	0.31	0.24–0.38	0.31	0.24–0.38
Estimated Fatality Rates (Fatalities/Turbine/Season)				
All Bird	5.31	1.93–9.68	0.76	n/a[2]
Large Bird	2.46	n/a[2]	0	n/a[2]
Small Bird	2.68	n/a[2]	0.76	n/a[2]
Bat	70.10	32.55–129.43	0	n/a[2]
Estimated Fatality Rates (Fatalities/Megawatt/Season)				
All Bird	1.26	0.47–2.31	0.18	n/a[2]
Large Bird	0.60	n/a[2]	0	n/a[2]
Small Bird	0.62	n/a[2]	0.18	n/a[2]
Bat	16.65	7.73–30.51	0	n/a[2]

1. The search interval was twice per month.

2. Confidence interval not calculated because the observed carcass count is less than five.

n/a = not applicable.

Appendix G3. GenEst estimated overall fatality rates per megawatt (MW) and per turbine for square plots for studies conducted at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

	Per MW Estimates		Per Turbine Estimates	
	Estimate	90% CI	Estimate	90% CI
All Bird	1.79	1.18–2.53	7.12	4.77–10.14
Large Bird	0.59	0.30–0.97	2.40	1.25–3.92
Small Bird	1.16	0.69–1.84	4.58	2.77–7.18
Bat	2.15	1.21–3.42	8.86	5.01–14.24

CI = confidence interval.

Appendix G4. GenEst estimated overall fatality rates per megawatt (MW) and per turbine for road and pad plots for studies conducted at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

	Per MW Estimates		Per Turbine Estimates	
	Estimate	90% CI	Estimate	90% CI
All Bird	1.45	0.62–2.67	6.11	2.59–11.25
Large Bird	0.60	n/a[1]	2.46	n/a[1]
Small Bird	0.80	n/a[1]	3.43	n/a[1]
Bat	16.65	7.73–30.51	70.10	32.55–129.43

[1] Confidence interval not calculated because the observed carcass count is less than 5.

CI = confidence interval; n/a = not applicable.

Appendix G5. GenEst estimated overall fatality rates and adjustment factors, with 90% confidence intervals (CIs) at overall search areas for studies conducted at the Dakota Range I and II Wind Project, Grant and Codington counties, South Dakota, from March 16 – December 11, 2022.

	Spring		Summer		Fall	
	22 turbines searched		22 turbines searched		22 turbines searched	
	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
Estimated Fatality Rates (Fatalities/Turbine/Season)						
All Bird	3.94	2.85–5.45	4.71	2.00–8.14	0.77	n/a[1]
Large Bird	1.03	0.60–1.59	2.17	0.66–4.38	0.06	n/a[1]
Small Bird	2.91	1.93–4.28	2.40	0.35–5.55	0.71	n/a[1]
Bat	1.09	0.52–1.92	58.44	27.88–106.84	0.23	n/a[1]
Estimated Fatality Rates (Fatalities/MW/Season)						
All Bird	0.98	0.69–1.36	1.12	0.48–1.94	0.18	n/a[1]
Large Bird	0.24	0.14–0.38	0.53	0.16–1.07	0.01	n/a[1]
Small Bird	0.73	0.48–1.09	0.57	0.09–1.29	0.16	n/a[1]
Bat	0.26	0.13–0.46	13.84	6.55–25.12	0.06	n/a[1]

[1] Confidence interval not calculated because the observed carcass count is less than 5.

n/a = not applicable.

Appendix H. Regional Comparison Tables

Appendix H1. Fatality rates for all birds (number of birds per megawatt [MW] per year), plot size, estimator, land cover, and study citation from recently constructed wind energy facilities in the South Dakota, North Dakota, and Minnesota with publicly available data.

Project	Fatality/MW/Year	Plot Size	Estimator	Land Cover	Citations
Blazing Star, MN (2020)	12.18	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Cropland, Pasture	Stucker et al. 2021b
Lake Benton II, MN (2020)	11.75	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Cropland, Herbaceous	Stucker et al. 2021a
Jeffers, MN (2021)	9.19	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Cropland, Developed, Deciduous Tree, Pasture, Herbaceous	Heist et al. 2022d
Blazing Star, MN (2021)	8.94	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Cropland, Wetlands	Stucker et al. 2022b
Black Oak Getty, MN (2017)	8.69	60 m radius road/pad	Huso	Cropland, Grassland, Wetlands	Pickle et al. 2018
Mower County, MN (2021)	8.31	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Developed, Corn, Soybean	Heist et al. 2022b
Blazing Star II, MN (2021)	6.64	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Agriculture, Cropland, Pasture, Herbaceous, Wetlands	Stucker et al. 2022a
Moraine II, MN (2009)	5.59	200 m x 200 m plot, 200 m x 200 m mowed strips, 100 m x 100 m cleared	Shoenfeld	Agriculture, Grassland	Derby et al. 2010d
Buffalo Ridge I, SD (2009–2010)	5.06	200 m x 200 m plot, 200 m x 200 m mowed strips, 100 m x 100 m cleared	Shoenfeld	Agriculture, Grassland	Derby et al. 2010b
Nobles 2, MN (2021)	4.88	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Cropland, Developed, Deciduous Tree, Herbaceous, Wetlands	Heist et al. 2022c
Odell, MN (2016–2017)	4.69	120 m x 120 m cleared	Huso	Agriculture	Chodachek and Gustafson 2018
Rugby, ND (2010–2011)	3.82	200 m x 200 m plot, 100 m x 100 m cleared, 200 m x 200 m mowed strips	Shoenfeld	Agriculture	Derby et al. 2011b
Elm Creek II, MN (2011–2012)	3.64	200 m x 200 m plot, 200 m x 200 m mowed strips, 100 m x 100 m cleared, 100 m radius road/pad	Shoenfeld	Agriculture, Grassland	Derby et al. 2012b
Black Oak Getty, MN (2018)	3.5	60 m radius road/pad	Huso	Cropland, Grassland, Wetlands	Pickle et al. 2019
Lake Benton II, MN (2021)	3.48	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Agriculture, Cropland, Developed, Pasture, Herbaceous, Wetlands	Stucker et al. 2022c

Appendix H1. Fatality rates for all birds (number of birds per megawatt [MW] per year), plot size, estimator, land cover, and study citation from recently constructed wind energy facilities in the South Dakota, North Dakota, and Minnesota with publicly available data.

Project	Fatality/MW/Year	Plot Size	Estimator	Land Cover	Citations
Red Pine, MN (2018)	2.68	60 m radius road/pad	Huso	Cropland, Developed, Deciduous Tree, Open Water, Pasture, Woody Wetlands, Wetlands	Trana et al. 2019
Dakota Range I & II, SD (2022)	2.30	150 m x 150 m, 100 m radius road/pad	GenEst	Cropland, Herbaceous, Pasture	This Study
Lakefield Wind, MN (2012)	2.22	100 m x 100 m plot	Shoenfeld	Agriculture	Minnesota Public Utilities Commission (MPUC) 2012
Community Wind North, MN (2021)	2.08	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Cropland, Developed, Deciduous Tree, Pasture, Herbaceous, Wetlands	Heist et al. 2022a
Prairie Winds SD1, SD (2012–2013)	2.01	200 m x 200 m plot, 200 m x 200 m road/pad	Shoenfeld	Grassland	Derby et al. 2013
Buffalo Ridge II, SD (2011–2012)	1.99	100 m x 100 m cleared, 100 m for roads and pads	Shoenfeld	Agriculture, Grassland	Derby et al. 2012a
Prairie Winds SD1, SD (2013–2014)	1.66	200 m x 200 m plot, 200 m x 200 m road/pad	Shoenfeld	Grassland	Derby et al. 2014
Elm Creek, MN (2009–2010)	1.55	100 m x 100 m cleared, 200 m x 200 m mowed strips	Shoenfeld	Agriculture	Derby et al. 2010c
Thunder Spirit, ND (2016–2017)	1.49	160 m x 160 m plot, 80 m radius road/pad	Huso	Agriculture, Grassland	Derby et al. 2018
Prairie Winds ND1, ND (2010)	1.48	200 m x 200 m plot	Shoenfeld	Agriculture, Grassland	Derby et al. 2011c
Prairie Winds SD1, SD (2011–2012)	1.41	200 m x 200 m plot	Shoenfeld	Grassland	Derby et al. 2012c
Lake Benton, MN (2021)	1.02	100 m radius road/pad, 120 m x 120 m plot	GenEst	Cropland, Pasture, Herbaceous	Voth et al. 2022
Wessington Springs, SD (2010)	0.89	200 m x 200 m plot	Shoenfeld	Grassland	Derby et al. 2011a
Pleasant Valley, MN (2016–2017)	0.68	160 m x 160 m cleared, 80 m radius road/pad	Huso	Agriculture, Grassland, Wetlands	Tetra Tech 2017
Oak Glen, MN (2013)	0.51	120 m x 120 m plot	Shoenfeld	Agriculture	Chodachek et al. 2014

m = meters.

Appendix H2. Fatality rates for all bats (number of bats per megawatt [MW] per year), plot size, estimator, land cover, and study citation from recently constructed wind energy facilities in South Dakota, North Dakota, and Minnesota with publicly available data.

Project	Fatality/MW/Year	Plot Size	Estimator	Land Cover	Citation
Black Oak Getty, MN (2018)	37.59	60 m radius road/pad	Huso	Cropland, Grassland, Wetlands	Pickle et al. 2019
Black Oak Getty, MN (2017)	29.88	60 m radius road/pad	Huso	Cropland, Grassland, Wetlands	Pickle et al. 2018
Lakefield, MN (2014)	20.19	100 m x 100 m cleared	Huso	Cropland, Conservation Reservation Program	Westwood 2015
Blazing Star, MN (2020)	19.06	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Cropland, Pasture	Stucker et al. 2021b
Red Pine, MN (2018)	18.74	60 m radius road/pad	Huso	Cropland, Developed, Deciduous Tree, Open Water, Pasture, Woody Wetlands, Wetlands	Trana et al. 2019
Lake Benton II, MN (2020)	18.44	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Cropland, Herbaceous	Stucker et al. 2021a
Blazing Star, MN (2021)	16.06	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Cropland, Wetlands	Stucker et al. 2022b
Lakefield Wind, MN (2012)	15.85	100 m x 100 m plot	Shoenfeld	Agriculture	Minnesota Public Utilities Commission (MPUC) 2012
Dakota Range I & II, SD (2022)	14.19	150 m x 150 m, 100 m radius road/pad	GenEst	Cropland, Herbaceous, Pasture	This Study
Blazing Star II, MN (2021)	14.07	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Agriculture, Cropland, Pasture, Herbaceous, Wetlands	Stucker et al. 2022a
Community Wind North, MN (2021)	12.18	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Cropland, Developed, Deciduous Tree, Pasture, Herbaceous, Wetlands	Heist et al. 2022a
Jeffers, MN (2021)	9.35	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Cropland, Developed, Deciduous Tree, Pasture, Herbaceous	Heist et al. 2022d
Nobles 2, MN (2021)	7.97	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Cropland, Developed, Deciduous Tree, Herbaceous, Wetlands	Heist et al. 2022c
Odell, MN (2016–2017)	6.74	120 m x 120 m cleared	Huso	Agriculture	Chodachek and Gustafson 2018
Big Blue, MN (2013)	6.33	120 m x 120 m plot	Shoenfeld	Agriculture	Chodachek et al. 2014
Lake Benton II, MN (2021)	5.96	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Agriculture, Cropland, Developed, Pasture, Herbaceous, Wetlands	Stucker et al. 2022c
Mower County, MN (2021)	5.82	120 m x 120 m cleared, 100 m radius road/pad	GenEst	Developed, Corn, Soybean	Heist et al. 2022b

Appendix H2. Fatality rates for all bats (number of bats per megawatt [MW] per year), plot size, estimator, land cover, and study citation from recently constructed wind energy facilities in South Dakota, North Dakota, and Minnesota with publicly available data.

Project	Fatality/MW/Year	Plot Size	Estimator	Land Cover	Citation
Grand Meadow, MN (2013)	3.11	120 m x 120 m plot	Shoenfeld	Agriculture	Chodachek et al. 2014
Oak Glen, MN (2013)	3.09	120 m x 120 m plot	Shoenfeld	Agriculture	Chodachek et al. 2014
Buffalo Ridge II, SD (2011–2012)	2.81	100 m x 100 m cleared, 100 m for roads and pads	Shoenfeld	Agriculture, Grassland	Derby et al. 2012a
Lake Benton, MN (2021)	2.68	100 m radius road/pad, 120 m x 120 m plot	GenEst	Cropland, Pasture, Herbaceous	Voth et al. 2022
PrairieWinds ND1, ND (2010)	2.13	200 m x 200 m plot	Shoenfeld	Agriculture, Grassland	Derby et al. 2011c
Pleasant Valley, MN (2016–2017)	1.8	160 m x 160 m cleared, 80 m radius road/pad	Huso	Agriculture, Grassland, Wetlands	Tetra Tech 2017
Wessington Springs, SD (2009)	1.48	200 m x 200 m plot	Shoenfeld	Grassland	Derby et al. 2010a
Prairie Winds SD1, SD (2011–2012)	1.23	200 m x 200 m plot	Shoenfeld	Grassland	Derby et al. 2012c
Prairie Winds SD1, SD (2013–2014)	0.52	200 m x 200 m plot, 200 m x 200 m road/pad	Shoenfeld	Grassland	Derby et al. 2014
Wessington Springs, SD (2010)	0.41	200 m x 200 m plot	Shoenfeld	Grassland	Derby et al. 2011a

m = meters.

Appendix H3. Wind energy projects, project characteristics, and study citations from publicly available wind energy facilities in South Dakota, North Dakota, and Minnesota with publicly available data.

Project	Total Turbines	Total MW	Number Turbines Searched	Search Area Type	Survey Frequency	Length of Study (months)	Tower Size (m)	Citations
Big Blue, MN (2013)	18	36	10	full plot	daily	4	120	Chodachek et al. 2014
Black Oak Getty, MN (2017)	39	78	34	road/pad	weekly	8	80	Pickle et al. 2018
Black Oak Getty, MN (2018)	39	78	18, 17	road/pad	weekly, twice per week	7	80	Pickle et al. 2019
Blazing Star II, MN (2021)	100	200	10, 60	cleared, road/pad	twice per week, weekly	8	90	Stucker et al. 2022a
Blazing Star, MN (2020)	100	200	5, 10, 33, 60	cleared, road/pad	twice per week, weekly	8		Stucker et al. 2021b
Blazing Star, MN (2021)	100	200	10, 60	cleared, road/pad	weekly, twice per week	7	80	Stucker et al. 2022b
Buffalo Ridge I, SD (2009–2010)	24	50.4	6, 5, 2	full plot, mowed strips, cleared	monthly, weekly	11.9	80	Derby et al. 2010b
Buffalo Ridge II, SD (2011–2012)	105	210	5, 60	cleared, road/pad	weekly, monthly	11.5	78	Derby et al. 2012a
Community Wind North, MN (2021)	12	26.4	5, 7	cleared, road/pad	weekly	8	87	Heist et al. 2022a
Elm Creek II, MN (2011–2012)	62	148.8	20, 8, 2, 10	full plot, mowed strips, cleared, road/pad	monthly, weekly	11.1	80	Derby et al. 2012b
Elm Creek, MN (2009–2010)	67	100.5	3, 16, 10	cleared, mowed strips	monthly, weekly	12.1	80	Derby et al. 2010c
Grand Meadow, MN (2013)	67	101	13	full plot	daily	4	80	Chodachek et al. 2014
Jeffers, MN (2021)	20	44	5, 15	cleared, road/pad	weekly, twice per week	8	87	Heist et al. 2022d
Lake Benton II, MN (2020)	44	100	5, 39	cleared, road/pad	weekly	8	80	Stucker et al. 2021a
Lake Benton II, MN (2021)	44	100	5, 39	cleared, road/pad	weekly, twice per week	7	80	Stucker et al. 2022c
Lake Benton, MN (2021)	139	107.25	40, 10	road/pad, full plot	weekly	8	53	Voth et al. 2022

Appendix H3. Wind energy projects, project characteristics, and study citations from publicly available wind energy facilities in South Dakota, North Dakota, and Minnesota with publicly available data.

Project	Total Turbines	Total MW	Number Turbines Searched	Search Area Type	Survey Frequency	Length of Study (months)	Tower Size (m)	Citations
Lakefield Wind, MN (2012)	137	205.5	26	full plot	other	7.7	80	Minnesota Public Utilities Commission (MPUC) 2012
Lakefield, MN (2014)	137	205.5	26	cleared	other	4	80	Westwood 2015
Moraine II, MN (2009)	33	49.5	4, 1, 15, 7, 2	full plot, mowed strips, cleared	monthly, weekly	9.1	64.7	Derby et al. 2010d
Mower County, MN (2021)	43	98.9	5, 4, 38, 39	cleared, road/pad	weekly	7	78.3	Heist et al. 2022b
Nobles 2, MN (2021)	74	250	15, 54	cleared, road/pad	twice per week	8	82	Heist et al. 2022c
Oak Glen, MN (2013)	24	44	10	full plot	daily	4	80	Chodachek et al. 2014
Odell, MN (2016–2017)	100	200	15	cleared	monthly, weekly	12	80	Chodachek and Gustafson 2018
Pleasant Valley, MN (2016–2017)	100	200	5, 92, 95	cleared, road/pad	weekly, monthly, weekly	12	80	Tetra Tech 2017
Prairie Winds SD1, SD (2011–2012)	108	162	50	full plot	twice per month, monthly	11.2	80	Derby et al. 2012c
Prairie Winds SD1, SD (2012–2013)	108	162	50, 37, 13	full plot, road/pad	twice per month, monthly	11.5	80	Derby et al. 2013
Prairie Winds SD1, SD (2013–2014)	108	162	9, 36	full plot, road/pad	twice per month, monthly	11.8	80	Derby et al. 2014
PrairieWinds ND1, ND (2010)	77	115.5	35	full plot	twice per month	7.6	80	Derby et al. 2011c
Red Pine, MN (2018)	100	200	40	road/pad	weekly	8	80	Trana et al. 2019
Rugby, ND (2010–2011)	71	149	22, 10, 1, 3, 28, 6, 32	full plot, cleared, mowed strips	monthly, weekly	12	80	Derby et al. 2011b
Thunder Spirit, ND (2016–2017)	43	107.5	10, 33	full plot, road/pad	twice per month	10	75	Derby et al. 2018
Wessington Springs, SD (2009)	34	51	20	full plot	twice per month	8.5	80	Derby et al. 2010a
Wessington Springs, SD (2010)	34	51	20	full plot	twice per month	8.4	80	Derby et al. 2011a

MW = megawatts; m = meters.

Appendix H4. Literature Cited for Appendix H.

Chodachek, K., C. Derby, D. Bruns Stockrahm, P. Rabie, K. Adachi, and T. Thorn. 2014. Bat Fatality Rates and Effects of Changes in Operational Cut-in Speeds at Commercial Wind Farms in Southern Minnesota - Year 1: July 9 - October 31, 2013. Prepared for Minnesota Department of Commerce, St. Paul, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota, and Minnesota State University Moorhead, Moorhead, Minnesota. May 23, 2014. Available online: http://mn.gov/commerce/energyfacilities/documents/MNDOC,%20Bat%20Fatality%20Study%20Year%201,%205.23.14.pdf

Chodachek, K. and Z. Gustafson. 2018. Tier 4 Post-Construction Mortality Monitoring Study for the Odell Wind Energy Project, Cottonwood and Jackson Counties, Minnesota. Final Fatality Report: December 2016 – December 2017. Prepared for Odell Wind Farm, LLC, Oakville, Ontario, Canada. Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. March 15, 2018. Available online https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={E0912A62-0000-C93E-88EA-844E240F695B}&documentTitle=20183-141067-02

Derby, C., A. Dahl, A. Merrill, and K. Bay. 2010a. 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. 2010b. 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. 2010c. 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. 2010d. 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., 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 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. 2011c. 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., A. Dahl, and D. Fox. 2013. 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.

Derby, C., D. Klostermeier, R. Tupling, and K. Moratz. 2018. Post-Construction Bird and Bat Fatality Monitoring for the Thunder Spirit Wind Energy Facility, Adams County, North Dakota. Final Fatality Report. Prepared for Thunder Spirit Wind, LLC, Bismarck, North Dakota. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota. March 1, 2018.

Heist, K., S. Cox, and L. Martinez Steele. 2022a. Post-Construction Bird and Bat Fatality Monitoring Study, Community Wind North Project, Lincoln County, Minnesota: March – November 2021. Prepared for Northern States Power, a Minnesota corporation, d/b/a Xcel Energy, Minneapolis, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. February 10, 2022. Available online: https://efiling.web.commerce.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={400F8F7F-0000-C85B-9EE1-609BEF7CF935}&documentTitle=20223-183801-03

Heist, K., A. Suehring, and T. Wilson. 2022b. Post-Construction Bird and Bat Fatality Monitoring Study, Mower County Wind Farm, Mower County, Minnesota. April - November 2021. Prepared for Northern States Power, a Minnesota corporation, d/b/a Xcel Energy, Minneapolis, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. February 24, 2022. 37 pp. + appendices.

Heist, K., N. O'Neil, and J. Swenson. 2022c. Post-Construction Bird and Bat Fatality Monitoring Study, Nobles 2 Wind Project, Nobles County, Minnesota: March 15 – November 15, 2021. Prepared for Nobles 2 Power Partners, LLC, Omaha, Nebraska. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. January 31, 2022. Available online: https://efiling.web.commerce.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={10608F7F-0000-C434-AA35-CA5C0BC0ED20}&documentTitle=20223-183815-02

Heist, K., S. Cox, M. Tuma, and F. Kulzer. 2022d. Post-Construction Bird and Bat Fatality Monitoring Study, Jeffers Wind Energy Center, Cottonwood County, Minnesota: March – November 2021. Prepared for Northern States Power, a Minnesota corporation, d/b/a Xcel Energy, Minneapolis, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. February 25, 2022. Available online: https://efiling.web.commerce.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={C07E947F-0000-C319-9EDC-1777E12D03EF}&documentTitle=20223-183896-01

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. Available online: https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={DEE3ABC0-1AD5-45CF-9451-EBF6F3C4C489}&documentTitle=201210-79566-01

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.

Pickle, J., J. Lombardi, J. Stucker, and G. DiDonato. 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. Available online: https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId=%7B80398269-0000-CD12-876A-A85CEB339B7A%7D&documentTitle=20193-151123-01

Stucker, J., A. Suehring, and J. Bushey. 2021a. Post-Construction Bird and Bat Fatality Monitoring Study, Lake Benton Ii Wind Farm, Pipestone County, Minnesota. Final: March - November 2020. Prepared for Northern States Power, Minneapolis, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. February 2021. 44 pp. + appendices.

Stucker, J., A. Suehring, and R. Clark. 2021b. Post-Construction Bird and Bat Fatality Monitoring Study. Blazing Star Wind Farm, Lincoln County, Minnesota. Final: March - November 2020. Prepared for Northern States Power, Minneapolis, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. January 28, 2021.

Stucker, J., A. Suehring, and F. Kulzer. 2022a. Post-Construction Bird and Bat Fatality Monitoring Study, Blazing Star 2 Wind Farm, Lincoln County, Minnesota. Final Year 2: March – November 2021. Prepared for Northern States Power, a Minnesota corporation, d/b/a Xcel Energy, Minneapolis, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. January 24, 2022. Available online: https://efiling.web.commerce.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={40E2897F-0000-C81C-82B2-5841F1FC8165}&documentTitle=20223-183759-01

Stucker, J., A. Suehring, and T. Wilson. 2022b. Post-Construction Bird and Bat Fatality Monitoring Study, Blazing Star Wind Farm, Lincoln County, Minnesota. Year 2: April – October 2021. Prepared for Northern States Power, a Minnesota corporation, d/b/a Xcel Energy, Minneapolis, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. January 7, 2022.

Stucker, J., S. Cox, M. Tuma, and F. Kulzer. 2022c. Post-Construction Bird and Bat Fatality Monitoring Study, Lake Benton Ii Wind Farm, Pipestone County, Minnesota. Year 2: April – October 2021. Prepared for Northern States Power, a Minnesota corporation, d/b/a Xcel Energy, Minneapolis, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. January 7, 2022. Available online: https://efiling.web.commerce.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={40238A7F-0000-CE1B-B83A-2D95F39F35B7}&documentTitle=20223-183762-01

Tetra Tech. 2017. 2016 - 2017 Post-Construction Mortality Monitoring Annual Report, Pleasant Valley Wind Farm, Mower and Dodge Counties, Minnesota. Prepared for Northern States Power Company-Minnesota, Xcel Energy. Prepared by Tetra Tech, Bloomington, Minnesota. June 2017. Available online: https://mn.gov/commerce/energyfacilities/Docket.html?Id=25724

Trana, M., B. Hyzy, J. Pickle, and Z. Gustafson. 2019. 2018 Post-Construction Monitoring Study, Red Pine Wind Energy Facility, Lincoln County, Minnesota, March 18 – November 15, 2018. Prepared for Red Pine Wind Farm, LLC. Prepared For: Red Pine Wind Farm, LLC. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. March 12, 2019. Available online: https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={70B97C69-0000-C23B-9709-02AD2C27BA4B}&documentTitle=20193-151072-02

Voth, M., J. Pickle, M. Tuma, and A. Tredennick. 2022. Post-construction Bird and Bat Fatality Monitoring Report, Lake Benton Wind Repower Project, Lincoln County, Minnesota. March – November 2021. Prepared for ALLETE Clean Energy, Inc., Lake Benton, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Golden Valley, Minnesota. February 16, 2022.

Westwood Professional Services (Westwood). 2015. 2014 Avian and Bat Fatality Monitoring, Lakefield Wind Project, Jackson County, Minnesota. Prepared for LWP Lessee, LLC, c/o EDF Renewable Energy, San Diego, California. Prepared by Westwood, Eden Prairie, Minnesota. March 30, 2015. Available online: https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId=%7B692D3147-C6D7-41DE-A8B3-EA7381C45948%7D&documentTitle=20154-109264-01