APPENDIX F – EAGLE AND RAPTOR NEST SURVEYS

Due to sensitive information contained in this Appendix, please contact WAPA to receive a copy.

APPENDIX G – AVIAN USE SURVEYS

Final Baseline Avian Studies for the Sweetland Wind Energy Project Hand County, South Dakota

May 2017 – April 2018

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EXECUTIVE SUMMARY

Scout Clean Energy has proposed the development of a wind energy facility called the Sweetland Wind Energy Project (Project), located in Hand County, South Dakota. Western EcoSystems Technology, Inc. conducted one year of baseline avian surveys for the Project. The following document contains results for the first year of fixed-point bird use surveys, prairie grouse surveys, vegetation/habitat mapping, and general wildlife observations.

The Survey area encompasses 6,736.3 hectares (16,645.5 acres) approximately 8.5 kilometers (km; 5.3 miles [mi]) southeast of the city of Wessington, South Dakota and 12.9 km (8.0 mi) southeast of the city of Miller, South Dakota. Based on a vegetation mapping effort that included a field reconnaissance effort combined with National Land Cover Database data for areas that were not visible or accessible during field efforts, approximately 84.2% of the land cover at the Survey area is either pasture/hay or cultivated crop.

The primary objective of the fixed-point large bird use surveys is to estimate levels of use by eagles and other large birds near potential turbine locations. These observational surveys are recommended in the US Fish and Wildlife Service's *Eagle Conservation Plan Guidance*, *Land-Based Wind Energy Guidelines*, and the 2016 Eagle Rule for characterizing levels of use and potential risk of a proposed wind energy project to eagles and other diurnal raptors. The fixed-point bird use surveys were designed to estimate the seasonal, spatial, and temporal use of the Survey area by birds, particularly diurnal raptors. Fixed-point surveys were conducted from May 26, 2017, to April 28, 2018, at 13 plots established throughout the Survey area. A total of 153 60-minute (min) fixed-point large bird use surveys were completed, and 43 unique large bird species were identified. The most abundant large bird species recorded was snow goose, followed by Canada goose. Diurnal raptor use was highest in the fall and spring, followed by summer and then winter. Irrespective of distance from observer, the most common diurnal raptors observations recorded were red-tailed hawk (42 observations) and northern harrier (19). Based on use and initial flight heights, the diurnal raptor species with the highest exposure index was red-tailed hawk, followed by bald eagle, northern harrier, Swainson's hawk, and prairie falcon.

In order to make comparisons to other publicly available studies, mean annual use was standardized to 20-min surveys. Mean annual diurnal raptor use recorded within the Survey area (0.22 raptors per 800-meter (m; 2,625-foot [ft]) plot per 20-min survey) ranked ninth lowest relative to 48 other comparable studies at wind energy facilities that implemented similar protocols to the present study and had data for three or four different seasons. Mean annual diurnal raptor use values from three publicly available South Dakota studies were 0.24 raptors/800-m plot/20-min survey for all three studies. Bald and golden eagles were observed within the Survey area during the study and there is the potential for impacts to bald and golden eagles at the Project which are protected by the Bald and Golden Eagle Protection Act of 1940 (BGEPA) and Migratory Bird Treaty Act of 1918 (MGTA). Siting turbines away from known raptor nest locations, abrupt topographic features, and areas of identified higher diurnal raptor use should help to minimize potential impacts to diurnal raptors including eagles.

A total of 153 10-min fixed-point small bird use surveys were completed, and 42 unique small bird species were identified. Passerine use was highest during the summer, followed by spring, winter, and fall. To date, passerines have been the most common bird species recorded during most fatality monitoring studies. However, population-level effects have not been detected or reported for birds to date. Further, according to NatureServe, the majority of all passerine species observed during the first year of baseline studies at the Survey area are considered globally abundant. Collision mortality is not expected to cause population level effects to passerines; however, there is the potential for small-scale local displacement of grassland passerines at the Project.

One historic greater prairie chicken lek location occurs along the western edge of the Survey area and two additional historic lek locations, one additional greater prairie chicken and one sharp-tailed grouse, occur within the 1-mile buffer. None of the three historic lek locations were active during aerial surveys. In addition, WEST biologists visually observed sharp-tailed grouse dancing/displaying at four new locations within the survey area during aerial surveys. Access issues limited the ability to conduct ground counts on one of the three historic leks and one of the four displaying grouse locations but these two locations were surveyed twice via helicopter in 2018. South Dakota Game, Fish and Park's define a lek as the traditional display area where two or more male grouse have attended in two or more of the previous five years. The four new dancing/displaying locations don't currently meet the definition of a lek since only one year of data has been collected in the last five years.

Three additional bird species (not identified during the standardized avian surveys) were documented incidentally as well as two mammal species. Special-status species are those that are designated Species of Greatest Conservation Need in the South Dakota State Wildlife Action Plan, or protected under the federal Endangered Species Act of 1973 or the BGEPA. Seven special-status species were recorded during the first year of fixed-point bird use surveys and as incidental general wildlife observations. There were no federally listed threatened or endangered species were observed within the Survey area during the first year studies.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Scout Clean Energy (Scout) has proposed the development of a wind energy facility called the Sweetland Wind Energy Project (Project), located in Hand County, South Dakota. The planned nameplate capacity of the Project is up to 200 megawatts (MW) generated from up to 80 wind turbine generators. Additionally the proposed Project would include a generation-tie in for the Project to the transmission grid as well as associated infrastructure (i.e., operations and maintenance facility, laydown yard, access roads, underground collector lines, switchyard, and a substation).

Western EcoSystems Technology, Inc. (WEST) conducted one year of baseline wildlife surveys for the Project. The following document contains results from the first year of fixed-point bird use surveys, prairie grouse surveys, vegetation/habitat mapping, and general wildlife observations. The principal objectives of the baseline study included: 1) providing site-specific bird resource and use data for use in evaluating potential impacts from the proposed Project, and 2) providing information for use in Project planning and design of the facility to avoid or minimize impacts to birds.

STUDY AREA

The proposed Survey area is located on approximately 6,736.3 hectares (16,645.5 acres) in Hand County, South Dakota, approximately 8.5 kilometers (km; 5.3 miles [mi]) southeast of the city of Wessington, South Dakota and 12.9 km (8.0 mi) southeast of the city of Miller, South Dakota (Figures 1 and 2). The vegetation mapping, completed by WEST via a field reconnaissance effort within the Survey area combined with National Land Cover Database (NLCD; US Geological Survey [USGS] NLCD 2011, Homer et al. 2015) mapping in areas that were not visible or accessible during the field reconnaissance effort, showed approximately 84.2% of the Survey area is dominated by pasture/hay (55.3%) and cultivated crops (28.9%; Figure 3, Table 1). Herbaceous cover accounted for 11.8%, followed by deciduous forest (2.5%), open water (0.8%) developed low intensity (0.4%), emergent wetlands (0.2%), and developed open space (0.1%).Of note, the not accessible or visible portions of the Survey area (597.4 hectares [1,475.9 acres]) for which the NLCD data was used showed that herbaceous cover made up approximately 76.1% of the not accessible or visible portion of the Survey area compared to pasture/hay (13.9%), and cultivated crops (7.7%).

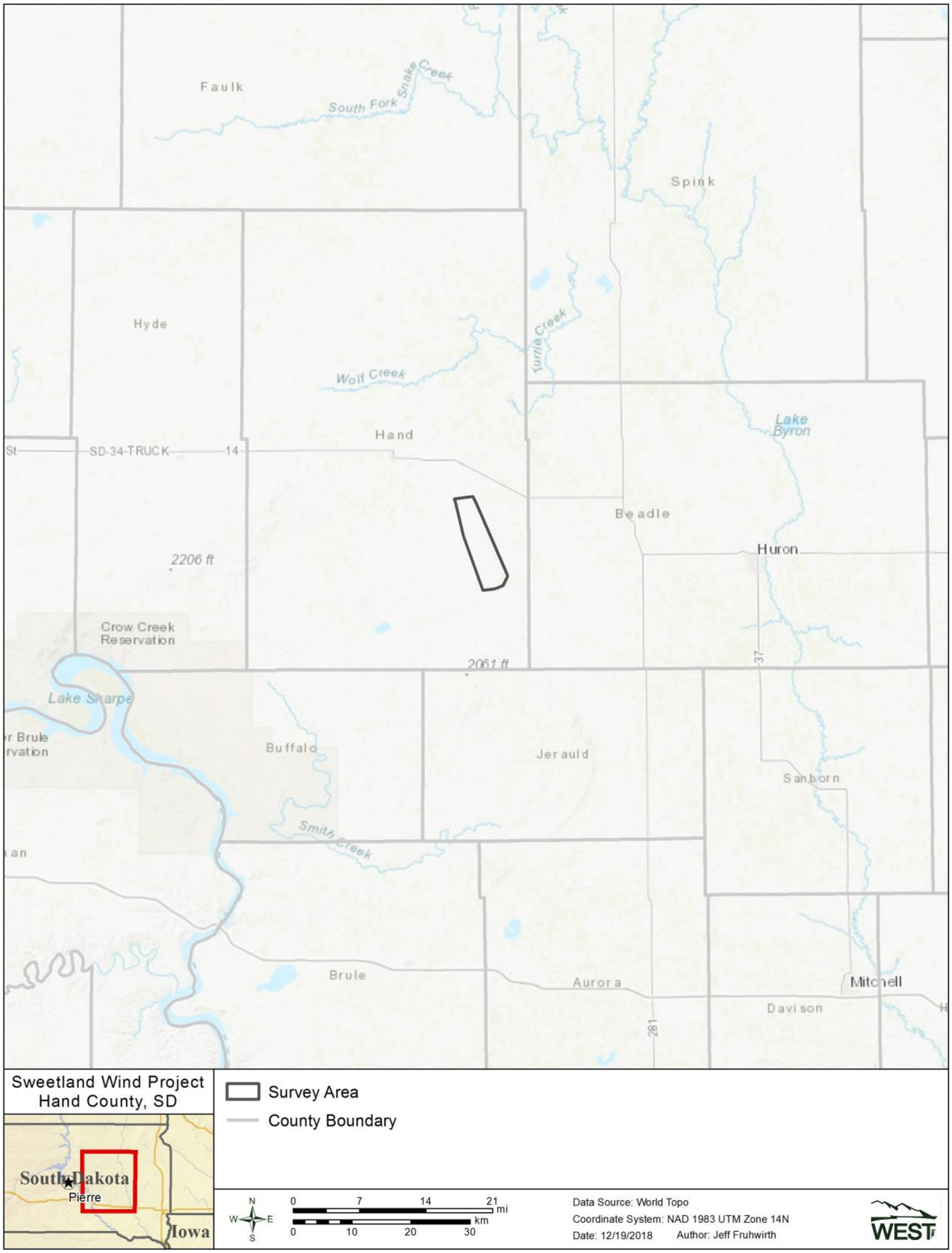

Figure 1. General location of the Sweetland Wind Energy Project.

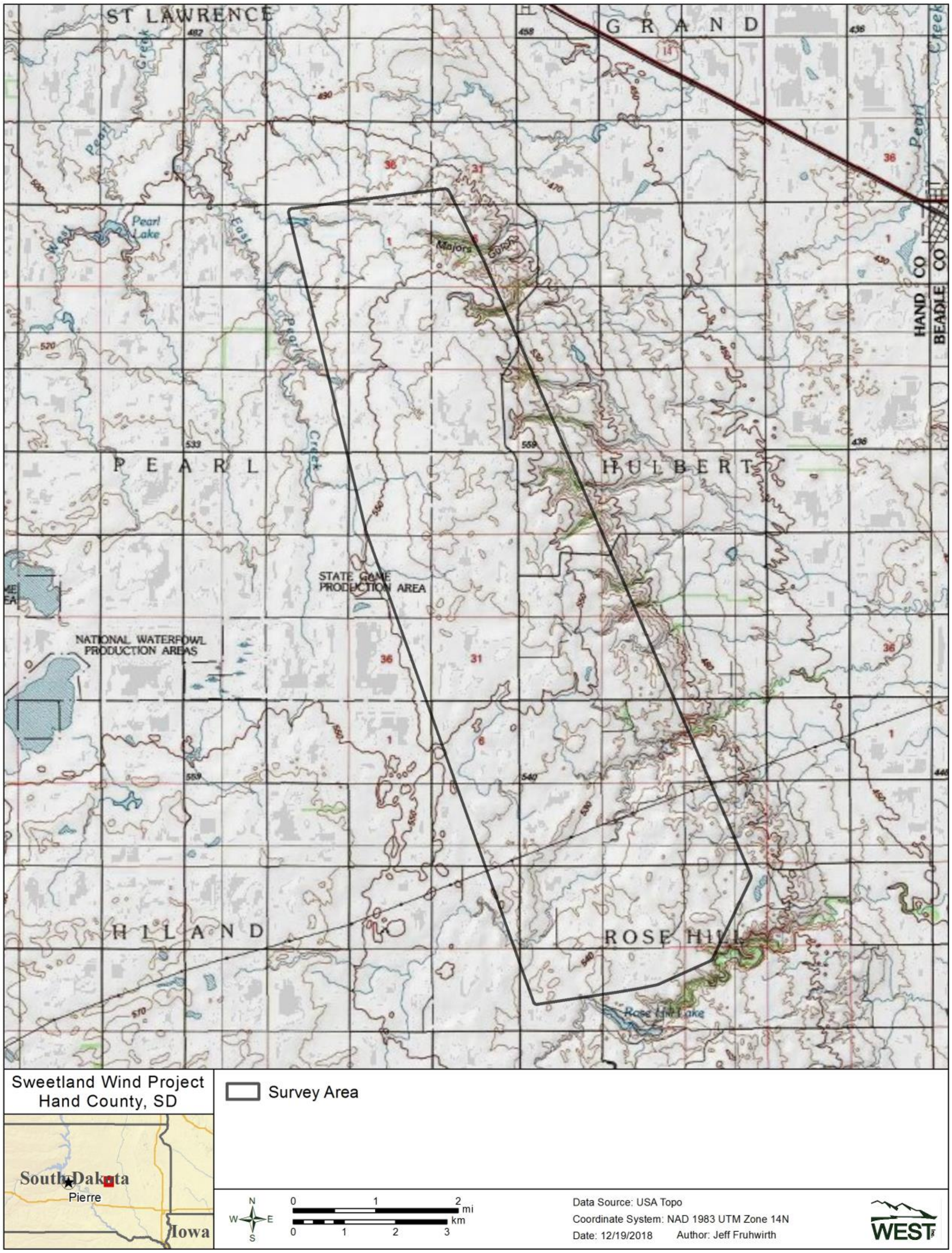

Figure 2. Topographic map of the Sweetland Wind Energy Project.

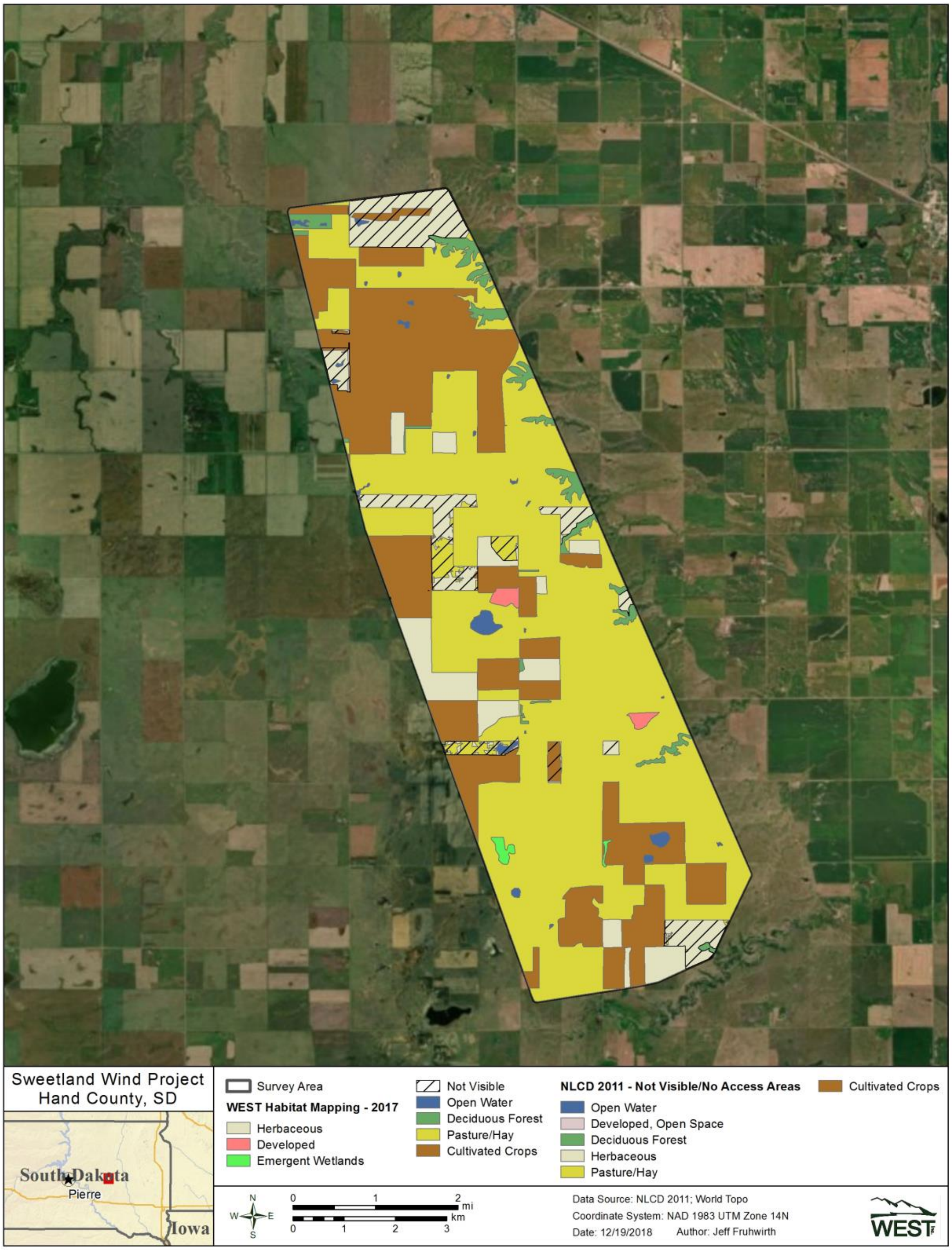

Figure 3. The land cover types and coverage based on vegetation mapping within the Sweetland Wind Energy Survey area, combined with National Land Cover Database (US Geological Survey National Land Cover Database 2011, Homer et al. 2015) types for areas not accessible or not visible from a public road.

Table 1. Land cover types based on vegetation mapping within the Sweetland Wind Energy Survey area, combined with National Land Cover Database (US Geological Survey National Land Cover Database 2011, Homer et al. 2015) types for areas not accessible or not visible from a public road.

	Vegetation Mapping[1]			NLCD[2]			Total		
Land Cover Type	Hectares	Acres	Percent (%)	Hectares	Acres	Percent (%)	Hectares	Acres	Percent (%)
Pasture/Hay	3,645.0	9,007.1	59.4	82.8	204.5	13.9	3,727.8	9,211.6	55.3
Cultivated Crops	1,897.0	4,687.7	30.9	46.1	113.8	7.7	1,943.1	4,801.5	28.9
Herbaceous	342.1	845.3	5.6	454.3	1,122.5	76.1	796.4	1,967.8	11.8
Deciduous Forest	165.8	409.6	2.7	0.1	0.3	<0.1	165.9	409.9	2.5
Open Water	45.3	111.9	0.7	8.0	19.8	1.3	53.3	131.7	0.8
Developed; Low Intensity	28.3	69.9	0.5	0	0	0	28.3	69.9	0.4
Emergent Wetlands	15.4	38.1	0.3	0.2	0.4	<0.1	15.6	38.5	0.2
Developed, Open Space	0	0	0	5.9	14.6	1.0	5.9	14.6	0.1
Totals[3]	**6,138.9**	**15,169.6**	**100**	**597.4**	**1,475.9**	**100**	**6,736.3**	**16,645.5**	**100**

[1] Based on vegetation mapping completed by Western EcoSystems Technology, Inc. during field reconnaissance

[2] Represent areas not accessible or visible during vegetation mapping and based on data from the National Land Cover Database (NLCD; US Geological Survey NLCD 2011, Homer et al. 2015).

[3] Sums of values may not add to total value shown, due to rounding.

METHODS

Fixed-Point Bird Use Surveys

The objective of the fixed-point bird use surveys was to estimate the seasonal and spatial use within the Survey area by birds, particularly diurnal raptors. Fixed-point bird surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980). Fixed-point large bird and separate fixed-point small bird use surveys were conducted within the Survey area. Large birds included waterbirds, waterfowl, shorebirds, gulls and terns, diurnal raptors, vultures, upland game birds, doves and pigeons, large corvids (e.g., ravens, and crows) and goatsuckers. Passerines (excluding large corvids), and unidentified small birds were considered small birds.

Survey Plots

The Survey area was defined as the minimum-convex polygon (MCP) that encompasses the proposed wind turbine locations along with the hazardous area around all proposed turbine locations. The 2013 USFWS Eagle Conservation Plan Guidance (USFWS 2013; ECPG) recommends that survey plots cover approximately 30% of the MCP. A grid with one-mile by one-mile cells was laid over the Survey area and grid cells were selected using a spatially balanced sampling method, Balance Acceptance Sampling (Brown et al. 2015). The center of the point count survey location was placed within the selected grid cells and locations were selected based on visibility and access. Thirteen plots were selected to survey representative habitats and topography, along public roads or areas where access had been granted (Figure 4). During surveys, bird observations were recorded regardless of distance from observer however, for the large bird survey analyses, observations were restricted to 800 meters (m; 2,625 feet [ft]), and observations were restricted to 100 m (328 ft) for small bird analyses.

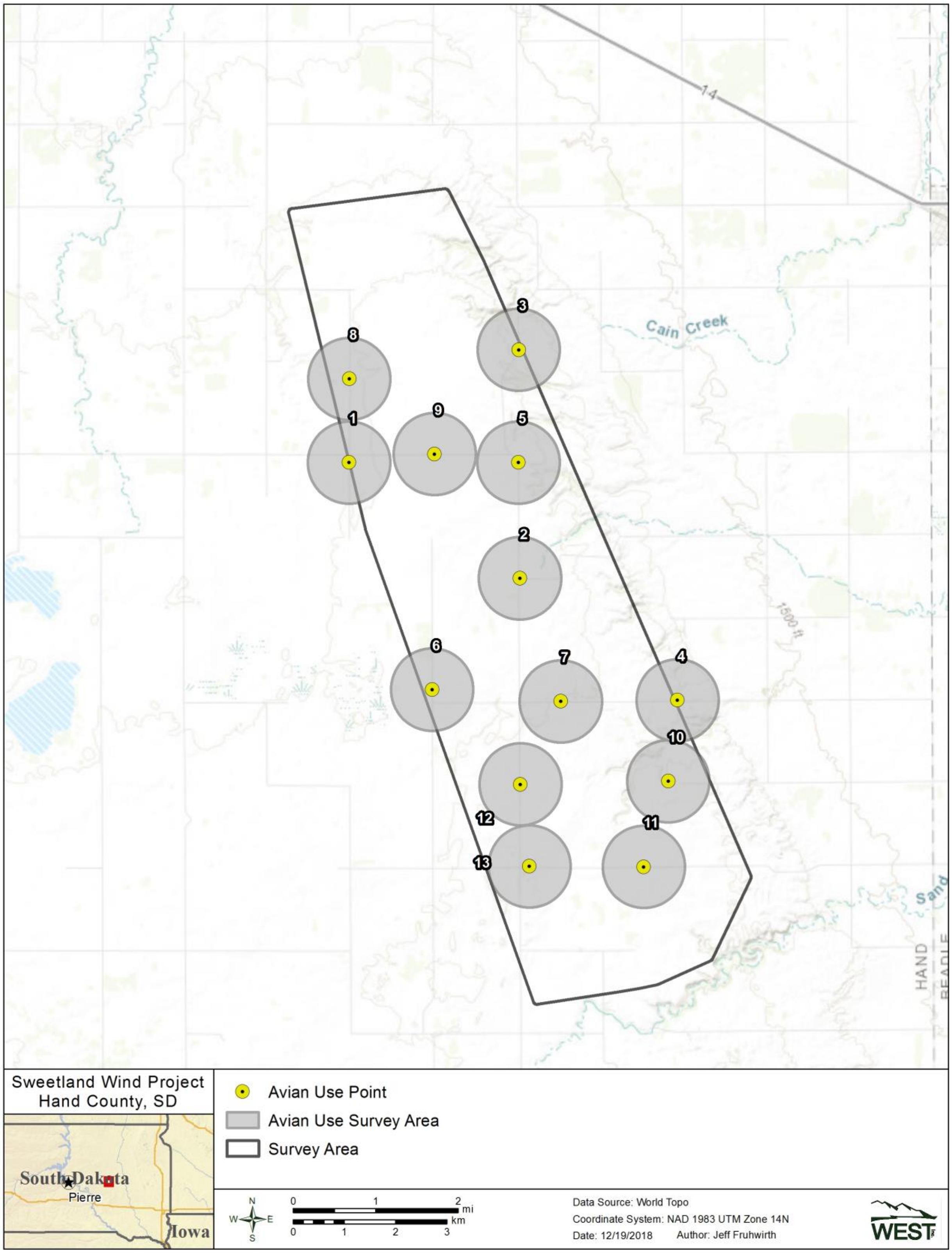

Figure 4. Location of fixed-point bird use survey stations at the Sweetland Wind Energy Project.

Survey Methods

Based on survey recommendations for eagles described in the ECPG (USFWS 2013) and final eagle rule (USFWS 2016), a 10-minute (min) fixed-point small bird use survey was conducted followed by a separate 60-min large bird survey. However, special status species, such as those that are federally endangered or threatened, South Dakota endangered, threatened, or species of greatest conservation need, were recorded for the full duration of the 70-min survey, but were considered incidental general wildlife observations if not recorded during their respective surveys (i.e., large birds or eagles recorded during the 10-min small bird survey, or small birds recorded during the 60-min large bird survey). All bird observations recorded during fixed-point bird use surveys were assigned a unique observation number.

The date, start and end time of each survey period, and weather information (e.g., temperature, wind speed, wind direction, and cloud cover) were recorded for each survey. Species or best possible identification, number of individuals, sex and age class (if identifiable), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded for each observation. Bird behavior and habitat type were recorded based on the point of first observation. Approximate flight height and distance from plot center were recorded to the nearest 5-m (16-ft) interval. Other information recorded about the observation included whether or not the observation was auditory only. Consistent with the ECPG, eagle observations were recorded on a per-min basis.

Locations of diurnal raptors, other large birds, and special status species observed during fixed-point bird use surveys were recorded on field maps by unique observation number. Topographic maps, aerial photographs, binoculars, and a rangefinder were used to aid in recording locations of observations as accurately as possible. Flight paths and perched locations were digitized using geographic information system (GIS) software, ArcGIS 10.3.1. Comments were recorded in the comments section of the datasheet.

Observation Schedule

Sampling intensity was designed to document bird use and behavior by habitat and season within the Survey area. Fixed-point bird use surveys were conducted from May 26, 2017, through April 28, 2018. Surveys were conducted on a monthly basis and each sampling station received one survey a month, to the extent possible (although weather influenced the ability to access all of the stations on a few occasions). Seasons were defined as summer (May 16 to July 31), fall (August 30 to November 15), winter (November 16 to March 15), and spring (March 16 to May 15). Surveys were carried out during daylight hours and survey periods varied to cover approximately all daylight hours during a season.

Prairie Grouse Surveys

During the spring of 2018, WEST conducted aerial and ground based surveys for prairie grouse (greater prairie chicken [*Tympanuchus* cupido] and sharp-tailed grouse [*Tympanuchus phasianellus*]) leks within the Survey area and surrounding 1-mile buffer. Aerial surveys utilized a helicopter and were conduct twice in the spring of 2018. Aerial surveys consisted of flying transects, oriented north/south spaced a quarter-mile apart, within the Survey area and surrounding one mile buffer. Follow-up ground based lek counts were conducted three times during the spring of 2018. To the extent possible all surveys, both aerial and ground were spaced at least seven days apart, were conducted from sunrise to 90-minutes post sunrise, and occurred on mornings that were calm and clear. All active lek locations were recorded by GPS coordinates. The date, time of each survey period, number of grouse observed and weather information (e.g., wind speed, wind direction, and precipitation) were recorded for each survey.

Vegetation/Habitat Mapping

Landcover and potential special status species habitat was mapped by a field biologist who drove around the site to visually assess landcover and topographic conditions from publicly-accessible roads. Private lands were accessed if permission was obtained. Landcover and potential habitat for special status species was identified and delineated on hardcopy maps with recent aerial imagery (NAIP). The mapped information was digitized in GIS so that it is available to view with facilities and other Project information.

General Wildlife Observations

General wildlife observations provide records of wildlife seen outside of the standardized surveys. All diurnal raptors, unusual or unique species, special status avian species, mammals, reptiles, and amphibians were recorded. Special status species include Species of Greatest Conservation Need (SGCN) as identified in the 2014 *South Dakota State Wildlife Action Plan* (SWAP; South Dakota Game, Fish, and Parks [SDGFP 2014]) and SDGFP and species listed as threatened or endangered under the federal Endangered Species Act of 1973 (ESA; 16 US Code [USC] 1531-1599]), Bald and Golden Eagle Protection Act of 1940 (BGEPA; 16 USC 668-668c [1940]) or Migratory Bird Treaty Act of 1918 (MBTA; 16 USC 703-712 [1918]). The observation number, date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species) and habitat were recorded. The location of special status species was recorded by Universal Transverse Mercator coordinates using a hand-held Global Positioning System unit. General wildlife observations were not a systematic sampling of the Survey area, but provided documentation of unique species that were observed within the Survey area and provided a record of the location and type of habitat the species potentially occur within (i.e., topographic or habitat associations).

Statistical Analysis

For analysis purposes, a visit was defined as a survey of all of the plots once within the Survey area. Visits were assigned according to the following criteria: 1) a single visit had to be completed in a single season, and 2) a visit could be spread across multiple dates. Under certain circumstances, such as extreme weather conditions, plots were not surveyed during some visits. In these cases, a visit might not have constituted a survey of all plots.

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, observers were responsible for inspecting data forms for completeness, accuracy, and legibility. Potentially erroneous data was identified using a series of database queries. Irregular codes or data suspected as questionable were discussed with the observer or Project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

Data Compilation and Storage

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

Fixed-Point Bird Use Surveys

Each metric described below was calculated separately for fixed-point large bird use surveys and fixed-point small bird use surveys.

Bird Diversity and Species Richness

Bird diversity was illustrated by the total number of unique species observed. Species lists (with the number of observations and the number of groups) were generated by season and included all observations of birds detected, regardless of their distance from the observer. Species richness was estimated using only birds observed within the study viewshed. Species richness was calculated by first averaging the total number of species observed within each plot during a visit, then averaging across plots within each visit, followed by averaging across visits within the season. Overall species richness was calculated as a weighted average of seasonal values by the number of days in each season. Species diversity and richness were compared among seasons for large and small birds.

Bird Use, Percent of Use, and Frequency of Occurrence

For the standardized, fixed-point large bird use estimates, large birds detected within the 800-m radius plot at any time during the 60-min survey were used in the analysis. For the standardized, fixed-point small bird use estimates, small birds recorded within a 100-m radius at any time during the 10-min survey were included. The metric used to measure mean bird use was number of birds per plot per survey. These standardized estimates of mean bird use were used to compare differences between bird types, seasons, survey plots, and other studies where similar methods were used. Mean use by season was calculated by first summing the total number of birds seen within each plot during a visit, then averaging across plots within each visit, followed by averaging across visits within the season. Overall mean use was calculated as a weighted average of seasonal values by the number of days in each season.

Exposure to Project infrastructure is affected by how much a species utilizes an area (percent of use), as well as how often use occurs (frequency of occurrence). Frequency of occurrence and percent of use provide relative measures of species exposure to the proposed Project. Percent of use was calculated as the proportion of mean large or small bird use that was attributable to a particular bird type or species. Frequency of occurrence was calculated as the percent of surveys in which a particular bird type or species was observed. For example, flocks of waterfowl, waterbirds, and shorebirds can comprise several hundred, a thousand, or tens of thousands of individual birds, which would result in a relatively high percentage of use. However, examining the percent of use alone would not account for the acute exposure to the Project associated with a comparatively small number of relatively large flocks (a relatively low frequency of occurrence). A relatively high percent of use may indicate that a species has higher exposure relative to other species, but when the exposure is acute, the species may be less likely to be adversely affected by a proposed project. Conversely, a species that has a relatively low percentage of use, but a relatively high frequency of occurrence would have long-term exposure to the Project, increasing the likelihood that this species may be affected by the Project. Exposure to Project infrastructure is more accurately assessed by evaluating both percent of use and frequency of occurrence.

Bird Flight Height and Behavior

Bird flight heights are important metrics to assess when evaluating potential exposure. Flight height information was used to calculate the percentage of birds observed flying within the rotor-swept height (RSH) for turbines likely to be used at the Project. The flight height recorded during the initial observation was used to calculate the percentage of birds flying within the RSH and mean flight height. The percentage of individuals flying within the RSH at any time was calculated using the lowest and highest flight heights recorded. A RSH for potential collision with a turbine blade of 25-150 m (82-492 ft) AGL was used for the analyses.

Bird Exposure Index

The bird exposure index is used as a relative measure of how often birds fly at heights similar to blades of modern wind turbines. A relative index of bird exposure (R) was calculated for bird species observed during the fixed-point bird use surveys using the following formula:

$$R = A*P_f*P_t$$

where A equals mean relative use for species *i* (large bird observations within 800 m of the observer or 100 m for small birds) averaged across all surveys, P_f equals the proportion of all observations of species *i* where activity was recorded as flying (an index to the approximate percentage of time species *i* spends flying during the daylight period) and P_t equals the proportion of all initial flight height observations of species *i* within the likely RSH.

Spatial Use

Large bird flight paths were qualitatively compared to Survey area characteristics (e.g., topographic features, landuse/landcover, and/or concentrated prey resources). The objective of mapping observed large bird locations and flight paths was to identify areas of concentrated use by eagles, diurnal raptors and other large birds and consistent flight patterns within the Survey area.

RESULTS

Fixed-point bird use surveys were conducted within the Survey area from May 26, 2017, through April 28, 2018. Eighty-eight bird species and two mammal species were identified during the first year of baseline studies.

Fixed-Point Large Bird Use Surveys

A total of 153 60-min fixed-point large bird use surveys were conducted within the Survey area (Table 2). An 800-m viewshed was utilized when calculating species richness, use, percent composition, percent frequency, and exposure index for fixed-point large bird use surveys. It should be noted that a March snowstorm restricted land access to portions of the Survey area during the spring season and as a result, three out of the initially planned 39 surveys were missed during the spring season.

Table 2. Summary of large bird species richness (species/800-meter plot/60-minute survey) and unique species, by season and overall, during the fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Season	Number of Visits	# Surveys Conducted	# Unique Species	Species Richness
Spring*	3	36	28	3.55
Summer	3	39	20	2.72
Fall	3	39	14	1.74
Winter	3	39	5	0.28
Overall	**12**	**153**	**43**	**2.08**

***** a March snowstorm resulted in three missed surveys for the spring season.

Bird Diversity and Species Richness

Forty-three unique large bird species were observed over the course of all fixed-point large bird use surveys (Table 2). Large bird diversity (the number of unique species observed) was highest in the spring, followed by summer (28 and 20 species; respectively). Fourteen unique species were observed during the fall, while five unique species were observed in the winter. Large bird species richness (mean number of species per plot per survey) was 3.55 species/800-m plot/60-min survey in the spring, followed by 2.72 in the summer, 1.74 in the fall and 0.28 in the winter (Table 2). A mean of 2.08 large bird species/800-m plot/60-min survey was observed throughout the year (Table 2).

Irrespective of distance, 53,214 large birds observations were recorded within 526 separate groups (defined as one or more individual) during the fixed-point large bird use surveys (Appendix A1). One species, snow goose (*Chen caerulescens*), accounted for 80.4% (42,793 observations) of all large bird observations. A total of 106 diurnal raptors were observed in 97 groups, representing 10 identifiable species. Several diurnal raptor species were observed during the first year of baseline studies with the most abundant diurnal raptors being red-tailed hawk (*Buteo jamaicensis;* 71 observations), and northern harrier (*Circus cyaneus*; 19; Appendix A1).

Large Bird Use, Percent of Use, and Frequency of Occurrence

Mean large bird use, percent of use, and frequency of occurrence were calculated by season for all bird types (Table 3) and species (Appendix B1). Large bird use was highest during the spring (1,246.57 birds/800-m plot/60-min survey) followed by winter (110.08), fall (85.82), and summer (49.72; Table 3). The relatively high large bird use in the spring was influenced by waterfowl use (1,211.52 birds/800-m plot/60-min survey; Table 3, Appendix B1).

Table 3. Mean bird use (number of birds/800-meter plot/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and raptor subtype by season during the fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Waterbirds	32.74	0.05	1.44	0	2.6	0.1	1.7	0	44.1	5.1	10.3	0
Waterfowl	1,211.52	5.36	1.64	109.69	97.2	10.8	1.9	99.7	83.1	15.4	10.3	7.7
Shorebirds	0.59	0.85	1.38	0	<0.1	1.7	1.6	0	23.1	38.5	10.3	0
Gulls/Terns	0.49	39.82	79.03	0	<0.1	80.1	92.1	0	15.1	25.6	23.1	0
Diurnal Raptors	0.68	0.72	1.15	0.15	<0.1	1.4	1.3	0.1	47.4	46.2	56.4	7.7
Buteos	0.15	0.46	0.51	0	<0.1	0.9	0.6	0	15.4	35.9	25.6	0
Northern Harrier	0.13	0.05	0.31	0	<0.1	0.1	0.4	0	7.7	5.1	20.5	0
Eagles	0.15	0.03	0	0.15	<0.1	<0.1	0	0.1	12.6	2.6	0	7.7
Falcons	0.03	0.05	0.08	0	<0.1	0.1	<0.1	0	2.6	5.1	5.1	0
Other Raptors	0.22	0.13	0.26	0	<0.1	0.3	0.3	0	16.9	10.3	23.1	0
Vultures	0.08	0.56	0.54	0	<0.1	1.1	0.6	0	5.1	20.5	12.8	0
Upland Game Birds	0.45	0.74	0.41	0.23	<0.1	1.5	0.5	0.2	19.5	30.8	12.8	10.3
Doves/Pigeons	0.03	1.51	0.23	0	<0.1	3	0.3	0	2.6	64.1	12.8	0
Large Corvids	0	0.05	0	0	0	0.1	0	0	0	2.6	0	0
Goatsuckers	0	0.05	0	0	0	0.1	0	0	0	2.6	0	0
Overall Large Birds*	**1,246.57**	**49.72**	**85.82**	**110.08**	**100**	**100**	**100**	**100**				

* Sums may not total values shown due to rounding.

Waterbirds

Waterbirds were observed in summer, fall, and spring (Appendix A1). Waterbird use was the highest in spring (32.74 birds/800-m plot/60-min survey), followed by fall (1.44), and summer (0.05; Table 3) no waterbird observations were recorded during the winter season (Appendix A1). Five identifiable waterbird species were recorded during the first year of baseline studies: American white pelican (*Pelecanus erythrorhynchos*), double-crested cormorant (*Phalacrocorax auritus*), great blue heron (*Ardea herodias*), sandhill crane (*Antigone canadensis*), and white-faced ibis (*Plegadis chihi*; Appendix A1). Sandhill crane was the most commonly observed waterbird during the first year of studies within the Survey area (Appendix A1). Sandhill cranes were observed during the fall, and spring, and great blue heron was the most commonly observed waterbird in summer (Appendix A1). Sandhill crane use was highest in the spring (32.12 birds/800-m/60-min survey) followed by fall (1.26; Appendix B1). Sandhill crane use accounted for 97.6% of the waterbird observations during the spring season (1,014 observations in 21 groups; Appendix A1). Great blue heron had the highest use in summer with 0.05 birds/800-m/60-min survey (Appendix B1). Waterbirds accounted for 2.6% of large bird use during the spring, followed by 1.7% of large bird use in the fall, and 0.1% of large bird use in summer (Table 3, Appendix B1). Waterbirds were observed during 44.1% of spring surveys, 10.3% of fall surveys, and 5.1 % of summer surveys (Table 3, Appendix B1).

Waterfowl

Waterfowl were observed in all four seasons (Appendix A1). Waterfowl use was the highest in spring (1,211.51 birds/800-m plot/60-min survey), followed by winter (109.69), summer (5.36) and fall (1.64; Table 3). Ten identifiable waterfowl species were recorded during the first year of baseline studies: Canada goose (*Branta canadensis*), common goldeneye (*Bucephala clangula*), gadwall (*Anas strepera*), greater white-fronted goose (*Anser albifrons*), green-winged teal (*Anas crecca*), mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), northern shoveler (*Anas clypeata*), ruddy duck (*Oxyura jamaicensis*), and snow goose (Appendix A1). Canada goose and snow goose were the most commonly observed waterfowl species during the first year of studies within the Survey area (Appendix A1). Snow goose was observed during spring and winter (Appendix A1) and use was highest during the spring (1,159.8 birds/800-m/60-min survey; Appendix B1). Canada goose was observed during the spring, summer, and fall (Appendix A1). Canada goose use was highest in the spring (34.85 birds/800-m/60-min survey), followed by fall and summer (1.31 and 0.03 respectively; Appendix B1). Waterfowl accounted for 99.7% of large bird use during the winter, followed by 97.2% of large bird use in the spring, 10.8% of large bird use in summer, and 1.9% of large bird us in the fall (Table 3, Appendix B1). The higher use of waterfowl during the spring and winter was influenced by relatively large flocks of snow geese: 40,915 observations in 63 groups during the spring season and 1,878 observations in six groups during the winter. In addition, 2,400 unidentified geese were observed in three groups during the winter (Appendix A1). Waterfowl were observed during 83.1% of spring surveys, 15.4% of summer surveys, 10.3 % of fall surveys, and 7.7% of winter surveys (Table 3, Appendix B1).

Shorebirds

Shorebirds were observed in spring, summer, and fall, with no observations recorded in winter (Appendix A1). Shorebird use was the highest in fall (1.38 birds/800-m plot/60-min survey), followed by summer (0.85) and spring (0.59; Table 3). Four identifiable shorebird species were recorded during the first year of baseline studies: American avocet (*Recurvirostra americana*), killdeer (*Charadrius vociferus*), marbled godwit (*Limosa fedoa*), and upland sandpiper (*Bartramia longicauda*; Appendix A1). Of identifiable species, killdeer accounted for the highest use in summer (0.79 bird/800-m plot/60-min survey) and fall (1.38), and use by marbled godwit as highest in spring (0.31; Table 3, Appendix B1). Shorebirds accounted for 1.7% of large bird use during the summer, followed by 1.6% of large bird use in the fall and less than 0.1% of large bird use in spring (Table 3, Appendix B1). Shorebirds were observed during 38.5% of summer surveys, 23.1% of spring surveys, and 10.3 % of fall surveys (Table 3, Appendix B1).

Gulls/Terns

Gulls/terns were observed in spring, summer, and fall, with no observations recorded in winter (Appendix A1). Gull/tern use was the highest in fall (79.03 birds/800-m plot/60-min survey), followed by summer (39.82) and spring (0.49; Table 3). Four identifiable gull/tern species were recorded during the first year of baseline studies: black tern (*Chlidonias niger*), Bonaparte's gull (*Chroicocephalus philadelphia*), Franklin's gull (*Leucophaeus pipixcan*), and ring-billed gull (*Larus delawarensis*; Appendix A1). High use in summer was due to use by Bonaparte's gull (32.46 birds/800-m plot/60-min survey), while Franklin's gull had the highest use in fall (51.85) and ring-billed gull had the highest use in spring (0.46 Table 3, Appendix B1). Gulls/terns accounted for 92.1% of large bird use during the fall, followed by 80.1% of large bird use in the summer and less than 0.1% of large bird use in spring (Table 3, Appendix B1). The relatively high use by gulls/terns in summer and fall was influenced by 1,266 Bonaparte's gulls in 11 groups in summer and 2,022 Franklin's gulls in 19 groups in fall (Appendix A1). Gulls/terns were observed during 25.6% of summer surveys, 23.1% of fall surveys, and 15.1% of spring surveys (Table 3, Appendix B1).

Diurnal Raptors

Diurnal raptor use was highest in the fall (1.15 birds/800-m plot/60-min survey), followed by summer, spring, and winter (0.72, 0.68, and 0.15, respectively; Table 3, Appendix B1). Among buteos, red-tailed hawk had the highest use during fall, summer, and spring (0.46, 0.44, and 0.13 bird/800-m plot/60-min survey each season, respectively; Appendix B1). There were no buteo observations during the winter (Appendix A1). Northern harrier was observed in the spring, summer, and fall seasons, with highest use in the fall (0.31 bird/800-m plot/60-min survey), followed by spring and summer (0.13 and 0.05 respectively; Table 3, Appendix B1). Eagle use was highest in spring and winter (0.15 bird/800-m plot/60-m survey in both seasons), followed by summer (0.03; Table 3, Appendix B1); no observations were recorded during fall (Appendix A1). Bald eagle observations were reported in the winter and spring (Appendix A1) with the highest use in the spring (0.08 bird/800-m plot/60-m survey), followed by winter (0.03; Appendix B1) Golden eagle observations were reported in the summer and winter seasons (Appendix A1) with the highest use in the winter (0.13 bird/800-m plot/60-m survey), followed by summer (0.03; Appendix B1). Eagles accounted for less than 0.1% of large bird use in any season (Table 3; Appendix B1). Eagles were seen during 12.6% of spring surveys, 7.7% of winter surveys, and 2.6% of summer surveys. Among falcons, American kestrel (*Falco sparverius*) and merlin (*F. columbarius*) were the only falcon species observed in the fall (0.08 falcons/800-m plot/60 min survey, Appendix A1). Additionally, peregrine falcon (*F.* peregrinus) was only observed in the spring season and prairie falcon (*F. mexicanus*) was only observed in the summer season (Appendix A1), with use of 0.03 bird/800-m plot/60-min survey, each (Appendix B1). Falcon use was highest in fall (0.08 bird/800-m plot/60-m survey) followed by summer (0.05) and spring (0.03; Table 3, Appendix B1). Overall, diurnal raptors accounted for 1.4% of large bird use in the summer, followed by fall (1.3%), winter (0.1%) and spring (less than 0.1%). Diurnal raptors were observed during 56.4% of fall surveys, 47.4% of spring surveys, 46.2% of summer surveys, and 7.7% of the winter surveys (Table 3, Appendix B1).

Vultures

Vultures were observed in spring, summer, and fall, with no observations recorded in winter (Appendix A1). Vulture use was the highest in summer (0.56 bird/800-m plot/60-min survey), followed by fall (0.54) and spring (0.08; Table 3). Turkey vulture (*Cathartes aura*) was the only vulture species recorded during the first year of baseline studies (Appendix A1). Vultures accounted for 1.1% of large bird use during the summer, followed by 0.6% of large bird use in the fall and less than 0.1% of large bird use in spring (Table 3, Appendix B1). Vultures were observed during 20.5% of summer surveys, 12.8% of fall surveys, and 5.1% of spring surveys (Table 3, Appendix B1).

Upland Game Birds

Upland game birds were observed in all four seasons (Appendix A1). Upland game bird use was the highest in summer (0.74 bird/800-m plot/60-min survey), followed by spring (0.45), fall (0.41), and winter (0.23; Table 3). Five identifiable upland game bird species were recorded during the first year of baseline studies: gray partridge (*Perdix perdix*), greater prairie-chicken (*Tympanuchus cupido*), ring-necked pheasant (*Phasianus colchicus*), sharp-tailed grouse (*Tympanuchus phasianellus*), and wild turkey (*Meleagris gallopavo*). Ring-necked pheasant accounted for the highest use in all four seasons: summer (0.72 bird/800-m plot/60-min survey), spring (0.28), fall (0.41), and winter (0.18; Table 3, Appendix B1). Upland game birds accounted for 1.5% of large bird use during the summer, followed by 0.5% of large bird use in the fall, 0.2% in the winter, and less than 0.1% of large bird use in spring (Table 3, Appendix B1). Upland game birds were observed during 30.8% of summer surveys, 19.5% of spring surveys, 12.8% of fall surveys, and 10.3% of spring surveys (Table 3, Appendix B1).

Doves/Pigeons

Doves/pigeons were observed in spring, summer, and fall (Appendix A1). Dove/pigeon use was the highest in summer (1.51 bird/800-m plot/60-min survey), followed by fall (0.23), and spring (0.03; Table 3). Two dove/pigeon bird species were recorded during the first year of baseline studies: rock pigeon (*Columba livia*) and mourning dove (*Zenaida macroura*). Mourning dove accounted for the highest use in all three of the seasons that doves/pigeons were observed: summer (1.31 bird/800-m plot/60-min survey), fall (0.23), and spring (0.03; Table 3, Appendix B1). Doves/pigeons accounted for 3.0% of large bird use during the summer, followed by 0.3%

of large bird use in the fall, and less than 0.1% in the spring (Table 3, Appendix B1). Doves/pigeons were observed during 64.1% of summer surveys, 12.8% of fall surveys, and 2.6% of spring surveys (Table 3, Appendix B1).

Large Corvids

Large corvids were only observed in the summer season, and American crow (*Corvus brachyrhynchos*) was the only large corvid species recorded (Appendix A1). Use by large corvids during the summer season was 0.05 bird/800-m plot/60-min survey, which accounted for less than 0.1% of large bird use and large corvids were observed during 2.6% of summer surveys (Table 3, Appendix B1).

Goatsuckers

Goatsuckers were only observed in the summer, and common nighthawk (*Chordeiles minor*) was the only goatsucker species recorded (Appendix A1). Use during the summer season was 0.05 bird/800-m plot/60-min survey, which accounted for less than 0.1% of large bird use and goatsuckers were observed during 2.6% of summer surveys (Table 3, Appendix B1).

Bird Flight Height and Behavior

Flight height characteristics, based on initial flight height observations, were estimated for both large bird types and species (Tables 4 and 5). During fixed-point large bird use surveys, 453 groups of large birds were initially observed flying within the 800-m plot, totaling 53,052 observations (Table 4). Approximately 54.4% of flying large birds were initially recorded within the RSH, 7.2% were below the RSH, and 38.4% were flying above the RSH. Roughly half (48.4%) of flying diurnal raptors were initially observed within the RSH, while the other half 51.6% were below the RSH. Of the diurnal raptors, other raptors had the highest percentage of flying birds initially recorded within the RSH (70.0%), which was based on 20 observations within 19 groups, followed by buetos (61.5%), eagles and falcons (25.0%), and northern harriers (16.7%). Goatsuckers were initially recorded within the RSH during observations 100% of intial observations and Waterbirds 97.2% of initial observations. Vultures, Waterfowl, shorebirds, gulls/terns, and dove/pigeons were initially observed within the RSH 56.8%, 56.3%, 36.5%, 27.2% and 3.4% of the time. Upland game birds and large corvids were not observed in the RSH (Table 4). Of individual raptor species, prairie falcon was observed flying within the likely RSH during 100% of initial observations, but this is based on one group (Table 5, Appendix C1). Bald eagle (based on four groups), unidentified raptors, and red-tailed hawk were observed within the RSH during at least 60.0% of initial observations, followed by turkey vulture (*Cathartes aura*), Swainson's hawk (*Buteo swainsoni;* based on two groups), and rough-legged hawk (*Buteo lagopus*; based on two groups) during at least 50.0% of initial observations, and northern harrier during 16.7% of initial observations (Table 5, Appendix C1).

Table 4. Flight height characteristics for each large bird type and raptor subtype observed within an 800-meter radius during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% Within Flight Height Categories[a]		
					0 - 25 m	25 - 150 m[b]	>150 m
Waterbirds	31	1,094	86.68	99.8	2.7	97.2	0.2
Waterfowl	175	47,003	78.74	99.9	0.4	56.3	43.3
Shorebirds	26	74	7.27	67.3	63.5	36.5	0
Gulls/Terns	56	4,650	30.05	100	72.8	27.2	0
Diurnal Raptors	86	93	40.10	89.4	51.6	48.4	0
Buteos	*33*	*39*	*44.45*	*88.6*	*38.5*	*61.5*	*0*
Northern Harrier	*18*	*18*	*12.67*	*94.7*	*83.3*	*16.7*	*0*
Eagles	*12*	*12*	*36.67*	*100*	*75.0*	*25.0*	*0*
Falcons	*4*	*4*	*31.25*	*66.7*	*75.0*	*25.0*	*0*
Other Raptors	*19*	*20*	*62.58*	*87.0*	*30.0*	*70.0*	*0*
Vultures	21	44	52.86	95.7	40.9	56.8	2.3
Upland Game Birds	17	33	2.53	46.5	100	0	0
Doves/Pigeons	40	59	7.50	85.5	96.6	3.4	0
Large Corvids	0	0	0	0	0	0	0
Goatsuckers	1	2	80.00	100	0	100	0
Large Birds Overall	**453**	**53,052**	**51.48**	**99.7**	**7.2**	**54.4**	**38.4**

[a] Sums may not total values shown due to rounding.

[b] Based on current assumptions rotor-swept height for potential collision with a turbine blade, or 25-150 meters (82-492 feet) above ground level.

Obs = observations

Bird Exposure Index

A relative exposure index, based on initial flight height observations and relative abundance (defined as the use estimate), was calculated for each large bird species. Those species that had exposure to the RSH are listed in Table 5, and a complete list of all species is presented in Appendix C1. The exposure index does not account for other possible collision risk factors, such as foraging, courtship, or avoidance behavior. Amongst identifiable large birds, snow goose had the highest estimated exposure index value (159.59), followed by sandhill crane (8.19), Canada goose (8.08), northern pintail (1.71), and Franklin's gull (1.70). All other large bird species had estimated exposure indices less than one (Table 5, Appendix C1). Of diurnal raptors, red-tailed hawk had the highest estimated exposure index of 0.14, followed by bald eagle and northern harrier (0.02 for both species). Swainson's hawk, prairie falcon, and rough-legged hawk had estimated exposure indices of less than 0.01 (Table 5; Appendix C1).

Table 5. Relative exposure index and flight characteristics for large bird species[a] during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying Within RSH[b] Based on Initial Obs	Exposure Index	% Within RSH at Anytime
snow goose	68	304.22	100	52.5	159.59	89.4
unidentified goose	9	16.15	100	99.9	16.13	99.9
sandhill crane	24	8.41	100	97.4	8.19	100
Canada goose	32	9.12	97.2	91.2	8.08	91.4
unidentified gull	11	7.76	100	81	6.29	83.1
northern pintail	20	1.97	97.5	89	1.71	89.5
Franklin's gull	22	13.68	100	12.4	1.70	50.3
unidentified waterfowl	7	1.45	100	95.1	1.38	95.1
mallard	30	0.85	96.6	49.6	0.41	75.2
killdeer	15	0.55	63.5	50	0.17	51.9
turkey vulture	21	0.30	95.7	56.8	0.16	75
greater white-fronted goose	2	0.14	100	100	0.14	100
red-tailed hawk	29	0.26	87.5	62.9	0.14	74.3
ring-billed gull	11	0.23	100	51.5	0.12	66.7
white-faced ibis	2	0.10	100	100	0.1	100
unidentified raptor	19	0.15	87	70	0.09	80
common goldeneye	3	0.19	100	30.4	0.06	43.5
American white pelican	1	0.04	100	100	0.04	100
double-crested cormorant	2	0.04	100	83.3	0.03	83.3
bald eagle	4	0.03	100	75	0.02	100
northern harrier	18	0.12	94.7	16.7	0.02	22.2
common nighthawk	1	0.01	100	100	0.01	100
mourning dove	39	0.39	83.6	3.9	0.01	5.9
Swainson's hawk	2	0.01	100	50	<0.01	50
prairie falcon	1	<0.01	100	100	<0.01	100
unidentified duck	2	0.03	60	33.3	<0.01	33.3
great blue heron	1	0.02	33.3	100	<0.01	100
rough-legged hawk	2	0.01	100	50	<0.01	50

[a] Only includes species with exposure indices greater than zero; for full listing, see Appendix C1.

[b] Based on current development plans rotor-swept height (RSH) for potential collision with a turbine blade, or 25-150 meters (82- 492 feet) above ground level.

Obs = observations.

Eagle Flight Minutes

Golden eagle and bald eagle observations were recorded on a per minute basis following the ECPG. Irrespective of distance from observer, flight height, and including observations of perched birds, golden eagles were observed for 11 eagle minutes during the first year of surveys (Table 6a). Golden eagles were observed for six eagle minutes in the summer, and five eagle minutes in winter, and no golden eagle minutes were recorded during the fall and spring (Table 6a). Of the 11 total eagle minutes, golden eagles were observed flying within 800 m and below 200 m (656 ft) for 10 eagle risk minutes during the first year of fixed-point large bird use surveys (Table 6b). Golden eagles were observed flying within 800 m and below 200 m for five minutes in the summer and five minutes in the winter (Table 6b).

Table 6a. Summary of survey minutes and percentage of minutes golden eagles were observed during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Season	Total Minutes of Eagle Observations	Total Survey Minutes	Eagle Minutes per Observation Hour
Spring*	0	2,160	0
Summer	6	2,340	0.15
Fall	0	2,340	0
Winter	5	2,340	0.13
Overall	**11**	**9,180**	**0.07**

***** a March snowstorm resulted in three missed surveys for the spring season.

Table 6b. Summary of survey minutes and percentage of eagle risk minutes golden eagles were observed during fixed-point large bird use surveys (restricted to those minutes where the eagle was observed flying within 800 meters of the point and below 200 meters) at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Season	Total Minutes of Eagle Observations (Excludes Perched Birds)	Total Survey Minutes	Eagle Risk Minutes per Observation Hour
Spring*	0	2,160	0
Summer	5	2,340	0.13
Fall	0	2,340	0
Winter	5	2,340	0.13
Overall	**10**	**9,180**	**0.07**

***** a March snowstorm resulted in three missed surveys for the spring season.

Irrespective of distance from observer, flight height, and including observations of perched birds, bald eagles were observed for 61 eagle minutes during the first year of surveys (Table 7a). Bald eagles were observed for 56 eagle minutes in the spring, and five eagle minutes in the winter, no bald eagle minutes were recorded in the summer or fall (Table 7a). Bald eagles were observed flying within 800 m and below 200 m for 16 eagle risk minutes during the first year of fixed-point large bird use surveys (Table 7b). Bald eagles were observed flying within 800 m and below 200 m for 11 minutes in the spring and five minutes in the winter (Table 7b).

Table 7a. Summary of survey minutes and percentage of minutes bald eagles were observed during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Season	Total Minutes of Eagle Observations	Total Survey Minutes	Eagle Minutes per Observation Hour
Spring*	56	2,160	1.56
Summer	0	2,340	0
Fall	0	2,340	0
Winter	5	2,340	0.13
Overall	**61**	**9,180**	**0.40**

*** =** a March snowstorm resulted in 3 missed surveys for the spring season.

Table 7b. Summary of survey minutes and percentage of minutes bald eagles were observed flying during fixed-point large bird use surveys (restricted to those minutes where the eagle was flying within 800 meters of the point and below 200 meters) at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Season	Total Minutes of Eagle Observations (Excludes Perched Birds)	Total Survey Minutes	Eagle Risk Minutes per Observation Hour
Spring*	11	2,160	0.31
Summer	0	2,340	0
Fall	0	2,340	0
Winter	5	2,340	0.13
Overall	**16**	**9,180**	**0.10**

*** =** a March snowstorm resulted in 3 missed surveys for the spring season.

Irrespective of distance from observer, flight height, and including observations of perched birds, unidentified eagles were observed for four eagle minutes during the first year of surveys (Table 8a). Unidentified eagles were observed for four eagle minutes in the spring and were not recorded other seasons (Table 8a). All of the recorded unidentified eagle minutes were observed flying within 800 m and below 200 m, resulting in four unidentified eagle risk minutes, during the first year of fixed-point large bird use surveys (Table 8b).

Table 8a. Summary of survey minutes and percentage of minutes unidentified eagles were observed flying during fixed-point large Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Season	Total Minutes of Eagle Observations	Total Survey Minutes	Eagle Minutes per Observation Hour
Spring*	4	2,160	0.11
Summer	0	2,340	0
Fall	0	2,340	0
Winter	0	2,340	0
Overall	**4**	**9,180**	**0.03**

*** =** a March snowstorm resulted in 3 missed surveys for the spring season.

Table 8b. Summary of survey minutes and percentage of minutes unidentified eagles were observed flying during fixed-point large bird use surveys (restricted to those minutes where the eagle was observed flying within 800 meters of the point and below 200 meters) at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Season	Total Minutes of Eagle Observations (Excludes Perched Birds)	Total Survey Minutes	Eagle Risk Minutes per Observation Hour
Spring*	4	2,160	0.11
Summer	0	2,340	0
Fall	0	2,340	0
Winter	0	2,340	0
Overall	**4**	**9,180**	**0.03**

*** =** a March snowstorm resulted in 3 missed surveys for the spring season.

Spatial Use

Spatial use by large bird type across the 13 avian use points within the Survey area are presented in Appendices D1 and D3. Spatial use is visually depicted using bubble plots of mean use values for each major bird type and for diurnal raptor subtypes (Appendix D3). In addition, Figures 5, 6, and 7 illustrate spatial use for large birds, diurnal raptors, and eagles, respectively, across the Survey area.

For all large bird species combined, use was highest at survey points 3, 2, and 5 (1,117.00, 785.50, and 636.67 birds/60-min survey, respectively; Figure 5, Appendix D1). Large bird use ranged from 20.55 to 446.25 birds/60-min survey at the remaining survey plots. The relatively higher use estimates recorded at points 3, 2, and 5 were due to waterfowl use (1,099.58, 752.17, and 631.58 birds/60-min survey, respectively; Appendix D1).

Diurnal raptor use was distributed among most survey points. Diurnal raptor use ranged from 0.33 bird/60-min survey at points 2 and 3, to 1.33 at Point 1 (Figure 6, Appendices D1 and D3). Among diurnal raptor subtypes, buteos were the most widespread across the Survey area, with observations recorded all 13 survey points. Use by buteos ranged from 0.08 bird/60-min survey at survey points 2 and 10, to 0.83 birds/60-min survey at Point 1 (Appendix D1). Northern harrier was observed at eight of the survey points, and eagles were observed at seven of the survey points. At points where northern harriers were recorded, northern harrier use ranged from 0.08 bird/60-min survey at survey points 4, 5, and 7, to 0.45 birds/60-min survey at Point 11. For survey points where eagles were recorded, eagle use ranged from 0.08 bird/60-min survey at points 1, 7, 12, and 13, to 0.25 birds/60-min survey at Point 10 (Figure 7, Appendix D1). Falcon use was recorded at four survey points and use by falcons at those points ranged from 0.08 to 0.18 bird/60-min survey.

Flight paths and perch locations for waterbirds, waterfowl, shorebirds, gulls/terns, diurnal raptors and diurnal raptor subtypes, vultures, upland game birds, and goatsuckers were digitized and mapped (Appendix E).

While overall large bird use and diurnal raptor use is scattered throughout the Survey area, use appears to be higher in the northern portion of the Survey area. For eagles, points without use were scatted throughout the Survey area; however, there were more points at which eagles were not observed in the northern portion of the Survey area. While hard to discern given the scale of the figures, eagle flight paths generally appear to be associated with survey plots that offered greater topographic variability, primarily drainages that run through the Survey area (Figures 7 and 8).

While waterfowl use is scattered throughout the Survey area, higher use appears to occur near survey plots that are associated with riparian areas, with three survey plots, numbers two, three and five in the central/eastern portion of the Survey area having higher use than other points (Appendix D). Similarly waterbird use is scattered throughout the Survey area with no discernable patterns associated with their use of the Survey area, though survey plot number 10 does have higher use compared to all other points.

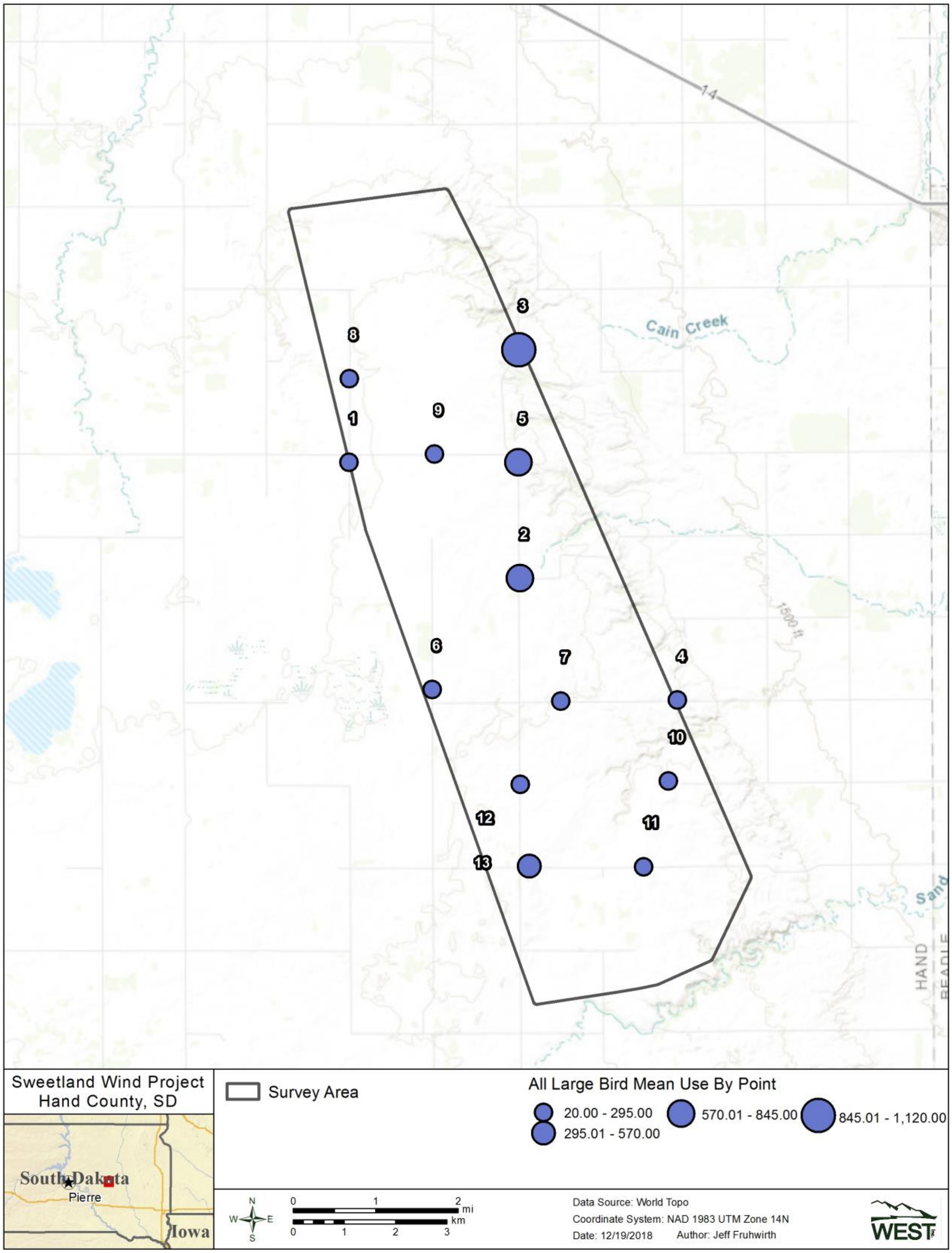

Figure 5. Large bird use by point recorded during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 - April 28, 2018.

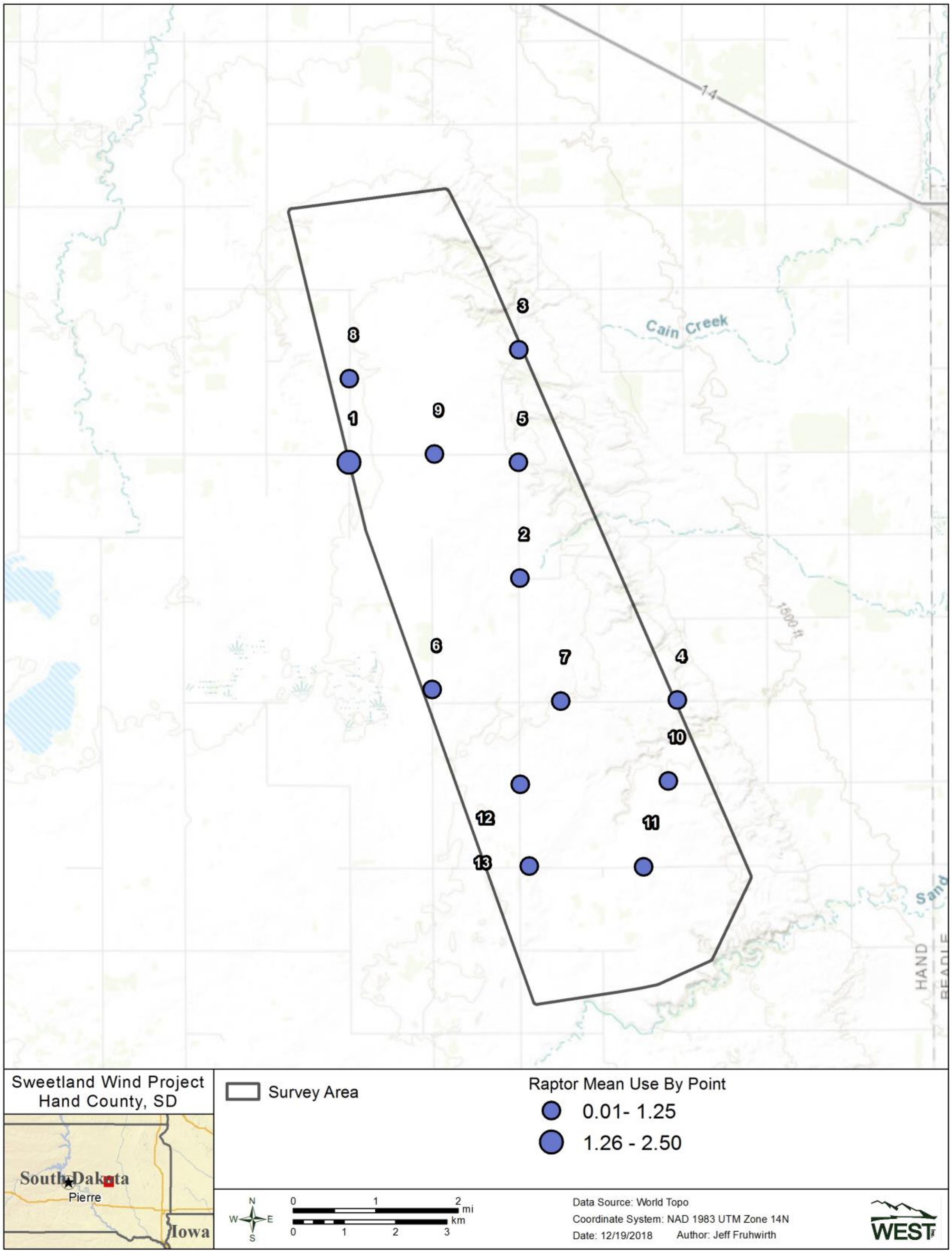

Figure 6. Diurnal raptor use by point recorded during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

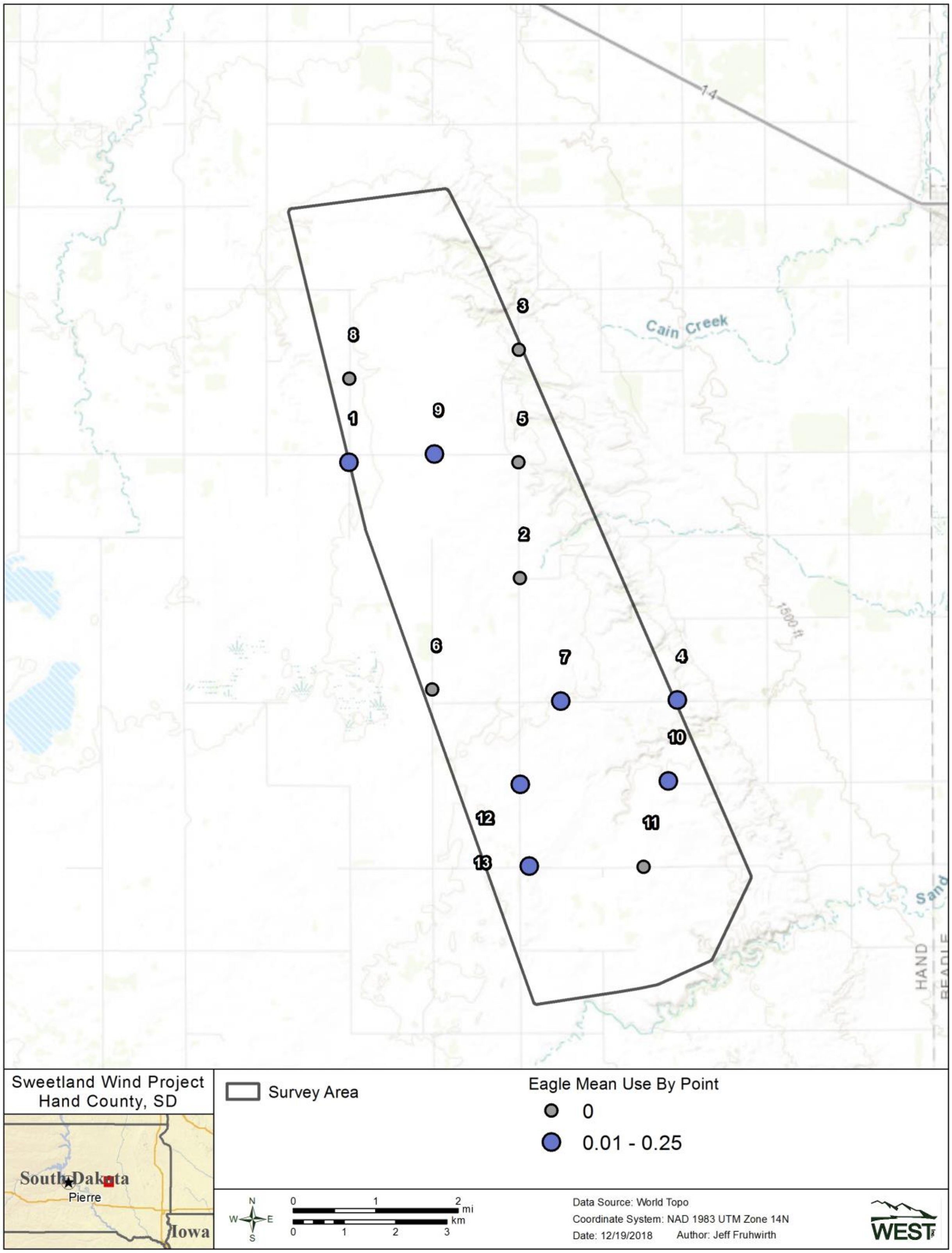

Figure 7. Eagle use by point recorded during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2018 – April 28, 2018.

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Fixed-Point Small Bird Use Surveys

A total of 153 10-min fixed-point small bird use surveys were conducted within the Survey area (Table 9). A 100-m viewshed was utilized when calculating species richness, use, percent composition, percent frequency, and exposure index for small bird use surveys.

Table 9. Summary of species richness (species/100-meter plot/10-minute survey) and unique species, by season and overall, during the fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Season	Number of Visits	# Surveys Conducted	# Unique Species	Species Richness
Spring*	3	36	28	2.67
Summer	3	39	28	3.23
Fall	3	39	13	1.13
Winter	3	39	5	0.36
Overall	**12**	**153**	**42**	**1.86**

***** a March snowstorm resulted in three missed surveys for the spring season.

Bird Diversity and Species Richness

Forty-two unique small bird species were observed over the course of the fixed-point small bird use surveys (Table 9). Small bird diversity (the number of unique species observed) was highest in both the summer and spring (28 species each) followed by fall, and winter (13, and five species, respectively; Table 9). Small bird species richness (mean number of species per plot per survey) was highest in summer, followed by spring (3.23 and 2.67 species/100-m plot/10-min survey, respectively), and lower in fall and winter (1.13 and 0.36, respectively). A mean of 1.86 small bird species/100-m plot/10-min survey was observed throughout the first year of baseline studies (Table 9).

Irrespective of distance from observer, a total of 1,642 small bird observations were recorded within 363 separate groups (defined as one or more individual) during the fixed-point small bird use surveys (Appendix A2). Barn swallow (*Hirundo rustica*) accounted for 7.6% of all small bird observations, red-winged blackbird (*Agelaius* phoeniceus), and house sparrow (*Passer domesticus*) each accounted for 5.5%. Among other identified small bird species, cliff swallow (*Petrochelidon pyrrhonota;* 75 observations; 4.6% of small birds) was the next most commonly recorded species (Appendix A2). Unidentified birds accounted for 659 observations and 40.1% of all small birds recorded, with 450 of the 659 unidentified small bird observations in one group and another 153 unidentified small bird observations in four groups (91.5% of the unidentified small bird observations were recorded in five large groups).

Small Bird Use, Percent of Use, and Frequency of Occurrence

Mean small bird use, percent of use, and frequency of occurrence were calculated by season for all bird types (Table 10) and species (Appendix B2). A 100-m viewshed and 10-min survey duration were used for small birds; therefore, descriptive statistics for small bird types are not directly comparable to large bird types. Passerines were the only identified small bird types observed.

Table 10. Mean small bird use (number of birds/100-meter plot/10-minute survey), percent of total use (%), and frequency of occurrence (%) for each small bird type by season during the fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Passerines	5.67	9.15	3.90	4.64	87.2	96.2	20.6	85.0	90.0	92.3	43.6	23.1
Unidentified Birds	0.83	0.36	15.05	0.82	12.8	3.8	79.4	15.0	6.7	20.5	38.5	12.8
Overall Small Birds	**6.51**	**9.51**	**18.95**	**5.46**	**100**	**100**	**100**	**100**				

Passerines

Passerine use was higher in the summer (9.15 birds/100-m plot/10-min survey) than in the other seasons: spring (5.67), winter (4.64), and fall (3.90; Table 10, Appendix B2). Cliff swallow accounted for 14.0% of use in the summer, while house sparrow accounted for 26.3% of small bird use in winter, and 3.5% in spring. Red-wing blackbird accounted for 17.7% of small bird use in spring, and 9.2% of small bird use in summer (Appendix B2). Other passerines commonly observed during surveys included horned lark (*Eremophila alpestris*), which accounted for 25.8% of small bird use in winter (Appendix B2). Passerines were observed during 92.3% of summer surveys, 90.0% of spring surveys, 43.6% of fall surveys, and 23.1% of surveys in winter (Table 10, Appendix B2).

Unidentified Birds

Three relatively large flocks of unidentified small birds including 558 observations influenced the relatively high fall use value for unidentified birds (Appendix A2)

Bird Flight Height and Behavior

Flight height characteristics, based on initial flight height observations and estimated use, were estimated for both small bird types and species (Tables 11 and 12). During fixed-point small bird use surveys, 189 groups of small birds were initially observed flying within the 100-m plot, totaling 1,241 observations (Table 11). Overall, 45.0% of flying small birds were initially recorded within the RSH during initial observation, and 55.0% were initially flying below the RSH. There were no small birds initially recorded above the RSH (Table 11). Among small bird species, only American goldfinch (*Spinus tristis;* 36.4%), American robin (*Turdus migratorius;* 9.1%), and red-winged blackbird (50.0%) were recorded flying within the RSH based on initial observations (Table 12).

Table 11. Initial flight height characteristics for each small bird type observed within a 100-meter (m) radius plot during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% within Flight Height Categories		
					0 - 25 m	25 - 150 m[a]	>150 m
Passerines	167	620	4.44	68.7	96.5	3.5	0
Unidentified Birds	22	621	21.23	94.4	13.7	86.3	0
Small Birds Overall	**189**	**1,241**	**6.39**	**79.6**	**55.0**	**45.0**	**0**

[a.] Based on current development plans rotor-swept height for potential collision with a turbine blade, or 25 – 150 m (82 – 492 feet) above ground level

Bird Exposure Index

A relative exposure index based on initial flight height observations and relative abundance (defined as the use estimate) was calculated for each small bird species. Those small bird species that had exposure to the RSH are listed in Table 11, and a complete list of all species is presented in Appendix C2. The exposure index does not account for other possible collision risk factors, such as foraging, courtship, or avoidance behavior. Among small birds species, American goldfinch, American robin, and red-winged blackbird had exposure indices higher than zero (Table 12, Appendix C2).

Table 12. Relative exposure index and flight characteristics for small bird species[a] observed within the 100-meter (m) radius plot during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying Within RSH[b] Based on Initial Obs	Exposure Index	% Within RSH at Anytime
American goldfinch	9	0.1	73.3	36.4	0.03	36.4
American robin	14	0.18	81.5	9.1	0.01	9.1
red-winged blackbird	23	0.51	65.8	1.9	<0.01	1.9

[a] Only includes species with exposure indices greater than zero; for full listing, see Appendix C2.

[b] Based on current development plans rotor-swept height (RSH) for potential collision with a turbine blade, or 25-150 m (82-492 feet) above ground level.

Obs = observations.

Spatial Use

Similar to large birds, spatial use of small birds is visually depicted using bubble plots of mean use values for small birds (Figure 8; Appendices D2 and D4), and use values for each point are provided in Appendix D2. Small birds were observed at all survey points (Figure 8). Small bird use was highest at survey Point 1 (41.92 birds/100-m plot/10-min survey), followed by survey points 12, 2, and 8 (18.00, 14.08, and 12.09, respectively; Appendix D2). Small bird use among other points ranged from 2.33 birds/100-m plot/10-min survey at Point 4 to 9.42 birds/100-m plot/10-min survey at survey Point 7 (Figure 8, Appendix D2). Survey plots with higher small bird use tend to have shelterbelts nearby and open water resources.

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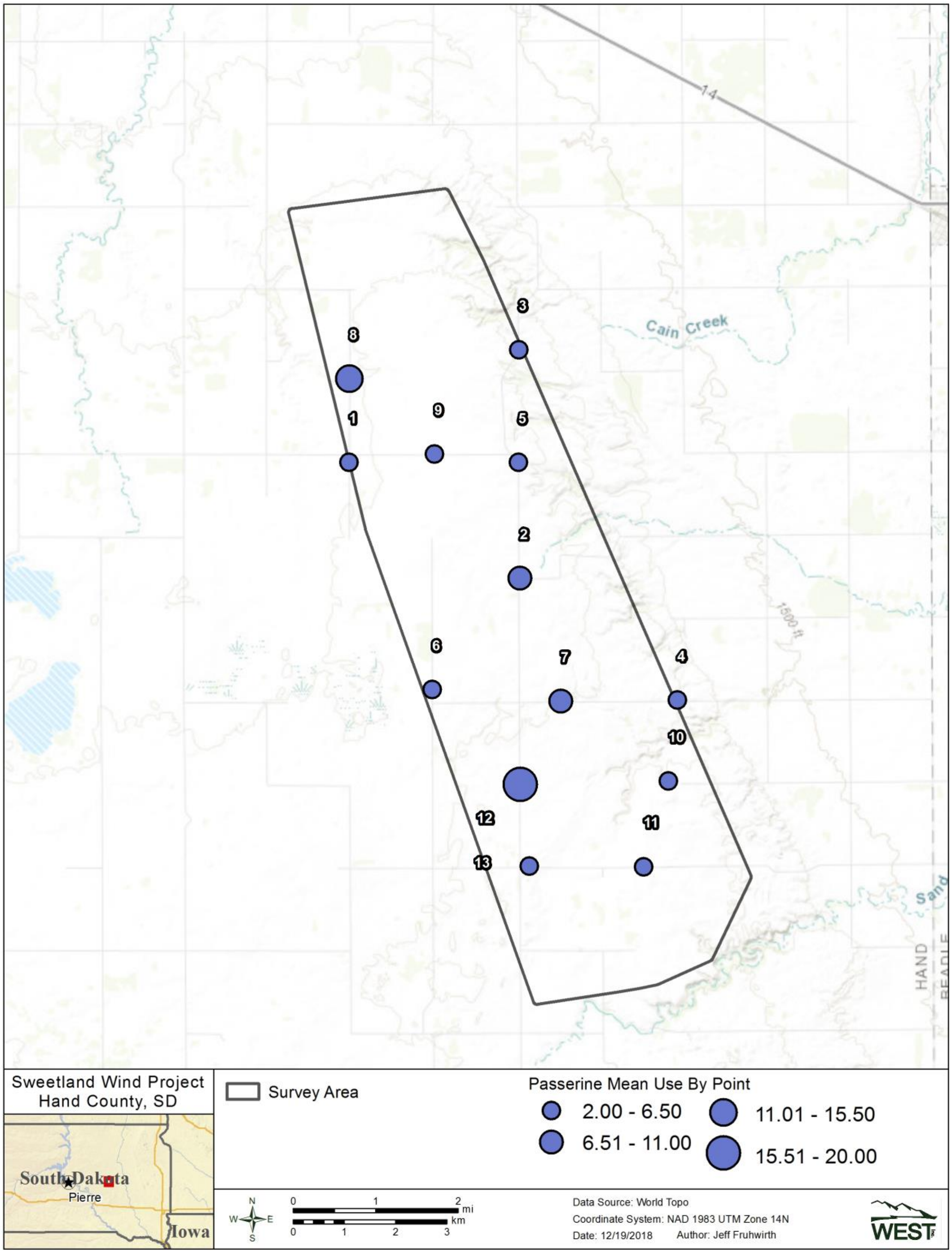

Figure 8. Passerine use by point recorded during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Prairie Grouse Surveys

One historic greater prairie chicken lek location occurs along the western edge of the Survey area and two additional historic lek locations (one greater prairie chicken and one sharp-tailed grouse), occur within the 1-mile buffer (Figure 9). Location information for historic leks was provided by SGDFP via email on 8/15/17. None of the historic leks were deemed to be active in 2018. On April 7, 2018, one unidentified grouse was observed flying adjacent to historic prairie chicken lek location number one. No other grouse were observed at this location during the second aerial survey and there were no grouse observed during the three ground counts at lek location number one (Table 13 and 14). On April 7, 2018, two unidentified grouse were observed flying adjacent to historic prairie chicken lek location number two (Table 13). No other grouse were observed at this location during the three ground counts (Table 13 and 14), No grouse were observed at historic sharp-tailed grouse lek location number three during the aerial surveys. Due to access constraints no ground counts were conducted at lek location number three (Table 14).

WEST biologists visually observed sharp-tailed grouse dancing/displaying at four new locations within the Survey area during the second round of aerial surveys (Table 13, Figure 9). Access issues limited the ability to conduct ground counts on one of the four newly identified displaying locations, but the location was surveyed twice via helicopter in 2018.

WEST biologists observed eight total sharp-tailed grouse at displaying grouse location 3 on April 17, 2018. Due to the aforementioned access constraints displaying grouse location 3 couldn't be surveyed from the ground. Displaying grouse location 1 had a maximum count of seven sharp-tailed grouse on April 29, 2018. Displaying grouse location 2 had a maximum count of 25 sharp-tailed grouse on April 28, 2018 and displaying grouse location 4 had a maximum count of 12 sharp-tailed grouse on April 29, 2018 (Table 13 and 14). No greater prairie chickens were observed during the 2018 surveys.

In accordance with SDGFP definitions for a lek the newly identified displaying grouse locations do not meet the criteria to be formally designated as a lek given only one year of data has been collected in the last five years.

Table 13. Summary of aerial counts of by sex on leks and newly identified displaying areas within the Sweetland Wind Energy Project and surrounding 1-mile buffer, spring of 2018.

Lek Name	Species	Survey One	# observed M	F	U	T	Survey Two	# observed M	F	U	T
Aerial Surveys											
Historic Lek 1	PC	4/7/2018	0	0	0	0	4/17/2018	0	0	0	0
Historic Lek 2	PC	4/7/2018	0	0	0	0	4/17/2018	0	0	0	0
Historic Lek 3	ST	4/7/2018	0	0	0	0	4/17/2018	0	0	0	0
Displaying Grouse Location 1	ST	-	-	-	-	-	4/16/2018	3	0	1	4
Displaying Grouse Location 2	ST	-	-	-	-	-	4/16/2018	6	5	3	14
Displaying Grouse Location 3	ST	-	-	-	-	-	4/17/2018	2	0	6	8
Displaying Grouse Location 4	ST	-	-	-	-	-	4/17/2018	6	5	0	11

PC – prairie chicken; ST – sharp-tailed grouse; M = Male; F = Female; U = Unknown; T = Total

Table 14. Summary of ground counts by sex on leks and newly identified displaying areas within the Sweetland Wind Energy Project and surrounding 1-mile buffer, spring of 2018.

Lek Name	Species	Survey One	# observed M	F	U	T	Survey Two	# observed M	F	U	T	Survey Three	# observed M	F	U	T
Ground Surveys																
Historic Lek 1	PC	4/29/2018	0	0	0	0	5/5/2018	0	0	0	0	5/12/2018	0	0	0	0
Historic Lek 2	PC	4/29/2018	0	0	0	0	5/5/2018	0	0	0	0	5/12/2018	0	0	0	0
Historic Lek 3[1]	ST	4/28/2018	-	-	-	-	5/5/2018	-	-	-	-	5/12/2015	-	-	-	-
Displaying Grouse Location 1	ST	4/29/2018	3	0	4	7	5/5/2018	3	3	0	6	5/12/2018	0	0	0	0
Displaying Grouse Location 2	ST	4/28/2019	12	9	4	25	5/5/2018	6	3	0	9	5/12/2018	1	0	5	6
Displaying Grouse Location 3[1]	ST	4/29/2018	-	-	-	-	5/5/2018	-	-	-	-	5/12/2018	-	-	-	-
Displaying Grouse Location 4	ST	4/29/2018	1	2	9	12	5/5/2018	0	0	0	0	5/12/2018	0	0	0	0

[1]Due to access constraints, ground counts were not conducted.

PC – prairie chicken; ST – sharp-tailed grouse; M = Male; F = Female; U = Unknown; T = Total

General Wildlife Observations

Nine identified bird species were recorded incidentally (outside of standardized surveys) within the Survey area, totaling 403 bird observations within 42 separate groups (Table 15). Bonaparte's gull was the most observed of these with 240 observations in two groups. Three of these, sora (*Porzana carolina*), boat-tailed grackle (*Quiscalus major*), and northern flicker (*Colaptes auratus*) were only observed incidentally and were not recorded during the standardized avian use surveys. Two identifiable mammals, badger (*Taxidea taxus*) and white-tailed deer (*Odocoileus virginianus*), were recorded incidentally, each with one observation.

Table 15. General wildlife observations recorded outside of standardized surveys at the Sweetland Wind Energy Project recorded incidentally from May 26, 2017 – April 28, 2018.

Species	Scientific Name	# grps	# obs
Bonaparte's gull	*Chroicocephalus philadelphia*	2	240
killdeer	*Charadrius vociferus*	6	74
common grackle	*Quiscalus quiscula*	13	49
unidentified large bird		4	17
northern flicker[1]	*Colaptes auratus*	11	14
boat-tailed grackle[1]	*Quiscalus major*	1	3
common nighthawk	*Chordeiles minor*	2	3
bald eagle	*Haliaeetus leucocephalus*	1	1
mourning dove	*Zenaida macroura*	1	1
sora[1]	*Porzana carolina*	1	1
Bird Subtotal	**9 species**	**42**	**403**
American badger	*Taxidea taxus*	1	1
white-tailed deer	Odocoileus virginianus	1	1
Mammal Subtotal	**5 species**	**2**	**2**

[1] = species only observed incidentally

Special-Status Species Observations

Special-status species include Species of Greatest Conservation Need (SGCN) as identified in the 2014 *South Dakota State Wildlife Action Plan* (SWAP; South Dakota Game, Fish, and Parks [SDGFP 2014]) and SDGFP and species listed as threatened or endangered under the federal Endangered Species Act of 1973 (ESA; 16 US Code [USC] 1531-1599]), Bald and Golden Eagle Protection Act of 1940 (BGEPA; 16 USC 668-668c [1940]) or Migratory Bird Treaty Act of 1918 (MBTA; 16 USC 703-712 [1918]). No federally listed endangered species were observed within the Survey area. Two state threatened species were observed, bald eagle and peregrine falcon. Four special-status species were recorded during the fixed-point bird use surveys and as general wildlife observations (Table 16). Bald and golden eagles, both protected under the BGEPA, were recorded within the Survey area during the first year of baseline studies.

Table 16. Summary of special-status species observed at the Sweetland Wind Energy Project during large and small bird fixed-point bird use surveys (FP) and as general wildlife observations (Inc.) from May 26, 2017 – April 28, 2018.

Species	Scientific Name	Status	FP Large Bird		FP Small Bird		Inc.		Total	
			# grps	# obs	# grps	# obs	# grps	# obs	# grps	# obs
American white pelican	*Pelecanus erythrorhynchos*	SGCN S3B	1	7	0	0	0	0	1	7
bald eagle	*Haliaeetus leucocephalus*	BGEPA; ST	4	4	0	0	1	1	5	5
black tern	*Chlidonias niger*	SGCN S3B	1	1	0	0	0	0	1	1
golden eagle	*Aquila chrysaetos*	BGEPA	6	6	0	0	0	0	6	6
Le Conte's sparrow	*Ammodramus leconteii*	SGCN S1S2B	0	0	3	3	0	0	3	3
marbled godwit	*Limosa fedoa*	SGCN S5B	8	12	0	0	0	0	8	12
peregrine falcon	*Falco peregrinus*	ST	1	1	0	0	0	0	1	1
Total	**7 species**		**21**	**31**	**3**	**3**	**1**	**1**	**25**	**35**

State status designations are based on the 2014 *South Dakota State Wildlife Action Plan* (South Dakota Game, Fish, and Parks 2014): ST = State Threatened, SGCN = Species of Greatest Conservation Need, S1 = State or federal listed species for which the state has a mandate for recovery, S2 = Species that are either regionally or globally imperiled or secure and which South Dakota represents an important portion of their remaining range, S3 = Species with characteristics that make them vulnerable, S5 = Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery, B = breeding population

BGEPA = Bald and Golden Eagle Protection Act of 1940

Grps = groups, obs = observations

DISCUSSION AND IMPACT ASSESSMENT

Potential Impacts

Impacts to wildlife resources from wind energy facilities can be direct or indirect. Direct impacts include fatalities from construction and operation of the facility. Indirect impacts include the displacement of wildlife, temporarily or permanently, during construction or operation of a wind energy facility. These potential impacts may be avoided or minimized through Project planning and design.

Direct Impacts

Mortality or injury due to collisions with turbines or the guy wires of meteorological towers are the most probable direct impact to birds from wind energy facilities. Collisions may occur with resident birds foraging and flying within the wind energy facility, or with migrant birds seasonally moving through the wind energy facility. Project construction could affect birds through removal of habitat or potential fatalities from workforce vehicles or construction equipment. Direct impacts during decommissioning or repowering of the facility are anticipated to be similar to construction. Potential mortality from construction equipment is expected to be relatively low, as equipment used in wind energy facility construction generally moves at slow rates or is stationary for long periods (e.g., cranes). The highest risk of direct mortality to birds from construction is most likely from potential destruction of a nest for ground- and shrub-nesting species during initial site clearing, which is best managed by timing ground disturbance outside of the nesting period.

Substantial data on bird mortality at wind energy facilities are available from studies across North America. Of 841 bird fatalities reported from California studies (more than 70% were from the Altamont Pass facility in California), approximately 39% were diurnal raptors, approximately 19% were passerines (excluding house sparrows and European starlings [*Sturnus vulgaris*]), and approximately 12% were owls. Non-protected birds (including house sparrows, European starlings, and rock pigeons) accounted for approximately 15% of the fatalities, while other bird types typically made up less than 10% of the fatalities (Erickson et al. 2002b). During 12 fatality-monitoring studies conducted outside of California, diurnal raptor fatalities composed about 2% of the wind energy facility-related fatalities and diurnal raptor fatality rate averaged 0.04 fatalities/MW/year. Passerines (excluding house sparrows and European starlings) were the most common collision victims, with about 82% of the 225 fatalities documented consisting of passerines (Johnson et al. 2007). Another review, focusing on studies from western North America, found that diurnal raptors composed 19.4% of all bird fatalities at newer wind energy facilities; passerines were the most common species recorded as fatalities and composed 59.3% of all avian fatalities (Johnson and Stephens 2011). Upland game birds, shorebirds, waterbirds, and waterfowl were also found as fatalities, but were much less common (Johnson and Stephens 2011). Using mortality data collected during a 10-year period from wind energy facilities throughout the entire US, the average number of bird collision fatalities was 3.1

fatalities/MW/year, or 2.3 fatalities/turbine/year (National Wind Coordinating Collaborative 2004).

One of the closest operational facilities with publicly available data is the Wessington Springs facility in Jerauld County, South Dakota (Figure 10, Appendix F1). At the Wessington Springs facility, overall bird fatality estimates ranged from 0.89 to 8.25 fatalities/MW/year and averaged 4.57 fatalities/MW/year. In the Midwest, 38 comparable fatality rate estimates for all bird species combined are publicly available from studies of wind energy facilities (Figure 10, Appendix F1). Overall bird fatality rates in Midwestern North America have ranged from 0.27 to 8.25 bird fatalities/MW/year and averaged 2.76 bird fatalities/MW/year (Figure 10, Appendix F1).

Collision mortality is well documented at most wind energy facilities; however, population level effects have not been detected or reported in the few studies/reviews that have evaluated the issue (Hunt 2002, Hunt and Hunt 2006, Johnson and Erickson 2010). Johnson and Erickson (2010) examined the potential for population level impacts caused by avian collision mortality associated with 6,700 MW of existing and proposed wind energy development in the Columbia Plateau Ecoregion of eastern Oregon and Washington. The number and species composition of bird collision fatalities was estimated based on results of 25 existing mortality studies in the ecoregion. Estimated breeding population sizes were available for most birds in the ecoregion based on USGS Breeding Bird Survey data. Predicted fatality rates for avian types, as well as species of concern, were compared to published annual mortality rates. Because the additional wind energy-associated fatalities were found to compose only a small fraction of existing mortality rates, it was concluded that population level impacts would not be expected for the ecoregion as a whole, but that local impacts to some species could occur (Johnson and Erickson 2010). In a publication that examined effects of collision mortality from buildings and communication towers found that although millions of birds are killed by collisions with manmade structures every year in North America, this source of mortality has had no discernible effect on populations (Arnold and Zink 2011). Further, an analysis conducted by Erickson et al. (2014) indicated that fewer fatalities occur from collisions with turbines than from other anthropogenic sources.

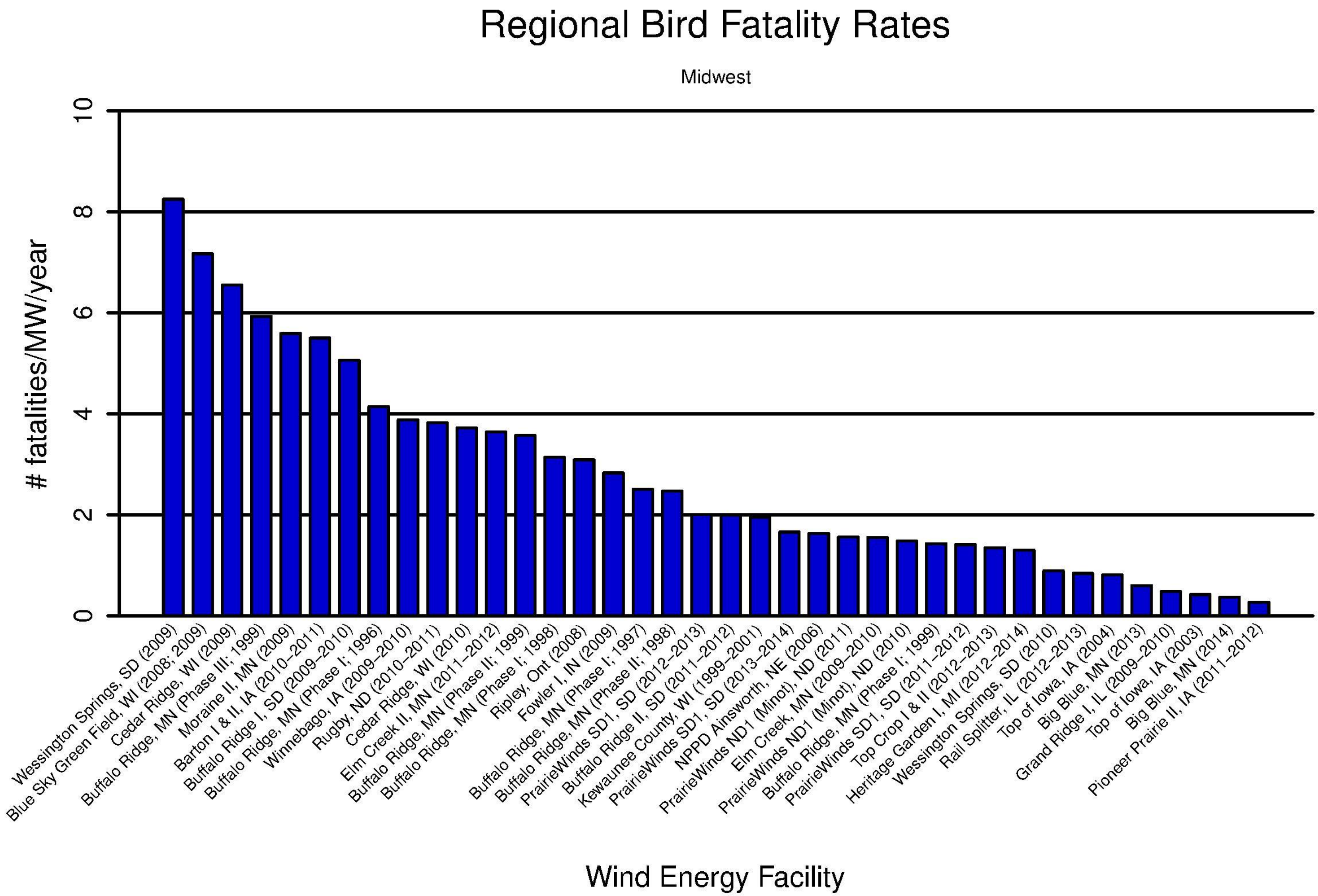

Figure 10. Fatality rates for all birds (number of birds per megawatt [MW] per year) from publicly available studies at wind energy facilities in the Midwestern region of North America.

Figure 10 (*continued*). Fatality rates for all birds (number of birds per megawatt [MW] per year) from publicly available studies at wind energy facilities in the Midwest region of North America.

Data from the following sources:

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

Diurnal Raptor Use and Exposure Risk

Annual mean diurnal raptor use (0.22 diurnal raptor/800-m plot/20-min survey) during the first year of baseline studies within the Survey area was compared with 48 other studies at wind energy facilities that implemented similar protocols and had data for three or four seasons. The annual mean diurnal raptor use at these wind energy facilities ranged from 0.06 to 2.34 diurnal raptors/800-m plot/20-min survey (Figure 11). Mean diurnal raptor use within the Survey area ranked ninth lowest out of the 49 comparable studies, and estimated raptor use observed during the first year of baseline studies within the Survey area is considered relatively low compared to the other raptor use values available from comparable studies (Figure 11).

Although diurnal raptors occur in most areas with the potential for wind energy development, individual species appear to differ from one another in their susceptibility to collision (National Research Council [NRC] 2007). Results from Altamont Pass in California suggest that fatality rates for some species is not necessarily related to abundance (Orloff and Flannery 1992). At Altamont Pass, American kestrels, red-tailed hawks, and golden eagles were killed more often than predicted based on abundance. For example, American kestrel use at the High Winds wind energy facility in California was nearly seven times higher than that recorded at the Altamont facility (Kerlinger et al. 2005), yet the fatality rates at the Altamont facility were higher than at the High Winds facility (Kerlinger et al. 2006, Altamont Pass Monitoring Team 2008). In contrast, relatively few northern harrier fatalities have been reported in publicly available documents to date, despite the fact they are commonly observed during fixed-point avian use surveys (Erickson et al. 2001b, Whitfield and Madders 2006, Smallwood and Karas 2009). Northern harriers often forage close to the ground (MacWhirter and Bildstein 1996), so risk of collision with turbine blades is considered low for this species (Whitfield and Madders 2005, 2006). It is likely that many factors, in addition to abundance, are important in predicting diurnal raptor fatality rates.

Exposure index analysis may also provide insight into which species might be the most likely turbine casualties; however, this index only considers relative probability of exposure as a function of abundance, proportion of observations flying, and proportion of flight height of each species within the RSH for turbines likely to be used at the Project. This analysis is based on observations of birds during the surveys and does not take into consideration behavior (e.g., foraging, courtship), habitat selection, ability to detect and avoid turbines, response to Project installation, and other factors that might vary among species as well as influence the likelihood for turbine collision. For these reasons, the exposure index is only a relative index among species observed during the surveys within the Survey area. Actual risk for some species may be lower or higher than indicated by these indices. Diurnal raptors had relatively low exposure indices, with red-tailed hawk having the highest relative exposure index.

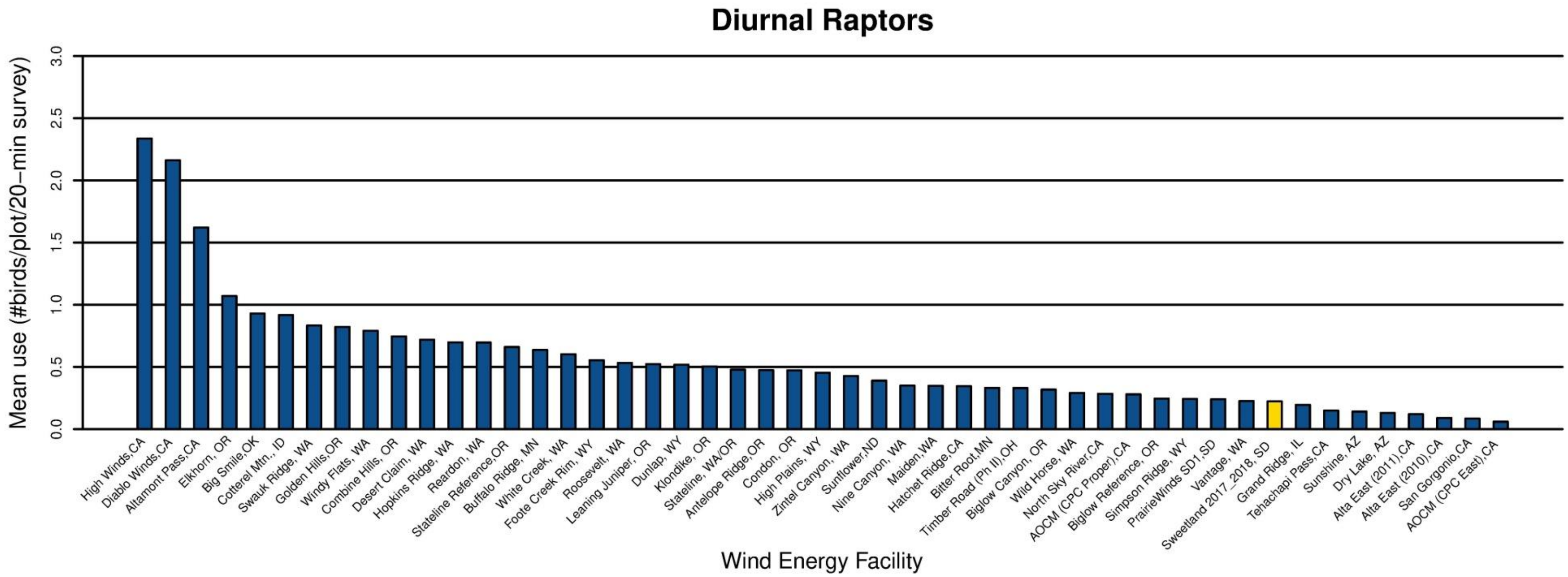

Figure 11. Comparison of estimated annual diurnal raptor use during the first year of fixed-point large bird use surveys at the Sweetland Wind Energy Project and other US wind energy facilities with comparable and publicly available data.

Figure 11 (*continued*). Comparison of estimated annual diurnal raptor use during the first year of fixed-point large bird use surveys at the Sweetland Wind Energy Project and other US wind energy facilities with comparable and publicly available data.

Data from the following sources:

Study and Location	Reference	Study and Location	Reference
Sweetland, SD	This study.		
High Winds, CA	Kerlinger et al. 2005	High Plains, WY	Johnson et al. 2009b
Diablo Winds, CA	WEST 2006	Zintel Canyon, WA	Erickson et al. 2002a, 2003a
Altamont Pass, CA	Orloff and Flannery 1992	Sunflower, ND	Derby and Thorn 2014
Elkhorn, OR	WEST 2005a	Nine Canyon, WA	Erickson et al. 2001a
Big Smile (Dempsey), OK	Derby et al. 2010c	Maiden, WA	Young et al. 2002
Cotterel Mtn., ID	BLM 2006	Hatchet Ridge, CA	Young et al. 2007b
Swauk Ridge, WA	Erickson et al. 2003c	Bitter Root. MN	Derby and Dahl 2009
Golden Hills, OR	Jeffrey et al. 2008	Timber Road (Phase II), OH	Good et al. 2010
Windy Flats, WA	Johnson et al. 2007	Biglow Canyon, OR	WEST 2005c
Combine Hills, OR	Young et al. 2003c	Wild Horse, WA	Erickson et al. 2003d
Desert Claim, WA	Young et al. 2003d	North Sky River, CA	Erickson et al. 2011
Hopkins Ridge, WA	Young et al. 2003e	AOCM (CPC Proper), CA	Chatfield et al. 2010b
Reardon, WA	WEST 2005b	Biglow Reference, OR	WEST 2005c
Stateline Reference, OR	URS et al. 2001	Simpson Ridge, WY	Johnson et al. 2000b
Buffalo Ridge, MN	Johnson et al. 2000a	PrairieWinds, SD1, SD	Derby and Thorn 2014
White Creek, WA	NWC and WEST 2005	Vantage, WA	Jeffrey et al. 2007
Foote Creek Rim, WY	Johnson et al. 2000b	Grand Ridge, IL	Derby et al. 2009
Roosevelt, WA	NWC and WEST 2004	Tehachapi Pass, CA	Anderson et al. 2000, Erickson et al. 2002b
Leaning Juniper, OR	Kronner et al. 2005	Sunshine, AZ	WEST and the CPRS 2006
Dunlap, WY	Johnson et al. 2009a	Dry Lake, AZ	Young et al. 2007a
Klondike, OR	Johnson et al. 2002	Alta East (2011), CA	Chatfield et al. 2011
Stateline, WA/OR	Erickson et al. 2003b	Alta East (2010), CA	Chatfield et al. 2011
Antelope Ridge, OR	WEST 2009	San Gorgonio, CA	Anderson et al. 2000, Erickson et al. 2002b
Condon, OR	Erickson et al. 2002b	AOCM (CPC East), CA	Chatfield et al. 2010b

Mean annual diurnal raptor use estimates are available for two wind resource areas based on three studies, in South Dakota (Table 17). The same diurnal raptor use estimate was reported across all of the studies (0.24 raptor/800-m plot/20-min survey). The estimated diurnal raptor use value within the Survey area (0.22 raptor/800-m plot/20-min survey) from the first year of baseline studies is similar to that reported for publicly available raptor use estimates at the other wind resource areas in South Dakota (Table 17). Publicly available diurnal raptor use estimates coupled with publicly available diurnal raptor fatality estimates are only available for one wind energy facility in South Dakota (Wessington Springs, 2009 and 2010). At the Wessington Springs facility, the mean annual diurnal raptor use estimate was 0.24 diurnal raptor/800-m plot/20-min survey (Table 17). Raptor fatality rates at the Wessington Springs facility averaged 0.06 and 0.07 diurnal raptor fatalities/MW/year (Appendix F2). Based on abundance of diurnal raptors, similar levels of mortality might be expected at the Project. A summary table of publicly available diurnal raptor use and fatality rate estimates across North America is presented in Appendix F2.

Table 17. Mean diurnal raptor use estimates (number of birds/800-meter plot/20-minute survey) for South Dakota wind resource areas.

Project Name	Average Overall Diurnal Raptor Use	Reference
Sweetland[1]	0.22	this study
Wessington Springs, SD (2010)	0.24	Derby et al. 2010d
Wessington Springs, SD (2009)	0.24	Derby et al. 2011a
PrairieWinds SD1, SD	0.24	Derby and Thorn 2014

[1]Adjusted from 60-min surveys

Both bald and golden eagles are protected by the MBTA and the BGEPA. During the first year of fixed-point large bird surveys within the Survey area, there were 16 bald eagle risk minutes and 10 golden eagle risk minutes recorded within 800 m and below 200 m from observers and as such, there is some risk to both species at the Project. The available data on eagle use within the Survey area may be used in planning the proposed wind energy facility to avoid and minimize potential impacts to eagles.

Non-Raptor Use and Exposure Risk

Waterbirds

Thirty-three groups totaling 1,096 observations of waterbirds were observed during fixed-point large bird use surveys, with the majority being sandhill cranes (24 groups and 1,063 observations, Appendix A1). Waterbirds composed only about 1% of bird fatalities reported at US wind energy facilities prior to 2007 (NRC 2007). There is some potential for sandhill cranes to collide with wind turbines at the Project; however, this species is rarely reported as a fatality from wind energy facilities in the US, even though sandhill crane is a relatively common species in areas with wind development. Only three sandhill crane fatalities at wind energy facilities are known: one fatality at Altamont Pass in California (Smallwood and Karas 2009) and two fatalities from a facility in west Texas (N. Gates, USFWS, pers. comm.; Stehn 2011) documented as part of a wintering crane displacement study conducted by graduate student L. Navarrete of Texas Tech University. The study in Texas also found sandhill cranes utilizing areas within three m (10 ft) of turbines (N. Gates, USFWS, pers. comm.).

Data are available from various wind energy facilities in North and South Dakota where migrating sandhill crane use was recorded in conjunction with post-construction fatality monitoring: Crow Lake (Derby and Thorn 2010b), Prairie Winds (Derby et al. 2011c), Wessington Springs (Derby and Dahl 2009a, 2009b, 2010; Derby et al. 2010g), and the Wilton Expansion (Derby and Thorn 2010a). For all six wind energy facilities combined, 30,248 observations of sandhill cranes were recorded (flying or foraging) within the vicinity of the wind energy facilities during spring and fall studies, yet no crane fatalities were found. At Forward Energy Center, a wind energy facility in southern Wisconsin, located about five km (three miles) east of the Horicon National Wildlife Refuge (a large wetland used by sandhill cranes), no crane fatalities were found during a crane fatality monitoring study in the fall of 2008, or during regular bird fatality monitoring studies conducted in the fall of 2008, spring and fall of 2009, and in the spring of 2010 (Grodsky and Drake 2011). Based on data collected, there is some potential for sandhill cranes to collide with wind turbines at the Project; however, based on the comparatively low number of waterbird fatalities observed at existing wind energy facilities despite the relatively high abundance of waterbirds at many facilities, significant impacts to waterbirds are unlikely. Siting turbines away from riparian corridors, waterbodies, wetland habitats and areas of identified high use, should help to minimize potential impacts to waterbirds.

Waterfowl

The number of waterfowl observed within the Survey area was relatively high, composing 88.4% of all large bird observations. Snow goose was the most commonly observed waterfowl species, accounting for 91.0% of waterfowl observations. In addition, snow goose had the highest exposure index of any species. Based on data from 21 fatality monitoring studies conducted at modern wind energy facilities in western North America, where 1,247 avian fatalities representing 128 species were reported, waterfowl were infrequently found (1.9% of all fatalities), and mallard (*Anas platyrhynchos*) was the most commonly found waterfowl fatality (nine; Johnson and Stephens 2011).

Similar findings were observed at the Buffalo Ridge wind energy facility in southwestern Minnesota, which is located in an area with relatively high waterfowl use. Snow geese, Canada geese, and mallards were the most common waterfowl observed. Three of the 55 fatalities observed during the fatality monitoring studies were waterfowl: two mallards and one blue-winged teal (*Anas discors*); two American coots (*Fulica americana*), one grebe, and one shorebird fatality were also found (Johnson et al. 2002b). While there is the potential for waterfowl collision mortality at the Project, based on available evidence, waterfowl do not seem especially vulnerable to turbine collisions and significant impacts are not likely. Siting turbines away from riparian corridors, waterbodies, wetland habitats, and areas of identified high use should help to minimize impacts to waterfowl.

Indirect Effects

In addition to direct effects through collision mortality, wind energy development results in indirect effects, such as the loss of habitat through behavioral avoidance and perhaps habitat fragmentation.

Behavioral displacement (avoidance) by wildlife may lead to decreased overall habitat availability and/or breeding and nesting habitat for local populations. Birds displaced from wind energy facilities may move to lower quality habitat with fewer disturbances, with an overall effect of reducing breeding success near the Project. Indirect impacts also include increased habitat fragmentation (e.g., more habitat edges through roads), which could provide more generalized habitats and resistance-free travel lanes for predators and competitors in, for example, comparatively large grasslands and forests. This may impact the survivorship and reproductive ability of wildlife near wind energy facilities.

Behavioral avoidance (displacement) may render much larger areas unsuitable or less suitable for some species of wildlife, depending on how far each species is displaced from wind energy facilities. Based on some studies in Europe, displacement effects associated with wind energy were thought to have a greater impact on birds than collision mortality (Gill et al. 1996). The greatest concern with displacement impacts for wind energy facilities has been where these facilities have been constructed in native habitats such as grasslands or shrublands, and particularly for diurnal raptors, passerines, waterfowl, and prairie grouse (Leddy et al. 1999, Mabey and Paul 2007, Johnson and Holloran 2010).

Raptor Displacement

Most studies on diurnal raptor displacement at wind energy facilities indicate effects to be negligible (Howell and Noone 1992; Johnson et al. 2000a, 2000b; Madders and Whitfield 2006). Notable exceptions include a study in Scotland that described territorial golden eagles avoiding the entire wind energy facility area, except when intercepting non-territorial birds (Walker et al. 2005). A study at the Buffalo Ridge wind energy facility in Minnesota found evidence of northern harriers avoiding turbines on both a small scale (less than 100 m from turbines) and a larger scale (105-5,364 m [344-17,598 ft]) in the year following construction (Johnson et al. 2000a). Two years following construction, however, no large-scale displacement of northern harriers was detected.

Based on extensive monitoring, using helicopter flights and ground observations, diurnal raptors continued to nest at the Stateline wind energy facility in eastern Oregon/Washington at approximately the same levels after construction, and several nests were located within 0.8 km (0.5 mi) of turbines (Erickson et al. 2004). At the Foote Creek Rim wind energy facility in southern Wyoming, one pair of red-tailed hawks nested within 0.5 km (0.3 mi) of the turbine strings, and seven red-tailed hawk nests, one great horned owl (*Bubo virginianus*) nest, and one golden eagle nest located within 1.6 km (1.0 mi) of the wind energy facility successfully fledged young (Johnson et al. 2000b). The golden eagle pair successfully nested (fledged chicks) 0.8 km from the facility for three different years after the facility became operational. In Oregon, a Swainson’s hawk also nested within 0.4 km (0.25 mi) of a turbine string at the Klondike I wind energy facility after the facility was operational (Johnson et al. 2003). These observations suggest that there will be limited nesting displacement of diurnal raptors at the Project, although the creation of a buffer surrounding known nests when siting turbines would further reduce any impact.

Displacement of Non-Raptor Bird Species

Studies concerning displacement of non-raptor species have concentrated on grassland passerines, waterfowl/waterbirds, and shorebirds (Winkelman 1990, Larsen and Madsen 2000, Mabey and Paul 2007). Wind energy facility construction appears to cause small-scale local displacement of some grassland passerines and is likely due to the birds avoiding turbine noise and maintenance activities. Construction also may reduce habitat effectiveness due to presence of access roads and large gravel pads surrounding turbines (Leddy 1996, Johnson et al. 2000a). Leddy et al. (1999) surveyed bird densities in Conservation Reserve Program grasslands at the Buffalo Ridge wind energy facility in Minnesota, and found mean densities of

10 grassland bird species were four times higher in areas located 180 m (591 ft) from turbines than they were in grasslands nearer turbines. Shaffer and Johnson (2009) examined displacement of grassland birds at two wind energy facilities in the northern Great Plains. Intensive transect surveys were conducted within grid cells that contained turbines as well as reference areas. The study focused on five species at two study sites, one in South Dakota and one in North Dakota. Based on this analysis, killdeer, western meadowlark (*Sturnella neglecta*), and chestnut-collared longspur (*Calcarius ornatus*) did not show any avoidance of wind turbines. However, grasshopper sparrow (*Ammodramus savannarum*) and clay-colored sparrow (*Spizella pallida*) showed avoidance out to 200 m (656 ft). Johnson et al. (2000a) found reduced use of habitat within 100 m of turbines by seven of 22 grassland-breeding birds (in addition to some types of shorebirds and waterfowl) following construction of the Buffalo Ridge facility, and Osborn et al. (1998) reported that birds at Buffalo Ridge avoided flying in areas with turbines. At the Stateline wind energy facility in Oregon and Washington, use of areas less than 50 m from turbines by grasshopper sparrows was reduced by approximately 60%, with no reduction in use more than 50 m from turbines (Erickson et al. 2004). At the Combine Hills facility in Oregon, use of areas within 150 m of turbines by western meadowlark was reduced by about 86%, compared to a 12.6% reduction in use of reference areas over the same time period (Young et al. 2005). Horned larks, however, showed significant increases in use of areas near turbines at both of these facilities, possibly because the cleared turbine pads and access roads provided habitat preferred by this species. There is the potential for small-scale local displacement of grassland passerines at the Project.

Waterfowl, waterbird, and shorebird displacement effects of wind energy facilities appear to be mixed. Disturbance tends to be greatest for migrating birds while feeding and resting (Crockford 1992, NRC 2007). Studies from the Netherlands and Denmark suggest that densities of these types of species near turbines were lower compared to densities in similar habitats away from turbines (Pedersen and Poulsen 1991, Winkelman 1990). However, a study from a facility in England found no effect of wind turbines on populations of great cormorant (*Phalacrocorax carbo*), purple sandpipers (*Calidris maritima*), common eiders (*Somateria mollissima*), or gulls, although the cormorants were temporarily displaced during construction (Lawrence et al. 2007). At the Buffalo Ridge wind energy facility in Minnesota, the abundance of several bird types (including shorebirds and waterfowl) was found to be significantly lower at survey plots with turbines than at reference plots without turbines (Johnson et al. 2000a). The report concluded that the area of reduced use was limited primarily to those areas within 100 m of the turbines. Siting turbines away from riparian areas, waterbodies, and wetlands should help to minimize potential displacement impacts to waterfowl, waterbirds, and shorebirds.

Special-Status Species Use and Exposure Risk

Two state threatened species were observed, bald eagle and peregrine falcon. Four special-status species were recorded during the fixed-point bird use surveys and as general wildlife observations. No federally listed threatened or endangered species were observed within the Survey area during the first year of baseline wildlife surveys. Both bald and golden eagles, protected under the MBTA and BGEPA, were observed within the Survey area.

Siting turbines away from known raptor nest locations, abrupt topography, and areas of identified concentrated use should help to minimize potential impacts to all diurnal raptors, including eagles and special-status diurnal raptor species. Siting turbines away from riparian corridors, waterbodies, and wetlands should help to minimize potential impacts to waterbirds, waterfowl, and shorebirds, including special-status species. There is the potential for small-scale localized displacement of special-status grassland bird species; however, the presence of similar habitats near the Project suggests that adverse population level impacts would be unlikely. There will be a second year of surveys to determine if the new displaying sharp-tailed grouse locations should be considered leks in accordance with SDGFP definitions. Should the newly identified displaying areas be confirmed as leks siting turbines away from known leks and in accordance to SDGFP recommendations should help to minimize impacts to prairie grouse species.

CONCLUSIONS AND RECOMMENDATIONS

Based on data collected during the first year of baseline studies, overall estimates of diurnal raptor use within the Survey area were similar to other publicly available diurnal raptor use estimates from wind resource areas evaluated in South Dakota and relatively low compared to the Midwestern US using similar methods. Assuming a relationship exists with abundance and mortality, diurnal raptor fatality rates at the Project would be expected to be similar to mortality rates observed at other South Dakota projects and within the range of mortality rates documented at other wind energy facilities located in the Midwestern US. Both bald and golden eagles were observed within the Survey area. Although levels of bald and golden eagle use were relatively low within the Survey area, there is the potential for collision risk to both bald and golden eagles at the Project. Siting turbines away from known raptor nest locations and abrupt topographic features, as well as away from areas of identified concentrated use, should help to minimize potential impacts to raptors including eagles. The second year of baseline studies will help to further inform raptor and eagle abundance and will help to inform risk assessments for raptors and eagles.

Waterfowl, waterbirds, and shorebirds were observed within the Survey area during the first year of baseline surveys. While these species do not appear to be highly susceptible to collision with turbines based on reported fatalities at existing wind energy facilities, there is the potential for collision mortality. In addition, the presence of similar habitat surrounding the Project suggests any displacement of these species is unlikely to impact their populations. Siting turbines away from waterbodies, and wetlands should help to minimize impacts to waterfowl, waterbirds, and shorebirds. Siting turbines away from known lekking areas and in accordance to SDGFP recommendations should help to minimize impacts to all prairie grouse species.

Forty-two unique passerine species were observed during the first year of baseline studies, with barn swallow contributing most of the small bird observations. To date, passerines have been the most common bird species recorded during fatality monitoring studies. However, population level effects have not been detected or reported for passerines to date. Further, according to NatureServe (2018), the majority of all small bird species observed during the first year of baseline studies at the Project are considered globally abundant. Collision mortality is not expected to cause population level effects to passerines; however, based on publicly available data, there is the potential for small-scale local displacement of grassland passerines at the Project.

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Appendix A. All Bird Types and Species Observed at the Sweetland Wind Energy Project during Fixed-Point Bird Use Surveys, May 26, 2017 - April 28, 2018

Appendix A1. Large bird types and species observed at the Sweetland Wind Energy Project during fixed-point bird use surveys, May 26, 2017 – April 28, 2018.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**27**	**1,038**	**2**	**2**	**4**	**56**	**0**	**0**	**33**	**1,096**
American white pelican	*Pelecanus erythrorhynchos*	0	0	0	0	1	7	0	0	1	7
double-crested cormorant	*Phalacrocorax auritus*	2	6	0	0	0	0	0	0	2	6
great blue heron	*Ardea herodias*	1	1	2	2	0	0	0	0	3	3
sandhill crane	*Antigone canadensis*	21	1,014	0	0	3	49	0	0	24	1,063
unidentified waterbird		1	2	0	0	0	0	0	0	1	2
white-faced ibis	*Plegadis chihi*	2	15	0	0	0	0	0	0	2	15
Waterfowl		**164**	**42,506**	**7**	**209**	**8**	**64**	**9**	**4,278**	**188**	**47,057**
Canada goose	*Branta canadensis*	28	1,058	1	1	5	51	0	0	34	1,110
common goldeneye	*Bucephala clangula*	3	23	0	0	0	0	0	0	3	23
gadwall	*Anas strepera*	1	1	0	0	0	0	0	0	1	1
greater white-fronted goose	*Anser albifrons*	2	17	0	0	0	0	0	0	2	17
green-winged teal	*Anas crecca*	2	2	0	0	0	0	0	0	2	2
mallard	*Anas platyrhynchos*	32	110	0	0	1	7	0	0	33	117
northern pintail	*Anas acuta*	22	243	0	0	0	0	0	0	22	243
northern shoveler	*Anas clypeata*	2	4	0	0	0	0	0	0	2	4
ruddy duck	*Oxyura jamaicensis*	0	0	1	1	0	0	0	0	1	1
snow goose	*Chen caerulescens*	63	40,915	0	0	0	0	6	1,878	69	42,793
unidentified duck		0	0	3	5	0	0	0	0	3	5
unidentified goose		5	115	1	2	0	0	3	2,400	9	2,517
unidentified waterfowl		4	18	1	200	2	6	0	0	7	224
Shorebirds		**13**	**23**	**17**	**33**	**7**	**54**	**0**	**0**	**37**	**110**
American avocet	*Recurvirostra americana*	1	2	0	0	0	0	0	0	1	2
killdeer	*Charadrius vociferus*	0	0	15	31	7	54	0	0	22	85
marbled godwit	*Limosa fedoa*	8	12	0	0	0	0	0	0	8	12
unidentified shorebird	*NA*	1	5	0	0	0	0	0	0	1	5
upland sandpiper	*Bartramia longicauda*	3	4	2	2	0	0	0	0	5	6
Gulls/Terns		**7**	**16**	**22**	**1,553**	**28**	**3,082**	**0**	**0**	**57**	**4,651**
black tern	*Chlidonias niger*	1	1	0	0	0	0	0	0	1	1
Bonaparte's gull	*Chroicocephalus philadelphia*	0	0	11	1,266	0	0	0	0	11	1,266
Franklin's gull	*Leucophaeus pipixcan*	0	0	4	117	19	2,022	0	0	23	2,139
ring-billed gull	*Larus delawarensis*	6	15	5	18	0	0	0	0	11	33
unidentified gull		0	0	2	152	9	1,060	0	0	11	1,212

Appendix A1. Large bird types and species observed at the Sweetland Wind Energy Project during fixed-point bird use surveys, May 26, 2017 – April 28, 2018.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Diurnal Raptors		**23**	**25**	**28**	**30**	**40**	**45**	**6**	**6**	**97**	**106**
Buteos		*6*	*6*	*18*	*20*	*15*	*20*	*0*	*0*	*39*	*46*
red-tailed hawk	*Buteo jamaicensis*	5	5	17	19	13	18	0	0	35	42
rough-legged hawk	*Buteo lagopus*	0	0	0	0	2	2	0	0	2	2
Swainson's hawk	*Buteo swainsoni*	1	1	1	1	0	0	0	0	2	2
Northern Harrier		*5*	*5*	*2*	*2*	*12*	*12*	*0*	*0*	*19*	*19*
northern harrier	*Circus cyaneus*	5	5	2	2	12	12	0	0	19	19
Eagles		*5*	*5*	*1*	*1*	*0*	*0*	*6*	*6*	*12*	*12*
bald eagle	*Haliaeetus leucocephalus*	3	3	0	0	0	0	1	1	4	4
golden eagle	*Aquila chrysaetos*	0	0	1	1	0	0	5	5	6	6
unidentified eagle		2	2	0	0	0	0	0	0	2	2
Falcons		*1*	*1*	*2*	*2*	*3*	*3*	*0*	*0*	*6*	*6*
American kestrel	*Falco sparverius*	0	0	0	0	2	2	0	0	2	2
merlin	*Falco columbarius*	0	0	0	0	1	1	0	0	1	1
peregrine falcon	*Falco peregrinus*	1	1	0	0	0	0	0	0	1	1
prairie falcon	*Falco mexicanus*	0	0	1	1	0	0	0	0	1	1
unidentified falcon	*Falco spp*	0	0	1	1	0	0	0	0	1	1
Other Raptors		*6*	*8*	*5*	*5*	*10*	*10*	*0*	*0*	*21*	*23*
unidentified raptor		6	8	5	5	10	10	0	0	21	23
Vultures		**3**	**3**	**11**	**22**	**8**	**21**	**0**	**0**	**22**	**46**
turkey vulture	*Cathartes aura*	3	3	11	22	8	21	0	0	22	46
Upland Game Birds		**13**	**21**	**15**	**29**	**9**	**16**	**5**	**9**	**42**	**75**
gray partridge	*Perdix perdix*	0	0	1	1	0	0	0	0	1	1
greater prairie-chicken	*Tympanuchus cupido*	1	4	0	0	0	0	0	0	1	4
ring-necked pheasant	*Phasianus colchicus*	8	11	14	28	9	16	4	7	35	62
sharp-tailed grouse	*Tympanuchus phasianellus*	0	0	0	0	0	0	1	2	1	2
unidentified gamebird		2	4	0	0	0	0	0	0	2	4
unidentified grouse		1	1	0	0	0	0	0	0	1	1
wild turkey	*Meleagris gallopavo*	1	1	0	0	0	0	0	0	1	1
Doves/Pigeons		**1**	**1**	**41**	**59**	**6**	**9**	**0**	**0**	**48**	**69**
mourning dove	*Zenaida macroura*	1	1	40	51	6	9	0	0	47	61
rock pigeon	*Columba livia*	0	0	1	8	0	0	0	0	1	8

Appendix A1. Large bird types and species observed at the Sweetland Wind Energy Project during fixed-point bird use surveys, May 26, 2017 – April 28, 2018.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Large Corvids		**0**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**1**	**2**
American crow	*Corvus brachyrhynchos*	0	0	1	2	0	0	0	0	1	2
Goatsuckers		**0**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**1**	**2**
common nighthawk	*Chordeiles minor*	0	0	1	2	0	0	0	0	1	2
Overall Large Birds		**251**	**43,633**	**145**	**1,941**	**110**	**3,347**	**20**	**4,293**	**526**	**53,214**

Appendix A2. Small bird types and species observed at the Sweetland Wind Energy Project during fixed-point bird use surveys, May 26, 2017 – April 28, 2018

		Spring		Summer		Fall		Winter		Total	
Type/Common Name	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Passerines		**129**	**212**	**150**	**433**	**37**	**152**	**11**	**185**	**327**	**982**
American goldfinch	*Spinus tristis*	4	5	9	12	0	0	0	0	13	17
American redstart	*Setophaga ruticilla*	1	1	0	0	0	0	0	0	1	1
American robin	*Turdus migratorius*	13	21	4	7	2	3	0	0	19	31
American tree sparrow	*Spizelloides arborea*	1	8	0	0	0	0	0	0	1	8
bank swallow	*Riparia riparia*	0	0	2	9	0	0	0	0	2	9
barn swallow	*Hirundo rustica*	4	5	22	90	3	29	0	0	29	124
blue jay	*Cyanocitta cristata*	0	0	0	0	1	4	0	0	1	4
bobolink	*Dolichonyx oryzivorus*	6	6	0	0	0	0	0	0	6	6
Brewer's blackbird	*Euphagus cyanocephalus*	1	2	0	0	0	0	0	0	1	2
brown-headed cowbird	*Molothrus ater*	8	13	9	41	0	0	0	0	17	54
brown thrasher	*Toxostoma rufum*	0	0	2	3	1	1	0	0	3	4
cedar waxwing	*Bombycilla cedrorum*	0	0	0	0	0	0	1	28	1	28
chipping sparrow	*Spizella passerina*	1	1	0	0	0	0	0	0	1	1
clay-colored sparrow	*Spizella pallida*	3	3	0	0	0	0	0	0	3	3
cliff swallow	*Petrochelidon pyrrhonota*	2	21	4	54	0	0	0	0	6	75
common grackle	*Quiscalus quiscula*	1	1	3	13	0	0	0	0	4	14
common redpoll	*Acanthis flammea*	0	0	0	0	0	0	2	27	2	27
common yellowthroat	*Geothlypis trichas*	1	1	1	1	0	0	0	0	2	2
dickcissel	*Spiza americana*	0	0	5	6	0	0	0	0	5	6
eastern bluebird	*Sialia sialis*	1	1	4	4	0	0	0	0	5	5
eastern kingbird	*Tyrannus tyrannus*	2	2	19	28	0	0	0	0	21	30
eastern meadowlark	*Sturnella magna*	0	0	15	35	7	21	0	0	22	56
European starling	*Sturnus vulgaris*	2	3	1	10	3	26	1	4	7	43
grasshopper sparrow	*Ammodramus savannarum*	0	0	3	5	0	0	0	0	3	5
great crested flycatcher	*Myiarchus crinitus*	0	0	1	1	0	0	0	0	1	1
horned lark	*Eremophila alpestris*	6	12	0	0	1	3	3	55	10	70
house sparrow	*Passer domesticus*	2	9	4	25	0	0	3	56	9	90
house wren	*Troglodytes aedon*	0	0	0	0	1	1	0	0	1	1
Le Conte's sparrow	*Ammodramus leconteii*	2	2	1	1	0	0	0	0	3	3
orchard oriole	*Icterus spurius*	0	0	1	2	0	0	0	0	1	2
ovenbird	*Seiurus aurocapilla*	0	0	0	0	1	1	0	0	1	1
red-winged blackbird	*Agelaius phoeniceus*	26	45	17	46	0	0	0	0	43	91
Savannah sparrow	*Passerculus sandwichensis*	1	1	1	2	1	6	0	0	3	9

Appendix A2. Small bird types and species observed at the Sweetland Wind Energy Project during fixed-point bird use surveys, May 26, 2017 – April 28, 2018

		Spring		Summer		Fall		Winter		Total	
Type/Common Name	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
song sparrow	*Melospiza melodia*	4	4	1	2	0	0	0	0	5	6
spotted towhee	*Pipilo maculatus*	0	0	0	0	1	1	0	0	1	1
tree swallow	*Tachycineta bicolor*	2	2	1	1	0	0	0	0	3	3
unidentified blackbird		0	0	0	0	0	0	1	15	1	15
unidentified sparrow		0	0	3	10	5	39	0	0	8	49
unidentified swallow		0	0	2	5	0	0	0	0	2	5
vesper sparrow	*Pooecetes gramineus*	1	1	2	2	2	4	0	0	5	7
warbling vireo	*Vireo gilvus*	1	1	0	0	0	0	0	0	1	1
western kingbird	*Tyrannus verticalis*	1	1	2	2	0	0	0	0	3	3
western meadowlark	*Sturnella neglecta*	31	39	9	14	8	13	0	0	48	66
yellow warbler	*Setophaga petechia*	1	1	2	2	0	0	0	0	3	3
Woodpeckers		**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**
red-headed woodpecker	*Melanerpes erythrocephalus*	0	0	1	1	0	0	0	0	1	1
Unidentified Birds		**2**	**25**	**9**	**15**	**19**	**587**	**5**	**32**	**35**	**659**
unidentified small bird		2	25	9	15	19	587	5	32	35	659
Overall Small Birds		**131**	**237**	**160**	**449**	**56**	**739**	**16**	**217**	**363**	**1,642**

Appendix B. Mean Use, Percent of Use, and Frequency of Occurrence Observed during Fixed-Point Large and Small Bird Use Surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018

Appendix B1. Mean large bird use (number of birds/800-meter plot/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and raptor subtype by season during the fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Waterbirds	**32.74**	**0.05**	**1.44**	**0**	**2.6**	**0.1**	**1.7**	**0**	**44.1**	**5.1**	**10.3**	**0**
American white pelican	0	0	0.18	0	0	0	0.2	0	0	0	2.6	0
double-crested cormorant	0.15	0	0	0	<0.1	0	0	0	5.1	0	0	0
great blue heron	0.03	0.05	0	0	<0.1	0.1	0	0	2.6	5.1	0	0
sandhill crane	32.12	0	1.26	0	2.6	0	1.5	0	31.3	0	7.7	0
unidentified waterbird	0.05	0	0	0	<0.1	0	0	0	2.6	0	0	0
white-faced ibis	0.38	0	0	0	<0.1	0	0	0	5.1	0	0	0
Waterfowl	**1,211.52**	**5.36**	**1.64**	**109.69**	**97.2**	**10.8**	**1.9**	**99.7**	**83.1**	**15.4**	**10.3**	**7.7**
Canada goose	34.85	0.03	1.31	0	2.8	<0.1	1.5	0	43.8	2.6	7.7	0
common goldeneye	0.77	0	0	0	<0.1	0	0	0	3.3	0	0	0
gadwall	0.03	0	0	0	<0.1	0	0	0	2.6	0	0	0
greater white-fronted goose	0.57	0	0	0	<0.1	0	0	0	6.7	0	0	0
green-winged teal	0.05	0	0	0	<0.1	0	0	0	2.6	0	0	0
mallard	3.19	0	0.18	0	0.3	0	0.2	0	40.8	0	2.6	0
northern pintail	7.81	0	0	0	0.6	0	0	0	27.9	0	0	0
northern shoveler	0.10	0	0	0	<0.1	0	0	0	2.6	0	0	0
ruddy duck	0	0.03	0	0	0	<0.1	0	0	0	2.6	0	0
snow goose	1,159.87	0	0	48.15	93.0	0	0	43.7	34.6	0	0	7.7
unidentified duck	0	0.13	0	0	0	0.3	0	0	0	7.7	0	0
unidentified goose	3.83	0.05	0	61.54	0.3	0.1	0	55.9	12.6	2.6	0	2.6
unidentified waterfowl	0.46	5.13	0.15	0	<0.1	10.3	0.2	0	5.1	2.6	2.6	0
Shorebirds	**0.59**	**0.85**	**1.38**	**0**	**<0.1**	**1.7**	**1.6**	**0**	**23.1**	**38.5**	**10.3**	**0**
American avocet	0.05	0	0	0	<0.1	0	0	0	2.6	0	0	0
killdeer	0	0.79	1.38	0	0	1.6	1.6	0	0	35.9	10.3	0
marbled godwit	0.31	0	0	0	<0.1	0	0	0	15.4	0	0	0
unidentified shorebird	0.13	0	0	0	<0.1	0	0	0	2.6	0	0	0
upland sandpiper	0.10	0.05	0	0	<0.1	0.1	0	0	7.7	5.1	0	0
Gulls/Terns	**0.49**	**39.82**	**79.03**	**0**	**<0.1**	**80.1**	**92.1**	**0**	**15.1**	**25.6**	**23.1**	**0**
black tern	0.03	0	0	0	<0.1	0	0	0	2.6	0	0	0
Bonaparte's gull	0	32.46	0	0	0	65.3	0	0	0	2.6	0	0

Appendix B1. Mean large bird use (number of birds/800-meter plot/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and raptor subtype by season during the fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Franklin's gull	0	3.00	51.85	0	0	6.0	60.4	0	0	10.3	12.8	0
ring-billed gull	0.46	0.46	0	0	<0.1	0.9	0	0	12.6	10.3	0	0
unidentified gull	0	3.90	27.18	0	0	7.8	31.7	0	0	5.1	12.8	0
Diurnal Raptors	**0.68**	**0.72**	**1.15**	**0.15**	**<0.1**	**1.4**	**1.3**	**0.1**	**47.4**	**46.2**	**56.4**	**7.7**
Buteos	*0.15*	*0.46*	*0.51*	*0*	*<0.1*	*0.9*	*0.6*	*0*	*15.4*	*35.9*	*25.6*	*0*
red-tailed hawk	0.13	0.44	0.46	0	<0.1	0.9	0.5	0	12.8	33.3	23.1	0
rough-legged hawk	0	0	0.05	0	0	0	<0.1	0	0	0	5.1	0
Swainson's hawk	0.03	0.03	0	0	<0.1	<0.1	0	0	2.6	2.6	0	0
Northern Harrier	*0.13*	*0.05*	*0.31*	*0*	*<0.1*	*0.1*	*0.4*	*0*	*7.7*	*5.1*	*20.5*	*0*
northern harrier	0.13	0.05	0.31	0	<0.1	0.1	0.4	0	7.7	5.1	20.5	0
Eagles	*0.15*	*0.03*	*0*	*0.15*	*<0.1*	*<0.1*	*0*	*0.1*	*12.6*	*2.6*	*0*	*7.7*
bald eagle	0.08	0	0	0.03	<0.1	0	0	<0.1	5.9	0	0	2.6
golden eagle	0	0.03	0	0.13	0	<0.1	0	0.1	0	2.6	0	5.1
unidentified eagle	0.07	0	0	0	<0.1	0	0	0	6.7	0	0	0
Falcons	*0.03*	*0.05*	*0.08*	*0*	*<0.1*	*0.1*	*<0.1*	*0*	*2.6*	*5.1*	*5.1*	*0*
American kestrel	0	0	0.05	0	0	0	<0.1	0	0	0	2.6	0
merlin	0	0	0.03	0	0	0	<0.1	0	0	0	2.6	0
peregrine falcon	0.03	0	0	0	<0.1	0	0	0	2.6	0	0	0
prairie falcon	0	0.03	0	0	0	<0.1	0	0	0	2.6	0	0
unidentified falcon	0	0.03	0	0	0	<0.1	0	0	0	2.6	0	0
Other Raptors	*0.22*	*0.13*	*0.26*	*0*	*<0.1*	*0.3*	*0.3*	*0*	*16.9*	*10.3*	*23.1*	*0*
unidentified raptor	0.22	0.13	0.26	0	<0.1	0.3	0.3	0	16.9	10.3	23.1	0
Vultures	**0.08**	**0.56**	**0.54**	**0**	**<0.1**	**1.1**	**0.6**	**0**	**5.1**	**20.5**	**12.8**	**0**
turkey vulture	0.08	0.56	0.54	0	<0.1	1.1	0.6	0	5.1	20.5	12.8	0
Upland Game Birds	**0.45**	**0.74**	**0.41**	**0.23**	**<0.1**	**1.5**	**0.5**	**0.2**	**19.5**	**30.8**	**12.8**	**10.3**
gray partridge	0	0.03	0	0	0	<0.1	0	0	0	2.6	0	0
ring-necked pheasant	0.28	0.72	0.41	0.18	<0.1	1.4	0.5	0.2	7.7	28.2	12.8	7.7
sharp-tailed grouse	0	0	0	0.05	0	0	0	<0.1	0	0	0	2.6
unidentified gamebird	0.11	0	0	0	<0.1	0	0	0	5.9	0	0	0
unidentified grouse	0.03	0	0	0	<0.1	0	0	0	2.6	0	0	0

Appendix B1. Mean large bird use (number of birds/800-meter plot/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each large bird type and raptor subtype by season during the fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
wild turkey	0.03	0	0	0	<0.1	0	0	0	3.3	0	0	0
Doves/Pigeons	**0.03**	**1.51**	**0.23**	**0**	**<0.1**	**3.0**	**0.3**	**0**	**2.6**	**64.1**	**12.8**	**0**
mourning dove	0.03	1.31	0.23	0	<0.1	2.6	0.3	0	2.6	61.5	12.8	0
rock pigeon	0	0.21	0	0	0	0.4	0	0	0	2.6	0	0
Large Corvids	**0**	**0.05**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**2.6**	**0**	**0**
American crow	0	0.05	0	0	0	0.1	0	0	0	2.6	0	0
Goatsuckers	**0**	**0.05**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**2.6**	**0**	**0**
common nighthawk	0	0.05	0	0	0	0.1	0	0	0	2.6	0	0
Overall Large Birds*	**1,246.57**	**49.72**	**85.82**	**110.08**	**100**	**100**	**100**	**100**				

* Sums may not total values shown due to rounding.

Appendix B2. Mean small bird use (number of birds/100-meter plot/10-minute survey), percent of total use (%), and frequency of occurrence (%) for each small bird type by season during the fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Passerines	**5.67**	**9.15**	**3.90**	**4.64**	**87.2**	**96.2**	**20.6**	**85.0**	**90.0**	**92.3**	**43.6**	**23.1**
American goldfinch	0.13	0.26	0	0	2.0	2.7	0	0	10.3	15.4	0	0
American redstart	0.03	0	0	0	0.4	0	0	0	2.6	0	0	0
American robin	0.57	0.08	0.08	0	8.7	0.8	0.4	0	23.8	5.1	5.1	0
American tree sparrow	0.27	0	0	0	4.1	0	0	0	3.3	0	0	0
bank swallow	0	0.10	0	0	0	1.1	0	0	0	2.6	0	0
barn swallow	0.13	1.56	0.74	0	2	16.4	3.9	0	10.3	46.2	5.1	0
blue jay	0	0	0.10	0	0	0	0.5	0	0	0	2.6	0
bobolink	0.15	0	0	0	2.4	0	0	0	12.8	0	0	0
Brewer's blackbird	0.05	0	0	0	0.8	0	0	0	2.6	0	0	0
brown-headed cowbird	0.33	1.03	0	0	5.1	10.8	0	0	15.4	20.5	0	0
brown thrasher	0	0.08	0.03	0	0	0.8	0.1	0	0	5.1	2.6	0
cedar waxwing	0	0	0	0.72	0	0	0	13.1	0	0	0	2.6
chipping sparrow	0.03	0	0	0	0.4	0	0	0	2.6	0	0	0
clay-colored sparrow	0.08	0	0	0	1.2	0	0	0	7.7	0	0	0
cliff swallow	0.54	1.33	0	0	8.3	14.0	0	0	5.1	7.7	0	0
common grackle	0.03	0.28	0	0	0.4	3.0	0	0	2.6	5.1	0	0
common redpoll	0	0	0	0.69	0	0	0	12.7	0	0	0	2.6
common yellowthroat	0.03	0.03	0	0	0.4	0.3	0	0	2.6	2.6	0	0
dickcissel	0	0.15	0	0	0	1.6	0	0	0	12.8	0	0
eastern bluebird	0.03	0.10	0	0	0.4	1.1	0	0	2.6	7.7	0	0
eastern kingbird	0.05	0.64	0	0	0.8	6.7	0	0	5.1	38.5	0	0
eastern meadowlark	0	0.87	0.54	0	0	9.2	2.8	0	0	35.9	12.8	0
European starling	0.08	0.26	0.67	0	1.2	2.7	3.5	0	5.1	2.6	7.7	0
grasshopper sparrow	0	0.13	0	0	0	1.3	0	0	0	7.7	0	0
great crested flycatcher	0	0.03	0	0	0	0.3	0	0	0	2.6	0	0
horned lark	0.38	0	0.08	1.41	5.9	0	0.4	25.8	15.1	0	2.6	7.7
house sparrow	0.23	0.64	0	1.44	3.5	6.7	0	26.3	5.1	10.3	0	7.7
house wren	0	0	0.03	0	0	0	0.1	0	0	0	2.6	0

Appendix B2. Mean small bird use (number of birds/100-meter plot/10-minute survey), percent of total use (%), and frequency of occurrence (%) for each small bird type by season during the fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Le Conte's sparrow	0.05	0.03	0	0	0.8	0.3	0	0	5.1	2.6	0	0
orchard oriole	0	0.05	0	0	0	0.5	0	0	0	2.6	0	0
ovenbird	0	0	0.03	0	0	0	0.1	0	0	0	2.6	0
red-winged blackbird	1.15	0.87	0	0	17.7	9.2	0	0	38.5	28.2	0	0
Savannah sparrow	0.03	0.05	0.15	0	0.4	0.5	0.8	0	2.6	2.6	2.6	0
song sparrow	0.10	0.05	0	0	1.6	0.5	0	0	10.3	2.6	0	0
spotted towhee	0	0	0.03	0	0	0	0.1	0	0	0	2.6	0
tree swallow	0.05	0	0	0	0.8	0	0	0	2.6	0	0	0
unidentified blackbird	0	0	0	0.38	0	0	0	7.0	0	0	0	2.6
unidentified sparrow	0	0.08	1.00	0	0	0.8	5.3	0	0	5.1	12.8	0
vesper sparrow	0.03	0.05	0.10	0	0.4	0.5	0.5	0	2.6	5.1	5.1	0
warbling vireo	0.03	0	0	0	0.4	0	0	0	2.6	0	0	0
western kingbird	0.03	0.05	0	0	0.4	0.5	0	0	2.6	5.1	0	0
western meadowlark	1.07	0.31	0.33	0	16.4	3.2	1.8	0	56.9	15.4	7.7	0
yellow warbler	0.03	0.05	0	0	0.4	0.5	0	0	2.6	5.1	0	0
Unidentified Birds	**0.83**	**0.36**	**15.05**	**0.82**	**12.8**	**3.8**	**79.4**	**15**	**6.7**	**20.5**	**38.5**	**12.8**
unidentified bird (small)	0.83	0.36	15.05	0.82	12.8	3.8	79.4	15	6.7	20.5	38.5	12.8
Overall Small Birds*	**6.51**	**9.51**	**18.95**	**5.46**	**100**	**100**	**100**	**100**				

* Sums may not total values shown due to rounding.

Appendix C. Species Exposure Indices during Fixed-Point Large Bird and Small Bird Use Surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018

Appendix C1. Relative exposure index and flight characteristics for large bird species[a] during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[b] Based on Initial Observation	Exposure Index	% Within RSH at Anytime
snow goose	68	304.22	100	52.5	159.59	89.4
unidentified goose	9	16.15	100	99.9	16.13	99.9
sandhill crane	24	8.41	100	97.4	8.19	100
Canada goose	32	9.12	97.2	91.2	8.08	91.4
unidentified gull	11	7.76	100	81	6.29	83.1
northern pintail	20	1.97	97.5	89	1.71	89.5
Franklin's gull	22	13.68	100	12.4	1.7	50.3
unidentified waterfowl	7	1.45	100	95.1	1.38	95.1
mallard	30	0.85	96.6	49.6	0.41	75.2
killdeer	15	0.55	63.5	50	0.17	51.9
turkey vulture	21	0.3	95.7	56.8	0.16	75
greater white-fronted goose	2	0.14	100	100	0.14	100
red-tailed hawk	29	0.26	87.5	62.9	0.14	74.3
ring-billed gull	11	0.23	100	51.5	0.12	66.7
white-faced ibis	2	0.1	100	100	0.1	100
unidentified raptor	19	0.15	87	70	0.09	80
common goldeneye	3	0.19	100	30.4	0.06	43.5
American white pelican	1	0.04	100	100	0.04	100
double-crested cormorant	2	0.04	100	83.3	0.03	83.3
bald eagle	4	0.03	100	75	0.02	100
northern harrier	18	0.12	94.7	16.7	0.02	22.2
common nighthawk	1	0.01	100	100	0.01	100
mourning dove	39	0.39	83.6	3.9	0.01	5.9
Swainson's hawk	2	0.01	100	50	<0.01	50
prairie falcon	1	<0.01	100	100	<0.01	100
unidentified duck	2	0.03	60	33.3	<0.01	33.3
great blue heron	1	0.02	33.3	100	<0.01	100
rough-legged hawk	2	0.01	100	50	<0.01	50
Bonaparte's gull	11	8.18	100	0	0	0
ring-necked pheasant	13	0.4	41.9	0	0	0
marbled godwit	7	0.08	91.7	0	0	9.1
rock pigeon	1	0.05	100	0	0	0
upland sandpiper	3	0.04	66.7	0	0	0
golden eagle	6	0.04	100	0	0	16.7
unidentified shorebird	1	0.03	100	0	0	0
unidentified gamebird	2	0.03	100	0	0	0
northern shoveler	1	0.03	25	0	0	0
unidentified eagle	2	0.02	100	0	0	50
unidentified waterbird	1	0.01	100	0	0	0
green-winged teal	0	0.01	0	0	0	0
American crow	0	0.01	0	0	0	0
American avocet	0	0.01	0	0	0	0

Appendix C1. Relative exposure index and flight characteristics for large bird species[a] during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[b] Based on Initial Observation	Exposure Index	% Within RSH at Anytime
American kestrel	0	0.01	0	0	0	0
sharp-tailed grouse	1	0.01	100	0	0	0
wild turkey	0	<0.01	0	0	0	0
unidentified grouse	1	<0.01	100	0	0	0
unidentified falcon	1	<0.01	100	0	0	100
ruddy duck	0	<0.01	0	0	0	0
peregrine falcon	1	<0.01	100	0	0	100
gray partridge	0	<0.01	0	0	0	0
gadwall	1	<0.01	100	0	0	0
black tern	1	<0.01	100	0	0	0
merlin	1	<0.01	100	0	0	0

[a] Based on current development plans rotor-swept height (RSH) for potential collision with a turbine blade, or 25 – 150 meters (82 – 492 feet) above ground level

[b] Based on current development plans rotor-swept height (RSH) for potential collision with a turbine blade, or 25- 150 meters (82- 492 feet) above ground level.

Appendix C2. Relative exposure index and flight characteristics for small bird species[a] observed within the 100-meter radius plot during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[b] Based on Initial Observation	Exposure Index	% Within RSH at Anytime
unidentified bird (small)	22	4.26	94.4	86.3	3.47	87.6
unidentified blackbird	1	0.09	100	100	0.09	100
American goldfinch	9	0.1	73.3	36.4	0.03	36.4
American robin	14	0.18	81.5	9.1	0.01	9.1
red-winged blackbird	23	0.51	65.8	1.9	<0.01	1.9
barn swallow	24	0.61	98.9	0	0	0
house sparrow	4	0.57	58.9	0	0	0
cliff swallow	5	0.47	100	0	0	27.4
horned lark	6	0.46	80	0	0	0
western meadowlark	10	0.43	25	0	0	0
eastern meadowlark	9	0.35	49.1	0	0	0
brown-headed cowbird	15	0.34	71.7	0	0	0
unidentified sparrow	4	0.27	83.3	0	0	88.6
European starling	3	0.25	82.1	0	0	0
cedar waxwing	0	0.18	0	0	0	0
eastern kingbird	13	0.17	70.4	0	0	0
common redpoll	1	0.17	92.6	0	0	0
common grackle	3	0.08	100	0	0	0
American tree sparrow	1	0.07	100	0	0	0
Savannah sparrow	1	0.06	22.2	0	0	0
vesper sparrow	0	0.04	0	0	0	0
song sparrow	1	0.04	16.7	0	0	0
dickcissel	1	0.04	16.7	0	0	0
bobolink	3	0.04	50	0	0	0
grasshopper sparrow	1	0.03	20	0	0	0
eastern bluebird	3	0.03	60	0	0	0
bank swallow	1	0.03	100	0	0	0
brown thrasher	2	0.03	75	0	0	0
blue jay	1	0.03	100	0	0	0
yellow warbler	2	0.02	66.7	0	0	0
western kingbird	1	0.02	33.3	0	0	0
Le Conte's sparrow	0	0.02	0	0	0	0
clay-colored sparrow	0	0.02	0	0	0	0
tree swallow	2	0.01	100	0	0	0
orchard oriole	1	0.01	100	0	0	0
common yellowthroat	1	0.01	50	0	0	0
Brewer's blackbird	1	0.01	100	0	0	0
warbling vireo	0	<0.01	0	0	0	0
great crested flycatcher	0	<0.01	0	0	0	0
chipping sparrow	0	<0.01	0	0	0	0
American redstart	0	<0.01	0	0	0	0
spotted towhee	0	<0.01	0	0	0	0
ovenbird	0	<0.01	0	0	0	0

Appendix C2. Relative exposure index and flight characteristics for small bird species[a] observed within the 100-meter radius plot during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[b] Based on Initial Observation	Exposure Index	% Within RSH at Anytime
house wren	0	<0.01	0	0	0	0

[a] Based on current development plans rotor-swept height (RSH) for potential collision with a turbine blade, or 25 – 150 meters (82 – 492 feet) above ground level

[b] Based on current development plans rotor-swept height (RSH) for potential collision with a turbine blade, or 25- 150 meters (82- 492 feet) above ground level.

Appendix D. Mean Use by Point for All Birds, Major Bird Types, and Diurnal Raptor Subtypes during Fixed-Point Large and Small Bird Use Surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018

Appendix D1. Mean use by point for major large bird types and diurnal raptor subtypes during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

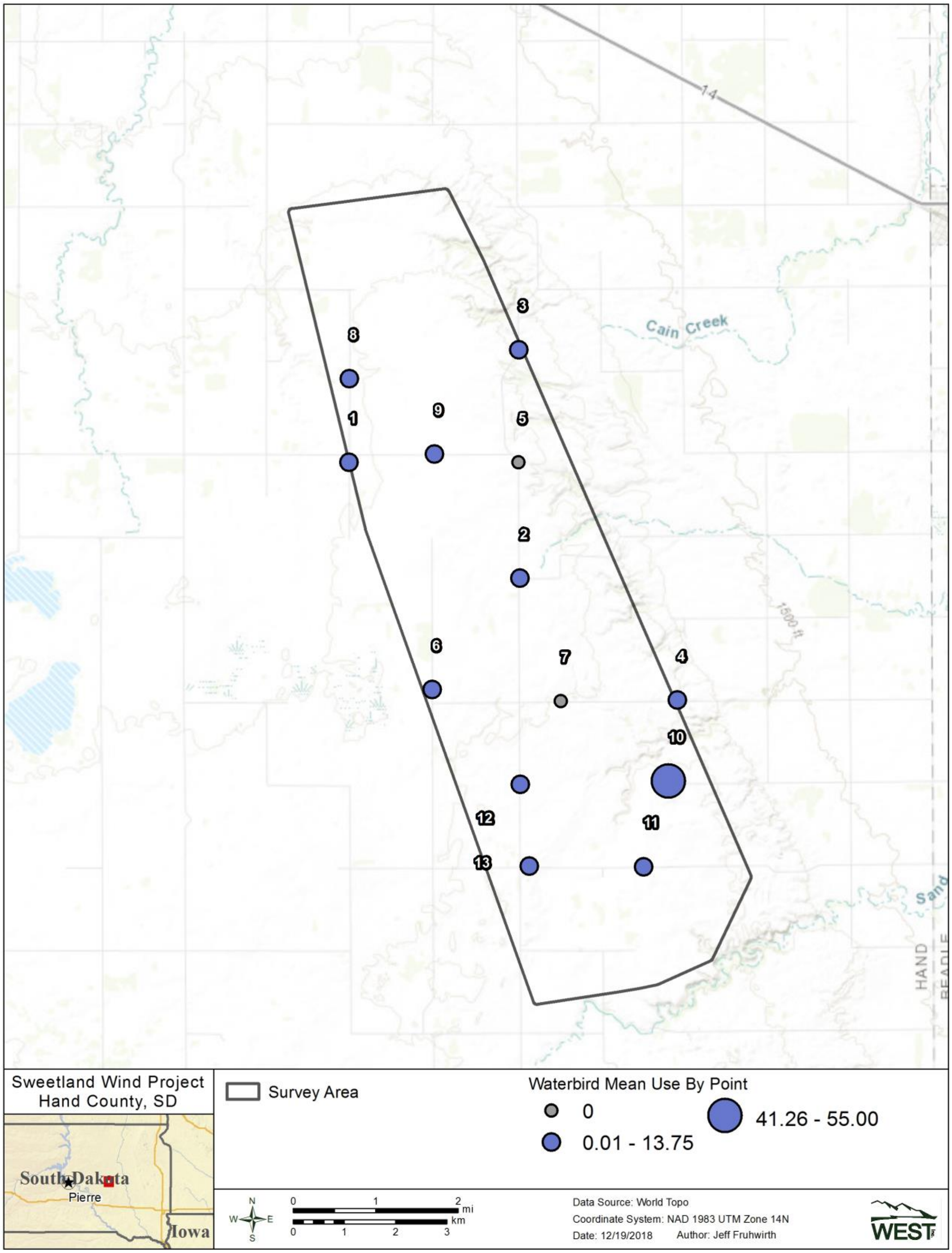
	Survey Point Location												
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Waterbirds	0.17	4.58	0.17	4.92	0	4.36	0	1.64	1.33	53.67	13.64	8.42	0.08
Waterfowl	288.50	752.17	1,099.58	163.17	631.58	19.00	181.83	8.91	210.33	60.58	3.64	60.58	444.17
Shorebirds	0.42	0.42	1.08	1.33	0.92	0.36	0.58	2.55	0.25	0.17	0.55	0.58	0.25
Gulls/Terns	2.75	26.17	14.25	86.00	2.00	0.18	58.33	128.82	3.58	2.33	1.55	71.83	0.67
Diurnal Raptors	1.33	0.33	0.33	0.58	0.42	0.36	0.58	1.09	1.25	0.67	0.82	0.33	0.75
Buteos	*0.83*	*0.08*	*0.17*	*0.08*	*0.25*	*0.27*	*0.33*	*0.45*	*0.42*	*0.08*	*0.18*	*0.25*	*0.33*
Northern Harrier	*0.25*	*0*	*0*	*0.08*	*0.08*	*0*	*0.08*	*0.18*	*0.33*	*0*	*0.45*	*0*	*0.17*
Eagles	*0.08*	*0*	*0*	*0.25*	*0*	*0*	*0.08*	*0*	*0.17*	*0.25*	*0*	*0.08*	*0.08*
Falcons	*0.08*	*0*	*0*	*0*	*0*	*0*	*0*	*0.18*	*0*	*0.17*	*0.09*	*0*	*0*
Other Raptors	*0.08*	*0.25*	*0.17*	*0.17*	*0.08*	*0.09*	*0.08*	*0.27*	*0.33*	*0.17*	*0.09*	*0*	*0.17*
Vultures	0.17	0	0.08	1.33	0.83	0	0.92	0	0.17	0	0.09	0.25	0
Upland Game Birds	0.42	0.83	1.08	0.08	0	0.82	0.67	1.27	0	0.25	0	0.33	0.33
Doves/Pigeons	0.42	1.00	0.42	0.58	0.92	0.45	0.17	1.09	0.08	0.42	0.27	0.08	0
Large Corvids	0.17	0	0	0	0	0	0	0	0	0	0	0	0
Goatsuckers	0	0	0	0	0	0	0	0	0	0.17	0	0	0
All Large Birds*	**294.33**	**785.50**	**1,117.00**	**258.00**	**636.67**	**25.55**	**243.08**	**145.36**	**217.00**	**118.25**	**20.55**	**142.42**	**446.25**

* Sums may not total values shown due to rounding.

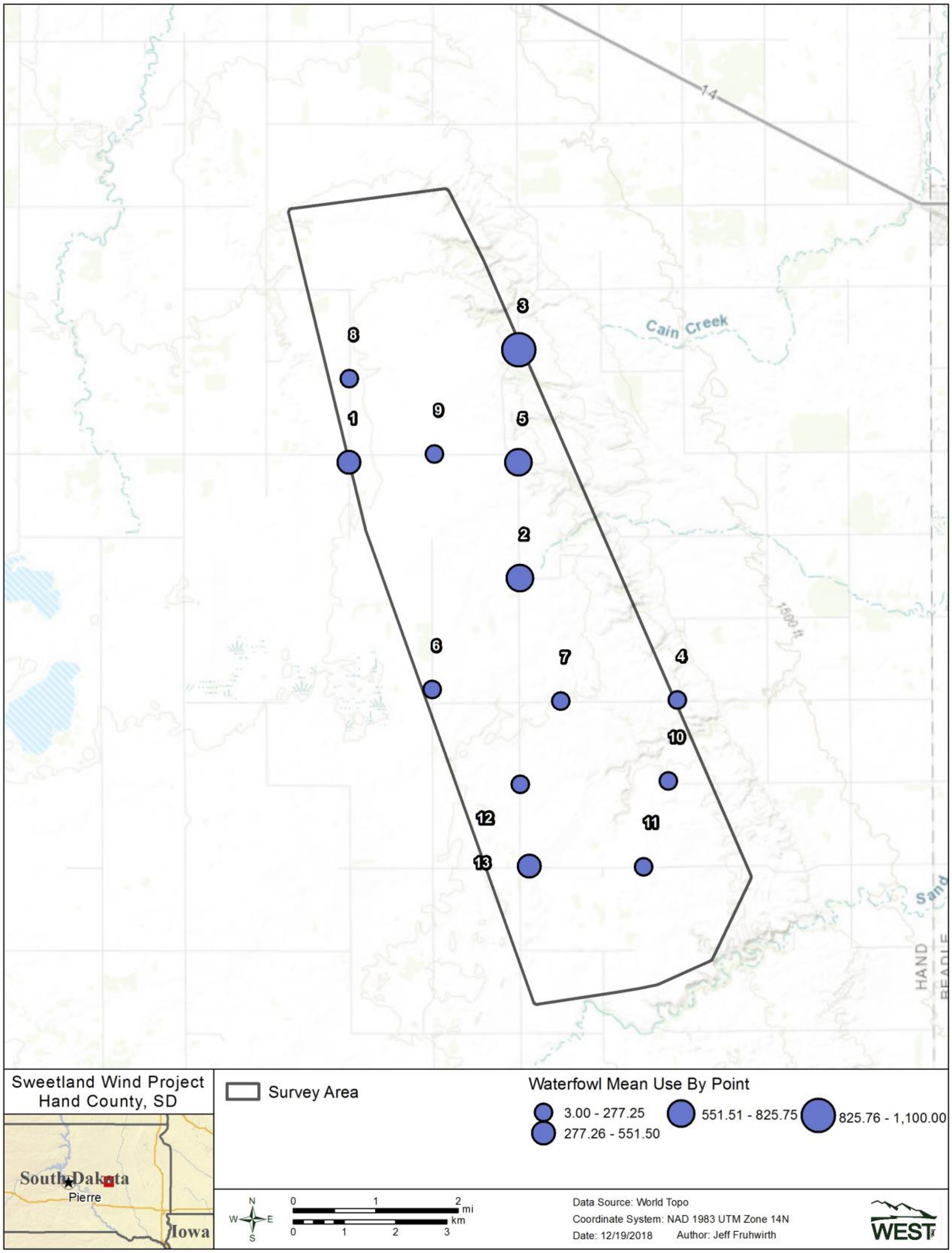
Appendix D2. Mean use by point for major small bird types during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

	Survey Point Location												
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Passerines	2.67	7.75	4.83	2.17	3.58	2.55	9.00	11.91	4.17	5.00	2.36	17.42	3.17
Unidentified Birds	39.25	6.33	1.50	0.17	0.42	0.55	0.42	0.18	5.17	0.17	0.18	0.58	0
All Small Birds*	**41.92**	**14.08**	**6.33**	**2.33**	**4.00**	**3.09**	**9.42**	**12.09**	**9.33**	**5.17**	**2.55**	**18.00**	**3.17**

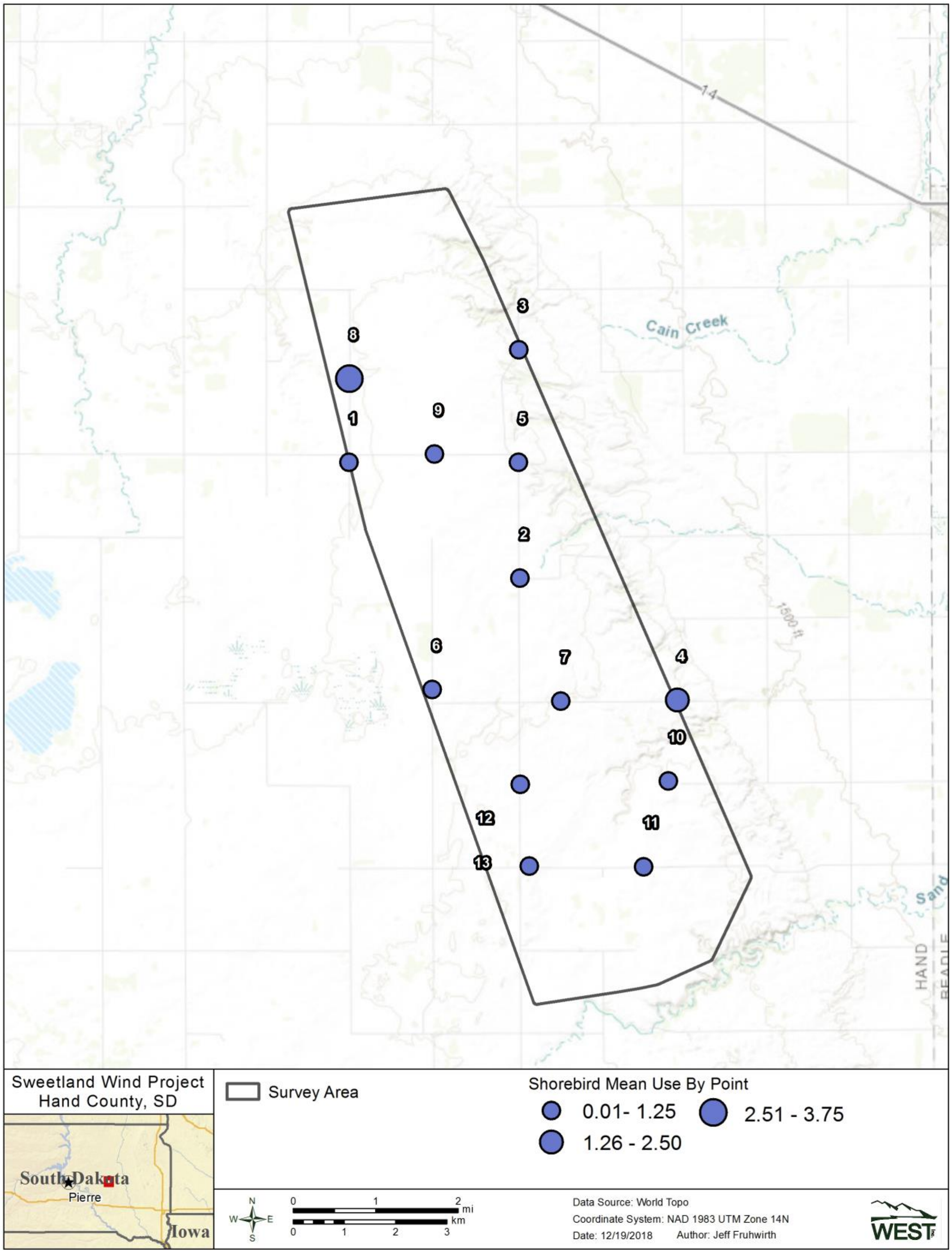
* Sums may not total values shown due to rounding.



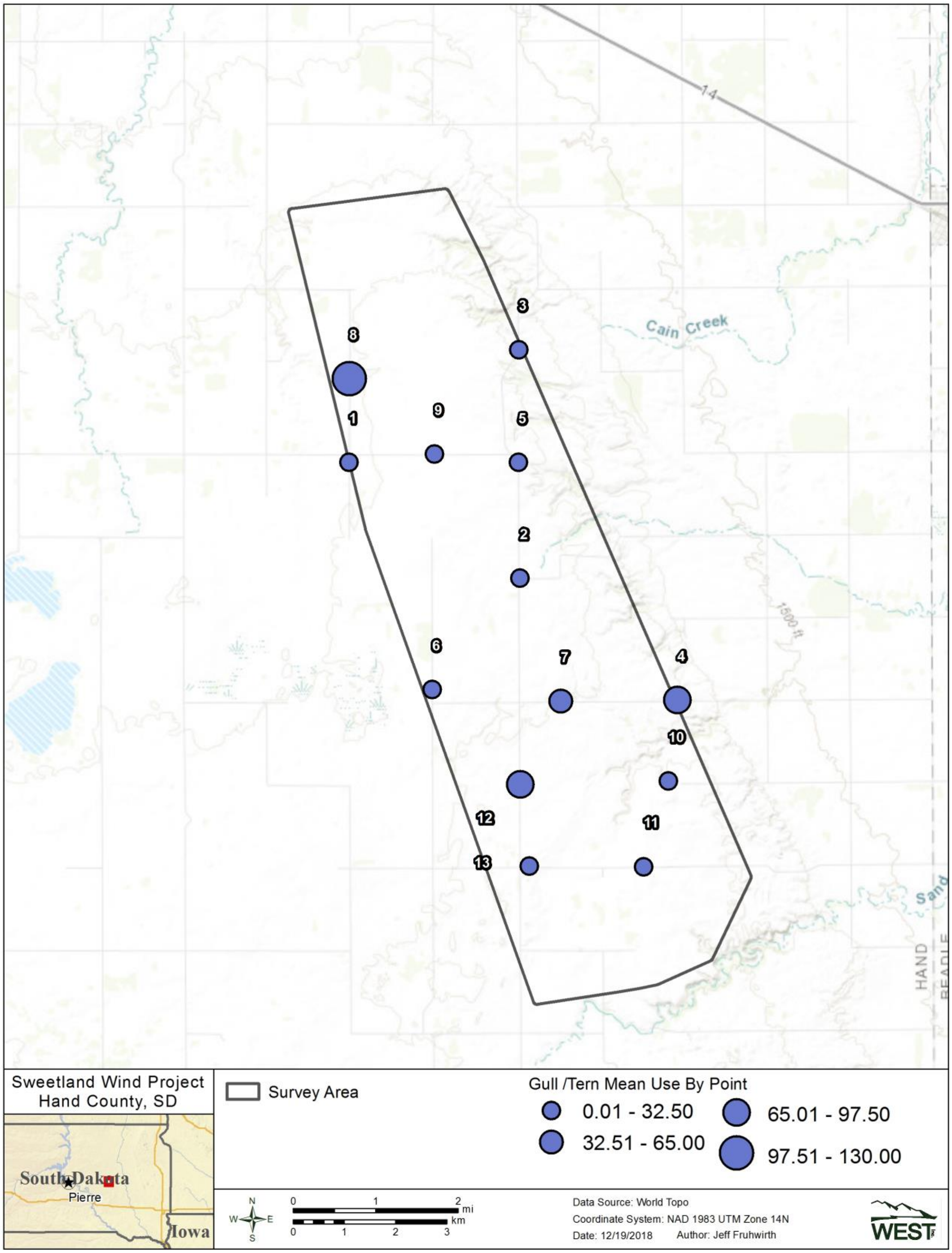
Appendix D3. Relative waterbird use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



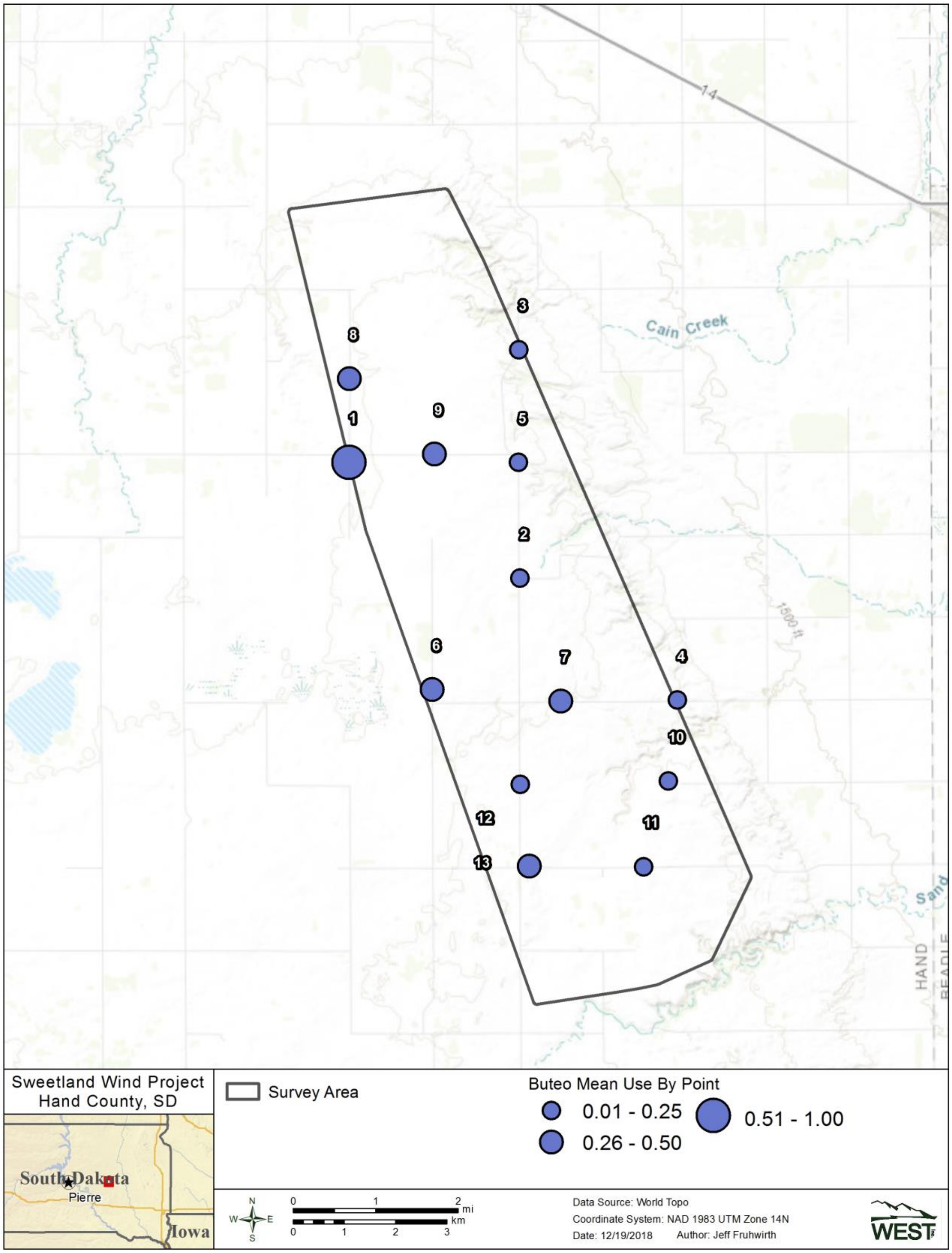
Appendix D3 (*continued*). Relative waterfowl use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



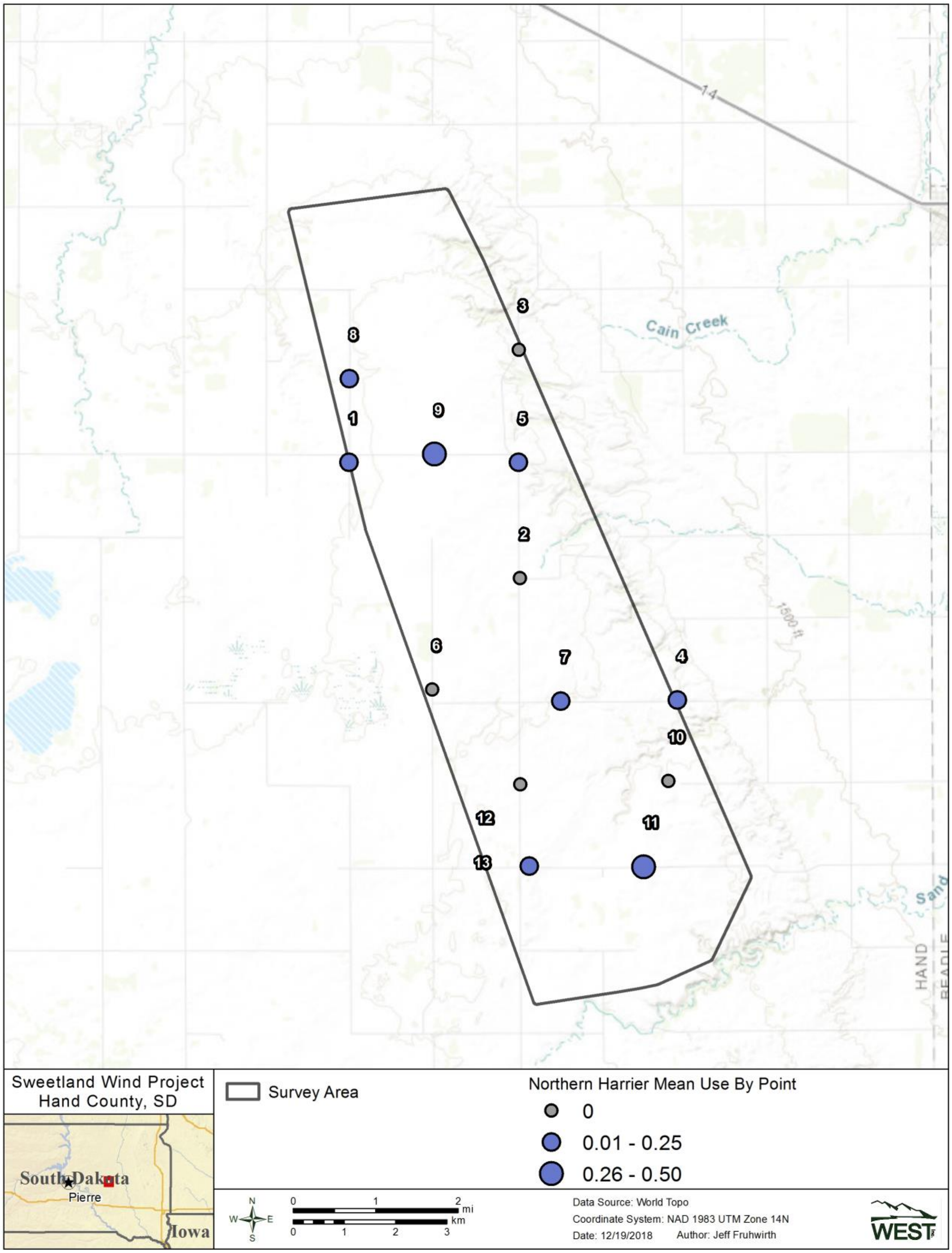
Appendix D3 (*continued*). Relative shorebird use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



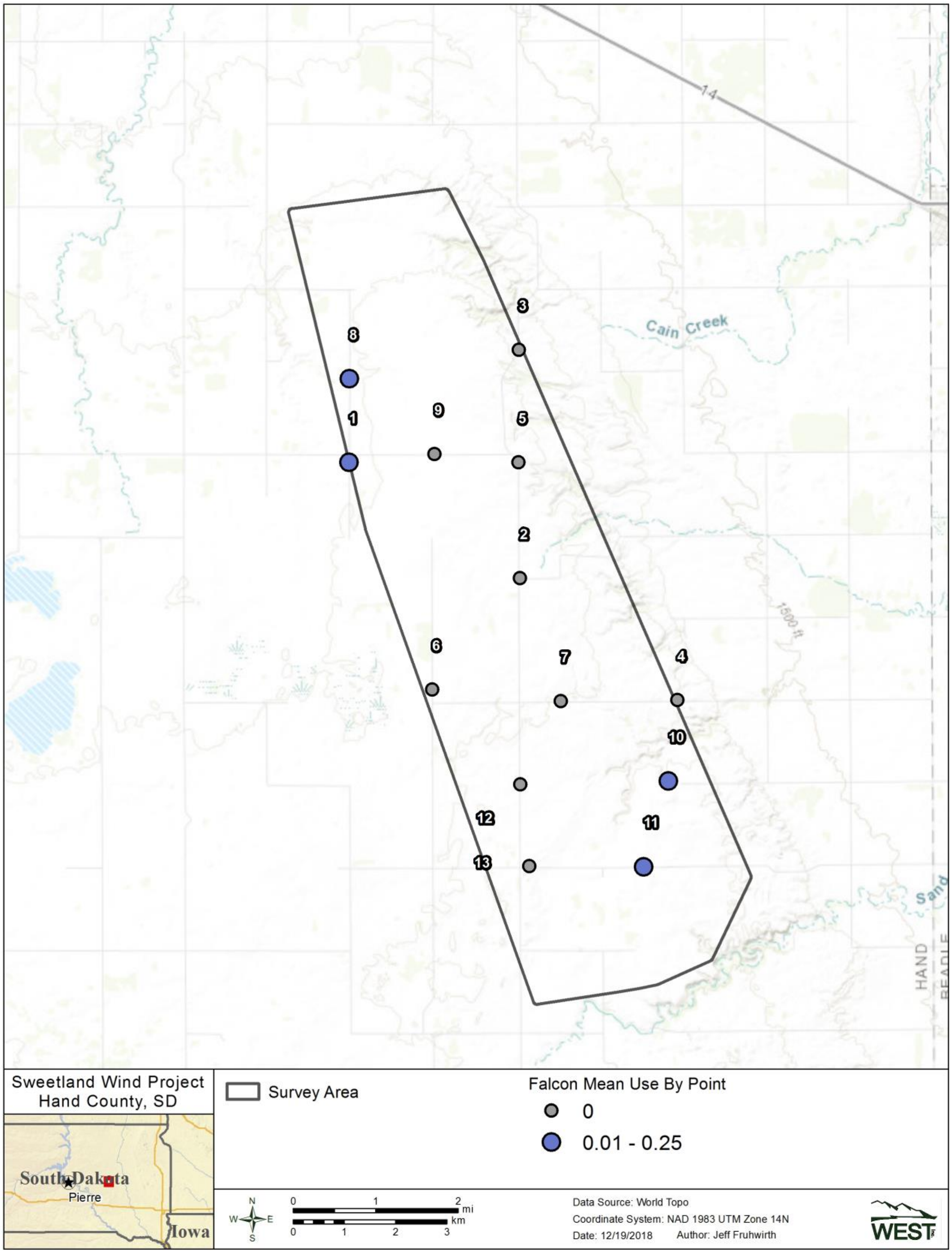
Appendix D3 (*continued*). Relative gull/tern use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



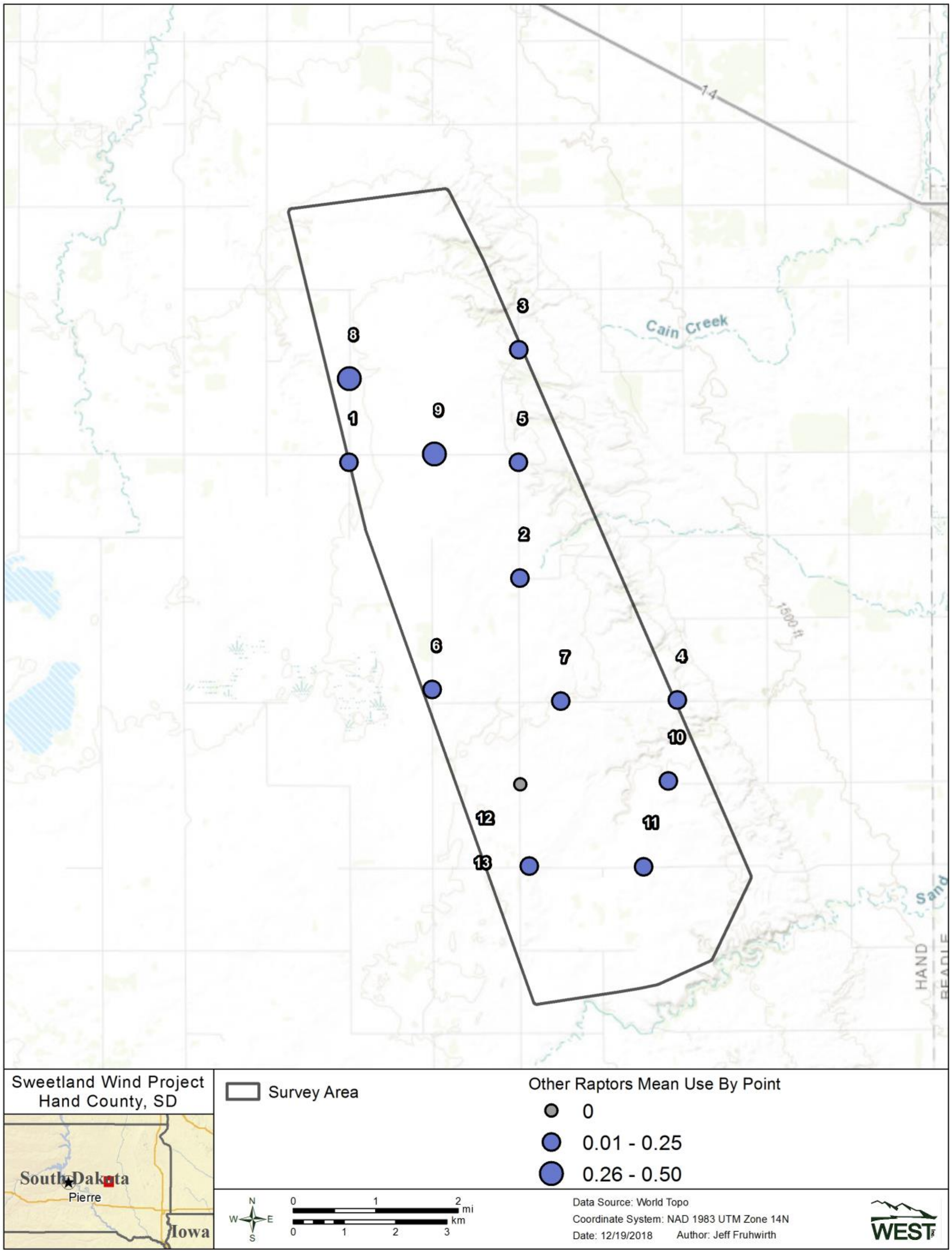
Appendix D3 (*continued*). Relative buteo use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



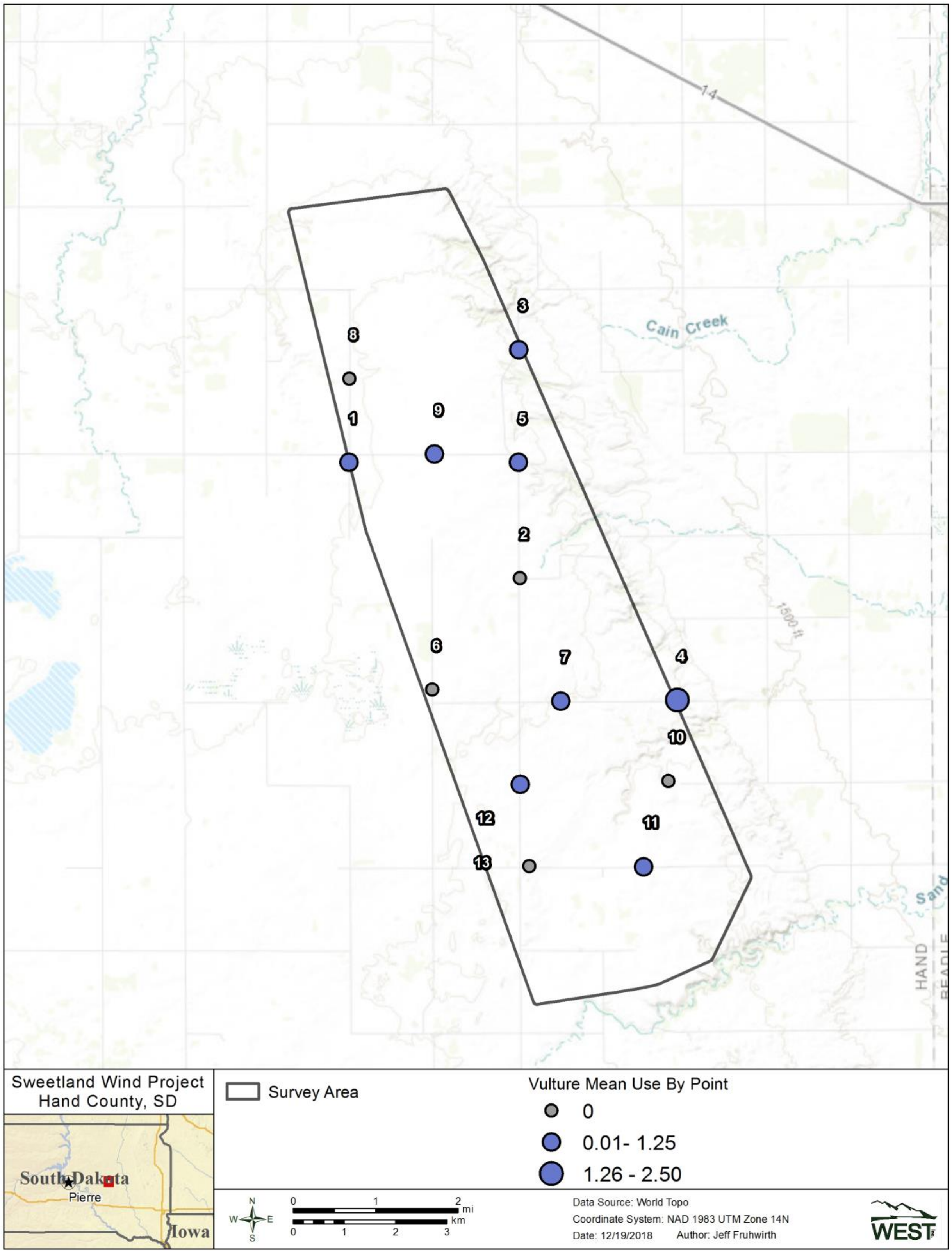
Appendix D3 (*continued*). Relative northern harrier use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



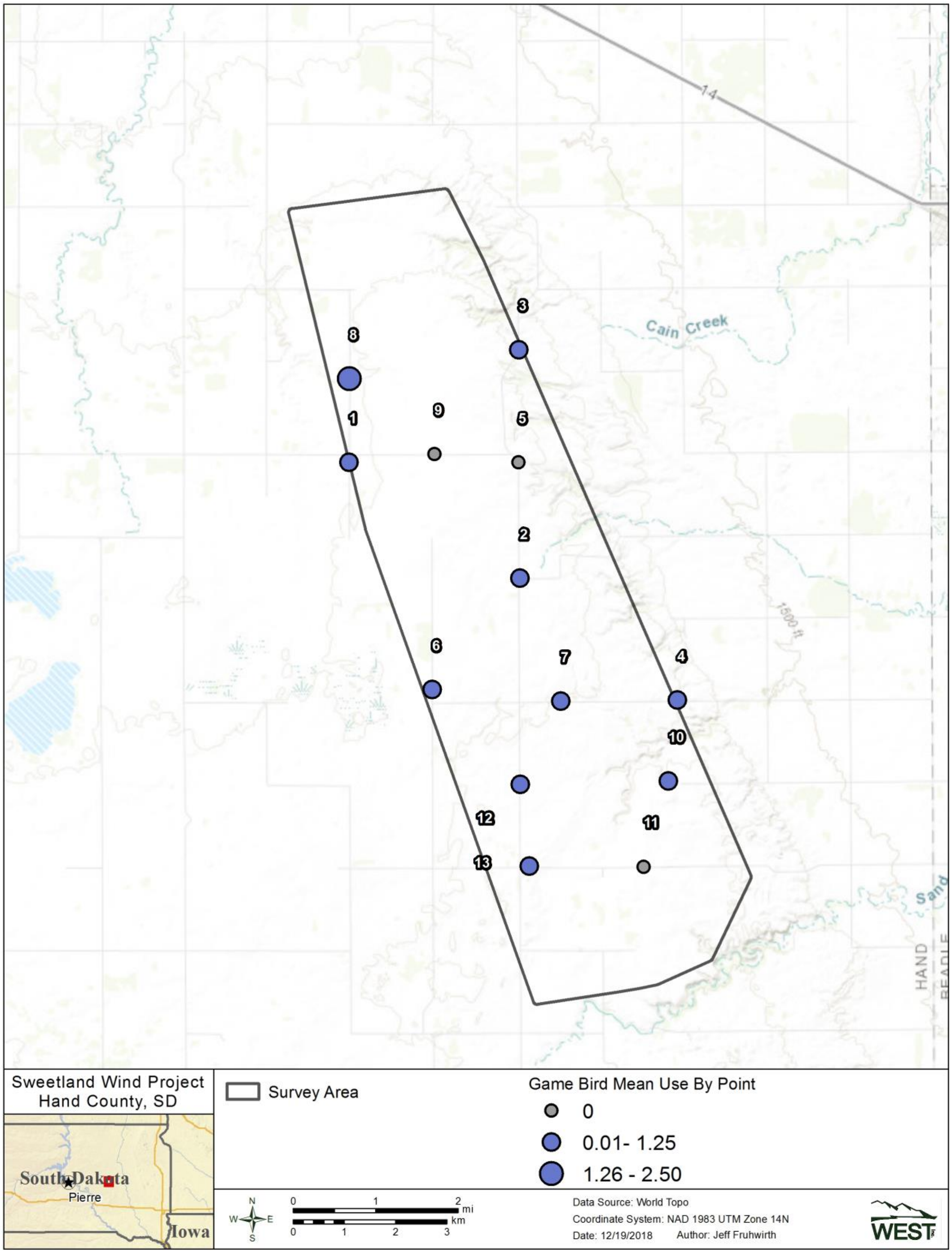
Appendix D3 (*continued*). Relative falcon use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



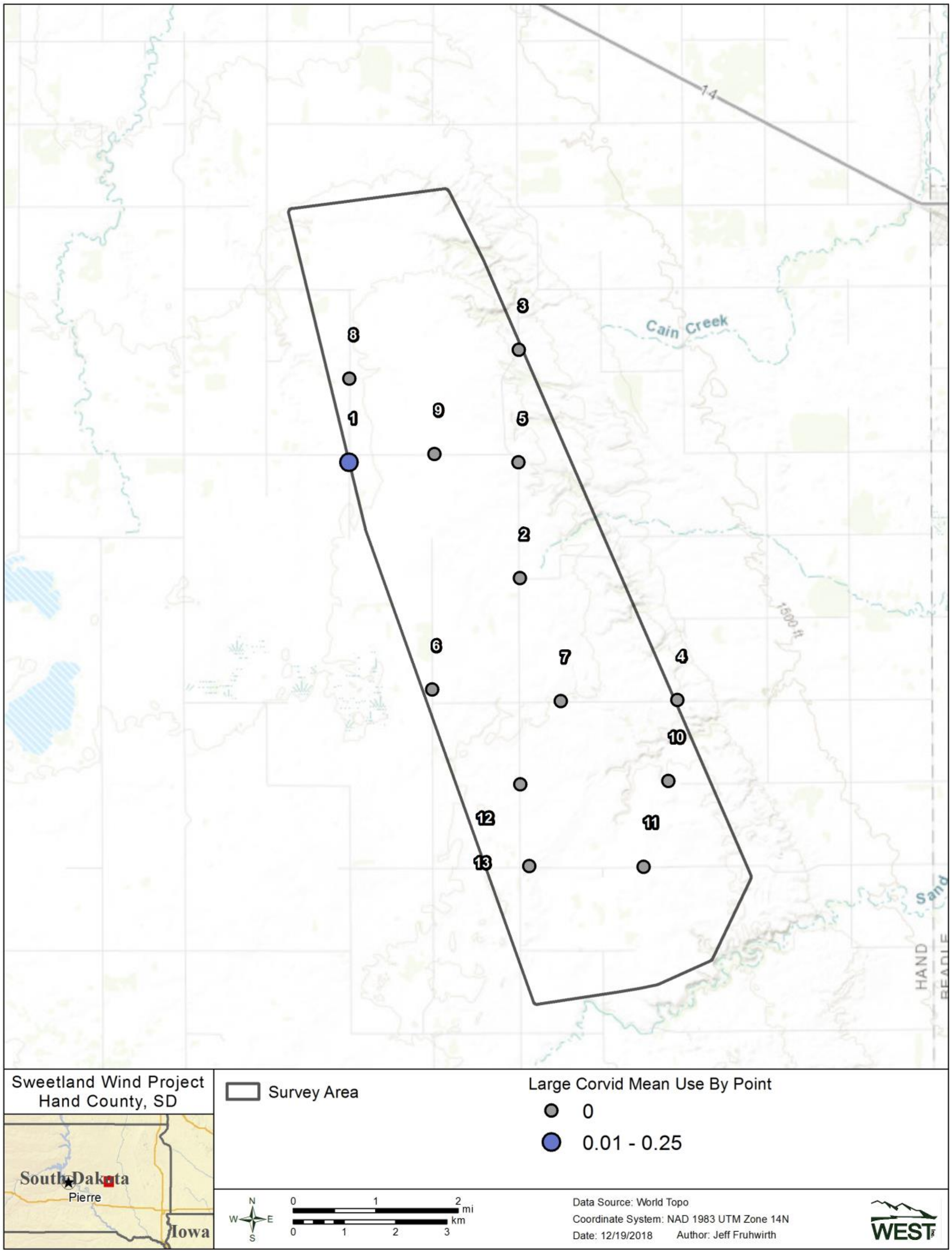
Appendix D3 (*continued*). Relative unidentified raptor use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



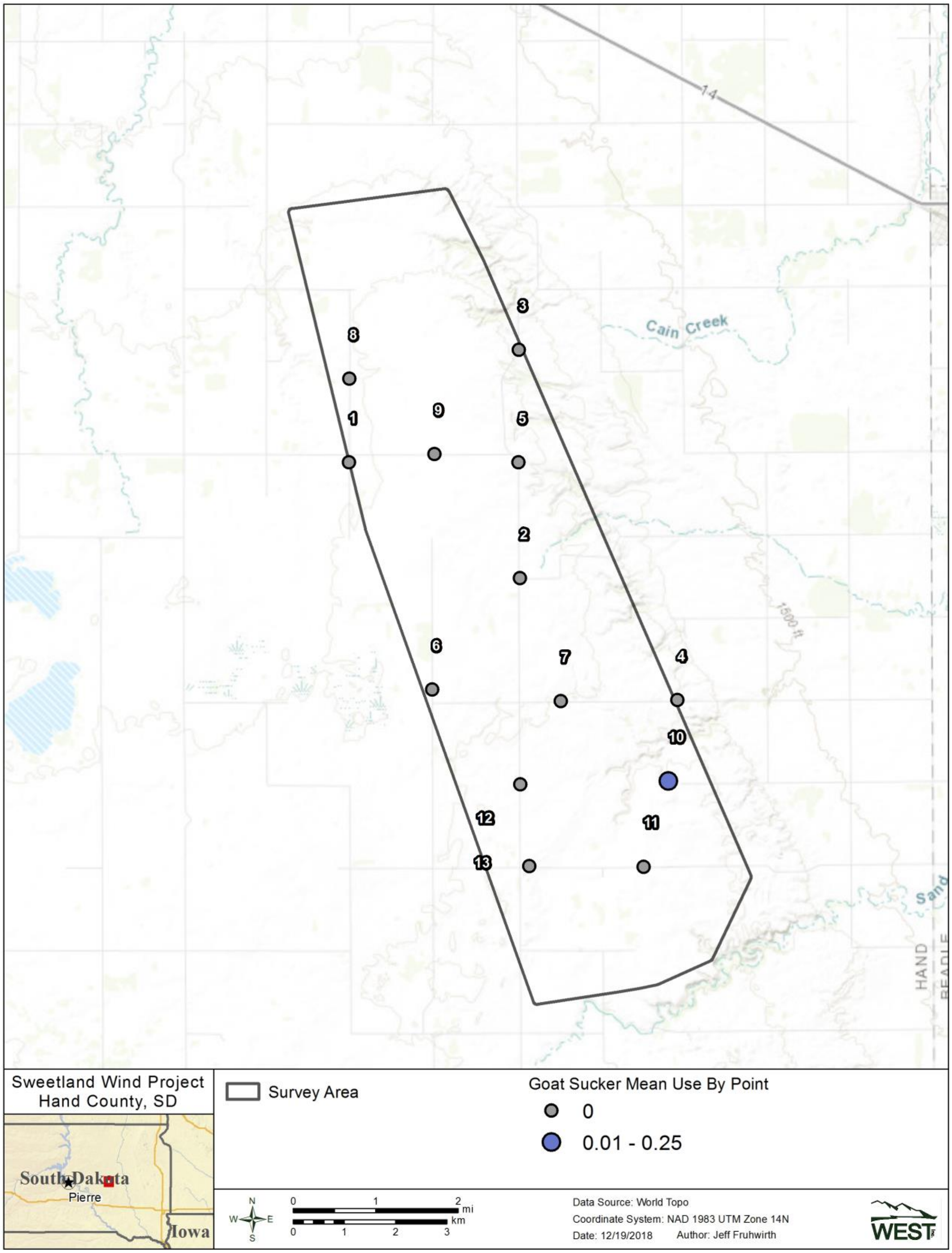
Appendix D3 (*continued*). Relative vulture use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



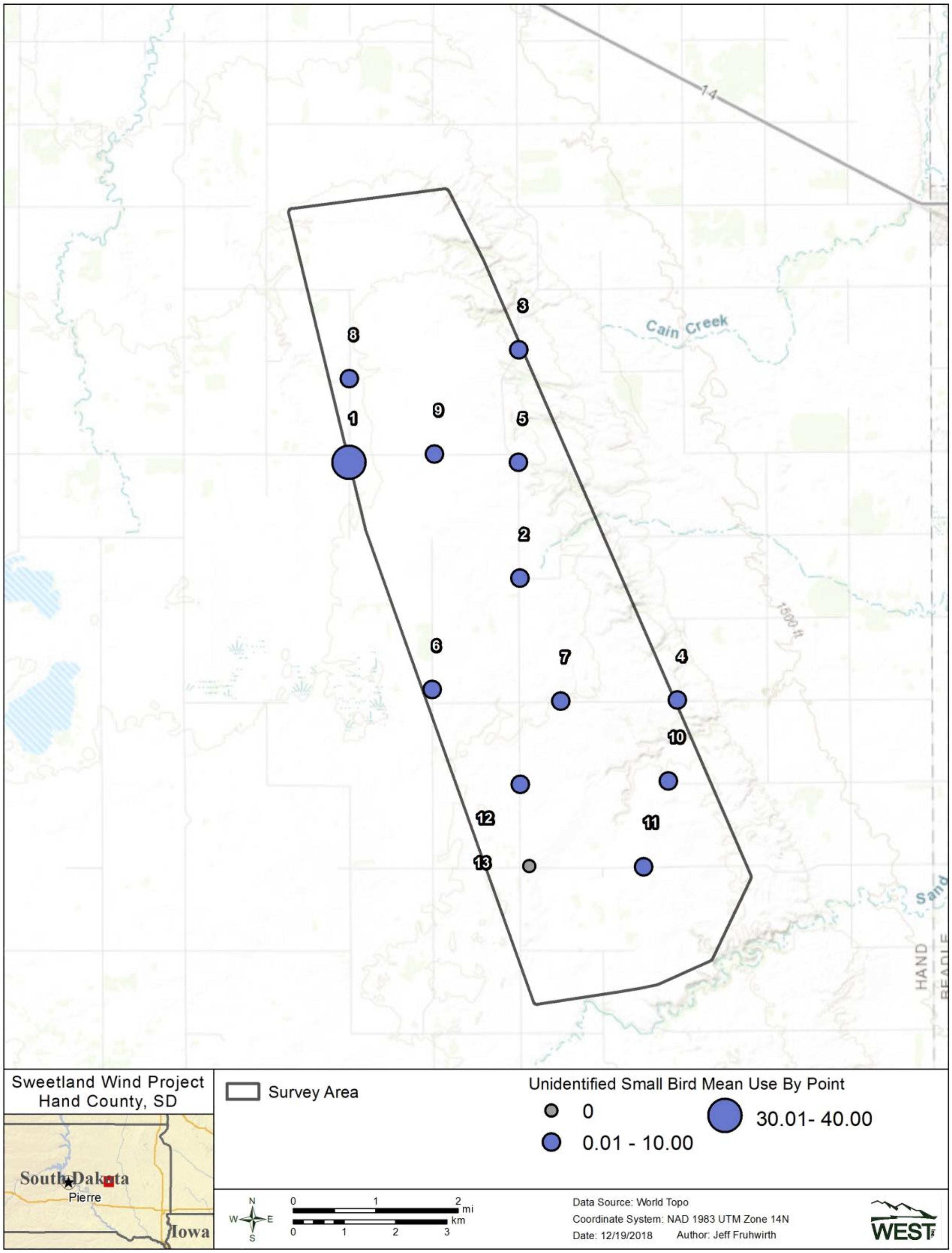
Appendix D3 (*continued*). Relative upland game bird use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



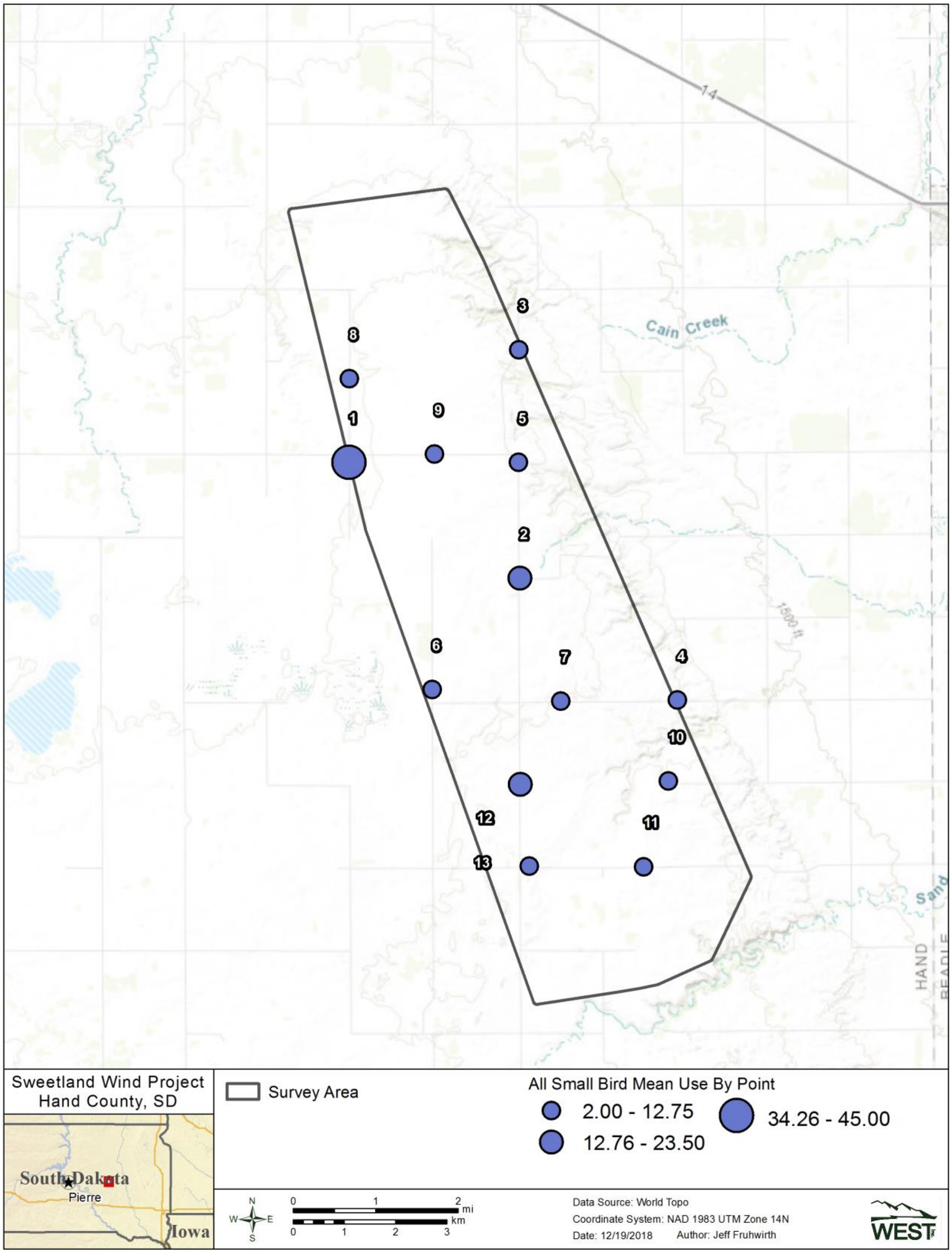
Appendix D3 (*continued*). Relative large corvid use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



Appendix D3 (*continued*). Relative goatsucker use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

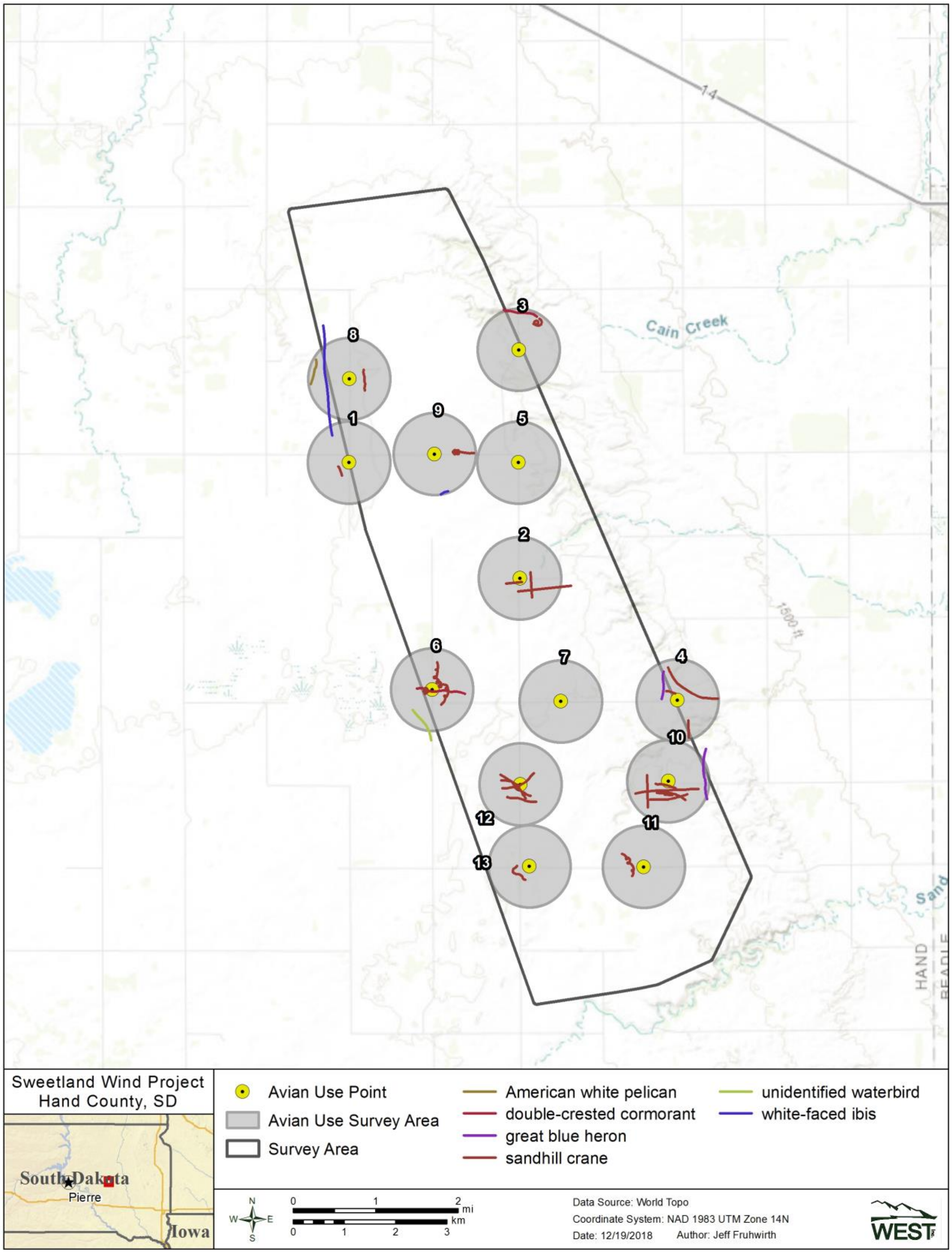


Appendix D3 (*continued*). Relative unidentified small bird use by observation point during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

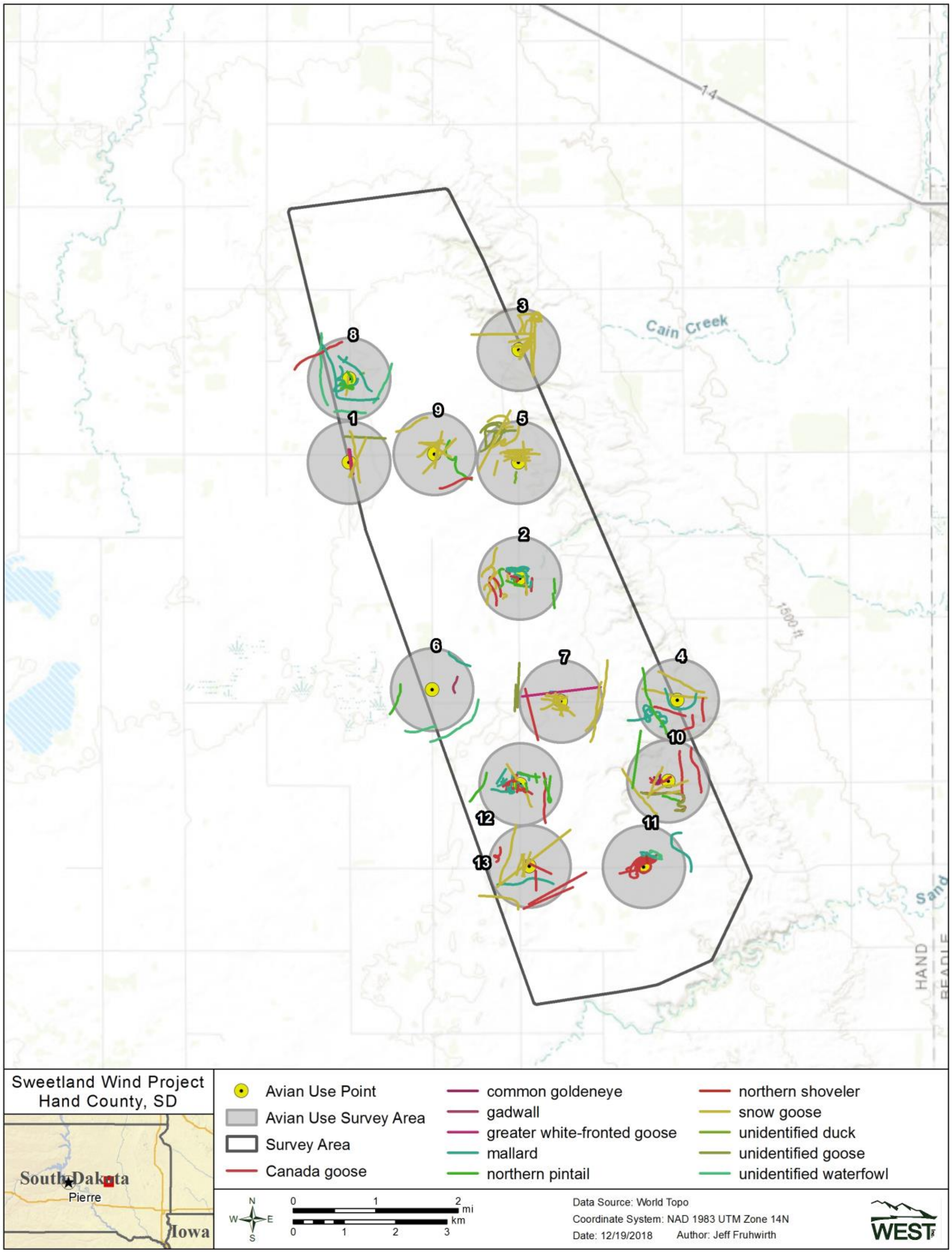


Appendix D3 (*continued*). Relative small bird use by observation point during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

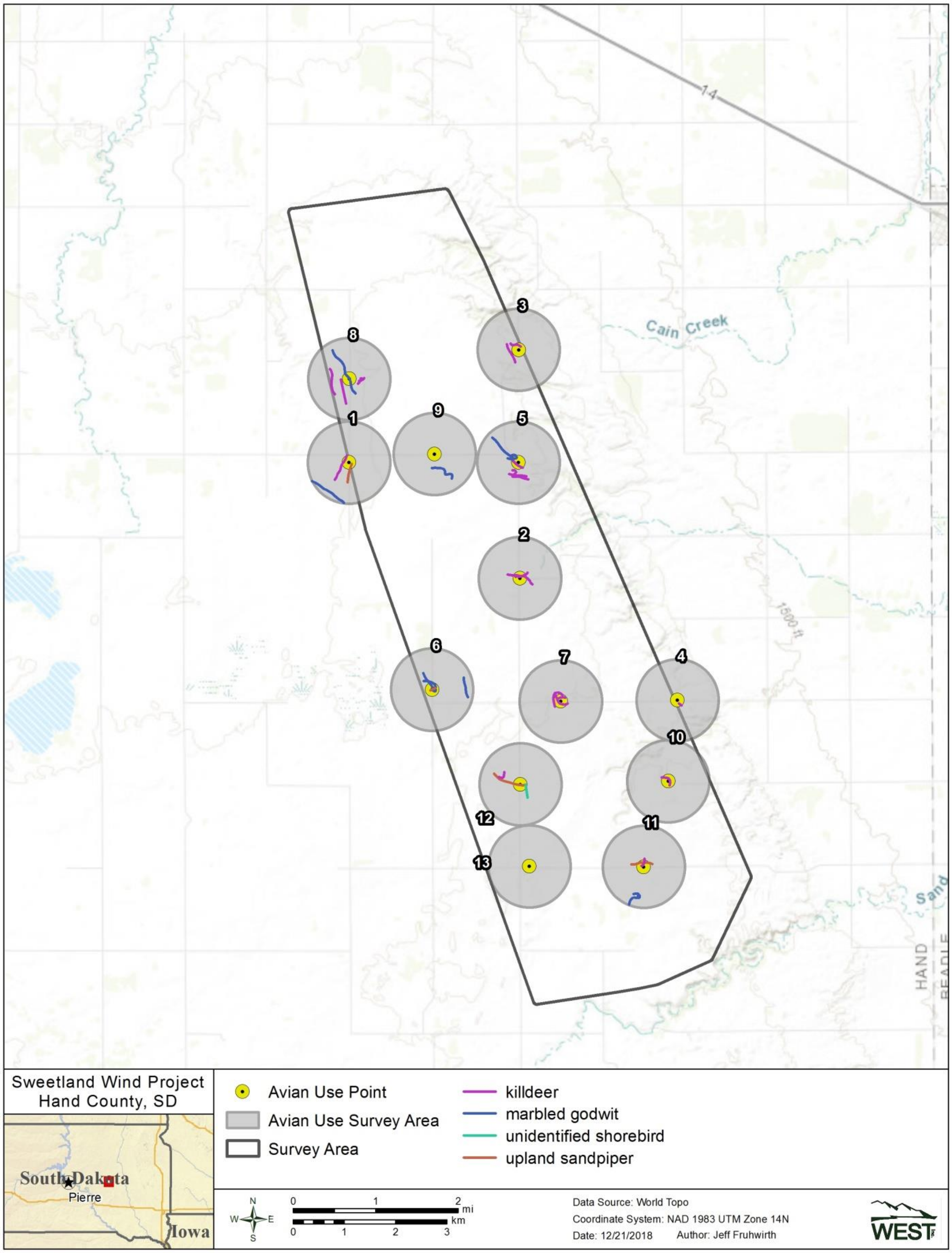
Appendix E. Large Bird Flight Paths Observed during Fixed-Point Large Bird Use Surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018



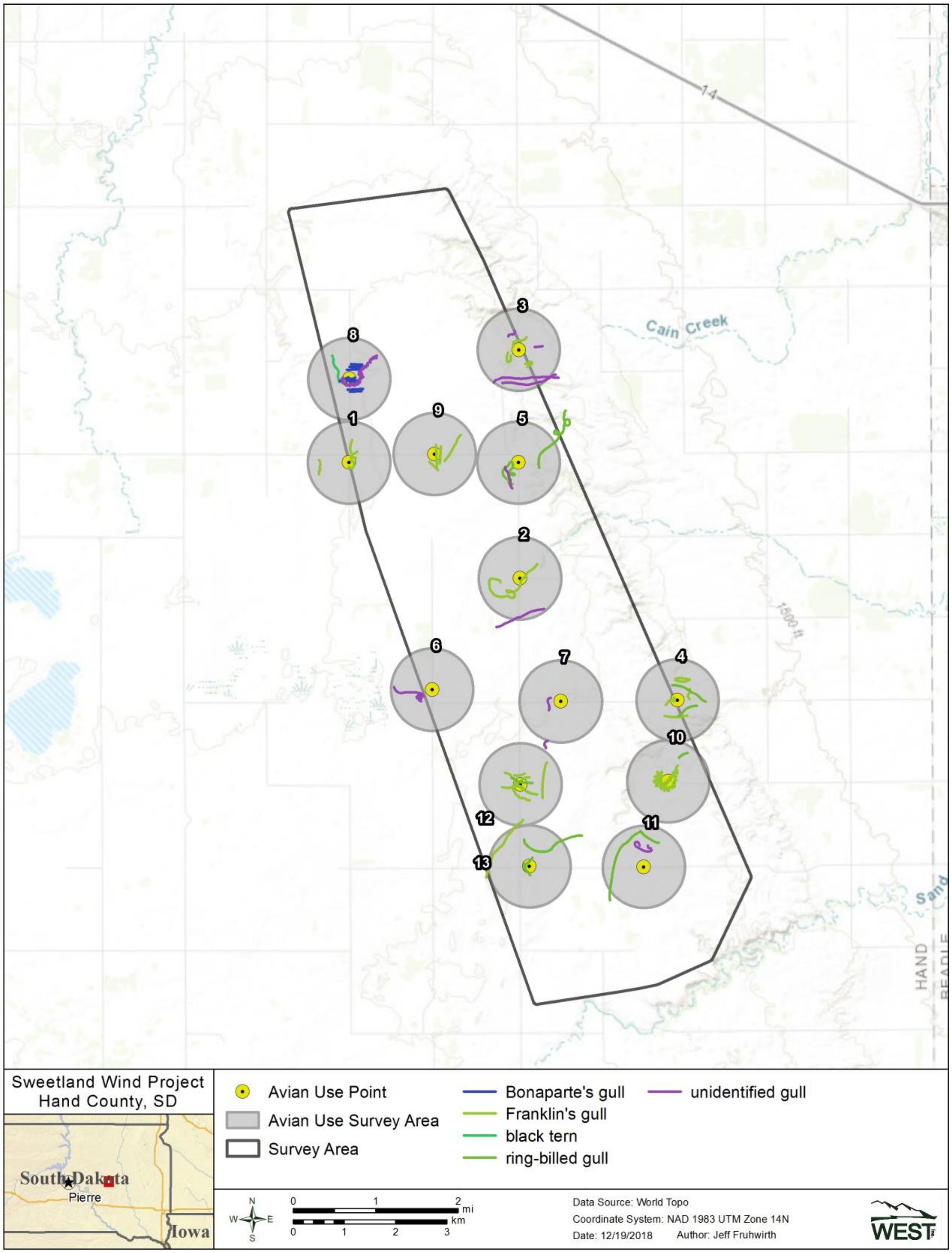
Appendix E. Waterbird flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



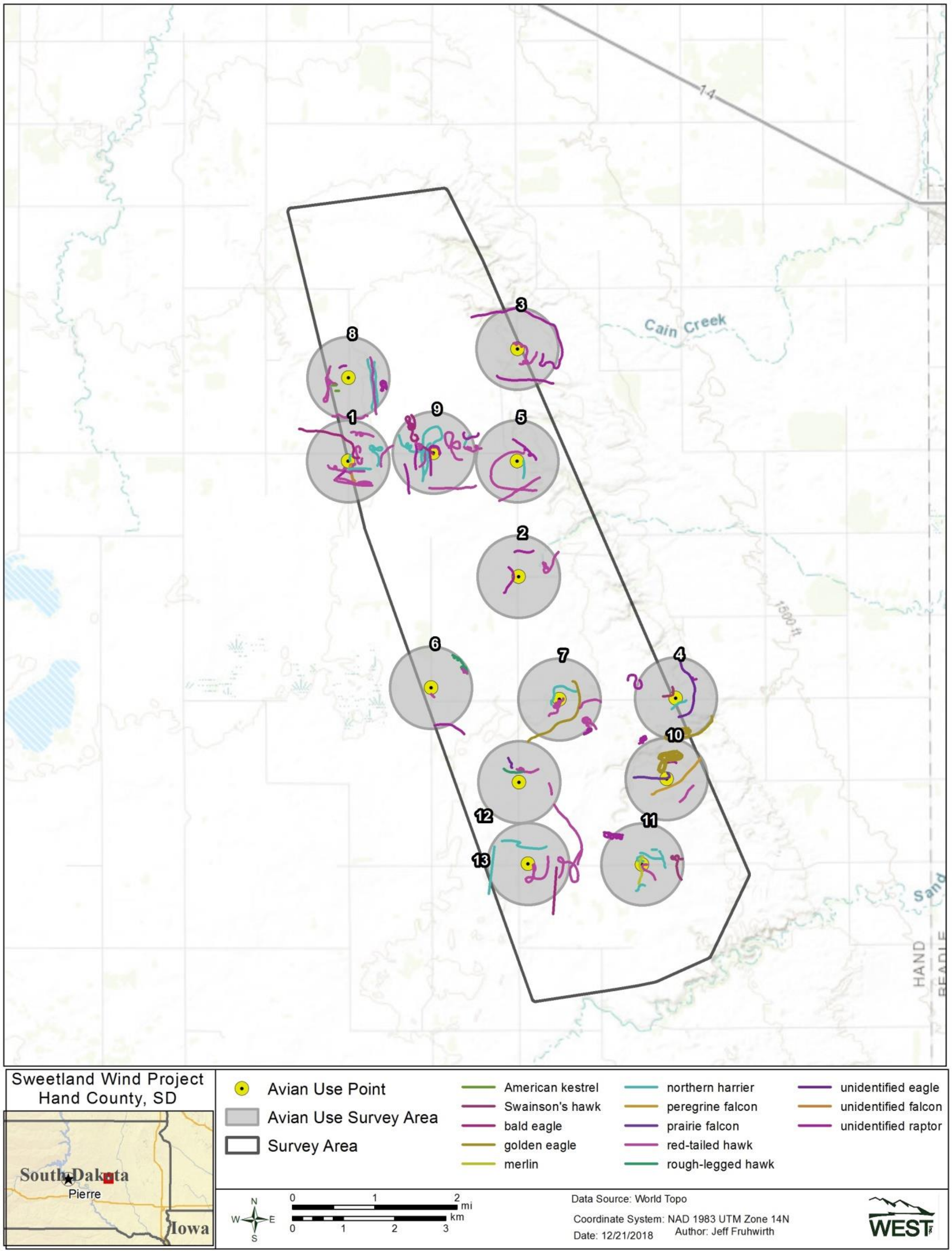
Appendix E (*continued*). Waterfowl flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



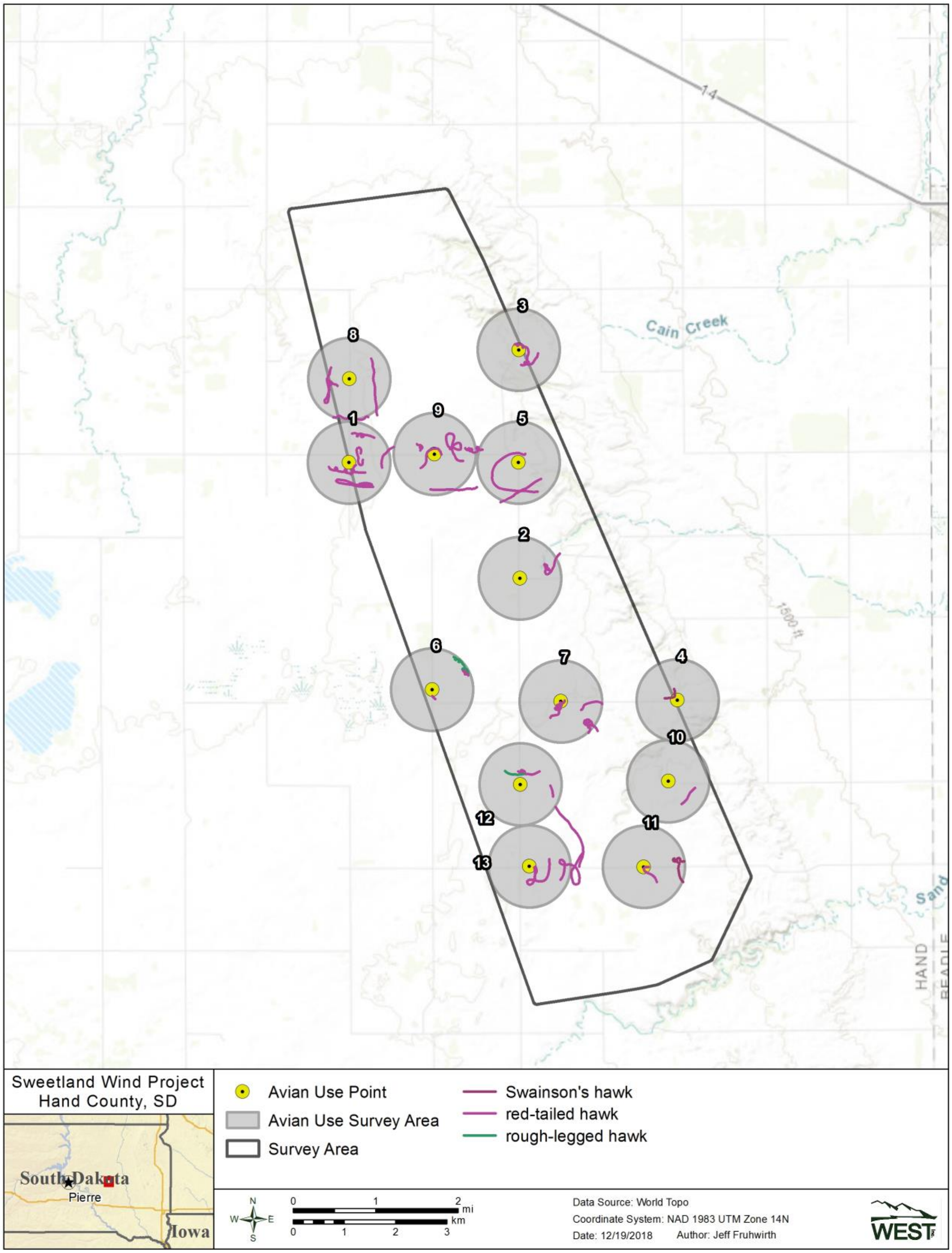
Appendix E (*continued*). Shorebird flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



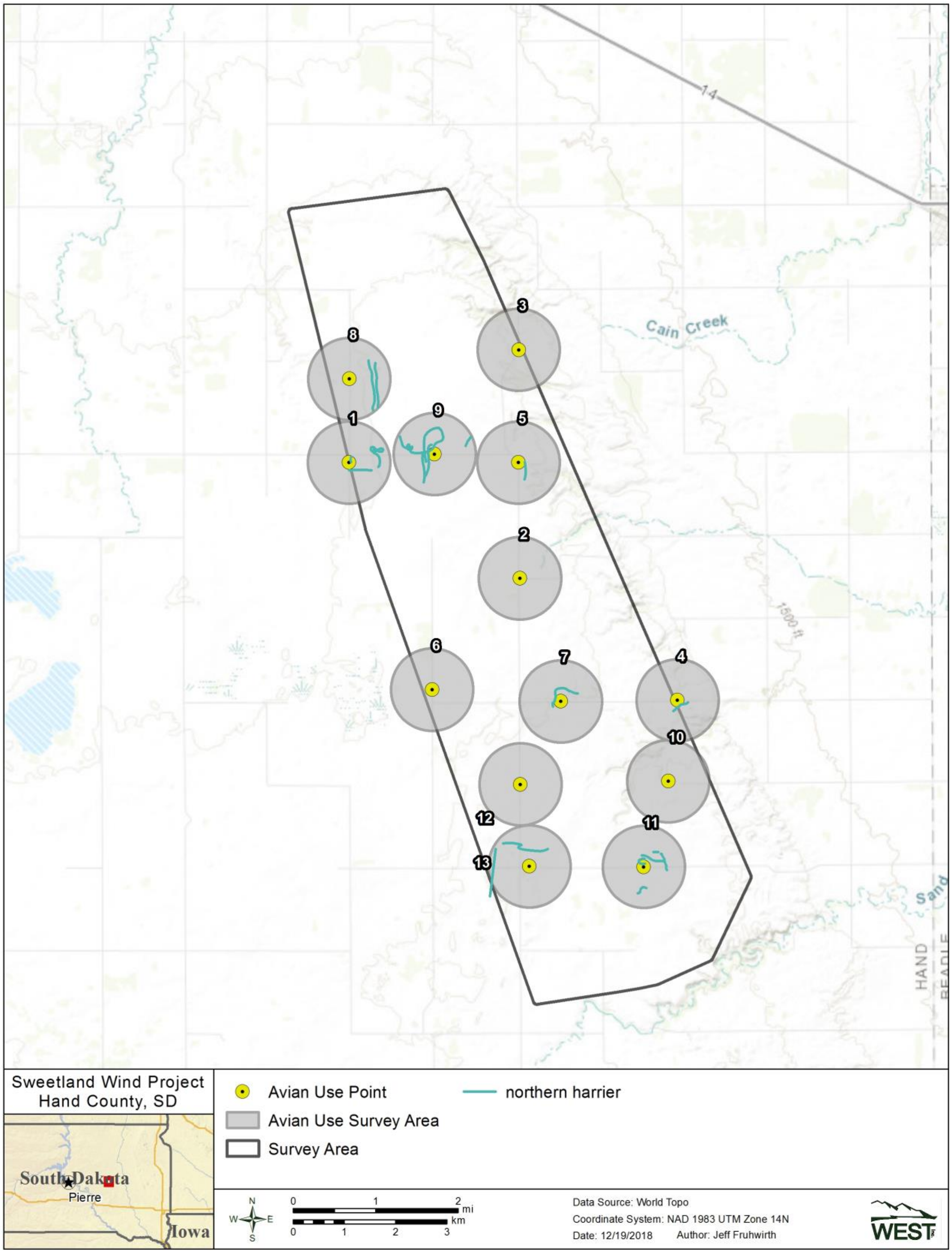
Appendix E (*continued*). Gull/tern flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



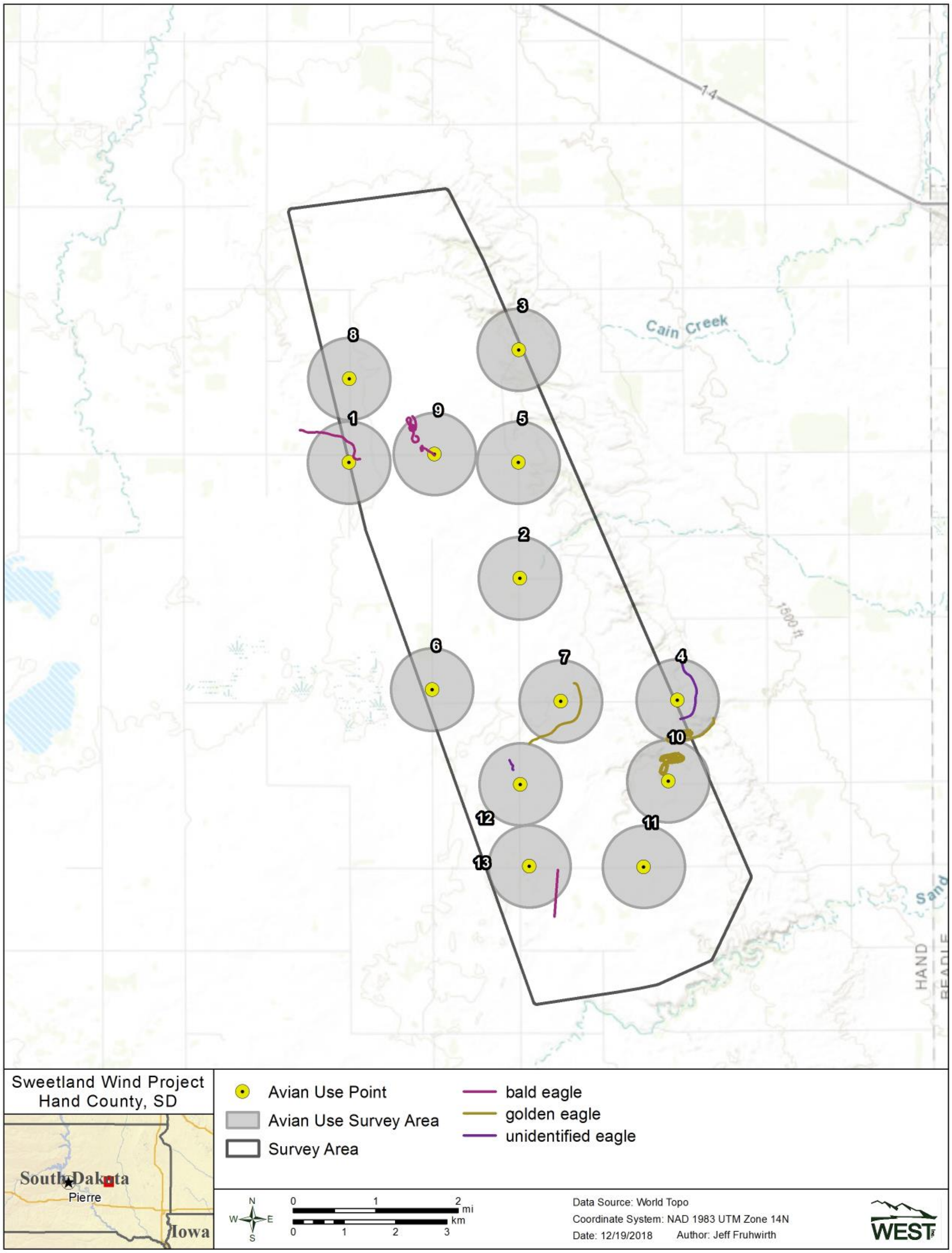
Appendix E (*continued*). Diurnal raptor flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



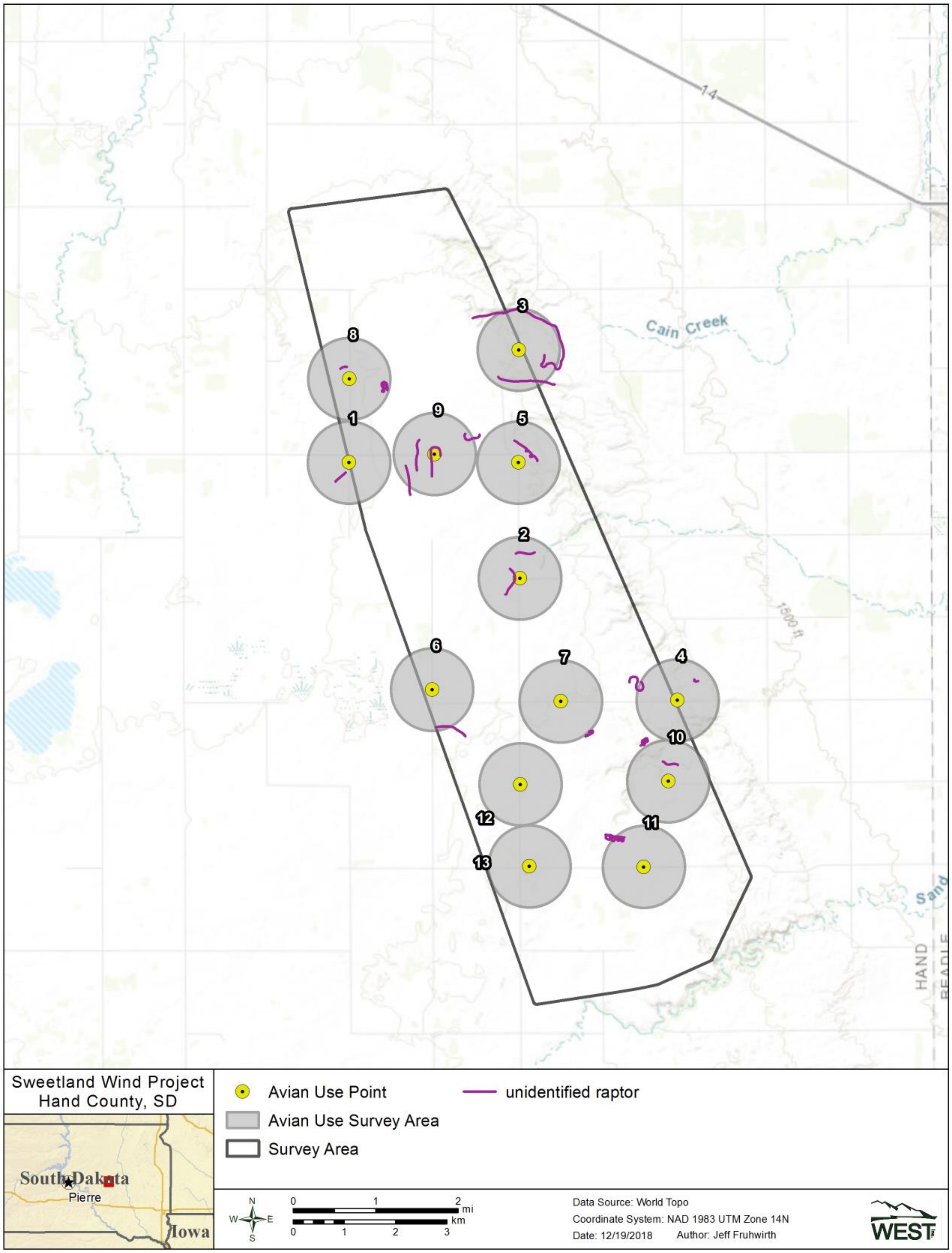
Appendix E (*continued*). Buteo flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



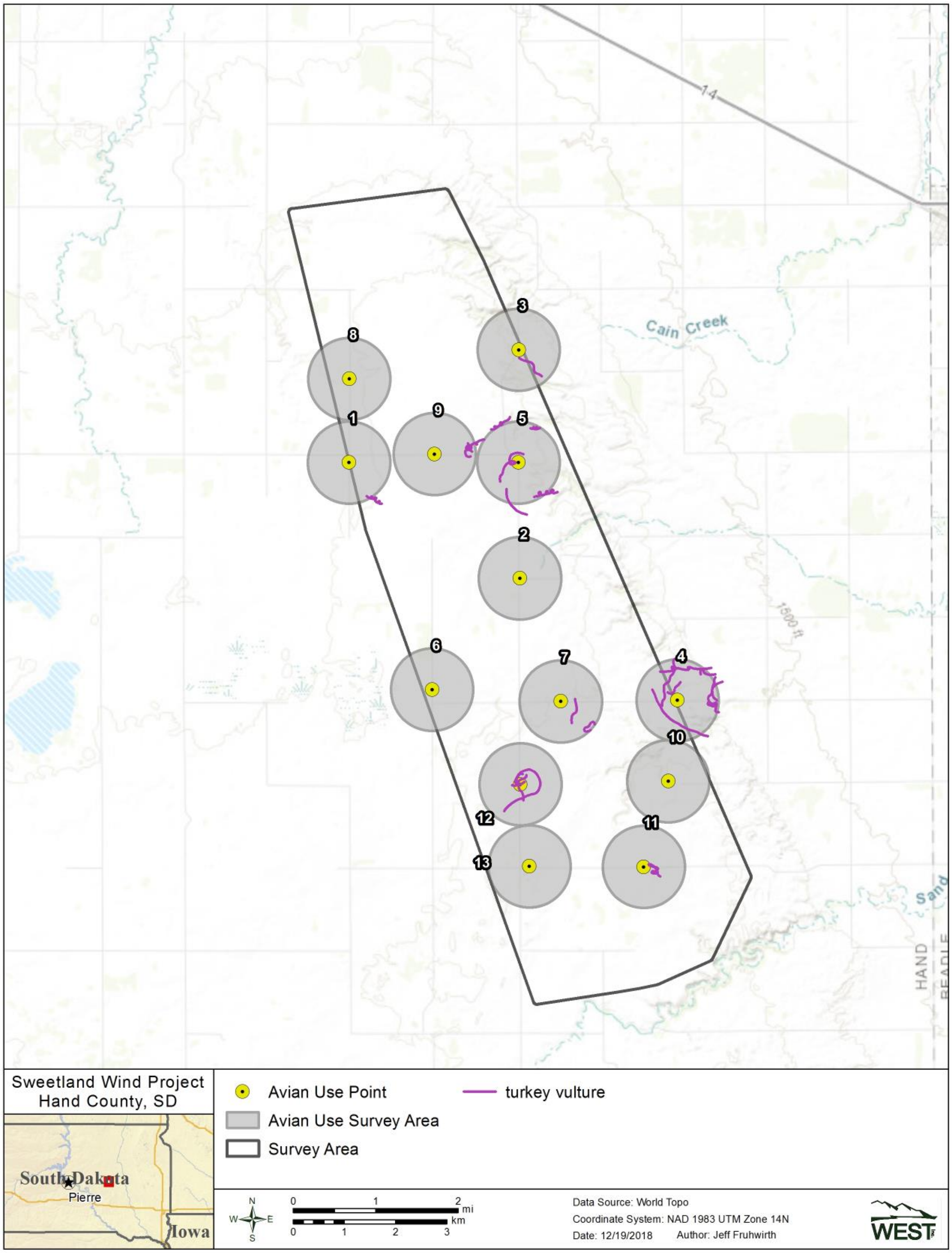
Appendix E (*continued*). Northern harrier flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



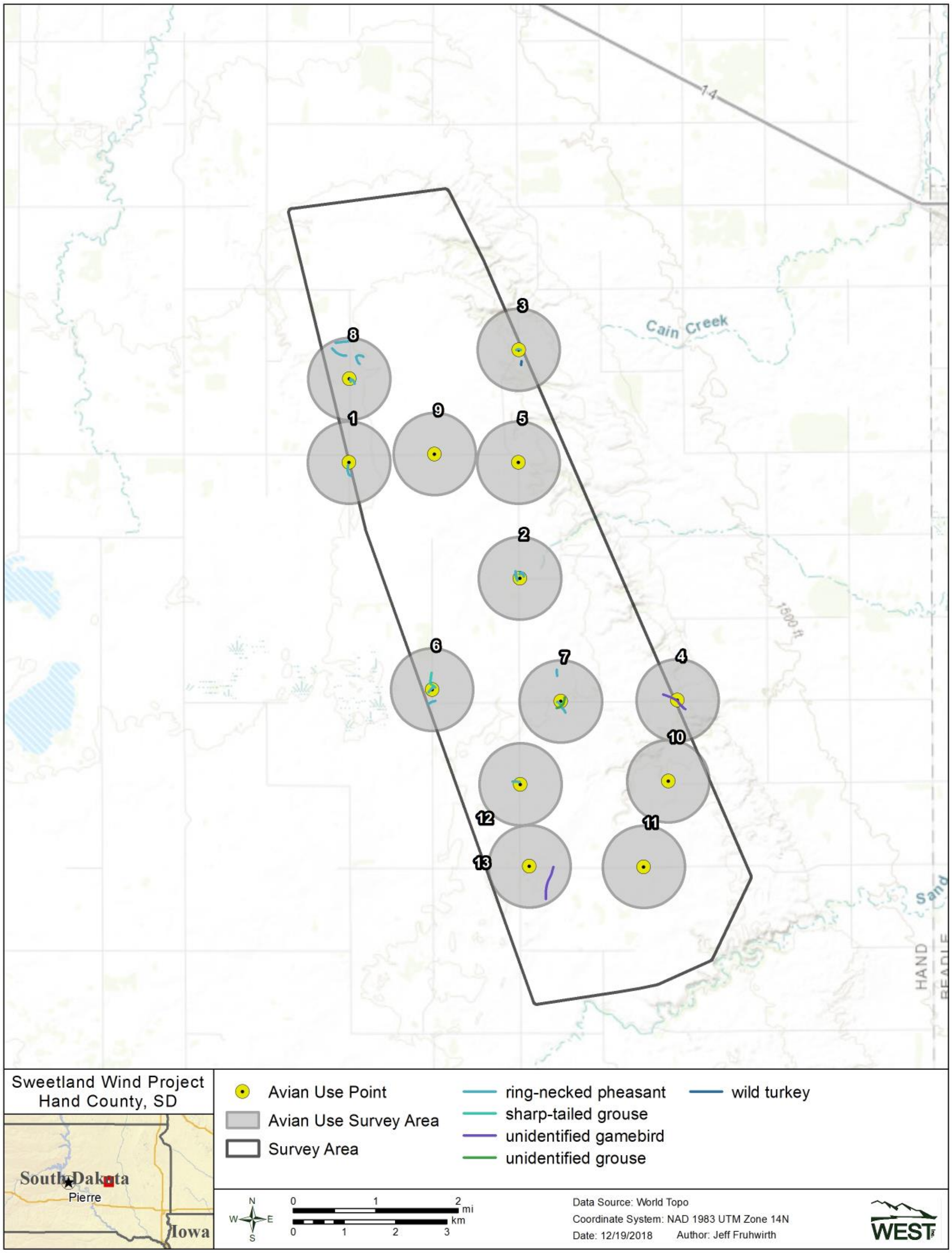
Appendix E (*continued*). Eagle flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



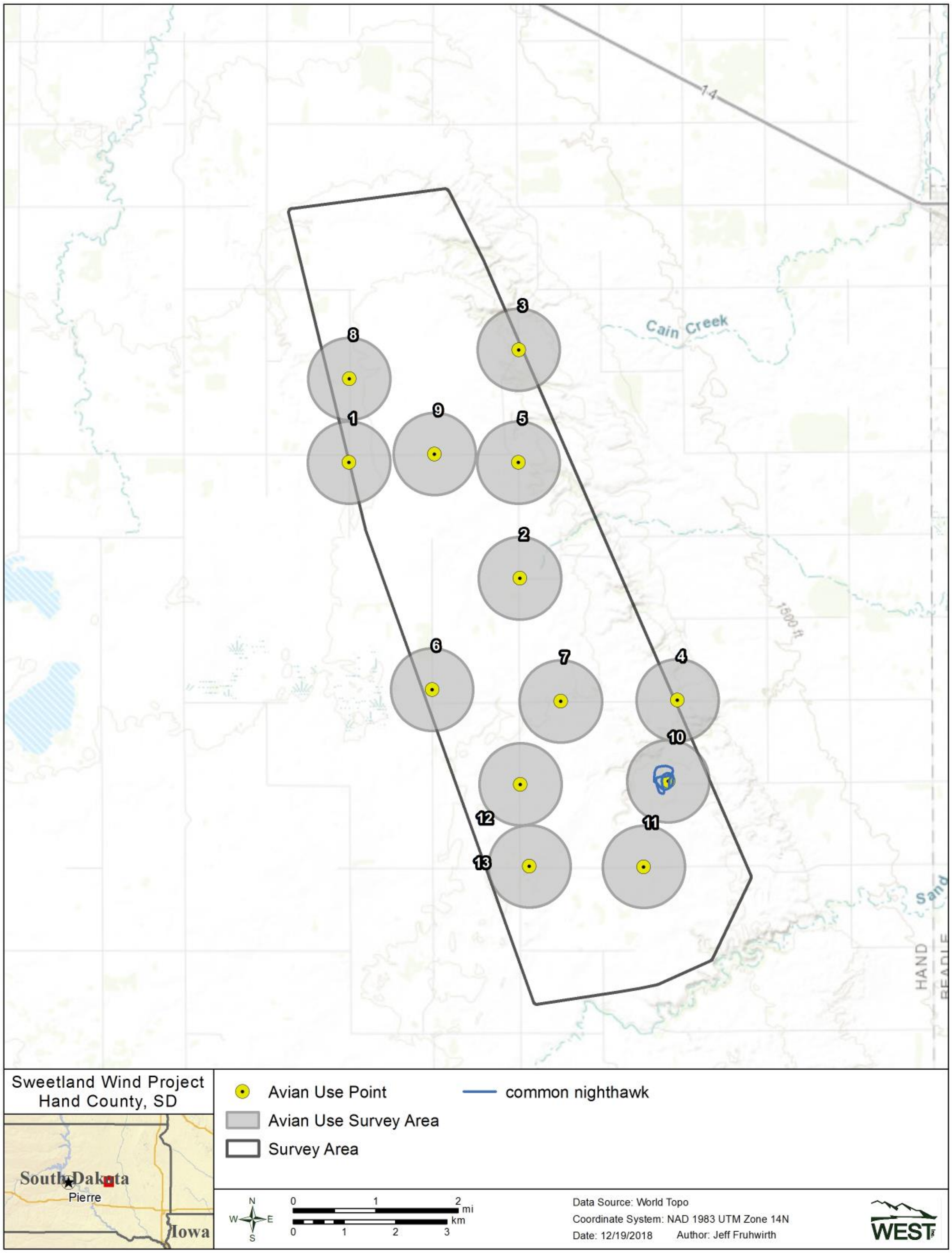
Appendix E (*continued*). Unidentified raptor flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



Appendix E (*continued*). Vulture flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



Appendix E (*continued*). Upland game bird flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



Appendix E (*continued*). Goatsucker flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Appendix F. North American Fatality Summary Tables

Appendix F1. Wind energy facilities in North America with publicly available and comparable fatality data for all bird species, by geographic region. Fatality rate estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Fatality Estimate	No. of Turbines	Total MW
	Midwest		
Wessington Springs, SD (2009)	8.25	34	51
Blue Sky Green Field, WI (2008; 2009)	7.17	88	145
Cedar Ridge, WI (2009)	6.55	41	67.6
Buffalo Ridge, MN (Phase III; 1999)	5.93	138	103.5
Moraine II, MN (2009)	5.59	33	49.5
Barton I & II, IA (2010-2011)	5.5	80	160
Buffalo Ridge I, SD (2009-2010)	5.06	24	50.4
Buffalo Ridge, MN (Phase I; 1996)	4.14	73	25
Winnebago, IA (2009-2010)	3.88	10	20
Rugby, ND (2010-2011)	3.82	71	149
Cedar Ridge, WI (2010)	3.72	41	68
Elm Creek II, MN (2011-2012)	3.64	62	148.8
Buffalo Ridge, MN (Phase II; 1999)	3.57	143	107.25
Buffalo Ridge, MN (Phase I; 1998)	3.14	73	25
Ripley, Ont (2008)	3.09	38	76
Fowler I, IN (2009)	2.83	162	301
Buffalo Ridge, MN (Phase I; 1997)	2.51	73	25
Buffalo Ridge, MN (Phase II; 1998)	2.47	143	107.25
PrairieWinds SD1, SD (2012-2013)	2.01	108	162
Buffalo Ridge II, SD (2011-2012)	1.99	105	210
Kewaunee County, WI (1999-2001)	1.95	31	20.46
PrairieWinds SD1, SD (2013-2014)	1.66	108	162
NPPD Ainsworth, NE (2006)	1.63	36	20.5
PrairieWinds ND1 (Minot), ND (2011)	1.56	80	115.5
Elm Creek, MN (2009-2010)	1.55	67	100
PrairieWinds ND1 (Minot), ND (2010)	1.48	80	115.5
Buffalo Ridge, MN (Phase I; 1999)	1.43	73	25
PrairieWinds SD1, SD (2011-2012)	1.41	108	162
Top Crop I & II, IL (2012-2013)	1.35	68 (Phase I) 132 (Phase II)	300 (102 Phase I, 198 Phase II)
Heritage Garden I, MI (2012-2014)	1.3	14	28
Wessington Springs, SD (2010)	0.89	34	51
Rail Splitter, IL (2012-2013)	0.84	67	100.5
Top of Iowa, IA (2004)	0.81	89	80
Big Blue, MN (2013)	0.6	18	36
Grand Ridge I, IL (2009-2010)	0.48	66	99
Top of Iowa, IA (2003)	0.42	89	80
Big Blue, MN (2014)	0.37	18	36
Pioneer Prairie II, IA (2011-2012)	0.27	62	102.3
	Southern Plains		
Buffalo Gap I, TX (2006)	1.32	67	134
Barton Chapel, TX (2009-2010)	1.15	60	120
Buffalo Gap II, TX (2007-2008)	0.15	155	233
Big Smile, OK (2012-2013)	0.09	66	132
Red Hills, OK (2012-2013)	0.08	82	123

Appendix F1. Wind energy facilities in North America with publicly available and comparable fatality data for all bird species, by geographic region. Fatality rate estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Fatality Estimate	No. of Turbines	Total MW
Rocky Mountains			
Foote Creek Rim, WY (Phase I; 1999)	3.4	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.42	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	69	41.4
Summerview, Alb (2005-2006)	1.06	39	70.2
Milford I & II, UT (2011-2012)	0.73	107	160.5 (58.5 Phase I, 102 Phase II)
Milford I, UT (2010-2011)	0.56	58	145
Southwest			
Dry Lake I, AZ (2009-2010)	2.02	30	63
Dry Lake II, AZ (2011-2012)	1.57	31	65
Pacific Northwest			
Windy Flats, WA (2010-2011)	8.45	114	262.2
Leaning Juniper, OR (2006-2008)	6.66	67	100.5
Linden Ranch, WA (2010-2011)	6.65	25	50
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	65	150
White Creek, WA (2007-2011)	4.05	89	204.7
Tuolumne (Windy Point I), WA (2009-2010)	3.2	62	136.6
Stateline, OR/WA (2001-2002)	3.17	454	299
Klondike II, OR (2005-2006)	3.14	50	75
Klondike III (Phase I), OR (2007-2009)	3.02	125	223.6
Hopkins Ridge, WA (2008)	2.99	87	156.6
Harvest Wind, WA (2010-2012)	2.94	43	98.9
Nine Canyon, WA (2002-2003)	2.76	37	48.1
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	65	150
Stateline, OR/WA (2003)	2.68	454	299
Klondike IIIa (Phase II), OR (2008-2010)	2.61	51	76.5
Combine Hills, OR (Phase I; 2004-2005)	2.56	41	41
Big Horn, WA (2006-2007)	2.54	133	199.5
Biglow Canyon, OR (Phase I; 2009)	2.47	76	125.4
Combine Hills, OR (2011)	2.33	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	76	174.8
Hay Canyon, OR (2009-2010)	2.21	48	100.8
Elkhorn, OR (2010)	1.95	61	101
Pebble Springs, OR (2009-2010)	1.93	47	98.7
Biglow Canyon, OR (Phase I; 2008)	1.76	76	125.4
Wild Horse, WA (2007)	1.55	127	229
Goodnoe, WA (2009-2010)	1.4	47	94
Vantage, WA (2010-2011)	1.27	60	90
Hopkins Ridge, WA (2006)	1.23	83	150
Stateline, OR/WA (2006)	1.23	454	299
Kittitas Valley, WA (2011-2012)	1.06	48	100.8
Klondike, OR (2002-2003)	0.95	16	24
Vansycle, OR (1999)	0.95	38	24.9
Palouse Wind, WA (2012-2013)	0.72	58	104.4
Elkhorn, OR (2008)	0.64	61	101
Marengo I, WA (2009-2010)	0.27	78	140.4
Marengo II, WA (2009-2010)	0.16	39	70.2

Appendix F1. Wind energy facilities in North America with publicly available and comparable fatality data for all bird species, by geographic region. Fatality rate estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Fatality Estimate	No. of Turbines	Total MW
	California		
Pine Tree, CA (2009-2010, 2011)	17.44	90	135
Montezuma I, CA (2012)	8.91	16	36.8
Alta I, CA (2011-2012)	7.07	100	150
Shiloh I, CA (2006-2009)	6.96	100	150
Montezuma I, CA (2011)	5.19	16	36.8
Dillon, CA (2008-2009)	4.71	45	45
Diablo Winds, CA (2005-2007)	4.29	31	20.46
Shiloh III, CA (2012-2013)	3.3	50	102.5
Shiloh II, CA (2010-2011)	2.8	75	150
Shiloh II, CA (2011-2012)	2.8	75	150
Shiloh II, CA (2009-2010)	1.9	75	150
Mustang Hills, CA (2012-2013)	1.66	50	150
Alta II-V, CA (2011-2012)	1.66	190	570
High Winds, CA (2003-2004)	1.62	90	162
Solano III, CA (2012-2013)	1.6	55	128
Pinyon Pines I & II, CA (2013-2014)	1.18	100	NA
High Winds, CA (2004-2005)	1.1	90	162
Montezuma II, CA (2012-2013)	1.08	34	78.2
Alta VIII, CA (2012-2013)	0.66	50	150
Alite, CA (2009-2010)	0.55	8	24
	Northeast		
Stetson Mountain I, ME (2013)	6.95	38	57
Criterion, MD (2011)	6.4	28	70
Mount Storm, WV (2011)	4.24	132	264
Pinnacle, WV (2012)	3.99	23	55.2
Mount Storm, WV (2009)	3.85	132	264
Record Hill, ME (2012)	3.7	22	50.6
Criterion, MD (2013)	3.49	28	70
Lempster, NH (2009)	3.38	12	24
Stetson Mountain II, ME (2012)	3.37	17	25.5
Rollins, ME (2012)	2.9	40	60
Casselman, PA (2009)	2.88	23	34.5
Mountaineer, WV (2003)	2.69	44	66
Stetson Mountain I, ME (2009)	2.68	38	57
Noble Ellenburg, NY (2009)	2.66	54	80
Lempster, NH (2010)	2.64	12	24
Mount Storm, WV (2010)	2.6	132	264
Maple Ridge, NY (2007)	2.34	195	321.75
Noble Bliss, NY (2009)	2.28	67	100
Criterion, MD (2012)	2.14	28	70
Maple Ridge, NY (2007-2008)	2.07	195	321.75
Record Hill, ME (2014)	1.84	22	50.6
Noble Altona, NY (2010)	1.84	65	97.5
High Sheldon, NY (2010)	1.76	75	112.5
Mars Hill, ME (2008)	1.76	28	42
Noble Wethersfield, NY (2010)	1.7	84	126
Mars Hill, ME (2007)	1.67	28	42
Noble Chateaugay, NY (2010)	1.66	71	106.5
Noble Clinton, NY (2008)	1.59	67	100

Appendix F1. Wind energy facilities in North America with publicly available and comparable fatality data for all bird species, by geographic region. Fatality rate estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Fatality Estimate	No. of Turbines	Total MW
High Sheldon, NY (2011)	1.57	75	112.5
Casselman, PA (2008)	1.51	23	34.5
Beech Ridge, WV (2013)	1.48	67	100.5
Munnsville, NY (2008)	1.48	23	34.5
Stetson Mountain II, ME (2010)	1.42	17	25.5
Cohocton/Dutch Hill, NY (2009)	1.39	50	125
Cohocton/Dutch Hills, NY (2010)	1.32	50	125
Noble Bliss, NY (2008)	1.3	67	100
Beech Ridge, WV (2012)	1.19	67	100.5
Stetson Mountain I, ME (2011)	1.18	38	57
Noble Clinton, NY (2009)	1.11	67	100
Locust Ridge, PA (Phase II; 2009)	0.84	51	102
Noble Ellenburg, NY (2008)	0.83	54	80
Locust Ridge, PA (Phase II; 2010)	0.76	51	102
Southeast			
Buffalo Mountain, TN (2000-2003)	11.02	3	1.98
Buffalo Mountain, TN (2005)	1.1	18	28.98

Appendix F1 (*continued*). Wind energy facilities in North America with publicly available and comparable fatality data for all bird species. Data from the following sources:

Wind Energy Facility	Estimate Reference	Wind Energy Facility	Estimate Reference
Alite, CA (09-10)	Chatfield et al. 2010a	Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Maple Ridge, NY (07)	Jain et al. 2009a
Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Maple Ridge, NY (07-08)	Jain et al. 2009b
Alta VIII, CA (12-13)	Chatfield and Bay 2014	Marengo I, WA (09-10)	URS Corporation 2010b
Barton I & II, IA (10-11)	Derby et al. 2011b	Marengo II, WA (09-10)	URS Corporation 2010c
Barton Chapel, TX (09-10)	WEST 2011	Mars Hill, ME (07)	Stantec 2008
Beech Ridge, WV (12)	Tidhar et al. 2013a	Mars Hill, ME (08)	Stantec 2009a
Beech Ridge, WV (13)	Young et al. 2014a	Milford I & II, UT (11-12)	Stantec 2012b
Big Blue, MN (13)	Fagen Engineering 2014	Milford I, UT (10-11)	Stantec 2011b
Big Blue, MN (14)	Fagen Engineering 2015	Montezuma I, CA (11)	ICF International 2012
Big Horn, WA (06-07)	Kronner et al. 2008	Montezuma I, CA (12)	ICF International 2013
Big Smile, OK (12-13)	Derby et al. 2013b	Montezuma II, CA (12-13)	Harvey & Associates 2013
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009b	Moraine II, MN (09)	Derby et al. 2010g
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011b	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Mount Storm, WV (11)	Young et al. 2011a, 2012a
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Munnsville, NY (08)	Stantec 2009b
Buffalo Gap I, TX (06)	Tierney 2007	Mustang Hills, CA (12-13)	Chatfield and Bay 2014
Buffalo Gap II, TX (07-08)	Tierney 2009	Nine Canyon, WA (02-03)	Erickson et al. 2003a
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Noble Altona, NY (10)	Jain et al. 2011a
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Noble Bliss, NY (08)	Jain et al. 2009c
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000a	Noble Bliss, NY (09)	Jain et al. 2010c
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000a	Noble Chateaugay, NY (10)	Jain et al. 2011b
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000a	Noble Clinton, NY (08)	Jain et al. 2009d
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000a	Noble Clinton, NY (09)	Jain et al. 2010a
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000a	Noble Ellenburg, NY (08)	Jain et al. 2009e
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a	Noble Ellenburg, NY (09)	Jain et al. 2010b
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000a	Noble Wethersfield, NY (10)	Jain et al. 2011c
Buffalo Ridge I, SD (09-10)	Derby et al. 2010e	NPPD Ainsworth, NE (06)	Derby et al. 2007
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Palouse Wind, WA (12-13)	Stantec 2013a
Casselman, PA (08)	Arnett et al. 2009b	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Casselman, PA (09)	Arnett et al. 2010	Pine Tree, CA (09-10, 11)	BioResource Consultants 2012
Cedar Ridge, WI (09)	BHE Environmental 2010	Pinnacle, WV (12)	Hein et al. 2013a
Cedar Ridge, WI (10)	BHE Environmental 2011	Pinyon Pines I & II, CA (13-14)	Chatfield and Russo 2014
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Cohocton/Dutch Hill, NY (10)	Stantec 2011a	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011d
Combine Hills, OR (Ph. I; 04-05)	Young et al. 2006	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012d

Appendix F1 (*continued*). Wind energy facilities in North America with publicly available and comparable fatality data for all bird species. Data from the following sources:

Wind Energy Facility	Estimate Reference	Wind Energy Facility	Estimate Reference
Combine Hills, OR (11)	Enz et al. 2012	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012c
Criterion, MD (11)	Young et al. 2012b	PrairieWinds SD1 (Crow Lake), SD (12-13)	Derby et al. 2013a
Criterion, MD (12)	Young et al. 2013	PrairieWinds SD1, SD (13-14)	Derby et al. 2014
Criterion, MD (13)	Young et al. 2014b	Rail Splitter, IL (12-13)	Good et al. 2013b
Diablo Winds, CA (05-07)	WEST 2006, 2008	Record Hill, ME (12)	Stantec 2013b
Dillon, CA (08-09)	Chatfield et al. 2009	Record Hill, ME (14)	Stantec 2015
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Red Hills, OK (12-13)	Derby et al. 2013c
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Ripley, Ont (08)	Jacques Whitford 2009
Elkhorn, OR (08)	Jeffrey et al. 2009a	Rollins, ME (12)	Stantec 2013c
Elkhorn, OR (10)	Enk et al. 2011a	Rugby, ND (10-11)	Derby et al. 2011c
Elm Creek, MN (09-10)	Derby et al. 2010f	Shiloh I, CA (06-09)	Kerlinger et al. 2009
Elm Creek II, MN (11-12)	Derby et al. 2012b	Shiloh II, CA (09-10)	Kerlinger et al. 2010, 2013a
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003a	Shiloh II, CA (10-11)	Kerlinger et al. 2013a
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003a	Shiloh II, CA (11-12)	Kerlinger et al. 2013a
Foote Creek Rim, WY (Ph. I; 01-02)	Young et al. 2003a	Shiloh III, CA (12-13)	Kerlinger et al. 2013b
Fowler I, IN (09)	Johnson et al. 2010a	Solano III, CA (12-13)	AECOM 2013
Goodnoe, WA (09-10)	URS Corporation 2010a	Stateline, OR/WA (01-02)	Erickson et al. 2004
Grand Ridge, IL (09-10)	Derby et al. 2010a	Stateline, OR/WA (03)	Erickson et al. 2004
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Stateline, OR/WA (06)	Erickson et al. 2007
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Stetson Mountain I, ME (09)	Stantec 2009c
Heritage Garden I, MI (12-14)	Kerlinger et al. 2014	Stetson Mountain I, ME (11)	Normandeau Associates 2011
High Sheldon, NY (10)	Tidhar et al. 2012a	Stetson Mountain I, ME (13)	Stantec 2014
High Sheldon, NY (11)	Tidhar et al. 2012b	Stetson Mountain II, ME (10)	Normandeau Associates 2010
High Winds, CA (03-04)	Kerlinger et al. 2006	Stetson Mountain II, ME (12)	Stantec 2013e
High Winds, CA (04-05)	Kerlinger et al. 2006	Summerview, Alb (05-06)	Brown and Hamilton 2006b
Hopkins Ridge, WA (06)	Young et al. 2007c	Top Crop I & II, IL (12-13)	Good et al. 2013c
Hopkins Ridge, WA (08)	Young et al. 2009b	Top of Iowa, IA (03)	Jain 2005
Kewaunee County, WI (99-01)	Howe et al. 2002	Top of Iowa, IA (04)	Jain 2005
Kittitas Valley, WA (11-12)	Stantec 2012	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
Klondike, OR (02-03)	Johnson et al. 2003	Vansycle, OR (99)	Erickson et al. 2000
Klondike II, OR (05-06)	NWC and WEST 2007	Vantage, WA (10-11)	Ventus 2012
Klondike III, OR (Phase I; 07-09)	Gritski et al. 2010	Wessington Springs, SD (09)	Derby et al. 2010d
Klondike IIIa, OR (Phase II; 08-10)	Gritski et al. 2011	Wessington Springs, SD (10)	Derby et al. 2011a
Leaning Juniper, OR (06-08)	Gritski et al. 2008	White Creek, WA (07-11)	Downes and Gritski 2012b
Lempster, NH (09)	Tidhar et al. 2010	Wild Horse, WA (07)	Erickson et al. 2008
Lempster, NH (10)	Tidhar et al. 2011	Windy Flats, WA (10-11)	Enz et al. 2011
Linden Ranch, WA (10-11)	Enz and Bay 2011	Winnebago, IA (09-10)	Derby et al. 2010h
Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011		

Appendix F2. Wind energy facilities in North America with publicly available and comparable use and fatality data for diurnal raptors, by geographic region. Use estimate given as the number of birds per 800-meter plot per 20-minute survey. Fatality rate estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Fatality Estimate	No. of Turbines	Total MW
Midwest				
Buffalo Ridge, MN (Phase I; 1999)	NA	0.47	73	25
Moraine II, MN (2009)	NA	0.37	33	49.5
Winnebago, IA (2009-2010)	NA	0.27	10	20
Buffalo Ridge I, SD (2009-2010)	NA	0.2	24	50.4
Cedar Ridge, WI (2009)	NA	0.18	41	67.6
PrairieWinds SD1, SD (2013-2014)	NA	0.17	108	162
Top of Iowa, IA (2004)	NA	0.17	89	80
Cedar Ridge, WI (2010)	NA	0.13	41	68
Ripley, Ont (2008)	NA	0.1	38	76
Wessington Springs, SD (2010)	0.232	0.07	34	51
Rugby, ND (2010-2011)	NA	0.06	71	149
NPPD Ainsworth, NE (2006)	NA	0.06	36	20.5
Wessington Springs, SD (2009)	0.232	0.06	34	51
PrairieWinds ND1 (Minot), ND (2011)	NA	0.05	80	115.5
PrairieWinds ND1 (Minot), ND (2010)	NA	0.05	80	115.5
PrairieWinds SD1, SD (2012-2013)	NA	0.03	108	162
Elm Creek, MN (2009-2010)	NA	0	67	100
Rail Splitter, IL (2012-2013)	NA	0	67	100.5
Pioneer Prairie II, IA (2011-2012)	NA	0	62	102.3
Buffalo Ridge, MN (Phase III; 1999)	NA	0	138	103.5
Buffalo Ridge, MN (Phase II; 1998)	NA	0	143	107.25
Buffalo Ridge, MN (Phase II; 1999)	NA	0	143	107.25
Blue Sky Green Field, WI (2008; 2009)	NA	0	88	145
Elm Creek II, MN (2011-2012)	NA	0	62	148.8
Barton I & II, IA (2010-2011)	NA	0	80	160
PrairieWinds SD1, SD (2011-2012)	NA	0	108	162
Kewaunee County, WI (1999-2001)	NA	0	31	20.46
Buffalo Ridge II, SD (2011-2012)	NA	0	105	210
Buffalo Ridge, MN (Phase I; 1996)	NA	0	73	25
Buffalo Ridge, MN (Phase I; 1997)	NA	0	73	25
Buffalo Ridge, MN (Phase I; 1998)	NA	0	73	25
Fowler I, IN (2009)	NA	0	162	301
Big Blue, MN (2013)	NA	0	18	36
Big Blue, MN (2014)	NA	0	18	36
Top of Iowa, IA (2003)	NA	0	89	80
Grand Ridge I, IL (2009-2010)	0.195	0	66	99
Southern Plains				
Barton Chapel, TX (2009-2010)	NA	0.25	60	120
Buffalo Gap I, TX (2006)	NA	0.1	67	134
Red Hills, OK (2012-2013)	NA	0.04	82	123
Big Smile, OK (2012-2013)	NA	0	66	132
Buffalo Gap II, TX (2007-2008)	NA	0	155	233

Appendix F2. Wind energy facilities in North America with publicly available and comparable use and fatality data for diurnal raptors, by geographic region. Use estimate given as the number of birds per 800-meter plot per 20-minute survey. Fatality rate estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Fatality Estimate	No. of Turbines	Total MW
Pacific Northwest				
White Creek, WA (2007-2011)	NA	0.47	89	204.7
Tuolumne (Windy Point I), WA (2009-2010)	0.77	0.29	62	136.6
Vantage, WA (2010-2011)	NA	0.29	60	90
Linden Ranch, WA (2010-2011)	NA	0.27	25	50
Harvest Wind, WA (2010-2012)	NA	0.23	43	98.9
Goodnoe, WA (2009-2010)	NA	0.17	47	94
Leaning Juniper, OR (2006-2008)	0.522	0.16	67	100.5
Klondike III (Phase I), OR (2007-2009)	NA	0.15	125	223.6
Hopkins Ridge, WA (2006)	0.698	0.14	83	150
Biglow Canyon, OR (Phase II; 2009-2010)	0.318	0.14	65	150
Big Horn, WA (2006-2007)	0.511	0.11	133	199.5
Stateline, OR/WA (2006)	0.478	0.11	454	299
Kittitas Valley, WA (2011-2012)	NA	0.09	48	100.8
Wild Horse, WA (2007)	0.291	0.09	127	229
Stateline, OR/WA (2001-2002)	0.478	0.09	454	299
Stateline, OR/WA (2003)	0.478	0.09	454	299
Elkhorn, OR (2010)	1.07	0.08	61	101
Hopkins Ridge, WA (2008)	0.698	0.07	87	156.6
Elkhorn, OR (2008)	1.07	0.06	61	101
Klondike II, OR (2005-2006)	0.504	0.06	50	75
Klondike IIIa (Phase II), OR (2008-2010)	NA	0.06	51	76.5
Combine Hills, OR (2011)	0.746	0.05	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	0.318	0.05	76	174.8
Marengo II, WA (2009-2010)	NA	0.05	39	70.2
Windy Flats, WA (2010-2011)	NA	0.04	114	262.2
Pebble Springs, OR (2009-2010)	NA	0.04	47	98.7
Biglow Canyon, OR (Phase I; 2008)	0.318	0.03	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)	0.318	0.03	65	150
Nine Canyon, WA (2002-2003)	0.35	0.03	37	48.1
Hay Canyon, OR (2009-2010)	NA	0	48	100.8
Biglow Canyon, OR (Phase I; 2009)	0.318	0	76	125.4
Marengo I, WA (2009-2010)	NA	0	78	140.4
Klondike, OR (2002-2003)	0.504	0	16	24
Vansycle, OR (1999)	0.66	0	38	24.9
Combine Hills, OR (Phase I; 2004-2005)	0.746	0	41	41
California				
Montezuma I, CA (2011)	NA	1.06	16	36.8
Shiloh II, CA (2011-2012)	NA	0.97	75	150
Solano III, CA (2012-2013)	NA	0.95	55	128
Montezuma I, CA (2012)	NA	0.79	16	36.8
High Winds, CA (2003-2004)	2.337	0.5	90	162
Montezuma II, CA (2012-2013)	NA	0.46	34	78.2
Shiloh II, CA (2010-2011)	NA	0.44	75	150
Shiloh I, CA (2006-2009)	NA	0.42	100	150
Diablo Winds, CA (2005-2007)	2.161	0.4	31	20.46

Appendix F2. Wind energy facilities in North America with publicly available and comparable use and fatality data for diurnal raptors, by geographic region. Use estimate given as the number of birds per 800-meter plot per 20-minute survey. Fatality rate estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Fatality Estimate	No. of Turbines	Total MW
High Winds, CA (2004-2005)	2.337	0.28	90	162
Alta I, CA (2011-2012)	0.19	0.27	100	150
Alite, CA (2009-2010)	NA	0.12	8	24
Shiloh II, CA (2009-2010)	NA	0.11	75	150
Mustang Hills, CA (2012-2013)	NA	0.08	50	150
Alta II-V, CA (2011-2012)	0.04	0.05	190	570
Alta VIII, CA (2012-2013)	NA	0.02	50	150
Dillon, CA (2008-2009)	NA	0	45	45
Rocky Mountains				
Summerview, Alb (2005-2006)	NA	0.11	39	70.2
Foote Creek Rim, WY (Phase I; 1999)	0.554	0.08	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	0.554	0.05	69	41.4
Milford I & II, UT (2011-2012)	NA	0.04	107	160.5 (58.5 Phase I, 102 Phase II)
Foote Creek Rim, WY (Phase I; 2001-2002)	0.554	0	69	41.4
Southwest				
Dry Lake I, AZ (2009-2010)	0.13	0	30	63
Dry Lake II, AZ (2011-2012)	NA	0	31	65
Northeast				
Munnsville, NY (2008)	NA	0.59	23	34.5
Noble Ellenburg, NY (2009)	NA	0.25	54	80
Noble Clinton, NY (2009)	NA	0.16	67	100
Noble Wethersfield, NY (2010)	NA	0.13	84	126
Noble Bliss, NY (2009)	NA	0.12	67	100
Noble Ellenburg, NY (2008)	NA	0.11	54	80
Noble Bliss, NY (2008)	NA	0.1	67	100
Noble Clinton, NY (2008)	NA	0.1	67	100
Mount Storm, WV (2010)	NA	0.1	132	264
Noble Chateaugay, NY (2010)	NA	0.08	71	106.5
Cohocton/Dutch Hills, NY (2010)	NA	0.08	50	125
Mountaineer, WV (2003)	NA	0.07	44	66
High Sheldon, NY (2010)	NA	0.06	75	112.5
Mount Storm, WV (2011)	NA	0.03	132	264
Maple Ridge, NY (2007-2008)	NA	0.03	195	321.75
Criterion, MD (2011)	NA	0.02	28	70
Beech Ridge, WV (2012)	NA	0.01	67	100.5
Beech Ridge, WV (2013)	NA	0.01	67	100.5
Locust Ridge, PA (Phase II; 2009)	NA	0	51	102
Locust Ridge, PA (Phase II; 2010)	NA	0	51	102
High Sheldon, NY (2011)	NA	0	75	112.5
Cohocton/Dutch Hill, NY (2009)	NA	0	50	125
Lempster, NH (2009)	NA	0	12	24
Lempster, NH (2010)	NA	0	12	24
Stetson Mountain II, ME (2010)	NA	0	17	25.5
Stetson Mountain II, ME (2012)	NA	0	17	25.5

Appendix F2. Wind energy facilities in North America with publicly available and comparable use and fatality data for diurnal raptors, by geographic region. Use estimate given as the number of birds per 800-meter plot per 20-minute survey. Fatality rate estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Fatality Estimate	No. of Turbines	Total MW
Mount Storm, WV (2009)	NA	0	132	264
Casselman, PA (2009)	NA	0	23	34.5
Casselman, PA (2008)	NA	0	23	34.5
Mars Hill, ME (2007)	NA	0	28	42
Mars Hill, ME (2008)	NA	0	28	42
Pinnacle, WV (2012)	NA	0	23	55.2
Stetson Mountain I, ME (2011)	NA	0	38	57
Stetson Mountain I, ME (2009)	NA	0	38	57
Stetson Mountain I, ME (2013)	NA	0	38	57
Noble Altona, NY (2010)	NA	0	65	97.5
Southeast				
Buffalo Mountain, TN (2000-2003)	NA	0	3	1.98
Buffalo Mountain, TN (2005)	NA	0	18	28.98

Appendix F2 (*continued*). Wind energy facilities in North America with publicly available and comparable use and fatality data for diurnal raptors. Data from the following sources:

Facility	Use Estimate Reference	Fatality Estimate Reference	Facility	Use Estimate Reference	Fatality Estimate Reference
Alite, CA (09-10)	NA	Chatfield et al. 2010a	Lempster, NH (09)	NA	Tidhar et al. 2010
Alta Wind I, CA (11-12)	Erickson et al. 2009	Chatfield et al. 2012	Lempster, NH (10)	NA	Tidhar et al. 2011
Alta Wind II-V, CA (11-12)	Erickson et al. 2009	Chatfield et al. 2012	Linden Ranch, WA (10-11)	NA	Enz and Bay 2011
Alta VIII, CA (12-13)	NA	Chatfield and Bay 2014	Locust Ridge, PA (Phase II; 09)	NA	Arnett et al. 2011
Barton I & II, IA (10-11)	NA	Derby et al. 2011b	Locust Ridge, PA (Phase II; 10)	NA	Arnett et al. 2011
Barton Chapel, TX (09-10)	NA	WEST 2011	Maple Ridge, NY (07-08)	NA	Jain et al. 2009b
Beech Ridge, WV (12)	NA	Tidhar et al. 2013a	Marengo I, WA (09-10)	NA	URS Corporation 2010b
Beech Ridge, WV (13)	NA	Young et al. 2014a	Marengo II, WA (09-10)	NA	URS Corporation 2010c
Big Blue, MN (13)	NA	Fagen Engineering 2014	Mars Hill, ME (07)	NA	Stantec 2008
Big Blue, MN (14)	NA	Fagen Engineering 2015	Mars Hill, ME (08)	NA	Stantec 2009a
Big Horn, WA (06-07)	Johnson and Erickson 2004	Kronner et al. 2008	Milford I & II, UT (11-12)	NA	Stantec 2012b
Big Smile, OK (12-13)	NA	Derby et al. 2013b	Montezuma I, CA (11)	NA	ICF International 2012
Biglow Canyon, OR (Phase I; 08)	WEST 2005c	Jeffrey et al. 2009b	Montezuma I, CA (12)	NA	ICF International 2013
Biglow Canyon, OR (Phase I; 09)	WEST 2005c	Enk et al. 2010	Montezuma II, CA (12-13)	NA	Harvey & Associates 2013
Biglow Canyon, OR (Phase II; 09-10)	WEST 2005c	Enk et al. 2011b	Moraine II, MN (09)	NA	Derby et al. 2010g
Biglow Canyon, OR (Phase II; 10-11)	WEST 2005c	Enk et al. 2012b	Mount Storm, WV (09)	NA	Young et al. 2009a, 2010b
Biglow Canyon, OR (Phase III; 10-11)	WEST 2005c	Enk et al. 2012a	Mount Storm, WV (10)	NA	Young et al. 2010a, 2011b
Blue Sky Green Field, WI (08; 09)	NA	Gruver et al. 2009	Mount Storm, WV (11)	NA	Young et al. 2011a, 2012a
Buffalo Gap I, TX (06)	NA	Tierney 2007	Mountaineer, WV (03)	NA	Kerns and Kerlinger 2004
Buffalo Gap II, TX (07-08)	NA	Tierney 2009	Munnsville, NY (08)	NA	Stantec 2009b
Buffalo Mountain, TN (00-03)	NA	Nicholson et al. 2005	Mustang Hills, CA (12-13)	NA	Chatfield and Bay 2014
Buffalo Mountain, TN (05)	NA	Fiedler et al. 2007	Nine Canyon, WA (02-03)	Erickson et al. 2001a	Erickson et al. 2003a
Buffalo Ridge, MN (Phase I; 96)	NA	Johnson et al. 2000a	Noble Altona, NY (10)	NA	Jain et al. 2011a
Buffalo Ridge, MN (Phase I; 97)	NA	Johnson et al. 2000a	Noble Bliss, NY (08)	NA	Jain et al. 2009c
Buffalo Ridge, MN (Phase I; 98)	NA	Johnson et al. 2000a	Noble Bliss, NY (09)	NA	Jain et al. 2010c
Buffalo Ridge, MN (Phase I; 99)	NA	Johnson et al. 2000a	Noble Chateaugay, NY (10)	NA	Jain et al. 2011b
Buffalo Ridge, MN (Phase II; 98)	NA	Johnson et al. 2000a	Noble Clinton, NY (08)	NA	Jain et al. 2009d

Appendix F2 (*continued*). Wind energy facilities in North America with publicly available and comparable use and fatality data for diurnal raptors. Data from the following sources:

Facility	Use Estimate Reference	Fatality Estimate Reference	Facility	Use Estimate Reference	Fatality Estimate Reference
Buffalo Ridge, MN (Phase II; 99)	NA	Johnson et al. 2000a	Noble Clinton, NY (09)	NA	Jain et al. 2010a
Buffalo Ridge, MN (Phase III; 99)	NA	Johnson et al. 2000a	Noble Ellenburg, NY (08)	NA	Jain et al. 2009e
Buffalo Ridge I, SD (09-10)	NA	Derby et al. 2010e	Noble Ellenburg, NY (09)	NA	Jain et al. 2010b
Buffalo Ridge II, SD (11-12)	NA	Derby et al. 2012a	Noble Wethersfield, NY (10)	NA	Jain et al. 2011c
Casselman, PA (08)	NA	Arnett et al. 2009b	NPPD Ainsworth, NE (06)	NA	Derby et al. 2007
Casselman, PA (09)	NA	Arnett et al. 2010	Pebble Springs, OR (09-10)	NA	Gritski and Kronner 2010b
Cedar Ridge, WI (09)	NA	BHE Environmental 2010	Pinnacle, WV (12)	NA	Hein et al. 2013a
Cedar Ridge, WI (10)	NA	BHE Environmental 2011	Pioneer Prairie I, IA (Phase II; 11-12)	NA	Chodachek et al. 2012
Cohocton/Dutch Hill, NY (09)	NA	Stantec 2010	PrairieWinds ND1 (Minot), ND (10)	NA	Derby et al. 2011d
Cohocton/Dutch Hills, NY (10)	NA	Stantec 2011a	PrairieWinds ND1 (Minot), ND (11)	NA	Derby et al. 2012d
Combine Hills, OR (Phase I; 04-05)	Young et al. 2003c	Young et al. 2006	PrairieWinds SD1 (Crow Lake), SD (11-12)	NA	Derby et al. 2012c
Combine Hills, OR (11)	Young et al. 2003c	Enz et al. 2012	PrairieWinds SD1 (Crow Lake), SD (12-13)	NA	Derby et al. 2013a
Criterion, MD (11)	NA	Young et al. 2012b	PrairieWinds SD1, SD (13-14)	NA	Derby et al. 2014
Diablo Winds, CA (05-07)	WEST 2006	WEST 2006, 2008	Rail Splitter, IL (12-13)	NA	Good et al. 2013b
Dillon, CA (08-09)	NA	Chatfield et al. 2009	Red Hills, OK (12-13)	NA	Derby et al. 2013c
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Thompson et al. 2011	Ripley, Ont (08)	NA	Jacques Whitford 2009
Dry Lake II, AZ (11-12)	NA	Thompson and Bay 2012	Rugby, ND (10-11)	NA	Derby et al. 2011c
Elkhorn, OR (08)	WEST 2005a	Jeffrey et a. 2009a	Shiloh I, CA (06-09)	NA	Kerlinger et al. 2009
Elkhorn, OR (10)	WEST 2005a	Enk et al. 2011a	Shiloh II, CA (09-10)	NA	Kerlinger et al. 2010, 2013a
Elm Creek, MN (09-10)	NA	Derby et al. 2010f	Shiloh II, CA (10-11)	NA	Kerlinger et al. 2013a
Elm Creek II, MN (11-12)	NA	Derby et al. 2012b	Shiloh II, CA (11-12)	NA	Kerlinger et al. 2013a
Foote Creek Rim, WY (Phase I; 99)	Johnson et al. 2000b	Young et al. 2003a	Solano III, CA (12-13)	NA	AECOM 2013
Foote Creek Rim, WY (Phase I; 00)	NA	Young et al. 2003a, 2003b	Stateline, OR/WA (01-02)	Erickson et al. 2003b	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 01-02)	NA	Young et al. 2003a, 2003b	Stateline, OR/WA (03)	Erickson et al. 2003b	Erickson et al. 2004
Fowler I, IN (09)	NA	Johnson et al. 2010a	Stateline, OR/WA (06)	Erickson et al. 2003b	Erickson et al. 2007
Goodnoe, WA (09-10)	NA	URS Corporation 2010a	Stetson Mountain I, ME (09)	NA	Stantec 2009c
Grand Ridge I, IL (09-10)	Derby et al. 2009	Derby et al. 2010a	Stetson Mountain I, ME (11)	NA	Normandeau Associates 2011

Appendix F2 (*continued*). Wind energy facilities in North America with publicly available and comparable use and fatality data for diurnal raptors. Data from the following sources:

Facility	Use Estimate Reference	Fatality Estimate Reference	Facility	Use Estimate Reference	Fatality Estimate Reference
Harvest Wind, WA (10-12)	NA	Downes and Gritski 2012a	Stetson Mountain I, ME (13)	NA	Stantec 2014
Hay Canyon, OR (09-10)	NA	Gritski and Kronner 2010a	Stetson Mountain II, ME (10)	NA	Normandeau Associates 2010
High Sheldon, NY (10)	NA	Tidhar et al. 2012a	Stetson Mountain II, ME (12)	NA	Stantec 2013e
High Sheldon, NY (11)	NA	Tidhar et al. 2012b	Summerview, Alb (05-06)	NA	Brown and Hamilton 2006b
High Winds, CA (03-04)	Kerlinger et al. 2005	Kerlinger et al. 2006	Top of Iowa, IA (03)	NA	Jain 2005
High Winds, CA (04-05)	Kerlinger et al. 2005	Kerlinger et al. 2006	Top of Iowa, IA (04)	NA	Jain 2005
Hopkins Ridge, WA (06)	Young et al. 2003e	Young et al. 2007c	Tuolumne (Windy Point I), WA (09-10)	Johnson et al. 2006	Enz and Bay 2010
Hopkins Ridge, WA (08)	Young et al. 2003e	Young et al. 2009b	Vansycle, OR (99)	WCIA and WEST 1997	Erickson et al. 2000
Kewaunee County, WI (99-01)	NA	Howe et al. 2002	Vantage, WA (10-11)	NA	Ventus 2012
Kittitas Valley, WA (11-12)	NA	Stantec 2012	Wessington Springs, SD (09)	Derby et al. 2008	Derby et al. 2010d
Klondike, OR (02-03)	Johnson et al. 2002	Johnson et al. 2003	Wessington Springs, SD (10)	Derby et al. 2008	Derby et al. 2011a
Klondike II, OR (05-06)	Johnson et al. 2002	NWC and WEST 2007	White Creek, WA (07-11)	NA	Downes and Gritski 2012b
Klondike III (Phase I), OR (07-09)	NA	Gritski et al. 2010	Wild Horse, WA (07)	Erickson et al. 2003d	Erickson et al. 2008
Klondike IIIa (Phase II), OR (08-10)	NA	Gritski et al. 2011	Windy Flats, WA (10-11)	NA	Enz et al. 2011
Leaning Juniper, OR (06-08)	Kronner et al. 2005	Gritski et al. 2008	Winnebago, IA (09-10)	NA	Derby et al. 2010h

Appendix F3. Fatality estimates for North American wind energy facilities. Fatality rate estimate given as the number of fatalities per megawatt per year.

Project	Bird Fatalities	Raptor Fatalities	Predominant Habitat Type	Citation
Alite, CA (2009-2010)	0.55	0.12	shrub/scrub and grassland	Chatfield et al. 2010a
Alta I, CA (2011-2012)	7.07	0.27	woodland, grassland, shrubland	Chatfield et al. 2012
Alta II-V, CA (2011-2012)	1.66	0.05	desert scrub	Chatfield et al. 2012
Alta VIII, CA (2012-2013)	0.66	0.02	grassland, riparian	Chatfield and Bay 2014
Barton I & II, IA (2010-2011)	5.5	0	agriculture	Derby et al. 2011b
Barton Chapel, TX (2009-2010)	1.15	0.25	agriculture/forest	WEST 2011
Beech Ridge, WV (2012)	1.19	0.01	forest	Tidhar et al. 2013a
Beech Ridge, WV (2013)	1.48	0.01	forest	Young et al. 2014a
Big Blue, MN (2013)	0.6	0	agriculture	Fagen Engineering 2014
Big Blue, MN (2014)	0.37	0	agriculture	Fagen Engineering 2015
Big Horn, WA (2006-2007)	2.54	0.11	agriculture/grassland	Kronner et al. 2008
Big Smile, OK (2012-2013)	0.09	0	grassland, agriculture	Derby et al. 2013b
Biglow Canyon, OR (Phase I; 2008)	1.76	0.03	agriculture/grassland	Jeffrey et al. 2009b
Biglow Canyon, OR (Phase I; 2009)	2.47	0	agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	0.14	agriculture	Enk et al. 2011b
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	0.03	grassland/shrub-steppe, agriculture	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	0.05	grassland/shrub-steppe, agriculture	Enk et al. 2012a
Blue Sky Green Field, WI (2008; 2009)	7.17	0	agriculture	Gruver et al. 2009
Buffalo Gap I, TX (2006)	1.32	0.1	grassland	Tierney 2007
Buffalo Gap II, TX (2007-2008)	0.15	0	forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	11.02	0	forest	Nicholson et al. 2005
Buffalo Mountain, TN (2005)	1.1	0	forest	Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 1996)	4.14	0	agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1997)	2.51	0	agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1998)	3.14	0	agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1999)	1.43	0.47	agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1998)	2.47	0	agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1999)	3.57	0	agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase III; 1999)	5.93	0	agriculture	Johnson et al. 2000a
Buffalo Ridge I, SD (2009-2010)	5.06	0.2	agriculture/grassland	Derby et al. 2010e
Buffalo Ridge II, SD (2011-2012)	1.99	0	agriculture, grassland	Derby et al. 2012a
Casselman, PA (2008)	1.51	0	forest	Arnett et al. 2009b
Casselman, PA (2009)	2.88	0	forest, pasture, grassland	Arnett et al. 2010
Cedar Ridge, WI (2009)	6.55	0.18	agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	3.72	0.13	agriculture	BHE Environmental 2011
Cohocton/Dutch Hill, NY (2009)	1.39	0	agriculture/forest	Stantec 2010
Cohocton/Dutch Hills, NY (2010)	1.32	0.08	agriculture, forest	Stantec 2011a
Combine Hills, OR (Phase I; 2004-2005)	2.56	0	agriculture/grassland	Young et al. 2006

Appendix F3. Fatality estimates for North American wind energy facilities. Fatality rate estimate given as the number of fatalities per megawatt per year.

Project	Bird Fatalities	Raptor Fatalities	Predominant Habitat Type	Citation
Combine Hills, OR (2011)	2.33	0.05	grassland/shrub-steppe, agriculture	Enz et al. 2012
Criterion, MD (2011)	6.4	0.02	forest, agriculture	Young et al. 2012b
Criterion, MD (2012)	2.14	NA	forest, agriculture	Young et al. 2013
Criterion, MD (2013)	3.49	NA	forest, agriculture	Young et al. 2014b
Diablo Winds, CA (2005-2007)	4.29	0.4	NA	WEST 2006, 2008
Dillon, CA (2008-2009)	4.71	0	desert	Chatfield et al. 2009
Dry Lake I, AZ (2009-2010)	2.02	0	desert grassland/forested	Thompson et al. 2011
Dry Lake II, AZ (2011-2012)	1.57	0	desert grassland/forested	Thompson and Bay 2012
Elkhorn, OR (2008)	0.64	0.06	shrub/scrub, agriculture	Jeffrey et al. 2009a
Elkhorn, OR (2010)	1.95	0.08	shrub/scrub, agriculture	Enk et al. 2011a
Elm Creek, MN (2009-2010)	1.55	0	agriculture	Derby et al. 2010f
Elm Creek II, MN (2011-2012)	3.64	0	agriculture, grassland	Derby et al. 2012b
Foote Creek Rim, WY (Phase I; 1999)	3.4	0.08	grassland	Young et al. 2003a
Foote Creek Rim, WY (Phase I; 2000)	2.42	0.05	grassland	Young et al. 2003a
Foote Creek Rim, WY (Phase I; 2001-2002)	1.93	0	grassland	Young et al. 2003a
Fowler I, IN (2009)	2.83	0	agriculture	Johnson et al. 2010a
Goodnoe, WA (2009-2010)	1.4	0.17	grassland, shrub-steppe	URS Corporation 2010a
Grand Ridge I, IL (2009-2010)	0.48	0	agriculture	Derby et al. 2010a
Harvest Wind, WA (2010-2012)	2.94	0.23	grassland/shrub-steppe	Downes and Gritski 2012a
Hay Canyon, OR (2009-2010)	2.21	0	agriculture	Gritski and Kronner 2010a
Heritage Garden I, MI (2012-2014)	1.3	NA	agriculture	Kerlinger et al. 2014
High Sheldon, NY (2010)	1.76	0.06	agriculture	Tidhar et al. 2012a
High Sheldon, NY (2011)	1.57	0	agriculture	Tidhar et al. 2012b
High Winds, CA (2003-2004)	1.62	0.5	agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2004-2005)	1.1	0.28	agriculture/grassland	Kerlinger et al. 2006
Hopkins Ridge, WA (2006)	1.23	0.14	agriculture/grassland	Young et al. 2007c
Hopkins Ridge, WA (2008)	2.99	0.07	agriculture/grassland	Young et al. 2009b
Kewaunee County, WI (1999-2001)	1.95	0	agriculture	Howe et al. 2002
Kittitas Valley, WA (2011-2012)	1.06	0.09	sagebrush-steppe, grassland	Stantec Consulting Services 2012
Klondike, OR (2002-2003)	0.95	0	agriculture/grassland	Johnson et al. 2003
Klondike II, OR (2005-2006)	3.14	0.06	agriculture/grassland	NWC and WEST 2007
Klondike III (Phase I), OR (2007-2009)	3.02	0.15	agriculture/grassland	Gritski et al. 2010
Klondike IIIa (Phase II), OR (2008-2010)	2.61	0.06	grassland/shrub-steppe, agriculture	Gritski et al. 2011
Leaning Juniper, OR (2006-2008)	6.66	0.16	agriculture	Gritski et al. 2008
Lempster, NH (2009)	3.38	0	grasslands/forest/rocky embankments	Tidhar et al. 2010

Appendix F3. Fatality estimates for North American wind energy facilities. Fatality rate estimate given as the number of fatalities per megawatt per year.

Project	Bird Fatalities	Raptor Fatalities	Predominant Habitat Type	Citation
Lempster, NH (2010)	2.64	0	grasslands/forest/rocky embankments	Tidhar et al. 2011
Linden Ranch, WA (2010-2011)	6.65	0.27	grassland/shrub-steppe, agriculture	Enz and Bay 2011
Locust Ridge, PA (Phase II; 2009)	0.84	0	grassland	Arnett et al. 2011
Locust Ridge, PA (Phase II; 2010)	0.76	0	grassland	Arnett et al. 2011
Maple Ridge, NY (2007)	2.34	NA	agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007-2008)	2.07	0.03	agriculture/forested	Jain et al. 2009b
Marengo I, WA (2009-2010)	0.27	0	agriculture	URS Corporation 2010b
Marengo II, WA (2009-2010)	0.16	0.05	agriculture	URS Corporation 2010c
Mars Hill, ME (2007)	1.67	0	forest	Stantec 2008
Mars Hill, ME (2008)	1.76	0	forest	Stantec 2009a
Milford I, UT (2010-2011)	0.56	NA	desert shrub	Stantec 2011b
Milford I & II, UT (2011-2012)	0.73	0.04	desert shrub	Stantec 2012b
Montezuma I, CA (2011)	5.19	1.06	agriculture, grasslands	ICF International 2012
Montezuma I, CA (2012)	8.91	0.79	agriculture, grasslands	ICF International 2013
Montezuma II, CA (2012-2013)	1.08	0.46	agriculture	Harvey & Associates 2013
Moraine II, MN (2009)	5.59	0.37	agriculture/grassland	Derby et al. 2010g
Mount Storm, WV (2009)	3.85	0	forest	Young et al. 2009a, 2010b
Mount Storm, WV (2010)	2.6	0.1	forest	Young et al. 2010a, 2011b
Mount Storm, WV (2011)	4.24	0.03	forest	Young et al. 2011a, 2012a
Mountaineer, WV (2003)	2.69	0.07	forest	Kerns and Kerlinger 2004
Munnsville, NY (2008)	1.48	0.59	agriculture/forest	Stantec 2009b
Mustang Hills, CA (2012-2013)	1.66	0.08	grasslands, riparian	Chatfield and Bay 2014
Nine Canyon, WA (2002-2003)	2.76	0.03	agriculture/grassland	Erickson et al. 2003a
Noble Altona, NY (2010)	1.84	0	forest	Jain et al. 2011a
Noble Bliss, NY (2008)	1.3	0.1	agriculture/forest	Jain et al. 2009c
Noble Bliss, NY (2009)	2.28	0.12	agriculture/forest	Jain et al. 2010c
Noble Chateaugay, NY (2010)	1.66	0.08	agriculture	Jain et al. 2011b
Noble Clinton, NY (2008)	1.59	0.1	agriculture/forest	Jain et al. 2009d
Noble Clinton, NY (2009)	1.11	0.16	agriculture/forest	Jain et al. 2010a
Noble Ellenburg, NY (2008)	0.83	0.11	agriculture/forest	Jain et al. 2009e
Noble Ellenburg, NY (2009)	2.66	0.25	agriculture/forest	Jain et al. 2010b
Noble Wethersfield, NY (2010)	1.7	0.13	agriculture	Jain et al. 2011c
NPPD Ainsworth, NE (2006)	1.63	0.06	agriculture/grassland	Derby et al. 2007
Palouse Wind, WA (2012-2013)	0.72	NA	agriculture, grasslands	Stantec 2013a
Pebble Springs, OR (2009-2010)	1.93	0.04	grassland	Gritski and Kronner 2010b
Pine Tree, CA (2009-2010, 2011)	17.44	NA	grassland	BioResource Consultants 2012

Appendix F3. Fatality estimates for North American wind energy facilities. Fatality rate estimate given as the number of fatalities per megawatt per year.

Project	Bird Fatalities	Raptor Fatalities	Predominant Habitat Type	Citation
Pinnacle, WV (2012)	3.99	0	forest	Hein et al. 2013a
Pinyon Pines I & II, CA (2013-2014)	1.18	NA	NA	Chatfield and Russo 2014
Pioneer Prairie II, IA (2011-2012)	0.27	0	agriculture, grassland	Chodachek et al. 2012
PrairieWinds ND1 (Minot), ND (2010)	1.48	0.05	agriculture	Derby et al. 2011d
PrairieWinds ND1 (Minot), ND (2011)	1.56	0.05	agriculture, grassland	Derby et al. 2012d
PrairieWinds SD1, SD (2011-2012)	1.41	0	grassland	Derby et al. 2012c
PrairieWinds SD1, SD (2012-2013)	2.01	0.03	grassland	Derby et al. 2013a
PrairieWinds SD1, SD (2013-2014)	1.66	0.17	grassland	Derby et al. 2014
Rail Splitter, IL (2012-2013)	0.84	0	agriculture	Good et al. 2013b
Record Hill, ME (2012)	3.7	NA	forest	Stantec 2013b
Record Hill, ME (2014)	1.84	NA	forest	Stantec 2015
Red Hills, OK (2012-2013)	0.08	0.04	grassland	Derby et al. 2013c
Ripley, Ont (2008)	3.09	0.1	agriculture	Jacques Whitford 2009
Rollins, ME (2012)	2.9	NA	forest	Stantec 2013c
Rugby, ND (2010-2011)	3.82	0.06	agriculture	Derby et al. 2011c
Shiloh I, CA (2006-2009)	6.96	0.42	agriculture/grassland	Kerlinger et al. 2009
Shiloh II, CA (2009-2010)	1.9	0.11	agriculture	Kerlinger et al. 2010, 2013a
Shiloh II, CA (2010-2011)	2.8	0.44	agriculture	Kerlinger et al. 2013a
Shiloh II, CA (2011-2012)	2.8	0.97	agriculture	Kerlinger et al. 2013a
Shiloh III, CA (2012-2013)	3.3	NA	NA	Kerlinger et al. 2013b
Solano III, CA (2012-2013)	1.6	0.95	NA	AECOM 2013
Stateline, OR/WA (2001-2002)	3.17	0.09	agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.68	0.09	agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2006)	1.23	0.11	agriculture/grassland	Erickson et al. 2007
Stetson Mountain I, ME (2009)	2.68	0	forest	Stantec 2009c
Stetson Mountain I, ME (2011)	1.18	0	forest	Normandeau Associates 2011
Stetson Mountain I, ME (2013)	6.95	0	forest	Stantec 2014
Stetson Mountain II, ME (2010)	1.42	0	forest	Normandeau Associates 2010
Stetson Mountain II, ME (2012)	3.37	0	forest	Stantec 2013e
Summerview, Alb (2005-2006)	1.06	0.11	agriculture	Brown and Hamilton 2006b
Top Crop I & II, IL (2012-2013)	1.35	NA	agriculture	Good et al. 2013c
Top of Iowa, IA (2003)	0.42	0	agriculture	Jain 2005
Top of Iowa, IA (2004)	0.81	0.17	agriculture	Jain 2005
Tuolumne (Windy Point I), WA (2009-2010)	3.2	0.29	grassland/shrub-steppe, agriculture, forest	Enz and Bay 2010
Vansycle, OR (1999)	0.95	0	agriculture/grassland	Erickson et al. 2000
Vantage, WA (2010-2011)	1.27	0.29	shrub-steppe, grassland	Ventus Environmental Solutions 2012
Wessington Springs, SD (2009)	8.25	0.06	grassland	Derby et al. 2010d
Wessington Springs, SD (2010)	0.89	0.07	grassland	Derby et al. 2011a

Appendix F3. Fatality estimates for North American wind energy facilities. Fatality rate estimate given as the number of fatalities per megawatt per year.

Project	Bird Fatalities	Raptor Fatalities	Predominant Habitat Type	Citation
White Creek, WA (2007-2011)	4.05	0.47	grassland/shrub-steppe, agriculture	Downes and Gritski 2012b
Wild Horse, WA (2007)	1.55	0.09	grassland	Erickson et al. 2008
Windy Flats, WA (2010-2011)	8.45	0.04	grassland/shrub-steppe, agriculture	Enz et al. 2011
Winnebago, IA (2009-2010)	3.88	0.27	agriculture/grassland	Derby et al. 2010h

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Alite, CA (2009-2010)	8	24	80	8	200 m x 200 m	1 year	weekly (spring, fall), bi-monthly (summer, winter)
Alta I, CA (2011-2012)	100	150	80	25	120-m radius circle	12.5 months	every two weeks
Alta I-V, CA (2013-2014)	290	720 (150 GE, 570 vestas)	80	55 (25 at Alta I, 30 at Alta II-V)	120-m radius circles	NA	monthly or bi-weekly
Alta II-V, CA (2011-2012)	190	570	80	41	120-m radius circle	14.5 months	every two weeks
Alta VIII, CA (2012-2013)	50	150	90	12 plots (equivalent to 15 turbines)	240 m x 240 m	1 year	bi-weekly
Barton I & II, IA (2010-2011)	80	160	100	35 (9 turbines were dropped in June 2010 due to landowner issues) 26 turbines were searched for the remainder of the study	200 m x 200 m	1 year	weekly (spring, fall; migratory turbines), monthly (summer, winter; non-migratory turbines)
Barton Chapel, TX (2009-2010)	60	120	78	30	200 m x 200 m	1 year	10 turbines weekly, 20 monthly
Beech Ridge, WV (2012)	67	100.5	80	67	40-m radius	7 months	every two days
Beech Ridge, WV (2013)	67	100.5	80	67	40-m radius	7.5 months	every two days
Big Blue, MN (2013)	18	36	78 or 90 (according to Gamesa website)	18	200-m diameter	NA	weekly, monthly (November and December)

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Big Blue, MN (2014)	18	36	78 or 90 (according to Gamesa website)	18	200-m diameter	NA	weekly, monthly (November and December)
Big Horn, WA (2006-2007)	133	199.5	80	133	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Big Smile, OK (2012-2013)	66	132	78	17 (plus one met tower)	100 m x 100 m	1 year	weekly (spring, summer, fall), monthly (winter)
Biglow Canyon, OR (Phase I; 2008)	76	125.4	80	50	110 m x 110 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase I; 2009)	76	125.4	80	50	110 m x 110 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2009-2010)	65	150	80	50	250 m x 250 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2010-2011)	65	150	80	50	252 m x 252 m	1 year	bi-weekly(spring, fall), monthly (summer, winter)
Biglow Canyon, OR (Phase III; 2010-2011)	76	174.8	80	50	252 m x 252 m	1 year	bi-weekly(spring, fall), monthly (summer, winter)
Blue Sky Green Field, WI (2008; 2009)	88	145	80	30	160 m x 160 m	fall, spring	daily(10 turbines), weekly (20 turbines)
Buena Vista, CA (2008-2009)	38	38	45-55	38	75-m radius	1 year	monthly to bi-monthly starting in September 2008
Buffalo Gap I, TX (2006)	67	134	78	21	215 m x 215 m	10 months	every 3 weeks
Buffalo Gap II, TX (2007-2008)	155	233	80	36	215 m x 215 m	14 months	every 21 days
Buffalo Mountain, TN (2000-2003)	3	1.98	65	3	50-m radius	3 years	bi-weekly, weekly, bi-monthly

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Buffalo Mountain, TN (2005)	18	28.98	V47 = 65; V80 = 78	18	50-m radius	1 year	bi-weekly, weekly, bi-monthly, and 2 to 5 day intervals
Buffalo Ridge, MN (1994-1995)	73	25	37	1994:10 plots (3 turbines/plot), 20 addition plots in September & October 1994, 1995: 30 turbines search every other week (January-March), 60 searched weekly (April, July, August) 73 searched weekly (May-June and September-October), 30 searched weekly (November-December)	100 m x 100 m	20 months	varies: see number turbines searched or page 44 of report
Buffalo Ridge, MN (Phase I; 1996)	73	25	36	21	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1997)	73	25	36	21	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1998)	73	25	36	21	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1999)	73	25	36	21	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1998)	143	107.25	50	40	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

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

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Cedar Ridge, WI (2010)	41	68	80	20	160 m x 160 m	1 year	5 turbines were surveyed daily, 15 turbines surveyed every 4 days in rotating groups each day. All 20 surveyed every three days during late fall
Cohocton/Dutch Hill, NY (2009)	50	125	80	17	130 m x 130 m	spring, summer, fall	daily (5 turbines), weekly (12 turbines)
Cohocton/Dutch Hills, NY (2010)	50	125	80	17	120 m x 120 m	spring, summer, fall	daily, weekly
Combine Hills, OR (Phase I; 2004-2005)	41	41	53	41	90-m radius	1 year	monthly
Combine Hills, OR (2011)	104	104	53	52 (plus 1 met tower)	180 m x 180 m	1 year	bi-weekly(spring, fall), monthly (summer, winter)
Condon, OR	84	NA	NA	NA	NA	NA	NA
Crescent Ridge, IL (2005-2006)	33	49.5	80	33	70-m radius	1 year	weekly (fall, spring)
Criterion, MD (2011)	28	70	80	28	40-50m radius	7.3 months	daily
Criterion, MD (2012)	28	70	80	14	40-50m radius	7.5 months	weekly
Criterion, MD (2013)	28	70	80	14	40- to 50-m radius	7.5 months	weekly
Crystal Lake II, IA (2009)	80	200	80	16 turbines through week 6, and then 15 for duration of study	100 m x 100 m	spring, summer, fall	3 times per week for 26 weeks
Diablo Winds, CA (2005-2007)	31	20.46	50 and 55	31	75 m x 75 m	2 years	monthly
Dillon, CA (2008-2009)	45	45	69	15	200 m x 200 m	1 year	weekly, bi-monthly in winter

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Dry Lake I, AZ (2009-2010)	30	63	78	15	160 m x 160 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Dry Lake II, AZ (2011-2012)	31	65	78	31: 5 (full plot), 26 (road & pad)	160 m x 160 m	1 year	twice weekly (spring, summer, fall), weekly (winter)
Elkhorn, OR (2008)	61	101	80	61	220 m x 220 m	1 year	monthly
Elkhorn, OR (2010)	61	101	80	31	220 m x 220 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Elm Creek, MN (2009-2010)	67	100	80	29	200 m x 200 m	1 year	weekly, monthly
Elm Creek II, MN (2011-2012)	62	148.8	80	30	200 m x 200 m (2 random migration search areas 100 m x 100 m)	1 year	20 searched every 28 days, 10 turbines every 7 days during migration)
Erie Shores, Ont (2006)	66	99	80	66	40-m radius	2 years	weekly, bi-monthly, 2-3 times weekly (migration)
Foote Creek Rim, WY (Phase I; 1999)	69	41.4	40	69	126 m x 126 m	1 year	monthly
Foote Creek Rim, WY (Phase I; 2000)	69	41.4	40	69	126 m x 126 m	1 year	monthly
Foote Creek Rim, WY (Phase I; 2001-2002)	69	41.4	40	69	126 m x 126 m	1 year	monthly
Forward Energy Center, WI (2008-2010)	86	129	80	29	160 m x 160 m	2 years	11 turbines daily, 9 every 3 days, 9 every 5 days
Fowler I, IN (2009)	162	301	78 (Vestas), 80 (Clipper)	25	160 m x 160 m	spring, summer, fall	weekly, bi-weekly

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Fowler I, II, III, IN (2010)	355	600	Vestas = 80, Clipper = 80, GE = 80	36 turbines, 100 road and pads	80 m x 80 m for turbines ; 40-m radius for roads and pads	spring, fall	daily, weekly
Fowler I, II, III, IN (2011)	355	600	Vestas = 80, Clipper = 80, GE = 80	177 road and pads (spring), 9 turbines & 168 roads and pads (fall)	turbines (80-m circular plot), roads and pads (out to 80 m)	spring, fall	daily, weekly
Fowler I, II, III, IN (2012)	355	600	Vestas = 80, Clipper = 80, GE = 80	118 roads and pads	roads and pads (out to 80 m)	2.5 months	weekly
Fowler III, IN (2009)	60	99	78	12	160 m x 160 m	10 weeks	weekly, bi-weekly
Goodnoe, WA (2009-2010)	47	94	80	24	180 m x 180 m	1 year	14 days during migration periods, 28 days during non-migration periods
Grand Ridge I, IL (2009-2010)	66	99	80	30	160 m x 160 m	1 year	weekly, monthly
Harrow, Ont (2010)	24 (four 6-turbine facilities)	39.6	NA	12 in July, 24 August-October	50-m radius from turbine base	4 months	twice-weekly
Harvest Wind, WA (2010-2012)	43	98.9	80	32	180 m x 180 m & 240 m x 240 m	2 years	twice a week, weekly and monthly
Hatchet Ridge, CA (2011-2012)	44	NA	80	22 (biweekly), 22 (monthly)	127 m x1 27 m (biweekly), 190 m x 190 m (monthly)	NA	bi-weekly and monthly

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Hay Canyon, OR (2009-2010)	48	100.8	79	20	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Heritage Garden I, MI (2012-2014)	14	28	90	14	120 m x 120 m except one plot that was 280 m x 280 m	1 years	weekly (spring, summer, and fall) and bi-weekly (winter)
High Winds, CA (2003-2004)	90	162	60	90	75-m radius	1 year	bi-monthly
High Winds, CA (2004-2005)	90	162	60	90	75-m radius	1 year	bi-monthly
Hopkins Ridge, WA (2006)	83	150	67	41	180 m x 180 m	1 year	monthly, weekly (subset of 22 turbines spring and fall migration)
Hopkins Ridge, WA (2008)	87	156.6	67	41-43	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Jersey Atlantic, NJ (2008)	5	7.5	80	5	130 m x 120 m	9 months	weekly
Judith Gap, MT (2006-2007)	90	135	80	20	190 m x 190 m	7 months	monthly
Judith Gap, MT (2009)	90	135	80	30	100 m x 100 m	5 months	bi-monthly
Kewaunee County, WI (1999-2001)	31	20.46	65	31	60 m x 60 m	2 years	bi-weekly (spring, summer), daily (spring, fall migration), weekly (fall, winter)
Kibby, ME (2011)	44	132	124	22 turbines	75-m diameter circular plots	22 weeks	average 5-day

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Kittitas Valley, WA (2011-2012)	48	100.8	80	48	100 m x 102 m	1 year	bi-weekly from August 15 - October 31 and March 16 - May 15; every 4 weeks from November 1 - March 15 and May 16 - August 14
Klondike, OR (2002-2003)	16	24	80	16	140 m x 140 m	1 year	monthly
Klondike II, OR (2005-2006)	50	75	80	25	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (summer, winter)
Klondike III (Phase I), OR (2007-2009)	125	223.6	GE = 80; Siemens= 80, Mitsubishi = 80	46	240 m x 240 m (1.5MW) 252 m x 252 m (2.3MW)	2 year	bi-monthly (spring, fall migration), monthly (summer, winter)
Klondike IIIa (Phase II), OR (2008-2010)	51	76.5	GE = 80	34	240 m x 240 m	2 years	bi-monthly (spring, fall), monthly (summer, winter)
Lakefield Wind, MN (2012)	137	205.5	80	26	100 m x 100 m	7.5 months	3 times per week
Leaning Juniper, OR (2006-2008)	67	100.5	80	17	240 m x 240 m	2 years	bi-monthly (spring, fall), monthly (winter, summer)
Lempster, NH (2009)	12	24	78	4	120 m x 130 m	6 months	daily
Lempster, NH (2010)	12	24	78	12	120 m x 130 m	6 months	weekly
Linden Ranch, WA (2010-2011)	25	50	80	25	110 m x 110 m	1 year	bi-weekly(spring, fall), monthly (summer, winter)
Locust Ridge, PA (Phase II; 2009)	51	102	80	15	120 m x 126 m	6.5 months	daily
Locust Ridge, PA (Phase II; 2010)	51	102	80	15	120 m x 126 m	6.5 months	daily

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Madison, NY (2001-2002)	7	11.55	67	7	60-m radius	1 year	weekly (spring, fall), monthly (summer)
Maple Ridge, NY (2006)	120	198	80	50	130 m x 120 m	5 months	daily (10 turbines), every 3 days (10 turbines), weekly (30 turbines)
Maple Ridge, NY (2007)	195	321.75	80	64	130 m x 120 m	7 months	weekly
Maple Ridge, NY (2007-2008)	195	321.75	80	64	130 m x 120 m	7 months	weekly
Maple Ridge, NY (2012)	195	321.75	80	105 (5 turbines, 100 roads/pads)	100 m x 100 m	3 months	weekly
Marengo I, WA (2009-2010)	78	140.4	67	39	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Marengo II, WA (2009-2010)	39	70.2	67	20	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Mars Hill, ME (2007)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	spring, summer, fall	daily (2 random turbines), weekly (all turbines): extended plot searched once per season
Mars Hill, ME (2008)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	spring, summer, fall	weekly: extended plot searched once per season
McBride, Alb (2004)	114	75	50	114	4 parallel transects 120-m wide	1 year	weekly, bi-weekly
Melancthon, Ont (Phase I; 2007)	45	NA	NA	45	35-m radius	5 months	weekly, twice weekly

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Meyersdale, PA (2004)	20	30	80	20	130 m x 120 m	6 weeks	daily (half turbines), weekly (half turbines)
Milford I, UT (2010-2011)	58	145	80	24	120 m x 120 m	NA	weekly
Milford I & II, UT (2011-2012)	107	160.5 (58.5 Phase I, 102 Phase II)	80	43	120 m x 120 m	NA	every 10.5 days
Montezuma I, CA (2011)	16	36.8	80	16	105-m radius	1 year	weekly and bi-weekly
Montezuma I, CA (2012)	16	36.8	80	16	105-m radius	1 year	weekly and bi-weekly
Montezuma II, CA (2012-2013)	34	78.2	80	17	105-m radius	1 year	weekly
Moraine II, MN (2009)	33	49.5	82.5	30	200 m x 200 m	1 year	weekly (migratory), monthly (non-migratory)
Mount Storm, WV (Fall 2008)	82	164	78	27	varied	3 months	weekly (18 turbines), daily (9 turbines)
Mount Storm, WV (2009)	132	264	78	44	varied	4.5 months	weekly (28 turbines), daily (16 turbines)
Mount Storm, WV (2010)	132	264	78	24	20 to 60 m from turbine	6 months	daily
Mount Storm, WV (2011)	132	264	78	24	varied	6 months	daily
Mountaineer, WV (2003)	44	66	80	44	60-m radius	7 months	weekly, monthly
Mountaineer, WV (2004)	44	66	80	44	130 m x 120 m	6 weeks	daily, weekly
Munnsville, NY (2008)	23	34.5	69.5	12	120 m x 120 m	spring, summer, fall	weekly

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Mustang Hills, CA (2012-2013)	50	150	90	13 plots (equivalent to 15 turbines)	240 x 240 m	1 year	bi-weekly
Nine Canyon, WA (2002-2003)	37	48.1	60	37	90-m radius	1 year	bi-monthly (spring, summer, fall), monthly (winter)
Nine Canyon II, WA (2004)	12	15.6	60	12	90 m x 90 m	3 months	once every two weeks
Noble Altona, NY (2010)	65	97.5	80	22	120 m x 120 m	spring, summer, fall	daily, weekly
Noble Altona, NY (2011)	65	97.5	80	22	120 m x 120 m	2 months	daily
Noble Bliss, NY (2008)	67	100	80	23	120 m x 120 m	spring, summer, fall	daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Bliss, NY (2009)	67	100	80	23	120 m x 120 m	spring, summer, fall	weekly, 8 turbines searched daily from July 1 to August 15
Noble Bliss/Wethersfield, NY (2011)	151	226	80	48 (24 from each site:12 agriculture, 12 forest)	road & pad 70 m out from turbine	2 months	daily
Noble Chateaugay, NY (2010)	71	106.5	80	24	120 m x 120 m	spring, summer, fall	weekly
Noble Clinton, NY (2008)	67	100	80	23	120 m x 120 m	spring, summer, fall	daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Clinton, NY (2009)	67	100	80	23	120 m x 120 m	spring, summer, fall	daily (8 turbines), weekly (15 turbines), all turbines weekly from July 1 to August 15

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Noble Ellenburg, NY (2008)	54	80	80	18	120 m x 120 m	spring, summer, fall	daily (6 turbines), 3-day (6 turbines), weekly (6 turbines)
Noble Ellenburg, NY (2009)	54	80	80	18	120 m x 120 m	spring, summer, fall	daily (6 turbines), weekly (12 turbines), all turbines weekly from July 1 to August 15
Noble Wethersfield, NY (2010)	84	126	80	28	120 m x 120 m	spring, summer, fall	weekly
NPPD Ainsworth, NE (2006)	36	20.5	70	36	220 m x 220 m	spring, summer, fall	bi-monthly
Oklahoma Wind Energy Center, OK (2004; 2005)	68	102	70	68	20-m radius	3 months (2 years)	bi-monthly
Pacific, CA (2012-2013)	70	140	78.5	20	126-m radius	NA	Twice weekly (fall), and biweekly
Palouse Wind, WA (2012-2013)	58	104.4	80, 90, or 105 M (according to the Vestas website)	19	120 m x 120 m	1 year	monthly (winter) and weekly (spring-fall)
Pebble Springs, OR (2009-2010)	47	98.7	79	20	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Pine Tree, CA (2009-2010, 2011)	90	135	65	40	100-m radius	1.5 year	bi-weekly, weekly
Pinnacle, WV (2012)	23	55.2	80	11	126 m x 120 m	9 months	weekly
Pinnacle Operational Mitigation Study (2012)	23	55.2	80	12	126 m x 120 m	2.5 months	daily

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Pinyon Pines I & II, CA (2013-2014)	100	NA	90	25 plots (approx. 31 turbines)	240 m x 240 m	NA	bi-weekly
Pioneer Prairie II, IA (2011-2012)	62	102.3	80	62 (57 road/pad) 5 full search plots	80 m x 80m	1 year	weekly (spring and fall), every two weeks (summer), monthly (winter)
Pioneer Prairie II, IA (2013)	62	102.3	80	62	80 m x 80 m (5 turbines), road and pad within 100 m of turbine (57 turbines)	NA	weekly
Pioneer Trail, IL (2012-2013)	94	150.5	NA	50	80 m x80 m	fall, spring	weekly
Prairie Rose, MN (2014)	119	200	80	10	100 m x100 m	6 months	weekly
PrairieWinds ND1 (Minot), ND (2010)	80	115.5	89	35	minimum of 100 m x 100 m	3 seasons	bi-monthly
PrairieWinds ND1 (Minot), ND (2011)	80	115.5	80	35	minimum 100 m x 100 m	3 season	twice monthly
PrairieWinds SD1, SD (2011-2012)	108	162	80	50	200 m x 200 m	1 year	twice monthly (spring, summer, fall), monthly (winter)
PrairieWinds SD1, SD (2012-2013)	108	162	80	50	200 m x 200 m	1 year	bi-weekly
PrairieWinds SD1, SD (2013-2014)	108	162	80	45	200 m x 200 m	1 year	twice monthly (spring, summer, fall), monthly (winter)
Prince Wind Farm, Ont (2006)	126	189	80	38	63-m radius	4 months	daily, weekly

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Prince Wind Farm, Ont (2007)	126	189	80	38 turbines from January 1st - July 8th, 126 turbines from July 9th-October 31st	63- to 45-m radius	10 months	daily, weekly
Prince Wind Farm, Ont (2008)	126	189	80	126	45-m radius	6.5 months	daily, 3x/week, 2x/week
Rail Splitter, IL (2012-2013)	67	100.5	80	34	60-m radius	1 year	weekly (spring, summer, and fall) and bi-weekly (winter)
Record Hill, ME (2012)	22	50.6	80	22	126.5 m x 126.5 m	5 months	three times every two weeks
Record Hill, ME (2014)	22	50.6	80	10	varied due to steep terrain and heavily vegetated areas	4.5 months	daily for 5 days a week
Red Canyon, TX (2006-2007)	56	84	70	28	200 m x 200 m in fall and winter; 160 m x 160 m in spring and summer	1 year	every 14 days in fall and winter; 7 days in spring, 3 days in summer
Red Hills, OK (2012-2013)	82	123	80	20 (plus one met tower)	100 m x 100 m	1 year	weekly (spring, summer, fall), monthly (winter)
Ripley, Ont (2008)	38	76	64	38	80 m x 80 m	spring, fall	twice weekly for odd turbines; weekly for even turbines.
Ripley, Ont (2008-2009)	38	76	64	38	80 m x 80 m	6 weeks	twice weekly for odd turbines; weekly for even turbines.

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Rollins, ME (2012)	40	60	80	20	varied; turbine laydown area and gravel access roads out to 60 m	6 months	weekly
Roth Rock, MD (2011)	20	50	80	10	80 m x 80 m	3 months	daily
Rugby, ND (2010-2011)	71	149	78	32	200 m x 200 m	1 year	weekly (spring, fall; migratory turbines), monthly (non-migratory turbines)
San Gorgonio, CA (1997-1998; 1999-2000)	3000	NA	24.4-42.7	NA	50-m radius	2 years	quarterly
Searsburg, VT (1997)	11	7	65	11	20- to 55-m radius	spring, fall	weekly (fall migration)
Sheffield, VT (2012)	16	40	80	8	126 m x 120 m	3 months	daily
Sheffield Operational Mitigation Study (2012)	16	40	80	16	126 m x 120 m	4 months	daily
High Sheldon, NY (2010)	75	112.5	80	25	115 m x 115 m	7 months	daily (8 turbines), weekly (17 turbines)
High Sheldon, NY (2011)	75	112.5	80	25	115 m x 115 m	7 months	daily (8 turbines), weekly (17 turbines)
Shiloh I, CA (2006-2009)	100	150	65	100	105-m radius	3 years	weekly
Shiloh II, CA (2009-2010)	75	150	80	25	100-m radius	1 year	weekly
Shiloh II, CA (2010-2011)	75	150	80	25	100-m radius	1 year	weekly

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Shiloh II, CA (2011-2012)	75	150	80	25	100-m radius	1 year	weekly
Shiloh III, CA (2012-2013)	50	102.5	78.5	25	100-m radius	NA	weekly
SMUD Solano, CA (2004-2005)	22	15	65	22	60-m radius	1 year	bi-monthly
Solano III, CA (2012-2013)	55	128	80	19	100-m radius	NA	bi-Weekly
Spruce Mountain, ME (2012)	10	20	78	10	100 m x 100 m	7 months	weekly
Stateline, OR/WA (2001-2002)	454	299	50	124	minimum 126 m x 126 m	17 months	bi-weekly, monthly
Stateline, OR/WA (2003)	454	299	50	153	minimum 126 m x 126 m	1 year	bi-weekly, monthly
Stateline, OR/WA (2006)	454	299	50	39	variable turbine strings	1 year	bi-weekly
Steel Winds I, NY (2007)	8	20	80	8	176 m x 176 m	6.5 months	every 10 days (spring, fall) every 21 days (summer)
Steel Winds I & II, NY (2012)	14	35	80	8 (1 was just gravel pad)	120 m x 120 m	6 months	weekly, bi-weekly (November only)
Stetson Mountain I, ME (2009)	38	57	80	19	76-m diameter	27 weeks (spring, summer, fall)	weekly
Stetson Mountain I, ME (2011)	38	57	80	19	79.45 m x79.45 m	6 months	weekly
Stetson Mountain I, ME (2013)	38	57	80	19	76-m diameter	6 months	weekly
Stetson Mountain II, ME (2010)	17	25.5	80	17	74.5 m x 74.5 m	6 months	weekly (3 turbines twice a week)
Stetson Mountain II, ME (2012)	17	25.5	80	17	laydown area and road up to 60 m	6 months	weekly

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Summerview, Alb (2005-2006)	39	70.2	67	39	140 m x 140 m	1 year	weekly, bi-weekly (May to July, September)
Summerview, Alb (2006; 2007)	39	70.2	65	39	52-m radius; 2 spiral transects 7 m apart	summer, fall (2 years)	daily (10 turbines), weekly (29 turbines)
Tehachapi, CA (1996-1998)	3300	n/a	14.7 to 57.6	201	50-m radius	20 months	quarterly
Top Crop I & II, IL (2012-2013)	68 (Phase I), 132 (Phase II)	300 (102 Phase I, 198 Phase II)	65 (Phase I), 80 (Phase II)	100	61-m radius	1 year	weekly (spring, summer, and fall) and bi-weekly (winter)
Top of Iowa, IA (2003)	89	80	71.6	26	76 m x 76 m	spring, summer, fall	once every 2 to 3 days
Top of Iowa, IA (2004)	89	80	71.6	26	76 m x 76 m	spring, summer, fall	once every 2 to 3 days
Tuolumne (Windy Point I), WA (2009-2010)	62	136.6	80	21	180 m x 180 m	1 year	monthly throughout the year, a sub-set of 10 turbines were also searched weekly during the spring, summer, and fall
Vansycle, OR (1999)	38	24.9	50	38	126 m x 126 m	1 year	monthly
Vantage, WA (2010-2011)	60	90	80	30	240 m x 240 m	1 year	monthly, a subset of 10 searched weekly during migration
Vasco, CA (2012-2013)	34	78.2	80	34	105-m radius	1 year	weekly, monthly
Wessington Springs, SD (2009)	34	51	80	20	200 m x 200 m	spring, summer, fall	bi-monthly
Wessington Springs, SD (2010)	34	51	80	20	200 m x 200 m	8 months	bi-weekly (spring, summer, fall)

Appendix F4. All post-construction monitoring studies, project characteristics, and select study methodology.

Project Name	Total # of Turbines	Total Megawatts	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
White Creek, WA (2007-2011)	89	204.7	80	89	180 m x 180 m & 240 m x 240 m	4 years	twice a week, weekly and monthly
Wild Horse, WA (2007)	127	229	67	64	110 m from two turbines in plot	1 year	monthly, weekly (fall, spring migration at 16 turbines)
Windy Flats, WA (2010-2011)	114	262.2	80	36 (plus 1 met tower)	180 m x 180 m (120 m at met tower)	1 year	monthly (spring, summer, fall, and winter), weekly (spring and fall migration)
Winnebago, IA (2009-2010)	10	20	78	10	200 m x 200 m	1 year	weekly (migratory), monthly (non-migratory)
Wolfe Island, Ont (May-June 2009)	86	197.8	80	86	60-m radius	spring	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2009)	86	197.8	80	86	60-m radius	summer, fall	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2010)	86	197.8	80	86	60-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2010)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2011)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (July-December 2011)	86	197.8	80	86	50-m radius	6 months	43 twice weekly, 43 weekly
Wolfe Island, Ont (January-June 2012)	86	197.8	NA	86	50-m radius	NA	1/2 searched twice weekly, 1/2 searched weekly

Appendix F4 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology. Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Alite, CA (09-10)	Chatfield et al. 2010a	Marengo II, WA (09-10)	URS Corporation 2010c
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Mars Hill, ME (07)	Stantec 2008
Alta Wind I-V, CA (13-14)	Chatfield et al. 2014	Mars Hill, ME (08)	Stantec 2009a
Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	McBride, Alb (04)	Brown and Hamilton 2004
Alta VIII, CA (12-13)	Chatfield and Bay 2014	Melancthon, Ont (Phase I; 07)	Stantec Ltd. 2008
Barton I & II, IA (10-11)	Derby et al. 2011b	Meyersdale, PA (04)	Arnett et al. 2005
Barton Chapel, TX (09-10)	WEST 2011	Milford I, UT (10-11)	Stantec 2011b
Beech Ridge, WV (12)	Tidhar et al. 2013a	Milford I & II, UT (11-12)	Stantec 2012b
Beech Ridge, WV (13)	Young et al. 2014a	Montezuma I, CA (11)	ICF International 2012
Big Blue, MN (13)	Fagen Engineering 2014	Montezuma I, CA (12)	ICF International 2013
Big Blue, MN (14)	Fagen Engineering 2015	Montezuma II, CA (12-13)	Harvey & Associates 2013
Big Horn, WA (06-07)	Kronner et al. 2008	Moraine II, MN (09)	Derby et al. 2010g
Big Smile, OK (12-13)	Derby et al. 2013b	Mount Storm, WV (Fall 08)	Young et al. 2009c
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009b	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011b	Mount Storm, WV (11)	Young et al. 2011a, 2012a
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Mountaineer, WV (04)	Arnett et al. 2005
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Munnsville, NY (08)	Stantec 2009b
Buena Vista, CA (08-09)	Insignia Environmental 2009	Mustang Hills, CA (12-13)	Chatfield and Bay 2014
Buffalo Gap I, TX (06)	Tierney 2007	Nine Canyon, WA (02-03)	Erickson et al. 2003a
Buffalo Gap II, TX (07-08)	Tierney 2009	Nine Canyon II, WA (04)	Erickson et al. 2005
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Noble Altona, NY (10)	Jain et al. 2011a
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Noble Altona, NY (11)	Kerlinger et al. 2011b
Buffalo Ridge, MN (94-95)	Osborn et al. 1996, 2000	Noble Bliss, NY (08)	Jain et al.2009c
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000a	Noble Bliss, NY (09)	Jain et al. 2010c
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000a	Noble Bliss/Wethersfield, NY (11)	Kerlinger et al. 2011a
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000a	Noble Chateaugay, NY (10)	Jain et al. 2011b
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000a	Noble Clinton, NY (08)	Jain et al. 2009d
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000a	Noble Clinton, NY (09)	Jain et al. 2010a
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000a	Noble Ellenburg, NY (08)	Jain et al. 2009e
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Noble Ellenburg, NY (09)	Jain et al. 2010b
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Noble Wethersfield, NY (10)	Jain et al. 2011c
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000a	NPPD Ainsworth, NE (06)	Derby et al. 2007
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Oklahoma Wind Energy Center, OK (04; 05)	Piorkowski and O'Connell 2010
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Pacific, CA (12-13)	Sapphos 2014
Buffalo Ridge I, SD (09-10)	Derby et al. 2010e	Palouse Wind, WA (12-13)	Stantec 2013a
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Casselman, PA (08)	Arnett et al. 2009b	Pine Tree, CA (09-10, 11)	BioResource Consultants 2012
Casselman, PA (09)	Arnett et al. 2010	Pinnacle, WV (12)	Hein et al. 2013a

Appendix F4 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology. Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Casselman Curtailment, PA (08)	Arnett et al. 2009a	Pinnacle Operational Mitigation Study (12)	Hein et al. 2013b
Castle River, Alb. (01)	Brown and Hamilton 2006a	Pinyon Pines I & II, CA (13-14)	Chatfield and Russo 2014
Castle River, Alb. (02)	Brown and Hamilton 2006a	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Cedar Ridge, WI (09)	BHE Environmental 2010	Pioneer Prairie II, IA (13)	Chodachek et al. 2014
Cedar Ridge, WI (10)	BHE Environmental 2011	Pioneer Trail, IL (12-13)	ARCADIS 2013
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Prairie Rose, MN (14)	Chodachek et al. 2015
Cohocton/Dutch Hills, NY (10)	Stantec 2011a	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011d
Combine Hills, OR (Phase I; 04-05)	Young et al. 2006	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012d
Combine Hills, OR (11)	Enz et al. 2012	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012c
Condon, OR	Fishman Ecological Services 2003	PrairieWinds SD1 (Crow Lake), SD (12-13)	Derby et al. 2013a
Crescent Ridge, IL (05-06)	Kerlinger et al. 2007	PrairieWinds SD1 (Crow Lake), SD (13-14)	Derby et al. 2014
Criterion, MD (11)	Young et al. 2012b	Prince Wind Farm, Ont (06)	NRSI 2008b, 2009
Criterion, MD (12)	Young et al. 2013	Prince Wind Farm, Ont (07)	NRSI 2008a, 2009
Criterion, MD (13)	Young et al. 2014b	Prince Wind Farm, Ont (08)	NRSI 2009
Crystal Lake II, IA (09)	Derby et al. 2010b	Rail Splitter, IL (12-13)	Good et al. 2013b
Diablo Winds, CA (05-07)	WEST 2006, 2008	Record Hill, ME (12)	Stantec 2013b
Dillon, CA (08-09)	Chatfield et al. 2009	Record Hill, ME (14)	Stantec 2015
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Red Canyon, TX (06-07)	Miller 2008
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Red Hills, OK (12-13)	Derby et al. 2013c
Elkhorn, OR (08)	Jeffrey et a. 2009a	Ripley, Ont (08)	Jacques Whitford 2009
Elkhorn, OR (10)	Enk et al. 2011a	Ripley, Ont (08-09)	Golder Associates 2010
Elm Creek, MN (09-10)	Derby et al. 2010f	Rollins, ME (12)	Stantec 2013c
Elm Creek II, MN (11-12)	Derby et al. 2012b	Roth Rock, MD (11)	Atwell 2012
Erie Shores, Ont. (06)	James 2008	Rugby, ND (10-11)	Derby et al. 2011c
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003a	San Gorgonio, CA (97-98; 99-00)	Anderson et al. 2005
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003a	Searsburg, VT (97)	Kerlinger 2002a
Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003a	Sheffield, VT (12)	Martin et al. 2013
Forward Energy Center, WI (08-10)	Grodsky and Drake 2011	Sheffield Operational Mitigation Study (12)	Martin et al. 2013
Fowler I, IN (09)	Johnson et al. 2010a	Shiloh I, CA (06-09)	Kerlinger et al. 2009
Fowler I, II, III, IN (10)	Good et al. 2011	Shiloh II, CA (09-10)	Kerlinger et al. 2010
Fowler I, II, III, IN (11)	Good et al. 2012	Shiloh II, CA (10-11)	Kerlinger et al. 2013a
Fowler I, II, III, IN (12)	Good et al. 2013a	Shiloh II, CA (11-12)	Kerlinger et al. 2013a
Fowler III, IN (09)	Johnson et al. 2010b	Shiloh III, CA (12-13)	Kerlinger et al. 2013b
Goodnoe, WA (09-10)	URS Corporation 2010a	SMUD Solano, CA (04-05)	Erickson and Sharp 2005
Grand Ridge I, IL (09-10)	Derby et al. 2010a	Solano III, CA (12-13)	AECOM 2013
Harrow, Ont (10)	Natural Resource Solutions 2011	Spruce Mountain, ME (12)	Tetra Tech 2013b
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Stateline, OR/WA (01-02)	Erickson et al. 2004
Hatchet Ridge, CA (11-12)	Tetra Tech 2013a	Stateline, OR/WA (03)	Erickson et al. 2004
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Stateline, OR/WA (06)	Erickson et al. 2007

Appendix F4 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology. Data from the following sources:

Project, Location	Reference	Project, Location	Reference
Heritage Garden I, MI (12-14)	Kerlinger et al. 2014	Steel Winds I, NY (07)	Grehan 2008
High Sheldon, NY (10)	Tidhar et al. 2012a	Steel Winds I & II, NY (12)	Stantec 2013d
High Sheldon, NY (11)	Tidhar et al. 2012b	Stetson Mountain I, ME (09)	Stantec 2009c
High Winds, CA (03-04)	Kerlinger et al. 2006	Stetson Mountain I, ME (11)	Normandeau Associates 2011
High Winds, CA (04-05)	Kerlinger et al. 2006	Stetson Mountain I, ME (13)	Stantec 2014
Hopkins Ridge, WA (06)	Young et al. 2007c	Stetson Mountain II, ME (10)	Normandeau Associates 2010
Hopkins Ridge, WA (08)	Young et al. 2009b	Stetson Mountain II, ME (12)	Stantec 2013e
Jersey Atlantic, NJ (08)	NJAS 2008a, 2008b, 2009	Summerview, Alb (05-06)	Brown and Hamilton 2006b
Judith Gap, MT (06-07)	TRC 2008	Summerview, Alb (06; 07)	Baerwald 2008
Judith Gap, MT (09)	Poulton and Erickson 2010	Tehachapi, CA (96-98)	Anderson et al. 2004
Kewaunee County, WI (99-01)	Howe et al. 2002	Top Crop I & II, IL (12-13)	Good et al. 2013c
Kibby, ME (11)	Stantec 2012a	Top of Iowa, IA (03)	Jain 2005
Kittitas Valley, WA (11-12)	Stantec Consulting 2012	Top of Iowa, IA (04)	Jain 2005
Klondike, OR (02-03)	Johnson et al. 2003	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
Klondike II, OR (05-06)	NWC and WEST 2007	Vansycle, OR (99)	Erickson et al. 2000
Klondike III (Phase I), OR (07-09)	Gritski et al. 2010	Vantage, WA (10-11)	Ventus Environmental Solutions 2012
Klondike IIIa (Phase II), OR (08-10)	Gritski et al. 2011	Vasco, CA (12-13)	Brown et al. 2013
Lakefield Wind, MN (12)	MPUC 2012	Wessington Springs, SD (09)	Derby et al. 2010d
Leaning Juniper, OR (06-08)	Gritski et al. 2008	Wessington Springs, SD (10)	Derby et al. 2011a
Lempster, NH (09)	Tidhar et al. 2010	White Creek, WA (07-11)	Downes and Gritski 2012b
Lempster, NH (10)	Tidhar et al. 2011	Wild Horse, WA (07)	Erickson et al. 2008
Linden Ranch, WA (10-11)	Enz and Bay 2011	Windy Flats, WA (10-11)	Enz et al. 2011
Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011	Winnebago, IA (09-10)	Derby et al. 2010h
Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011	Wolfe Island, Ont (May-June 09)	Stantec Ltd. 2010a
Madison, NY (01-02)	Kerlinger 2002b	Wolfe Island, Ont (July-December 09)	Stantec Ltd. 2010b
Maple Ridge, NY (06)	Jain et al. 2007	Wolfe Island, Ont (January-June 10)	Stantec Ltd. 2011a
Maple Ridge, NY (07)	Jain et al. 2009a	Wolfe Island, Ont (July-December 10)	Stantec Ltd. 2011b
Maple Ridge, NY (07-08)	Jain et al. 2009b	Wolfe Island, Ont (January-June 11)	Stantec Ltd. 2011c
Maple Ridge, NY (12)	Tidhar et al. 2013b	Wolfe Island, Ont (July-December 11)	Stantec Ltd. 2012
Marengo I, WA (09-10)	URS Corporation 2010b	Wolfe Island, Ont (January-June 12)	Stantec Ltd. 2014

Final Baseline Avian Studies for the Sweetland Wind Energy Project Hand County, South Dakota

May 2018 – April 2019

Prepared for:

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EXECUTIVE SUMMARY

Scout Clean Energy has proposed the development of a wind energy facility called the Sweetland Wind Energy Project (Project), located in Hand County, South Dakota. Western EcoSystems Technology, Inc. conducted a second year of baseline avian surveys for the Project. The following document contains results for the second year of fixed-point bird use surveys, prairie grouse surveys, vegetation/habitat mapping, and general wildlife observations.

The Survey area encompasses 9,174.6 hectares (22,671.0 acres) approximately 7.4 kilometers(km; 4.6 miles [mi]) southwest of the city of Wessington, South Dakota and 12.1 km (7.5 mi) southeast of the city of Miller, South Dakota. Based on a vegetation mapping effort that included a field reconnaissance combined with National Land Cover Database data for areas that were not visible or accessible during field efforts, approximately 88.6% of the land cover at the Survey area is either grassland or cultivated crops.

The primary objective of the fixed-point large bird use surveys was to estimate levels of use by eagles and other large birds near potential turbine locations. These observational surveys are recommended in the US Fish and Wildlife Service's *Eagle Conservation Plan Guidance*, *Land-Based Wind Energy Guidelines*, and the 2016 Eagle Rule for characterizing levels of use and potential risk of a proposed wind energy project to eagles and other diurnal raptors. The fixed-point bird use surveys were designed to estimate the seasonal, spatial, and temporal use of the Survey area by birds, particularly diurnal raptors. Fixed-point surveys were conducted from May 12, 2018 - April 31, 2019, at 19 plots established throughout the Survey area. A total of 209 60-minute (min) fixed-point large bird use surveys were completed, and 47 unique large bird species were identified. One additional bird species (ferruginous hawk) not identified during the standardized avian surveys was documented incidentally. The most abundant large bird species recorded was snow goose, followed by Canada goose. Diurnal raptor use was highest in the fall, followed by spring, summer, and winter. Irrespective of distance from the observer, the most common diurnal raptor observations recorded were red-tailed hawk (44 observations) and northern harrier (12). A single bald eagle was observed during winter, which resulted in eagle use of less than 0.01.

In order to make comparisons to other publicly available studies, mean annual use was standardized to 20-min surveys. Mean annual diurnal raptor use recorded within the Survey area (0.10 raptor per 800-meter (m; 2,625-foot [ft]) plot per 20-min survey) ranked fourth lowest relative to 50 other comparable studies at wind energy facilities that implemented similar protocols to the present study and had data for three or four different seasons. Mean annual diurnal raptor use values from three publicly available South Dakota studies were 0.24 raptor/800-m plot/20-min survey for all three studies, and 0.22 for Sweetland Year One surveys.

A total of 209 10-min fixed-point small bird use surveys were completed, and 42 unique small bird species were identified. Passerine use was highest during the spring, followed by summer, fall, and winter.

None of the four historic lek locations were active during aerial surveys for prairie grouse. WEST biologists visually observed sharp-tailed grouse dancing/displaying at three locations identified in 2018, making them official sharp-tailed grouse lek locations. In addition, sharp-tailed grouse and great prairie chickens were visually observed dancing/displaying at three new locations. South Dakota Game, Fish and Parks define a lek as the traditional display area where two or more male grouse have attended in two or more of the previous five years. The three new dancing/displaying locations don't currently meet the definition of a lek, since only one year of data has been collected in the last five years for those locations.

Special-status species are those that are designated Species of Greatest Conservation Need in the South Dakota State Wildlife Action Plan, or protected under the federal Endangered Species Act of 1973 or the BGEPA. There were no federally listed threatened or endangered species observed within the Project during the first year studies. A single peregrine falcon, a state-endangered species, was recorded during the first year surveys. Five special-status species were recorded during the second year of fixed-point bird use surveys and as incidental general wildlife observations, American white pelican, ferruginous hawk, lark bunting, long-billed curlew, and marbled godwit.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Scout Clean Energy has proposed the development of a wind energy facility called the Sweetland Wind Energy Project (Project), located in Hand County, South Dakota. As currently proposed, the Project would have a generation capacity of approximately 200 megawatts (MW), consisting of up to 71 GE 2.8/127 wind turbines. Additionally, the proposed Project would include a generation-tie in for the Project to the transmission grid as well as associated infrastructure (i.e., operations and maintenance facility, laydown yard, access roads, underground collector lines, switchyard, and a substation).

Western EcoSystems Technology, Inc. (WEST) conducted a second year of baseline wildlife surveys for the Project. The following document contains results from the second year of fixed-point bird use surveys, prairie grouse surveys, vegetation/habitat mapping, and general wildlife observations. The principal objectives of the baseline study included: (1) providing site-specific bird resource and use data for use in evaluating potential impacts from the proposed Project, and (2) providing information for use in Project planning and design to avoid or minimize impacts to birds.

STUDY AREA

The proposed Survey area is located on approximately 9,174.6 hectares (22,671.0 acres) in Hand County, South Dakota, approximately 7.4 kilometers (km; 4.6 miles [mi]) southwest of the city of Wessington, South Dakota and 12.1 km (7.5 mi) southeast of the city of Miller, South Dakota (Figures 1 and 2). The vegetation mapping, completed by WEST via a field reconnaissance effort within the Survey area combined with National Land Cover Database (NLCD; Yang et al. 2018, Multi-Resolution Land Characteristics 2019) mapping in areas that were not visible or accessible during the field reconnaissance effort, showed approximately 88.6% of the Survey area is dominated by grassland (55.7%) and cultivated crops (32.9%; Figure 3, Table 1). Deciduous trees accounted for 3.8%, followed by hayfields (3.2%), herbaceous (2.7%) developed (1.0%), open water (0.6%), and emergent wetlands (0.2%).

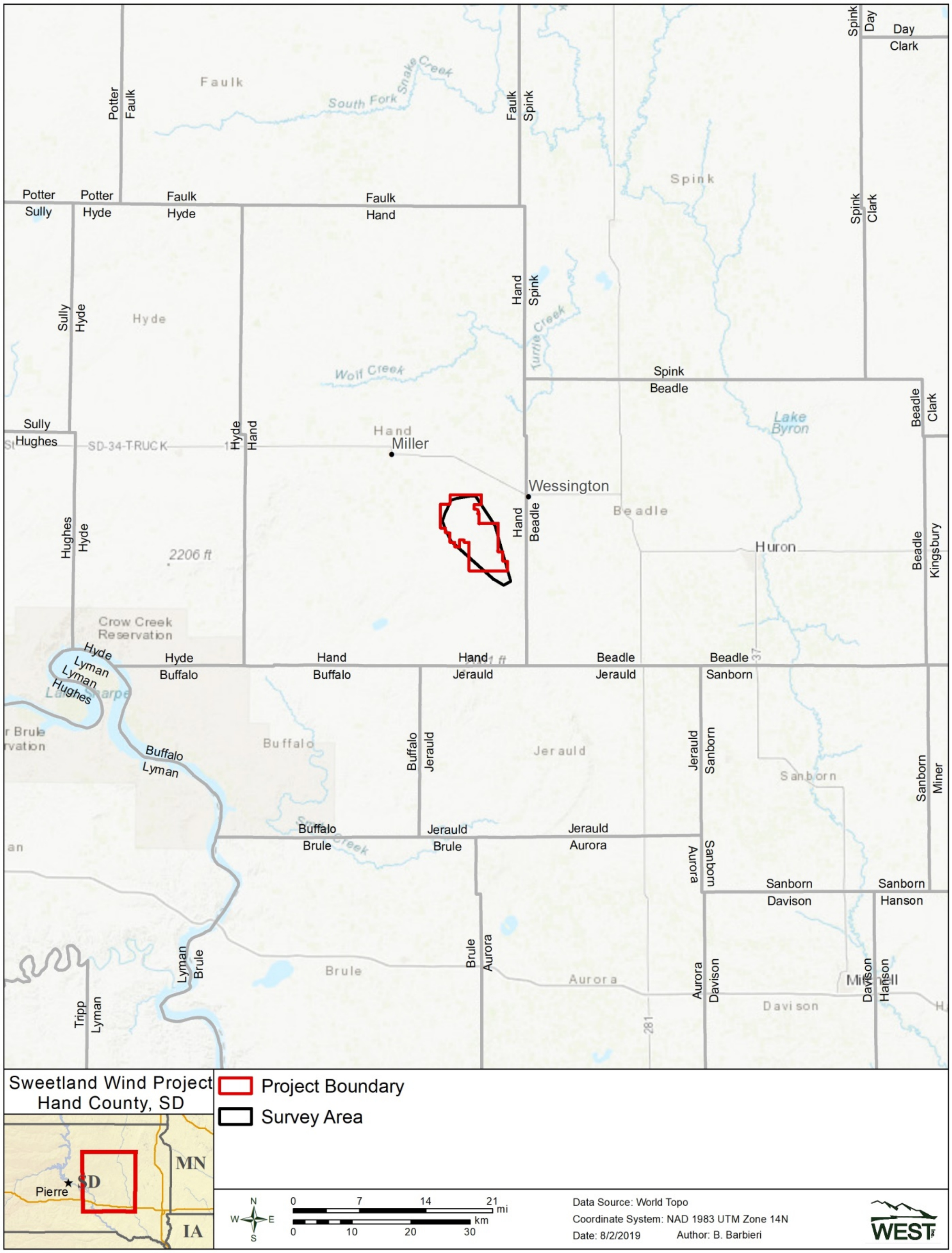

Figure 1. General location of the Sweetland Wind Energy Project.

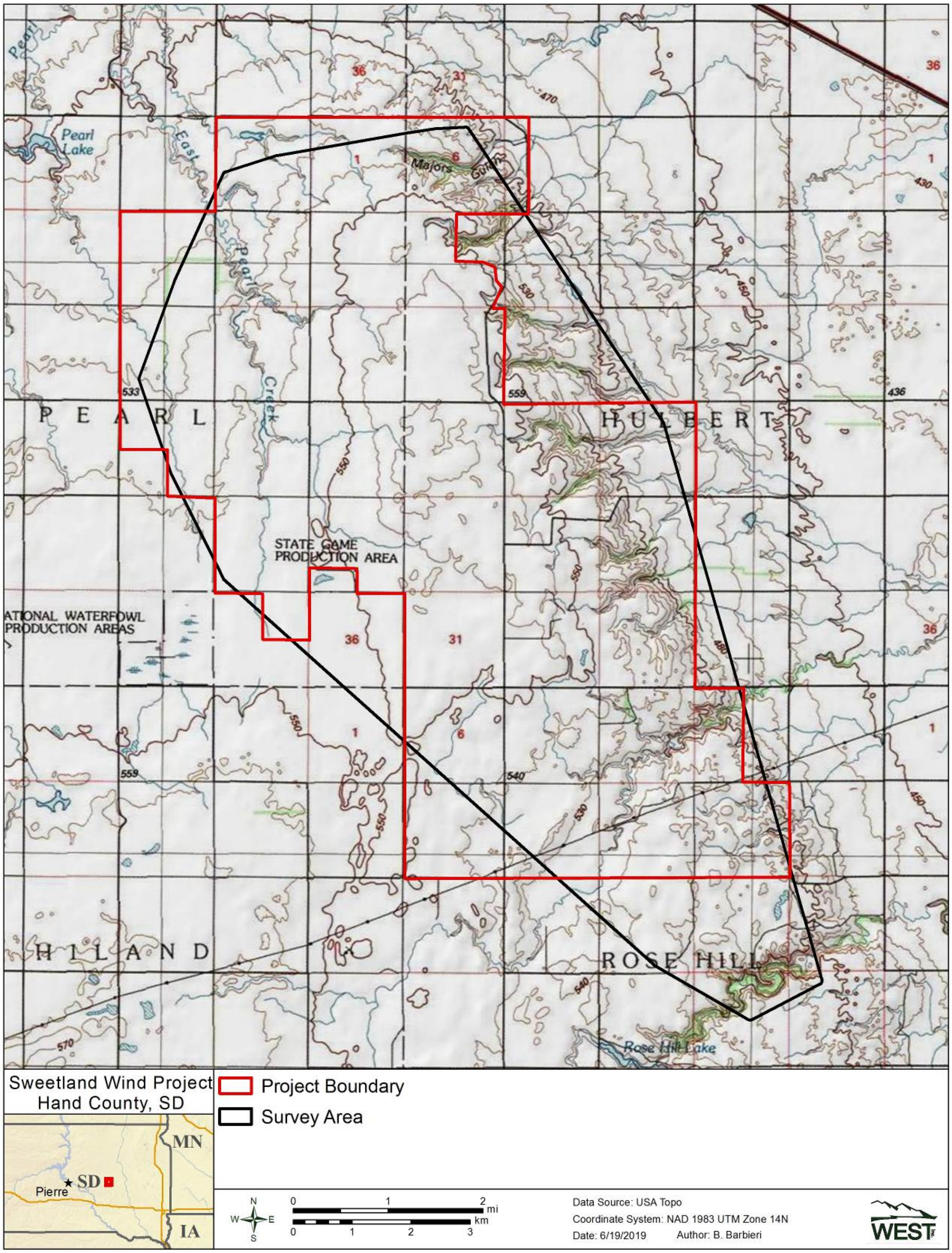

Figure 2. Topographic map of the Sweetland Wind Energy Project.

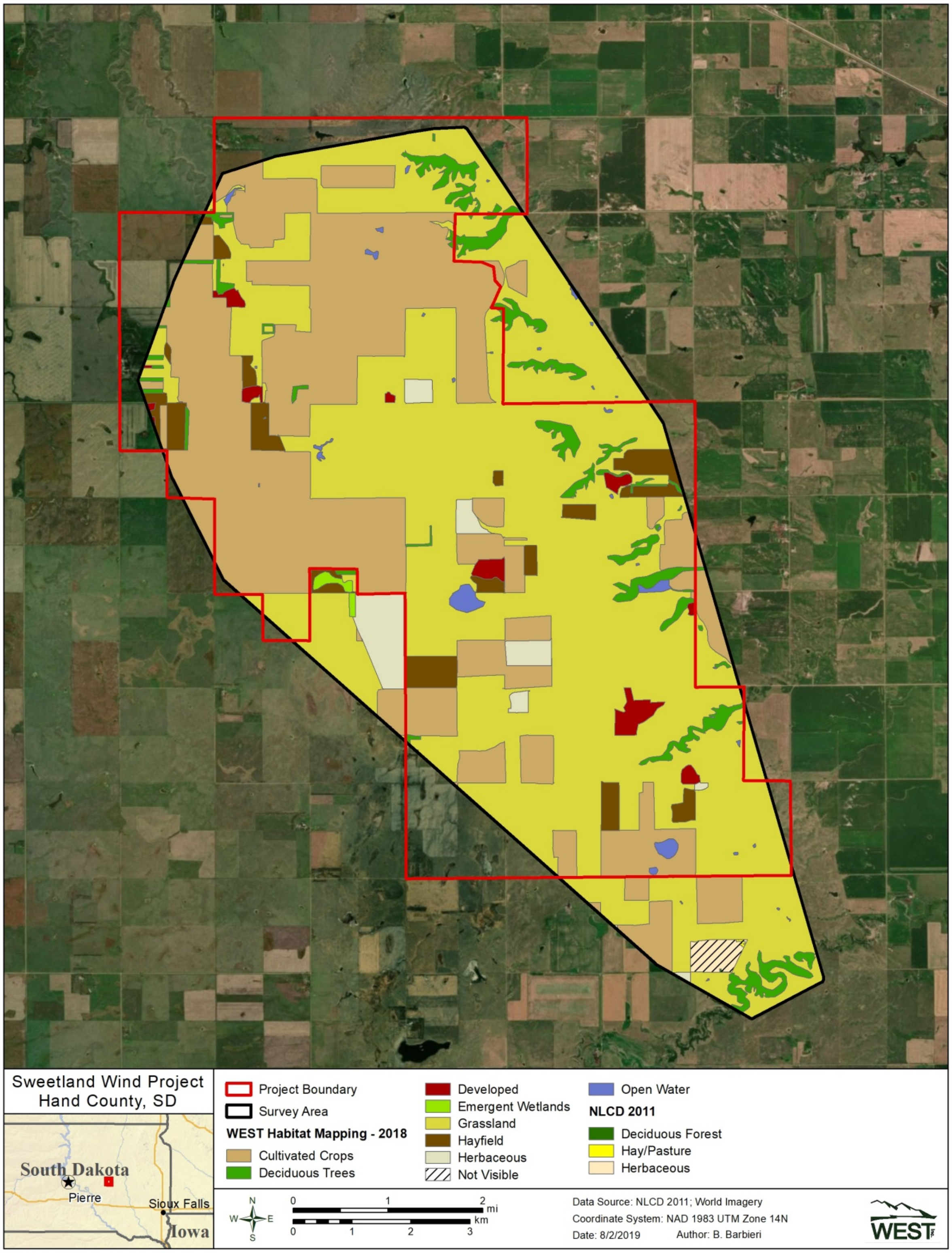

Figure 3. Land cover types based on vegetation mapping within the Sweetland Wind Energy Project Survey area, of from National Land Cover Database (Yang et al. 2018, Multi-Resolution Land Characteristics 2019) types for areas not accessible or not visible from a public road.

Table 1. Land cover types based on vegetation mapping within the Sweetland Wind Energy Survey area or from National Land Cover Database types for areas not accessible or not visible from a public road.

	Vegetation Mapping[a]			NLCD[b]			Total		
Land Cover Type	Hectares	Acres	Percent	Hectares	Acres	Percent	Hectares	Acres	Percent
Grassland	5,111.48	12,630.74	56.0	0	0	0	5,111.48	12,630.74	55.7
Cultivated Crops	3,018.10	7,457.89	33.1	0	0	0	3,018.10	7,457.89	32.9
Deciduous Trees	343.83	849.63	3.8	0.31	0.77	0.7	344.14	850.40	3.8
Hayfield	296.14	731.79	3.2	0.89	2.20	2.0	297.03	733.99	3.2
Herbaceous	199.40	492.73	2.2	43.84	108.32	97.3	243.24	601.05	2.7
Developed	94.72	234.06	1.0	0	0	0	94.72	234.06	1.0
Open Water	50.31	124.32	0.6	0	0	0	50.31	124.32	0.6
Emergent Wetlands	15.61	38.58	0.2	0	0	0	15.61	38.58	0.2
Totals[c]	**9,129.60**	**22,559.74**	**100**	**45.04**	**111.29**	**100**	**9,174.64**	**22,671.03**	**100**

[a] Based on vegetation mapping completed by Western EcoSystems Technology, Inc. during field reconnaissance

[b] Represent areas not accessible or visible during vegetation mapping and based on data from the National Land Cover Database (NLCD; Yang et al. 2018, Multi-Resolution Land Characteristics 2019).

[c] Sums of values may not add to total value shown, due to rounding.

METHODS

Fixed-Point Bird Use Surveys

The objective of the fixed-point bird use surveys was to estimate the seasonal and spatial use within the Survey area by birds, particularly diurnal raptors. Fixed-point bird surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980). Fixed-point large bird and separate fixed-point small bird use surveys were conducted within the Survey area. Large birds included waterbirds, waterfowl, shorebirds, gulls, coots, diurnal raptors, owls, vultures, upland game birds, doves and pigeons, large corvids (e.g., ravens, and crows) and goatsuckers. Passerines (excluding large corvids), woodpeckers, and unidentified small birds were considered small birds.

Survey Plots

The Survey area was defined as the minimum-convex polygon (MCP) that encompassed the proposed wind turbine locations along with the hazardous area around all proposed turbine locations. The 2013 US Fish and Wildlife Service (USFWS) *Eagle Conservation Plan Guidance* (ECPG; USFWS 2013) recommends that survey plots cover approximately 30% of the MCP. A grid with 1-mile by 1-mile cells was laid over the Survey area and grid cells were selected using a spatially balanced sampling method, Balance Acceptance Sampling (Brown et al. 2015). The center of the point-count survey location was placed within the selected grid cells and locations were selected based on visibility and access. The 13 survey plots used in Year One were used again in Year Two, with an additional six plots being added, due to expansion of the Project, for a total of 19 plots selected to survey representative habitats and topography, along public roads or areas where access had been granted (Figure 4). During surveys, bird observations were recorded regardless of distance from observer; however, for the large bird survey analyses, observations were restricted to 800 meters (m; 2,625 feet [ft]), and observations were restricted to 100 m (328 ft) for small bird analyses.

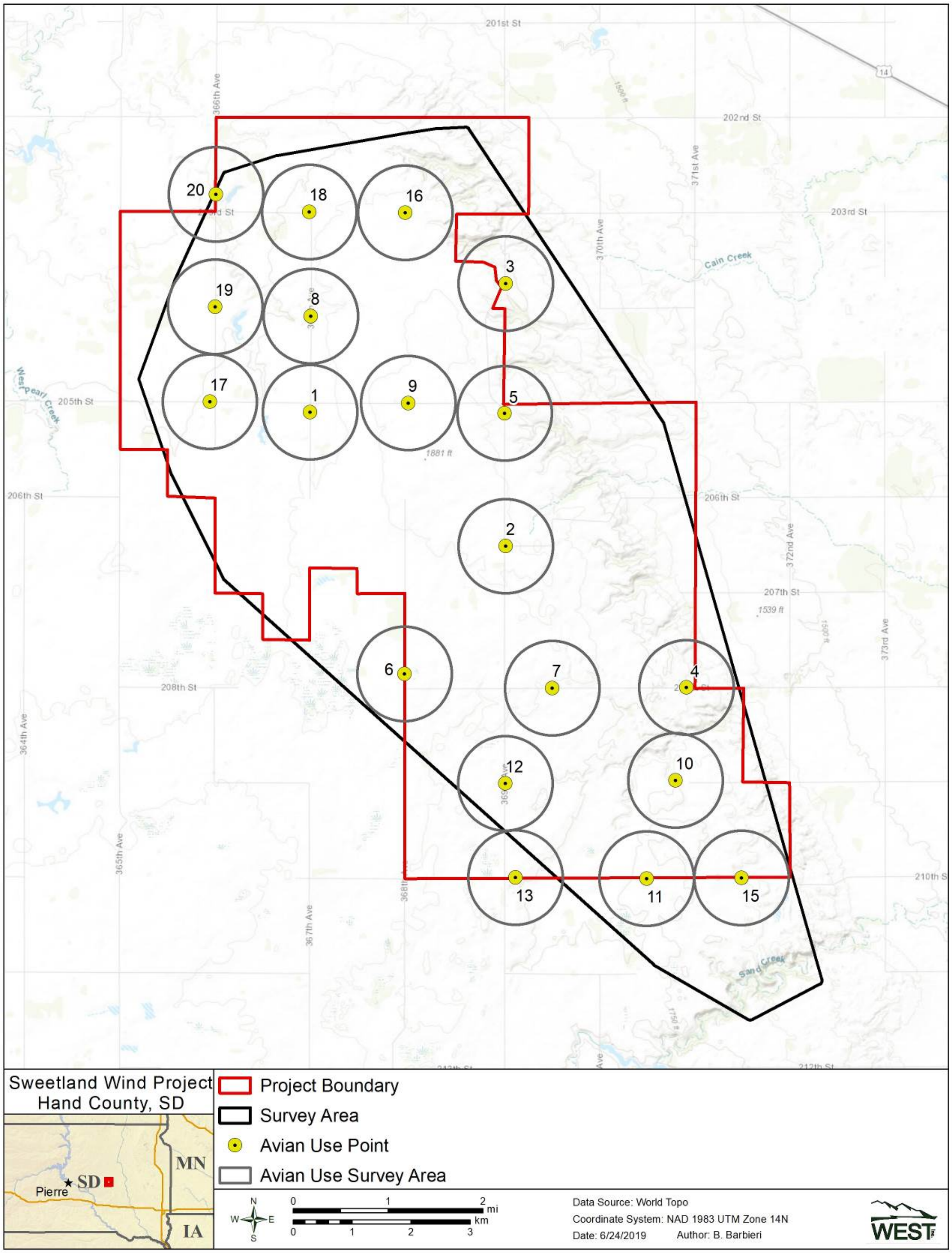

Figure 4. Location of fixed-point bird use survey stations at the Sweetland Wind Energy Project.

Survey Methods

Based on survey recommendations for eagles described in the ECPG (USFWS 2013) and Final Eagle Rule (USFWS 2016), a 10-minute (min) fixed-point small bird use survey was conducted followed by a separate 60-min large bird survey. However, special-status species, such as those that are federally endangered or threatened; or South Dakota endangered, threatened, or Species of Greatest Conservation Need (SGCN), were recorded for the full duration of the 70-min survey, but were considered incidental general wildlife observations if not recorded during their respective surveys (i.e., large birds or eagles recorded during the 10-min small bird survey, or small birds recorded during the 60-min large bird survey). All bird observations recorded during fixed-point bird use surveys were assigned a unique observation number.

The date, start and end time of each survey period, and weather information (e.g., temperature, wind speed, wind direction, and cloud cover) were recorded for each survey. Species or best possible identification, number of individuals, sex and age class (if identifiable), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded for each observation. Bird behavior and habitat type were recorded based on the point of first observation. Approximate flight height and distance from plot center were recorded to the nearest 5-m (16-ft) interval. Other information recorded included whether or not the observation was auditory only. Consistent with the ECPG, eagle observations were recorded on a per-min basis.

Locations of diurnal raptors, other large birds, and special-status species observed during fixed-point bird use surveys were recorded on field maps by unique observation number. Topographic maps, aerial photographs, binoculars, and a rangefinder were used to aid in recording locations of observations as accurately as possible. Flight paths and perched locations were digitized using geographic information system (GIS) software, ArcGIS 10.3.1.

Observation Schedule

Sampling intensity was designed to document bird use and behavior by habitat and season within the Survey area. Fixed-point bird use surveys were conducted from May 12, 2018 - April 30, 2019. Surveys were conducted on a monthly basis and each sampling station received one survey a month, to the extent possible (although weather influenced the ability to access all of the stations on 19 occasions). Seasons were defined as spring (March 1 – May 31), summer (June 1 - August 31), fall (September 1 - November 30), and winter (December 1 - February 28). Surveys were carried out during daylight hours and survey periods varied to cover approximately all daylight hours during a season.

Prairie Grouse Surveys

During spring 2019, WEST conducted aerial and ground-based surveys for prairie grouse (greater prairie chicken [*Tympanuchus* cupido] and sharp-tailed grouse [*Tympanuchus phasianellus*]) leks within the Survey area and surrounding 1-mile buffer. Aerial surveys utilized a helicopter and were conduct twice in spring 2019. Aerial surveys consisted of flying transects, oriented north/south, spaced a quarter-mile apart, within the Survey area and surrounding 1-mile buffer. Follow-up ground-based lek counts were conducted three times during spring 2019. To the extent possible, all surveys, both aerial and ground, were spaced at least seven days apart, were conducted from sunrise to 90 mins post sunrise, and occurred on mornings that were calm and clear. All active lek locations were recorded by global positioning system (GPS) coordinates. The date, time of each survey period, number of grouse observed, and weather information (e.g., wind speed, wind direction, and precipitation) were recorded for each survey. South Dakota Game, Fish and Park's define a lek as the traditional display area where two or more male grouse have attended in two or more of the previous five years.

Vegetation/Habitat Mapping

Land cover and potential special-status species habitat were mapped by a field biologist who drove around the site to visually assess land cover and topographic conditions from publicly accessible roads. Private lands were accessed if permission was obtained. Land cover and potential habitat for special- status species was identified and delineated on hard-copy maps with recent aerial imagery (US Department of Agriculture National Agriculture Imagery Program 2016). The mapped information was digitized in GIS so that it would be available to view with facilities and other Project information.

General Wildlife Observations

General wildlife observations provided records of wildlife seen outside of the standardized surveys. All diurnal raptors, unusual or unique species, special-status avian species, mammals, reptiles, and amphibians were recorded. Special-status species included SGCN, as identified in the 2014 *South Dakota State Wildlife Action Plan* (SWAP; South Dakota Game, Fish, and Parks [SDGFP 2014]) and species listed as threatened or endangered under the federal Endangered Species Act of 1973 (ESA; 16 US Code [USC] 1531-1599]), Bald and Golden Eagle Protection Act of 1940 (BGEPA; 16 USC 668-668c [1940]). The observation number, date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species) and habitat were recorded. The location of special-status species was recorded by Universal Transverse Mercator coordinates using a hand-held GPS unit. General wildlife observations were not a systematic sampling of the Survey area, but provided documentation of unique species that were observed within the Survey area and provided a record of the location and type of habitat the species potentially occur within (i.e., topographic or habitat associations).

Statistical Analysis

For analysis purposes, a visit was defined as a survey of all of the survey plots once within the Survey area. Visits were assigned according to the following criteria: (1) a single visit had to be completed in a single season and, (2) a visit could be spread across multiple dates. Under certain circumstances, such as extreme weather conditions, plots were not surveyed during some visits. In these cases, a visit might not have constituted a survey of all plots.

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, observers were responsible for inspecting data forms for completeness, accuracy, and legibility. Potentially erroneous data were identified using a series of database queries. Irregular codes or data suspected as questionable were discussed with the observer or project manager. If needed, errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

Data Compilation and Storage

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

Fixed-Point Bird Use Surveys

Each metric described below was calculated separately for fixed-point large bird use surveys and fixed-point small bird use surveys.

<u>Species Richness and Index to Species Richness</u>

Species richness is a count of species plus unidentified species groups, if a species from that group is not recorded during avian use surveys. A species list (with the number of individuals and the number of groups) was generated by season including all observations of birds detected, regardless of their distance from the observer. Species observed include those seen visually or heard aurally. In some cases, the count of observations may have represented repeated observations of the same individual.

The index to species richness is the average number of species observed within the observer viewshed per survey plot per visit within season (species observed/plot/visit/season). This metric is calculated by summing the total number of species observed within each plot during a visit, then averaging across plots within each visit, followed by averaging across visits within a season. The annual index to species richness was calculated as a weighted average of seasonal values by the number of days in each season. Species richness and index to species richness were compared among seasons for avian use surveys. These metrics were analyzed separately for small and large birds.

<u>Mean Use, Percent of Use, and Frequency of Occurrence</u>

Mean use is the average number of birds observed per plot per survey for small or large birds. Small bird use (per 100-m plot per 10-min survey) and large bird use (per 800-m plot per 60-min survey) is calculated by: 1) summing birds per plot per visit, 2) averaging number of birds over plots within a visit, and 3) averaging number of birds across visits within a season. Overall mean use was calculated as a weighted average of seasonal values by the number of days in each season. *Percent of use* was calculated as the percentage of small or large bird use that was attributable to a particular bird type or species. *Frequency of occurrence* was calculated as the percent of surveys in which a particular bird type or species was observed.

Mean use and frequency of occurrence describe different aspects of relative abundance, in that mean use is based on the number of birds (i.e., large groups can produce high estimates), whereas frequency of occurrence is based on the number of groups (i.e., it is not influenced by group size). Qualitative comparisons were made with these metrics among bird types, seasons, and survey points to help one understand how birds are using the Project area over time and space.

Bird Flight Height and Behavior

Bird flight heights are important metrics to assess when evaluating potential exposure. Flight height information was used to calculate the percentage of birds observed flying within the rotor-swept height (RSH) for turbines likely to be used at the Project. The flight height recorded during the initial observation was used to calculate the percentage of birds flying within the RSH and mean flight height. The percentage of individuals flying within the RSH at any time was calculated using the lowest and highest flight heights recorded. A RSH for potential collision with a turbine blade of 25-150 m (82-492 ft) above ground level was used for the analyses.

Bird Exposure Index

The bird exposure index is used as a relative measure of how often birds fly at heights similar to blades of modern wind turbines. A relative index of bird exposure (R) was calculated for bird species observed during the fixed-point bird use surveys using the following formula:

$$R = A{*}P_f{*}P_t$$

where A equals mean relative use for species i (large bird observations within 800 m of the observer or 100 m for small birds) averaged across all surveys, P_f equals the proportion of all observations of species i where activity was recorded as flying (an index to the approximate percentage of time species i spends flying during the daylight period) and P_t equals the proportion of all initial flight height observations of species i within the likely RSH.

Spatial Use

Large bird flight paths were qualitatively compared to Survey area characteristics (e.g., topographic features, land use/land cover, and/or concentrated prey resources). The objective of mapping observed large bird locations and flight paths was to identify areas of concentrated use by eagles, diurnal raptors and other large birds and consistent flight patterns within the Survey area.

RESULTS

Fixed-point bird use surveys were conducted within the Survey area from May 12, 2018 - April 30, 2019. Eighty-nine bird species, one mammal species, and one amphibian species were identified during the second year of baseline studies.

Fixed-Point Large Bird Use Surveys

A total of 209 60-min fixed-point large bird use surveys were conducted within the Survey area (Table 2). An 800-m viewshed was utilized when calculating species richness, use, percent composition, percent frequency, and exposure index for fixed-point large bird use surveys. It should be noted that snow accumulation restricted land access to portions of the Survey area during the winter and spring season and as a result, 19 surveys were missed during the winter and spring seasons.

Table 2. Summary of large bird species richness (species/800-meter plot/60-minute survey) and unique species, by season and overall, during the fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 30, 2019.

Season	Number of Visits	Number of Surveys Conducted	Number of Unique Species	Species Richness
Spring	3	50	40	4.10
Summer	3	57	19	2.35
Fall	3	57	11	0.75
Winter	3	45	4	0.10
Overall	**12**	**209**	**47**	**1.84**

Species Richness and Index to Species Richness

Forty-seven unique large bird species were observed over the course of all fixed-point large bird use surveys (Table 2). Large bird diversity (the number of unique species observed) was highest in the spring, followed by summer (40 and 19 species; respectively). Eleven unique species were observed during the fall, while four unique species were observed in the winter. Large bird species richness (mean number of species per plot per survey) was 4.10 species/800-m plot/60-min survey in the spring, followed by 2.35 in the summer, 0.75 in the fall and 0.10 in the winter (Table 2). A mean of 1.84 large bird species/800-m plot/60-min survey was observed throughout the year (Table 2).

Regardless of distance, 5,406 large bird observations were recorded within 775 separate groups (defined as one or more individuals) during the fixed-point large bird use surveys (Appendix A1). Two species, snow goose (*Chen caerulescens;* 1,785 observations), and Canada goose (*Branta canadensis*; 1,741 observations) accounted for 65.2% (3,526 observations) of all large bird observations. A total of 66 diurnal raptors were observed in 65 groups, representing seven identifiable species. The most abundant diurnal raptor was red-tailed hawk (*Buteo jamaicensis;* 44 observations), followed by northern harrier (*Circus hudsonius*; 12 observations; Appendix A1).

Large Bird Mean Use, Percent of Use, and Frequency of Occurrence

Mean large bird use, percent of use, and frequency of occurrence were calculated by season for all large bird types (Table 3) and species (Appendix B1). Large bird use was highest during the spring (119.25 birds/800-m plot/60-min survey) followed by summer (8.30), fall (2.39), and winter (0.10; Table 3). The relatively high large bird use in the spring was heavily influenced by waterfowl use (111.86 birds/800-m plot/60-min survey; Table 3, Appendix B1).

<u>Waterbirds</u>

Waterbirds were observed in summer, fall, and spring (Appendix A1). Waterbird use was the highest in fall (1.18 birds/800-m plot/60-min survey), followed by spring (0.28), and summer (0.11; Table 3); no waterbird observations were recorded during the winter season (Appendix A1). Three identifiable waterbird species were recorded during the second year of baseline studies: American white pelican (*Pelecanus erythrorhynchos*), great blue heron (*Ardea herodias*), and sandhill crane (*Antigone canadensis*; Appendix A1). Sandhill crane was the most commonly observed waterbird during the second year of studies within the Survey area and were observed during the spring and fall (Appendix A1). Sandhill crane use was highest in the fall (1.16 birds/800-m/60-min survey) followed by spring (0.26; Appendix B1). Sandhill crane use accounted for 48.5% of the waterbird observations during the fall season (66 observations in one group; Appendix A1). Great blue heron was the most commonly observed waterbird in summer (Appendix A1). Great blue heron had the highest use in summer with 0.11 bird/800-m/60-min survey (Appendix B1). Waterbirds accounted for 49.3% of large bird use during the fall, followed by 1.3% of large bird use in the summer, and 0.2% of large bird use in spring (Table 3, Appendix B1). Waterbirds were observed during 8.8% of summer surveys, and 3.5% of spring, and fall surveys, each (Table 3, Appendix B1).

Table 3. Mean bird use (number of birds/800-meter plot/60-minute survey), percent of total use, and frequency of occurrence for each large bird type and raptor subtype by season during the fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 30, 2019.

	Mean Use				Percent of Use				Frequency of Occurence			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Waterbirds	0.28	0.11	1.18	0	0.2	1.3	49.3	0	3.5	8.8	3.5	0
Waterfowl	111.86	0.98	0	0	93.8	11.8	0	0	64.8	19.3	0	0
Shorebirds	2.48	2.58	0.04	0	2.1	31.1	1.5	0	72.8	52.6	3.5	0
Gulls	2.55	1.37	0.40	0	2.1	16.5	16.9	0	17.1	1.8	3.5	0
Coots	0.04	0	0	0	<0.1	0	0	0	1.8	0	0	0
Diurnal Raptors	0.30	0.30	0.44	0.08	0.2	3.6	18.4	75.3	21.3	21.1	38.6	7.8
Accipiters	*0*	*0.02*	*0*	*0*	*0*	*0.2*	*0*	*0*	*0*	*1.8*	*0*	*0*
Buteos	*0.24*	*0.21*	*0.28*	*0.06*	*0.2*	*2.5*	*11.8*	*58.4*	*16.1*	*15.8*	*26.3*	*6.1*
Northern Harrier	*0.04*	*0.07*	*0.11*	*0*	*<0.1*	*0.8*	*4.4*	*0*	*3.5*	*3.5*	*10.5*	*0*
Eagles	*0*	*0*	*0*	*0.02*	*0*	*0*	*0*	*16.9*	*0*	*0*	*0*	*1.8*
Falcons	*0*	*0*	*0.05*	*0*	*0*	*0*	*2.2*	*0*	*0*	*0*	*5.3*	*0*
Other Raptors	*0.02*	*0*	*0*	*0*	*<0.1*	*0*	*0*	*0*	*1.8*	*0*	*0*	*0*
Owls	0	0.02	0	0	0	0.2	0	0	0	1.8	0	0
Vultures	0.14	0.39	0.04	0	0.1	4.7	1.5	0	3.5	8.8	3.5	0
Upland Game Birds	0.69	1.18	0.09	0.03	0.6	14.2	3.7	24.7	41.4	29.8	7.0	2.6
Doves/Pigeons	0.65	1.33	0.21	0	0.5	16.1	8.8	0	24.6	50.9	12.3	0
Large Corvids	0.23	0	0	0	0.2	0	0	0	4.5	0	0	0
Goatsuckers	0.04	0.05	0	0	<0.1	0.6	0	0	1.8	5.3	0	0
Overall Large Birds*	**119.25**	**8.30**	**2.39**	**0.10**	**100**	**100**	**100**	**100**				

* Sums may not total values shown due to rounding.

Waterfowl

Waterfowl were observed in spring and summer, with no observations in the fall or winter (Appendix A1). Waterfowl use was the highest in spring (111.86 birds/800-m plot/60-min survey), followed by summer (0.98; Table 3). Eleven identifiable waterfowl species were recorded during the second year of baseline studies: American wigeon (*Anas americana*), blue-winged teal (*Spatula discors*), Canada goose, canvasback (*Aythya valisineria*), gadwall (*Mareca strepera*), lesser scaup (*Aythya affinis*), mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), northern shoveler (*Spatula clypeata*), snow goose, and wood duck (*Aix sponsa*) (Appendix A1). Canada goose and snow goose were the most commonly observed waterfowl species during the second year of studies within the Survey area (Appendix A1). Snow goose was observed during spring with a use of 49.58 birds/800-m/60-min survey (Appendix B1). Canada goose was observed during the spring with a use of 47.58 birds/800-m/60-min survey (Appendix B1). Mallard had the highest use of all waterfowl in the summer with a use of 0.56 bird/800-m/60-min survey. Waterfowl accounted for 93.8% of large bird use during the spring, and 11.8% during the summer (Table 3, Appendix B1). Waterfowl were observed during 64.8% of spring surveys, and 19.3% of summer surveys (Table 3, Appendix B1).

Shorebirds

Shorebirds were observed in spring, summer, and fall, with no observations recorded in winter (Appendix A1). Shorebird use was the highest in summer (2.58 birds/800-m plot/60-min survey), followed by spring (2.48) and fall (0.04; Table 3). Six identifiable shorebird species were recorded during the second year of baseline studies: killdeer (*Charadrius vociferus*), lesser yellowlegs (*Tringa flavipes*), long-billed curlew (*Numenius americanus*), marbled godwit (*Limosa fedoa*), upland sandpiper (*Bartramia longicauda*), and Wilson's snipe (*Gallinago delicata*; Appendix A1). Killdeer accounted for the highest use in summer (1.82 birds/800-m plot/60-min survey), spring (1.81), and fall (0.04; Table 3, Appendix B1). Shorebirds accounted for 31.1% of large bird use during the summer, followed by 2.1% of large bird use in the spring and 1.5% of large bird use in fall (Table 3, Appendix B1). Shorebirds were observed during 72.8% of spring surveys, 52.6% of summer surveys, and 3.5 % of fall surveys (Table 3, Appendix B1).

Gulls

Gulls were observed in spring, summer, and fall, with no observations recorded in winter (Appendix A1). Gull use was the highest in spring (2.55 birds/800-m plot/60-min survey), followed by summer (1.37) and fall (0.40; Table 3). Two identifiable gull species were recorded during the second year of baseline studies: Franklin's gull (*Leucophaeus pipixcan*), and ring-billed gull (*Larus delawarensis*; Appendix A1). Franklin's gull had the highest use in spring (1.70 birds/800-m plot/60-min survey) while ring-billed gull had the highest use in summer (1.37 birds/800-m plot/60-min survey), and fall (0.02; Appendix B1). Gulls accounted for 16.9% of large bird use during the fall, followed by 16.5% of large bird use in the summer and 2.1% of large bird use in spring (Table 3, Appendix B1). Gulls were observed during 17.1% of spring surveys, 3.5% of fall surveys, and 1.8% of summer surveys (Table 3, Appendix B1).

Coots

Coots were only observed in spring with a use of 0.04 bird/800-m plot/60-min survey (Table 3; Appendices A1 and B1). American coot (*Fulica americana*) was the only coot species recorded during the second year of baseline studies (Appendix A1). Coots accounted for less than 0.1% of large bird use during the spring and were observed during 1.8% of spring surveys (Table 3, Appendix B1).

Diurnal Raptors

Diurnal raptor use was highest in the fall (0.44 bird/800-m plot/60-min survey), followed by spring and summer (each 0.30), and winter (0.08, Table 3, Appendix B1). Amongst accipiters, Cooper's hawk (*Accipiter cooperii*) was only observed in summer with use of 0.02 bird/800-m/60-min survey. Amongst buteos, red-tailed hawk (*Buteo jamaicensis*) had the highest use during fall, spring, summer, and winter (0.28, 0.21, 0.21, and 0.04 bird/800-m plot/60-min survey each season, respectively; Appendix B1). Northern harrier was observed in the spring, summer, and fall seasons, with highest use in the fall (0.11 bird/800-m plot/60-min survey), followed by summer and spring (0.07 and 0.04 respectively; Table 3, Appendix B1). Eagles were only observed in the winter with a use of 0.04 bird/800-m plot/60-m survey (Appendix A1). A single bald eagle (*Haliaeetus leucocephalus*) was the only eagle species observed. Eagles accounted for 16.9% of large bird use in the winter, and were seen during 1.8% of winter surveys (Table 3; Appendix B1). Amongst falcons, American kestrel (*Falco sparverius*) was the only falcon species observed and that was in the fall with a use of 0.05 falcon/800-m plot/60-min survey (Appendix A1). Overall, diurnal raptors accounted for 75.3% of large bird use in the winter, followed by fall (18.4%), summer (3.6%) and spring (0.2%). Diurnal raptors were observed during 38.6% of fall surveys, 21.3% of spring surveys, 21.1% of summer surveys, and 7.8% of the winter surveys (Table 3, Appendix B1).

Owls

Owls were only observed in summer with no observations in spring, fall, and winter (Appendix A1). Owl use in summer was 0.02 bird/800-m plot/60-min survey (Table 3). Great horned owl (*Bubo virginianus*) was the only owl species recorded during the second year of baseline studies (Appendix A1). Owls accounted for 0.2% of large bird use during the summer and were observed during 1.8% of summer surveys (Table 3, Appendix B1).

Vultures

Vultures were observed in spring, summer, and fall, with no observations recorded in winter (Appendix A1). Vulture use was the highest in summer (0.39 bird/800-m plot/60-min survey), followed by spring (0.14) and fall (0.04; Table 3). Turkey vulture (*Cathartes aura*) was the only vulture species recorded during the second year of baseline studies (Appendix A1). Vultures accounted for 4.7% of large bird use during the summer, followed by 1.5% of large bird use in the fall and 0.1% of large bird use in spring (Table 3, Appendix B1). Vultures were observed during 8.8% of summer surveys, and 3.5% of spring and fall surveys, each (Table 3, Appendix B1).

Upland Game Birds

Upland game birds were observed in all four seasons (Appendix A1). Upland game bird use was the highest in summer (1.18 birds/800-m plot/60-min survey), followed by spring (0.69), fall (0.09), and winter (0.03; Table 3). Three identifiable upland game bird species were recorded during the second year of baseline studies: ring-necked pheasant (*Phasianus colchicus*), sharp-tailed grouse, and wild turkey (*Meleagris gallopavo*). Ring-necked pheasant accounted for the highest use in all four seasons: summer (1.18 birds/800-m plot/60-min survey), spring (0.65), fall (0.09), and winter (0.03; Table 3, Appendix B1). Upland game birds accounted for 24.7% of large bird use during the winter, followed by 14.2% of large bird use in the summer, 3.7% in the fall, and 0.6% of large bird use in spring (Table 3, Appendix B1). Upland game birds were observed during 41.4% of spring surveys, 29.8% of summer surveys, 7.0% of fall surveys, and 2.6% of winter surveys (Table 3, Appendix B1).

Doves/Pigeons

Doves/pigeons were observed in spring, summer, and fall, with no observations in the winter (Appendix A1). Dove/pigeon use was the highest in summer (1.33 birds/800-m plot/60-min survey), followed by spring (0.65), and fall (0.21; Table 3). Three dove/pigeon bird species were recorded during the second year of baseline studies: Eurasian collared-dove (*Streptopelia decaocta*), rock pigeon (*Columba livia*), and mourning dove (*Zenaida macroura*). Mourning dove accounted for the highest use in all three of the seasons that doves/pigeons were observed: summer (1.32 birds/800-m plot/60-min survey), spring (0.56), and fall (0.21; Table 3, Appendix B1). Doves/pigeons accounted for 16.1% of large bird use during the summer, followed by 8.8% of large bird use in the fall, and 0.5% in the spring (Table 3, Appendix B1). Doves/pigeons were observed during 50.9% of summer surveys, 24.6% of spring surveys, and 12.3% of fall surveys (Table 3, Appendix B1).

Large Corvids

Large corvids were only observed in the spring season, and American crow (*Corvus brachyrhynchos*) was the only large corvid species recorded (Appendix A1). Use by large corvids during the summer season was 0.23 bird/800-m plot/60-min survey, which accounted for 0.2% of large bird use and large corvids were observed during 4.5% of summer surveys (Table 3, Appendix B1).

Goatsuckers

Goatsuckers were only observed in spring and summer, and common nighthawk (*Chordeiles minor*) was the only goatsucker species recorded (Appendix A1). Use by goatsuckersduring the summer season was 0.05 bird/800-m plot/60-min survey and 0.04 in spring. Goatsuckers accounted for 0.6% of large bird use in the summer and less than 0.1% in spring. Large corvids were observed during 5.3% of summer surveys and 1.8% of spring surveys (Table 3, Appendix B1).

Bird Flight Height and Behavior

Flight height characteristics, based on initial flight height observations, were estimated for both large bird types and species (Tables 4 and 5). During fixed-point large bird use surveys, 411 groups of large birds were initially observed flying within the 800-m plot, totaling 4,523 observations (Table 4). Approximately 72.4% of flying large birds were initially recorded within the RSH, 27.3% were below the RSH, and 0.3% were flying above the RSH. Of flying diurnal raptors 28.0% were initially observed within the RSH, while 70.0% were below the RSH, and 2.0% were flying above the RSH. Of the diurnal raptors, accipiters and eagles had the highest percentage of flying birds initially recorded within the RSH (100%), which was based on a single observed accipiter and a single observed bald eagle, followed by buteos (34.4%), northern harriers (8.3%), and other raptors and falcons (none). Goatsuckers were initially recorded within at 100% within the RSH during initial observations and vultures 95.7% of initial observations. Waterfowl, waterbirds, gulls, shorebirds, and doves/pigeons were initially observed within the RSH 79.0%, 50.0%, 40.7%, 8.8%, and 1.1% of the time, respectively. Upland game birds and large corvids were not observed in the RSH, and coots were not seen initially flying (Table 4). Of individual diurnal raptor species, bald eagle, and Cooper's hawk were observed flying within the RSH during 100% of initial observations, but this is based on one group of each species (Table 5, Appendix C1). Red-tailed hawk and northern harrier were observed within the RSH during 37.9% and 8.3%, respectively, during initial observations (Table 5, Appendix C1).

Table 4. Flight height characteristics for each large bird type and raptor subtype observed within an 800-meter radius during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

Bird Type	Number of Groups Flying	Number Obs Flying	Mean Flight Height (m)	Percent Obs Flying	Percent Within Flight Height Categories[a]		
					0 - 25 m	25 - 150 m[b]	>150 m
Waterbirds	8	8	45.75	9.0	50.0	50.0	0
Waterfowl	135	3,947	22.30	89.7	20.7	79.0	0.3
Shorebirds	118	148	8.55	54.6	91.2	8.8	0
Gulls	14	243	19.43	100	59.3	40.7	0
Coots	0	0	NA	0	NA	NA	NA
Diurnal Raptors	49	50	23.02	83.3	70.0	28.0	2.0
Accipiters	*1*	*1*	*70.00*	*100*	*0*	*100*	*0*
Buteos	*32*	*32*	*26.91*	*76.2*	*62.5*	*34.4*	*3.1*
Northern Harrier	*11*	*12*	*13.09*	*100*	*91.7*	*8.3*	*0*
Eagles	*1*	*1*	*30.00*	*100*	*0*	*100*	*0*
Falcons	*3*	*3*	*6.67*	*100*	*100*	*0*	*0*
Other Raptors	*1*	*1*	*3.00*	*100*	*100*	*0*	*0*
Owls	0	0	NA	0	NA	NA	NA
Vultures	19	23	86.58	71.9	0	95.7	4.3
Upland Game Birds	7	8	1.57	7.1	100	0	0
Doves/Pigeons	57	91	6.79	72.8	98.9	1.1	0
Large Corvids	1	2	3.00	22.2	100	0	0
Goatsuckers	3	3	60.00	60.0	0	100	0
Large Birds Overall	**411**	**4,523**	**19.49**	**84.6**	**27.3**	**72.4**	**0.3**

[a] Sums may not total values shown due to rounding.

[b] Based on current assumptions, the rotor-swept height for potential collision with a turbine blade, or 25-150 meters (82-492 feet) above ground level.

Obs = observed

Bird Exposure Index

A relative exposure index, based on initial flight height observations and relative abundance (defined as the use estimate), was calculated for each large bird species. Those species that had exposure to the RSH are listed in Table 5, and a complete list of all species is presented in Appendix C1. The exposure index does not account for other possible collision risk factors, such as foraging, courtship, or avoidance behavior. Among identifiable large birds, snow goose had the highest estimated exposure index value (12.50), followed by Canada goose (8.35). All other large bird species had estimated exposure indices less than one (Table 5, Appendix C1). Of diurnal raptors, red-tailed hawk had the highest estimated exposure index of 0.05, followed by bald eagle, Cooper's hawk, and northern harrier, of which each had estimated exposure indices of less than 0.01 (Table 5; Appendix C1).

Table 5. Relative exposure index and flight characteristics for large bird species[a] during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

Species	Number of Groups Flying	Overall Mean Use	Percent Flying	Percent Flying Within RSH[b] Based on Initial Obs	Exposure Index	Percent Within RSH at Anytime
snow goose	3	12.50	100	100	12.50	100
Canada goose	11	11.99	79.3	87.8	8.35	87.8
ring-billed gull	9	0.50	100	77.1	0.38	77.1
unidentified goldeneye	4	0.72	100	38.3	0.27	38.3
unidentified duck	11	0.65	100	25.0	0.16	30.4
turkey vulture	19	0.14	71.9	95.7	0.10	95.7
unidentified gull	2	0.16	100	40.5	0.07	40.5
red-tailed hawk	29	0.18	74.4	37.9	0.05	41.4
mallard	51	1.18	89.5	4.8	0.05	13.5
upland sandpiper	23	0.26	47.5	25.0	0.03	28.6
gadwall	4	0.04	80.0	62.5	0.02	62.5
killdeer	83	0.93	56.3	3.7	0.02	3.7
great blue heron	8	0.04	100	50.0	0.02	50.0
American wigeon	2	0.04	71.4	60.0	0.02	60.0
northern pintail	20	0.71	97.4	2.0	0.01	3.3
common nighthawk	3	0.02	60.0	100	0.01	100
marbled godwit	10	0.06	71.4	20.0	<0.01	30.0
unidentified waterfowl	7	0.12	100	7.1	<0.01	82.1
Cooper's hawk	1	<0.01	100	100	<0.01	100
mourning dove	56	0.53	72.3	1.2	<0.01	4.7
northern harrier	11	0.05	100	8.3	<0.01	16.7
bald eagle	1	<0.01	100	100	<0.01	100

[a] Only includes species with exposure indices greater than zero; for full listing, see Appendix C1.

[b] Based on current development plans rotor-swept height (RSH) for potential collision with a turbine blade, or 25- 150 meters (82- 492 feet) above ground level.

Obs = observations.

Eagle Flight Minutes

Bald eagle observations were recorded on a per min basis following the ECPG. A single bald eagle was observed during the winter resulting in four eagle risk mins (i.e. observations of flying eagles within 800 m and below 200 m) during the second year of fixed-point large bird use surveys (Table 6). This observation results in 0.02 eagle risk minutes per observation hour (Table 6).

Table 6. Summary of survey minutes and percentage of minutes bald eagles were observed flying during fixed-point large bird use surveys* at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

Season	Total Minutes of Eagle Observations (Excludes Perched Birds)	Total Survey Minutes	Eagle Risk Minutes per Observation Hour
Spring	0	3,000	0
Summer	0	3,420	0
Fall	0	3,420	0
Winter	4	2,700	0.09
Overall	**4**	**12,540**	**0.02**

* Restricted to those minutes where the eagle was flying within 800 meters of the point and below 200 meters

Spatial Use

Spatial use by large bird type across the 19 avian use points within the Survey area are presented in Appendices D1 and D3. Spatial use is visually depicted using bubble plots of mean use values for each major bird type and for diurnal raptor subtypes (Appendix D3). In addition, Figures 5, 6, and 7 illustrate spatial use for large birds, diurnal raptors, and eagles, respectively, across the Survey area.

For all large bird species combined, use was highest at survey plot 13 (292.50 birds/60-min survey; Figure 5, Appendix D1). Large bird use ranged from 1.58 to 42.00 birds/60-min survey at the remaining survey plots. The relatively higher use estimates recorded at survey plot 13 were largely due to waterfowl use (279.00 birds/60-min survey; Appendix D1).

Diurnal raptor use was distributed among most survey plots, except for survey plot 17. Where recorded, diurnal raptor use ranged from 0.08 bird/60-min survey at survey plot nine, to 0.75 at survey plot 13 (Figure 6, Appendices D1 and D3). Among diurnal raptor subtypes, buteos were the most widespread across the Survey area, with observations recorded at 16 survey plots. Where recorded, use by buteos ranged from 0.08 bird/60-min survey at survey plots three and 20, to 0.58 bird/60-min survey at survey plot 10 (Appendix D1). Accipiters were observed at one survey plot, northern harrier was observed at nine of the survey plots, eagles were observed at one survey plot, and falcons were observed at three survey plots. The only survey plot where accipiters were recorded was survey plot 19, with a use of 0.08 bird/60-min survey. At points where northern harriers were recorded, northern harrier use ranged from 0.08 bird/60-min survey at survey plots one, three, five, 12, 19, and 20, to 0.25 bird/60-min survey at survey plot 13. A single bald eagle only recorded at survey plot nine with a use of 0.08 bird/60-min survey (Figure

7, Appendix D1). At all three survey plots (11, 15, and 18) where falcons were recorded had a use of 0.11 bird/60-min survey (Appendix D1).

Flight paths and perch locations for waterbirds, waterfowl, shorebirds, gulls, diurnal raptors and diurnal raptor subtypes, owls, vultures, upland game birds, doves/pigeons, and goatsuckers were digitized and mapped (Appendix E).

While overall large bird use and diurnal raptor use is scattered throughout the Survey area, use is higher in the south due to high use at survey plot 13.. For eagles, only survey plot nine was recorded to have use (Figures 7 and 8).

While waterfowl use is scattered throughout the Survey area, higher use appears to occur near survey plots that are associated with riparian areas, with survey plots 13 and 20 having higher use than other points (Appendix D). Waterbird use is scattered throughout the Survey area, with the highest use occurring at survey plots two and five, in the central portion of the Survey area, but there are no discernible patterns.

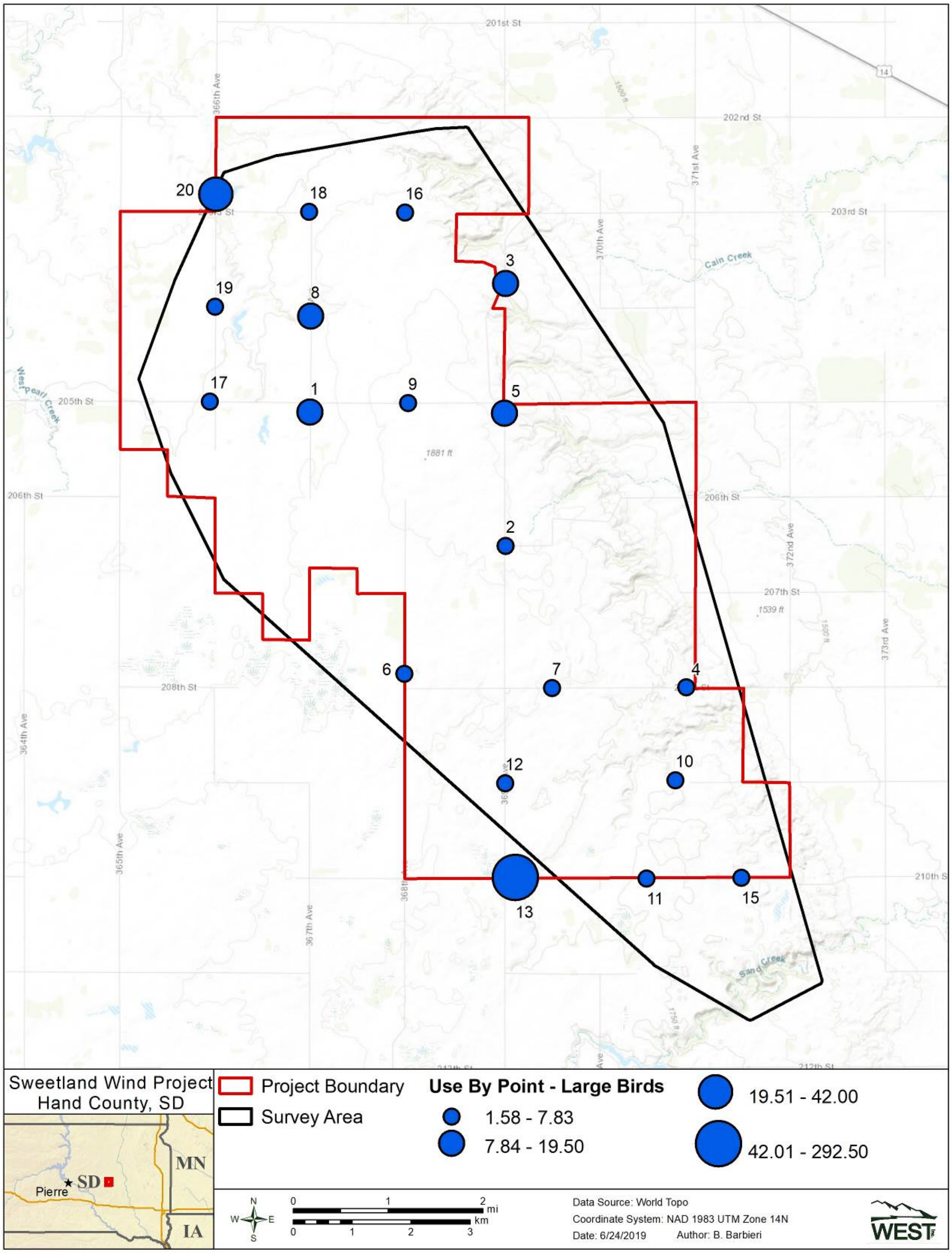

Figure 5. Large bird use by point recorded during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 - April 31, 2019.

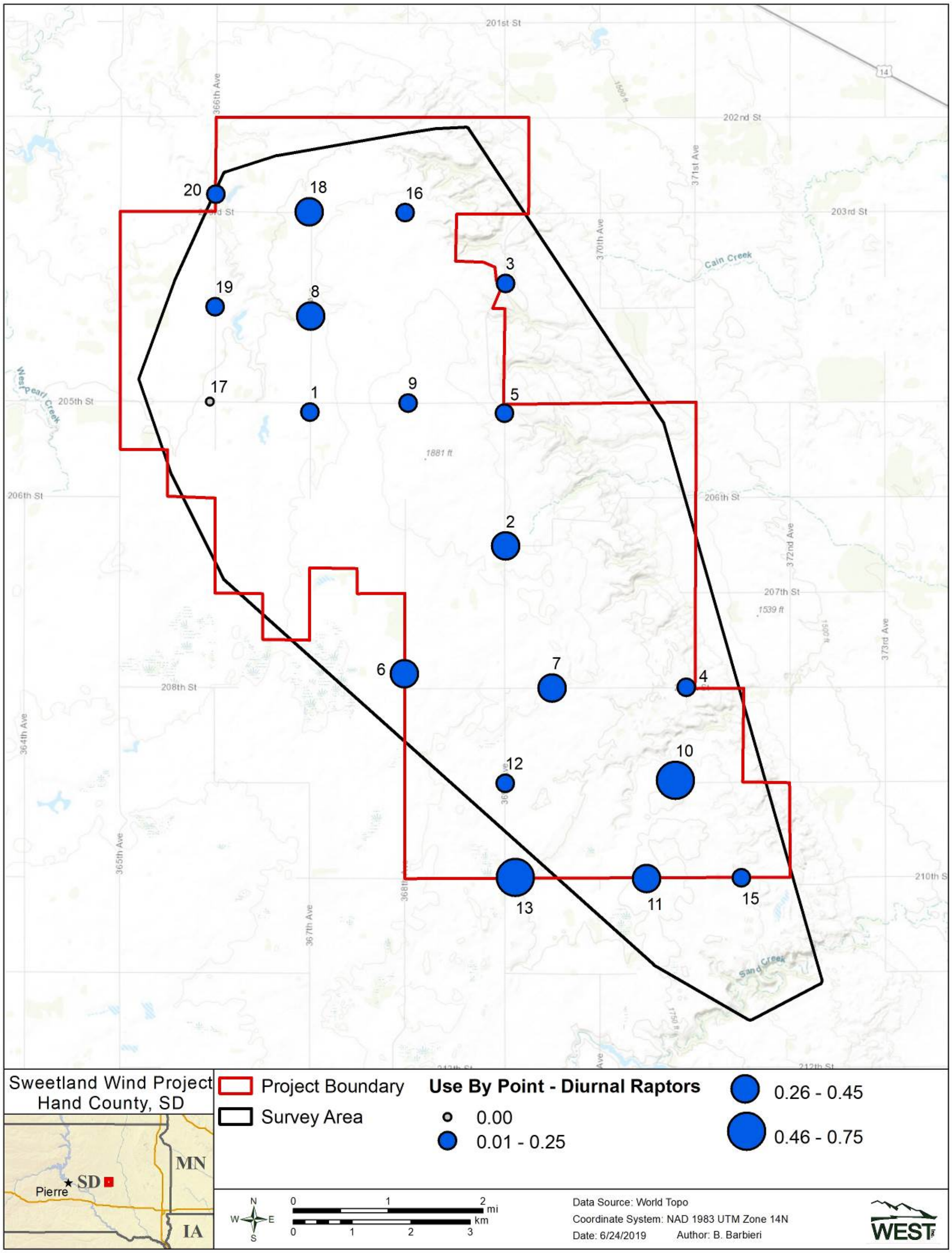

Figure 6. Diurnal raptor use by point recorded during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

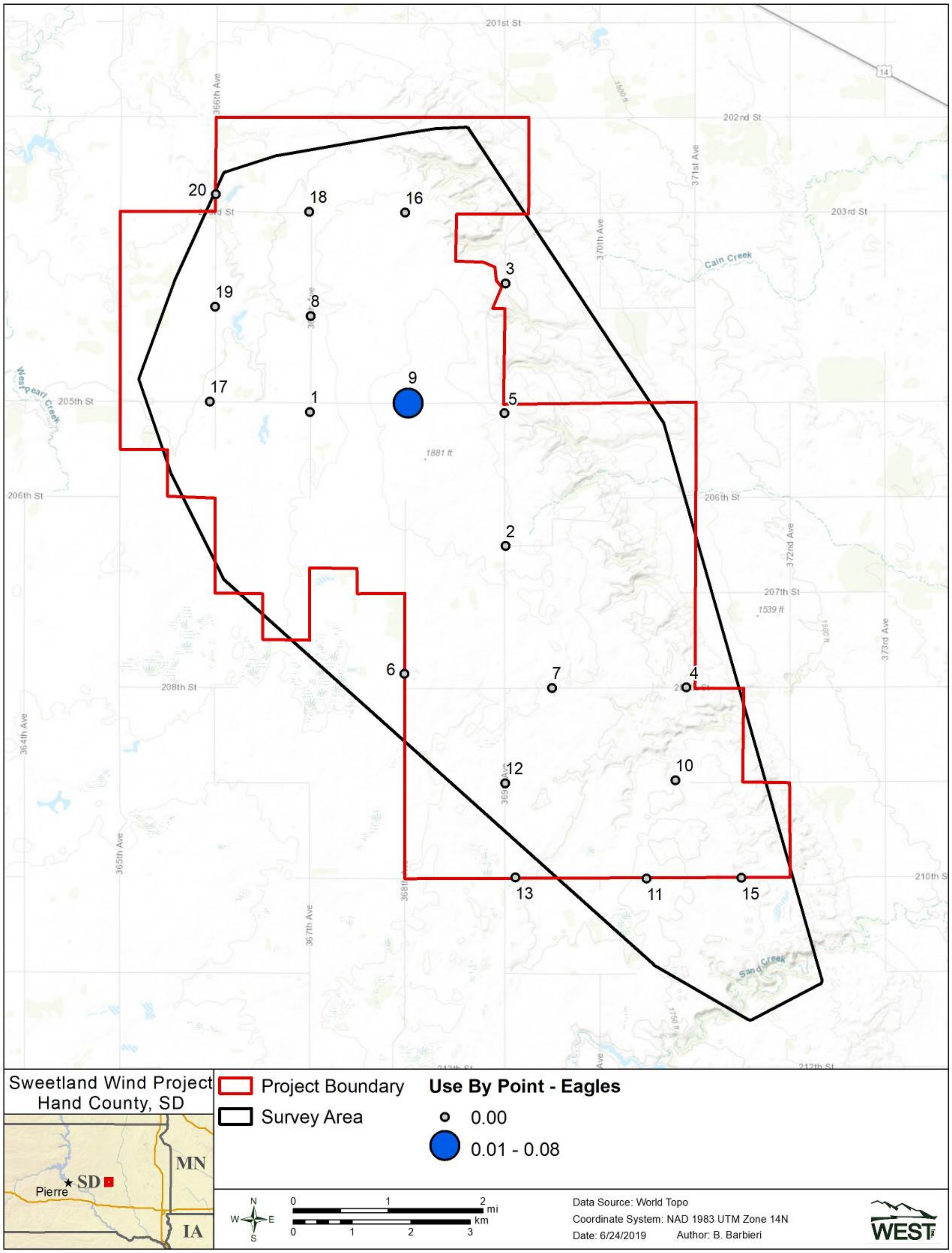

Figure 7. Eagle use by point recorded during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

Fixed-Point Small Bird Use Surveys

A total of 209 10-min fixed-point small bird use surveys were conducted within the Survey area (Table 7). A 100-m viewshed was used when calculating species richness, use, percent composition, percent frequency, and exposure index for small bird use surveys.

Table 7. Summary of species richness (species/100-meter plot/10-minute survey) and unique species, by season and overall, during the fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

Season	Number of Visits	Number of Surveys Conducted	Number of Unique Species	Species Richness
Spring	3	50	28	3.10
Summer	3	57	26	4.28
Fall	3	57	16	1.28
Winter	3	45	2	0.16
Overall	**12**	**209**	**42**	**2.22**

Species Richness and Index to Species Richness

Forty-two unique small bird species were observed over the course of the fixed-point small bird use surveys (Table 8). Small bird diversity (the number of unique species observed) was highest in spring (28 species) followed by summer, fall, and winter (26, 16, and two species, respectively; Table 7). Small bird species richness (mean number of species per plot per survey) was highest in summer, followed by spring (4.28 and 3.10 species/100-m plot/10-min survey, respectively), and lower in fall and winter (1.28, and 0.16, respectively). A mean of 2.22 small bird species/100-m plot/10-min survey was observed throughout the second year of baseline studies (Table 8).

Regardless of the distance from the observer, 1,749 small bird observations were recorded within 694 separate groups (defined as one or more individual) during the fixed-point small bird use surveys (Appendix A2). Horned lark (*Eremophila alpestris*) accounted for 19.0% of all small bird observations, red-winged blackbird (*Agelaius phoeniceus*) accounted for 17.2%, and brown-headed cowbird (*Molothrus ater*) accounted for 12.2%. Among other identified small bird species, barn swallow (*Hirundo rustica;* 182 observations; 10.4% of small birds) was the next most commonly recorded species (Appendix A2). All other small bird species accounted for less than 10% of the total recorded small bird species.

Small Bird Mean Use, Percent of Use, and Frequency of Occurrence

Mean small bird use, percent of use, and frequency of occurrence were calculated by season for all small bird types (Table 8) and species (Appendix B2). A 100-m viewshed and 10-min survey duration were used for small birds; therefore, descriptive statistics for small bird types are not directly comparable to large bird types. Passerines and woodpeckers were the only identified small bird types observed.

Table 8. Mean small bird use (number of birds/100-meter plot/10-minute survey), percent of total use, and frequency of occurrence for each small bird type by season during the fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

	Mean Use				Percent Use				Frequency of Occurence			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Passerines	15.07	10.35	4.70	1.03	99.9	98.2	98.5	98.3	86.1	100	80.7	14.7
Woodpeckers	0.02	0.04	0.07	0.02	0.1	0.3	1.5	1.7	1.8	3.5	3.5	1.8
Unidentified Birds	0	0.16	0	0	0	1.5	0	0	0	8.8	0	0
Overall Small Birds*	**15.09**	**10.54**	**4.77**	**1.05**	**100**	**100**	**100**	**100**				

* Sums may not total values shown due to rounding.

Passerines

Passerine use was higher in the spring (15.07 birds/100-m plot/10-min survey) than in the other seasons: summer (10.35), fall (4.70), and winter (1.03; Table 8, Appendix B2). Horned lark accounted for 98.3% of use in the winter, and 39.7% of use in the spring. Red-winged blackbird accounted for 33.5% of small bird use in fall, and brown-headed cowbird accounted for 20.0% of small bird use in summer (Appendix B2). Passerines were observed during 100% of summer surveys, 86.1% of spring surveys, 80.7% of fall surveys, and 14.7% of surveys in winter (Table 8, Appendix B2).

Woodpeckers

Woodpeckers were observed in all four seasons (Appendix A2). Woodpecker use was the highest in fall (0.07 bird/100-m plot/10-min survey), followed by summer (0.04) and fall and winter (0.02, each; Table 8). Three identifiable woodpecker species were observed: northern flicker (*Colaptes auratus*), hairy woodpecker (*Dryobates villosus*), and red-headed woodpecker (*Malenerpes erythrocephalus*). Woodpeckers accounted for 1.7% of winter surveys, 1.5% of fall surveys, 0.3% of summer surveys, and 0.1% of spring surveys (Table 8; Appendix B2). Woodpeckers were observed during 3.5% of summer and fall surveys, and 1.8% of spring and winter surveys (Table 8; Appendix B2).

Unidentified Birds

Twenty-five observations in 11 groups were recorded during the summer of the second year of surveys (Appendix A2). Unidentified bird use during the summer was 0.16 bird/100-m plot/10-min survey, which accounted for 1.5% of summer small bird use (Table 8). Unidentified birds were observed during 8.8% of summer surveys (Table 8).

Bird Flight Height and Behavior

Flight height characteristics, based on initial flight height observations and estimated use, were estimated for both small bird types (Table 9). During fixed-point small bird use surveys, 276 groups of small birds were initially observed flying within the 100-m plot, totaling 999 observations (Table 9). Overall, 100% of flying small birds were initially recorded below the RSH (Table 9).

Table 9. Initial flight height characteristics for each small bird type observed within a 100-meter radius plot during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

Bird Type	Number of Groups Flying	Number Obs Flying	Mean Flight Height (m)	Percent Obs Flying	Percent within Flight Height Categories		
					0 - 25 m	25 - 150 m[a]	>150 m
Passerines	272	992	3.61	61.7	100	0	0
Woodpeckers	2	2	6.00	25.0	100	0	0
Unidentified Birds	2	5	1.00	55.6	100	0	0
Small Birds Overall	**276**	**999**	**3.61**	**61.5**	**100**	**0**	**0**

[a.] Based on current development plans rotor-swept height for potential collision with a turbine blade, or 25 – 150 meters (82 – 492 feet) above ground level.

m = meters; Obs = observed

Bird Exposure Index

A relative exposure index based on initial flight height observations and relative abundance (defined as the use estimate) was calculated for each small bird species. Since all small birds were initially recorded below the RSH, all small bird species had an exposure index of zero (Appendix C2).

Spatial Use

Similar to large birds, spatial use of small birds is visually depicted using bubble plots of mean use values for small birds (Figure 8; Appendix D2), and use values for each point are provided in Appendix D2. Small birds were observed at all survey plots (Figure 8). Small bird use was highest at survey plot 3 (15.33 birds/100-m plot/10-min survey), followed by survey plots 11, 19, and 12 (13.89, 12.67, and 10.25, respectively; Appendix D2). Small bird use among other survey plots ranged from 3.56 birds/100-m plot/10-min survey at survey plot 15 to 9.83 birds/100-m plot/10-min survey at survey plot 17 (Figure 8, Appendix D2).

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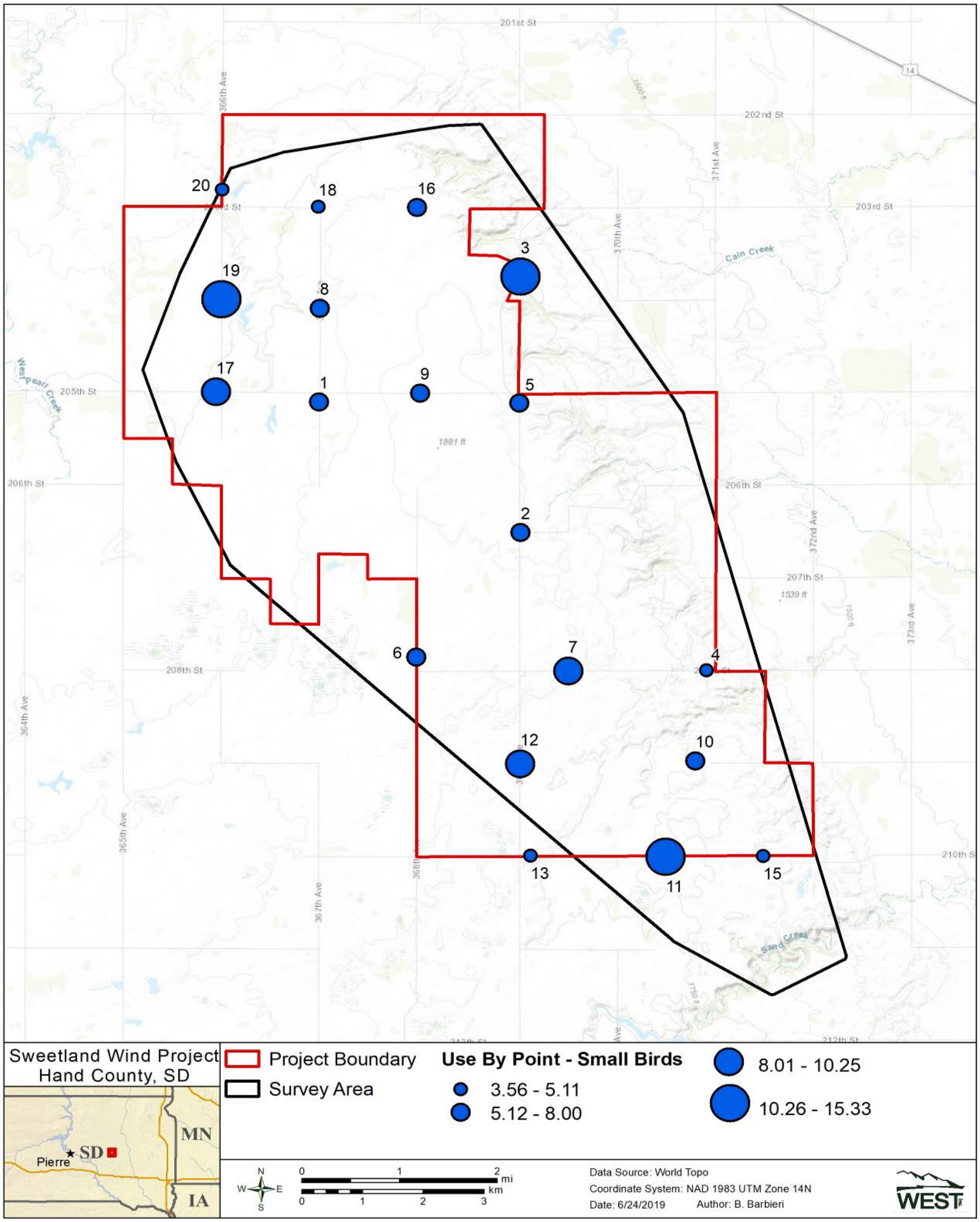

Figure 8. Small bird use by point recorded during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

Prairie Grouse Surveys

Two historic greater prairie chicken lek locations occur within the Project area. Two additional historic lek locations (one sharp-tailed grouse and one prairie chicken lek) occur within the 1-mile buffer (Figure 9). Location information for historic leks was provided by SDGFP via email on August 15, 2017. None of the historic leks were deemed to be active in 2019. No grouse were seen flying adjacent or within 0.43 miles to historic lek locations during either aerial survey.

During the two aerial surveys displaying sharp-tailed grouse were seen at or near all three locations observed last year, now classifying them as leks according to SDGFP definitions for a lek. A satellite sharp-tailed grouse lek was identified. Sharp-tailed grouse lek 2 was flooded and the satellite location was established approximately 0.25 mi to the west (Figure 9). An additional two displaying grouse locations were observed, one a sharp-tailed grouse and one a greater prairie chicken.

During the three follow-up ground checks, all three sharp-tailed grouse lek locations were observed with sharp-tailed grouse at least twice. Displaying grouse location five had no sharp-tailed grouse observations, and displaying grouse location six had observation on the first two visits. An additional greater prairie chicken displaying location was observed during the first ground check.

In summary there is one sharp-tailed grouse lek (sharp-tailed grouse lek 3) within the project area, the other two are just outside of the project area but within the one mile survey area. In addition, all three displaying grouse locations are located outside of the Proejct area, but within the one mile survey area (Figure 9).

In accordance with SDGFP definitions for a lek, the newly identified displaying grouse locations do not meet the criteria to be formally designated as a lek, as only one year of data has been collected in the last five year.

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Table 10. Summary of aerial counts of by sex on leks and newly identified displaying areas within the Sweetland Wind Energy Project and surrounding 1-mile buffer, Spring 2019.

Lek Name	Species	Survey One	Number Observed M	F	U	T	Survey Two	Number Observed M	F	U	T
Historic Lek 1	PC	4/7/2019	0	0	0	0	4/15/2019	0	0	0	0
Historic Lek 2	PC	4/7/2019	0	0	0	0	4/15/2019	0	0	0	0
Historic Lek 3	ST	4/7/2019	0	0	0	0	4/15/2019	0	0	0	0
Historic Lek 4		4/7/2019	0	0	0	0	4/15/2019	0	0	0	0
Sharp-tailed Grouse Lek 1	ST	4/7/2019	4	0	10	14	4/14/2019	7	5	4	16
Sharp-tailed Grouse Lek 2*	ST	4/7/2019	0	0	12	12	4/15/2019	8	0	10	18
Sharp-tailed Grouse Lek 3	ST	4/7/2019	0	0	2	2	4/15/2019	0	0	4	4
Displaying Grouse Location 5	ST	4/7/2019	2	0	3	5	4/15/2019	0	0	5	5
Displaying Grouse Location 6	PC	-	-	-	-	-	4/15/2019	2	2	3	7

*Due to flooding, a satellite location was established 0.25 mile to the west.

PC = prairie chicken; ST = sharp-tailed grouse; M = male; F = female; U = unknown; T = total

Table 11. Summary of ground counts by sex on leks and newly identified displaying areas within the Sweetland Wind Energy Project and surrounding 1-mile buffer, spring of 2019.

Lek Name	Species	Survey One	Number Observed M	F	U	T	Survey Two	Number Observed M	F	U	T	Survey Three	Number Observed M	F	U	T
Historic Lek 1	PC	4/24/2019	0	0	0	0	5/1/2019	0	0	0	0	5/9/2019	0	0	0	0
Historic Lek 2	PC	4/24/2019	0	0	0	0	5/1/2019	0	0	0	0	5/10/2019	0	0	0	0
Historic Lek 3	ST	4/23/2019	0	0	0	0	4/30/2019	0	0	0	0					
Historic Lek 4		4/24/2019	0	0	0	0	4/30/2019	0	0	0	0	5/10/2019	0	0	0	0
Sharp-tailed Grouse Lek 1	ST	4/23/2019	4	4	0	8	4/30/2019	7	2	0	9	5/9/2019	3	3	0	6
Sharp-tailed Grouse Lek 2*	ST	4/24/2019	0	0	0	0	5/1/2019	7	3	3	13	5/10/2019	5	3	6	14
Sharp-tailed Grouse Lek 3	ST	4/23/2019	3	2	0	5	4/30/2019	3	1	3	7	5/9/2019	2	3	0	5
Displaying Grouse Location 5	ST	4/23/2019	0	0	0	0	4/30/2019	0	0	0	0	5/9/2019	0	0	0	0
Displaying Grouse Location 6	PC	4/23/2019	3	0	1	4	4/30/2019	3	3	0	6	5/9/2019	0	0	0	0
Displaying Grouse Location 7+	PC	4/24/2019	5	3	0	8	4/30/2019	4	4	0	8	5/10/2019	0	0	0	0

*Due to flooding, a satellite location was established 0.25 mile to the west.

+this displaying location was identified on April 24, 2019 during ground based lek checks

PC = prairie chicken; ST = sharp-tailed grouse; M = male; F = female; U = unknown; T = total

General Wildlife Observations

Seven identified bird species were recorded incidentally (outside of standardized surveys) within the Survey area, totaling 107 bird observations within 38 separate groups (Table 12). Red-tailed hawk was the most observed of these, with 15 observations in 15 groups. One of these, ferruginous hawk (*Buteo regalis*), was only observed incidentally and was not recorded during the standardized avian use surveys. One mammal, white-tailed deer (*Odocoileus virginianus*), was recorded incidentally, with five observations in three groups. Four unidentified toads were observed in one group.

Table 12. General wildlife observations recorded incidentally outside of standardized surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

Species	Scientific Name	Number of Groups	Number of Observations
red-tailed hawk	*Buteo jamaicensis*	15	15
ferruginous hawk	*Buteo regalis*	1	1
turkey vulture	*Cathartes aura*	2	14
sharp-tailed grouse	*Tympanuchus phasianellus*	1	1
common grackle	*Quiscalus quiscula*	14	69
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	2	4
northern flicker	*Colaptes auratus*	3	3
Bird Subtotal	**7 species**	**38**	**107**
white-tailed deer	*Odocoileus virginianus*	3	5
unidentified toad		1	4
Other Subtotal	**1 species**	**4**	**9**

Special-Status Species Observations

No federally listed endangered species were observed within the Survey area. One state-threatened species was observed, bald eagle. Five special-status species were recorded during the fixed-point bird use surveys and as general wildlife observations (Table 13). A single bald eagle, protected under the BGEPA, was recorded within the Survey area during the second year of baseline studies.

Table 13. Summary of special-status species observed at the Sweetland Wind Energy Project during large and small bird fixed-point bird use surveys (FP) and as general wildlife observations (Inc.) from May 12, 2018 – April 31, 2019.

			FP Large Bird		FP Small Bird		Inc.		Total	
Species	**Scientific Name**	**Status**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**
marbled godwit	*Limosa fedoa*	SGCN; S5B	14	14	0	0	0	0	14	14
American white pelican	*Pelecanus erythrorhynchos*	SGCN; S3B	1	10	0	0	0	0	1	10
long-billed curlew	*Numenius americanus*	SGCN; S3B	1	2	0	0	0	0	1	2
bald eagle	*Haliaeetus leucocephalus*	BGEPA; ST	1	1	0	0	0	0	1	1
ferruginous hawk	Buteo regalis	SGCN S3B	0	0	0	0	1	1	1	1
lark bunting	*Calamospiza melanocorys*	SGCN; S5B	0	0	1	1	0	0	1	1
Total	**6 species**		**17**	**27**	**1**	**1**	**1**	**1**	**19**	**29**

State status designations are based on the 2014 *South Dakota State Wildlife Action Plan* (South Dakota Game, Fish, and Parks 2014): ST = State Threatened, SGCN = Species of Greatest Conservation Need, S1 = State or federal listed species for which the state has a mandate for recovery, S2 = Species that are either regionally or globally imperiled or secure and which South Dakota represents an important portion of their remaining range, S3 = Species with characteristics that make them vulnerable, S5 = Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery, B = breeding population

BGEPA = Bald and Golden Eagle Protection Act of 1940

Grps = groups, obs = observations

DISCUSSION

The results of the avian use surveys are compared between the two years of study at the Sweetland Wind Energy Project below.

Eleven groups totaling 99 observations of waterbirds were observed during fixed-point large bird use surveys, with the majority being sandhill cranes during the Year 2 survey (two groups and 81 observations, Appendix A1). When compared to the Year 1 survey there were 1,096 observations in 33 groups, with the majority of those being sandhill cranes (24 groups and 1,063 observations).

A total of 4,400 waterfowl were observed within the Survey Area during Year 2. This is relatively high, comprising 81.4% of all large bird observations, which is similar to the Year 1 survey, when waterfowl comprised 88.4% of all large bird observations. However, a total of 47,057 waterfowl were observed during the Year 1 surveys. Canada goose and snow goose were the most commonly observed waterfowl species, accounting for 65.2% of waterfowl observations during Year 2 surveys. Which is similar to Year 1 surveys, in which snow goose were the most commonly observed waterfowl species, accounting for 90.9% of waterfowl observations.

During the Year 2 survey red-tailed hawks were the majority of diurnal raptor observations (n=42), comprising 66.7% of diurnal raptor observations and during Year 1 surveys red-tailed hawks were the most observed diurnal raptor (n=42) comprising 39.6% of diurnal raptor observations. During Year 2 there was one bald eagle observation, as compared to Year 1 which had 4 bald eagles, 6 golden eagles, and 2 unidentified eagles. During the second year of fixed-point large bird surveys within the Survey area, there were four bald eagle risk mins recorded within 800 m and below 200 m from observers and during Year 1 there were 16 bald eagle risk minutes and 10 golden eagle risk minutes recorded within 800 m and below 200 m.

Mean annual diurnal raptor use estimates are publically available for two wind resource in eastern South Dakota along with the first year of surveys at Sweetland (Table 14). Similar diurnal raptor use estimates were observed across all studies compared to year 1 raptor use at Sweetland. The estimated diurnal raptor use value (0.10 raptor/800-m plot/20-min survey) from the second year of baseline studies is lower to that reported for publicly available raptor use estimates at the other wind resource areas in South Dakota (Table 14).

Annual mean diurnal raptor use (0.10 diurnal raptor/800-m plot/20-min survey) during the Year 2 was compared with 48 other studies at wind energy facilities that implemented similar protocols and had data for three or four seasons. The annual mean diurnal raptor use at these wind energy facilities ranged from 0.06 to 2.34 diurnal raptors/800-m plot/20-min survey (Figure 10). Mean diurnal raptor use within the Survey area ranked fourth-lowest out of the 50 comparable studies, and estimated raptor use observed during the second year of baseline studies is considered relatively low compared to the other raptor use values available from comparable studies (Figure 10). When compared to the first year of surveys, the second year had approximately half as much diurnal raptor use.

Table 14. Mean diurnal raptor use estimates (number of birds/800-meter plot/20-minute survey) for South Dakota wind resource areas.

Project Name	Average Overall Diurnal Raptor Use	Reference
Sweetland[a]	0.10	This study
Sweetland; Year 1[a]	0.22	This study
Wessington Springs, South Dakota (2010)	0.24	Derby et al. 2011a
Wessington Springs, South Dakota (2009)	0.24	Derby et al.2010
PrairieWinds SD1, South Dakota	0.24	Derby et al. 2014a

[a]Adjusted from 60-minute surveys

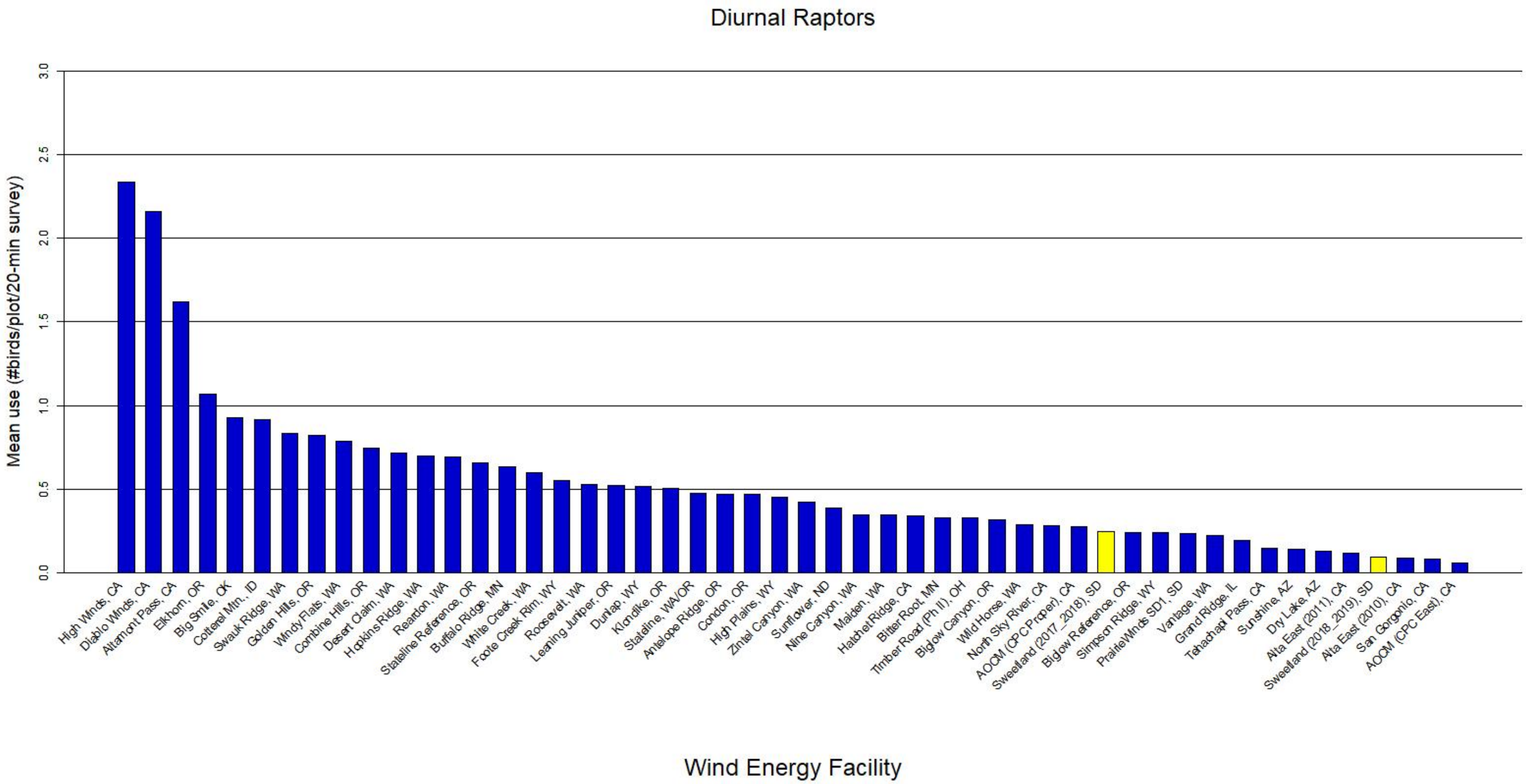

Figure 10. Comparison of estimated annual diurnal raptor use during the first and second year of fixed-point large bird use surveys at the Sweetland Wind Energy Project and other US wind energy facilities with comparable and publicly available data.

Figure 10 (*continued*). Comparison of estimated annual diurnal raptor use during the first and second year of fixed-point large bird use surveys at the Sweetland Wind Energy Project and other US wind energy facilities with comparable and publicly available data.

Data from the following sources:

Study and Location	Reference	Study and Location	Reference
Sweetland, SD	This study.		
High Winds, CA	Kerlinger et al. 2005	High Plains, WY	Johnson et al. 2009b
Diablo Winds, CA	WEST 2006	Zintel Canyon, WA	Erickson et al. 2002a, 2003a
Altamont Pass, CA	Orloff and Flannery 1992	Sunflower, ND	Erickson et al. 2001a
Elkhorn, OR	WEST 2005a	Nine Canyon, WA	Young et al. 2002
Big Smile (Dempsey), OK	Derby et al. 2010c	Maiden, WA	Young et al. 2007b
Cotterel Mtn., ID	BLM 2006	Hatchet Ridge, CA	Derby and Dahl 2009c
Swauk Ridge, WA	Erickson et al. 2003c	Bitter Root. MN	Good et al. 2010
Golden Hills, OR	Jeffrey et al. 2008	Timber Road (Phase II), OH	WEST 2005c
Windy Flats, WA	Johnson et al. 2007	Biglow Canyon, OR	Erickson et al. 2003d
Combine Hills, OR	Young et al. 2003c	Wild Horse, WA	Erickson et al. 2011
Desert Claim, WA	Young et al. 2003d	North Sky River, CA	Chatfield et al. 2010b
Hopkins Ridge, WA	Young et al. 2003e	AOCM (CPC Proper), CA	WEST 2005c
Reardon, WA	WEST 2005b	Biglow Reference, OR	Johnson et al. 2000c
Stateline Reference, OR	URS et al. 2001	Simpson Ridge, WY	Jeffrey et al. 2007
Buffalo Ridge, MN	Johnson et al. 2000b	PrairieWinds, SD1, SD	Derby et al. 2009
White Creek, WA	NWC and WEST 2005	Vantage, WA	Anderson et al. 2000, Erickson et al. 2002b
Foote Creek Rim, WY	Johnson et al. 2000c	Grand Ridge, IL	WEST and the CPRS 2006
Roosevelt, WA	NWC and WEST 2004	Tehachapi Pass, CA	Young et al. 2007a
Leaning Juniper, OR	Kronner et al. 2005	Sunshine, AZ	Chatfield et al. 2011
Dunlap, WY	Johnson et al. 2009a	Dry Lake, AZ	Chatfield et al. 2011
Klondike, OR	Johnson 2002	Alta East (2011), CA	Anderson et al. 2000, Erickson et al. 2002b
Stateline, WA/OR	Erickson et al. 2003b	Alta East (2010), CA	Chatfield et al. 2010b
Antelope Ridge, OR	WEST 2009	San Gorgonio, CA	Johnson et al. 2009b
Condon, OR	Erickson et al. 2002b	AOCM (CPC East), CA	Erickson et al. 2002a, 2003a

CONCLUSION

Forty-seven unique large bird species were observed during the second year of baseline studies, with snow goose contributing most of the large bird observations. While forty-two unique small bird species were observed during the second year of baseline studies, with horned lark contributing most of the small bird observations. Forty-three and forty-two unique large and small bird species were observed, respectively, during the first year of baseline studies.

Waterfowl, waterbirds, and shorebirds were observed within the Survey area during the second year of baseline surveys, and these bird types were also observed during the first year of surveys. While these bird types accounted for similar percentages of the overall large bird observations across the two years, there was large variation in the total number of observations for waterfowl between the first and second year of baseline studies.

Based on data collected during the second year of baseline studies, overall estimates of diurnal raptor use within the Survey area were similar to other publicly available diurnal raptor use estimates from wind resource areas evaluated in South Dakota, relatively low compared to the Midwestern US using similar methods, and approximately half the use observed during the first year of surveys at the Project.

A single bald eagle was observed within the Survey area during Year 2 surveys. No golden eagles were observed during the Year 2 surveys. A total of four bald eagles, six golden eagles and two unidentified eagles were observed during the Year 1 surveys. Although levels of bald eagle use were relatively low within the Survey area, there is the potential for collision risk to bald eagles at the Project.

A Bird and Bat Conservation Strategy that summarizes avian risk is being developed for the Project.

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Appendix A. All Bird Types and Species Observed at the Sweetland Wind Energy Project during Fixed-Point Bird Use Surveys, May 12, 2018 - April 31, 2019

Appendix A1. Large bird types and species observed at the Sweetland Wind Energy Project during fixed-point bird use surveys, May 12, 2018 – April 31, 2019.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**
Waterbirds		**2**	**16**	**6**	**6**	**3**	**77**	**0**	**0**	**11**	**99**
sandhill crane	*Antigone canadensis*	1	15	0	0	1	66	0	0	2	81
great blue heron	*Ardea herodias*	1	1	6	6	1	1	0	0	8	8
American white pelican	*Pelecanus erythrorhynchos*	0	0	0	0	1	10	0	0	1	10
Waterfowl		**147**	**4,344**	**29**	**56**	**0**	**0**	**0**	**0**	**176**	**4,400**
wood duck	*Aix sponsa*	1	2	0	0	0	0	0	0	1	2
northern pintail	*Anas acuta*	23	154	0	0	0	0	0	0	23	154
American wigeon	*Anas americana*	3	7	0	0	0	0	0	0	3	7
mallard	*Anas platyrhynchos*	42	225	17	32	0	0	0	0	59	257
unidentified teal	*Anas spp*	0	0	1	2	0	0	0	0	1	2
lesser scaup	*Aythya affinis*	2	23	0	0	0	0	0	0	2	23
canvasback	*Aythya valisineria*	1	10	0	0	0	0	0	0	1	10
Canada goose	*Branta canadensis*	23	1,741	0	0	0	0	0	0	23	1,741
unidentified goldeneye	*Bucephala spp*	4	162	0	0	0	0	0	0	4	162
snow goose	*Chen caerulescens*	3	1,785	0	0	0	0	0	0	3	1,785
gadwall	*Mareca strepera*	2	4	3	6	0	0	0	0	5	10
northern shoveler	*Spatula clypeata*	12	21	0	0	0	0	0	0	12	21
blue-winged teal	*Spatula discors*	19	47	2	3	0	0	0	0	21	50
unidentified duck		5	135	6	13	0	0	0	0	11	148
unidentified waterfowl		7	28	0	0	0	0	0	0	7	28
Shorebirds		**104**	**122**	**130**	**147**	**2**	**2**	**0**	**0**	**236**	**271**
upland sandpiper	*Bartramia longicauda*	16	17	38	42	0	0	0	0	54	59
killdeer	*Charadrius vociferus*	69	84	91	104	2	2	0	0	162	190
Wilson’s snipe	*Gallinago delicata*	2	2	0	0	0	0	0	0	2	2
marbled godwit	*Limosa fedoa*	13	13	1	1	0	0	0	0	14	14
long-billed curlew	*Numenius americanus*	1	2	0	0	0	0	0	0	1	2
lesser yellowlegs	*Tringa flavipes*	2	3	0	0	0	0	0	0	2	3
unidentified shorebird		1	1	0	0	0	0	0	0	1	1
Gulls		**11**	**142**	**1**	**78**	**2**	**23**	**0**	**0**	**14**	**243**
ring-billed gull	*Larus delawarensis*	7	30	1	78	1	1	0	0	9	109

Appendix A1. Large bird types and species observed at the Sweetland Wind Energy Project during fixed-point bird use surveys, May 12, 2018 – April 31, 2019.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**
Franklin's gull	*Leucophaeus pipixcan*	3	97	0	0	0	0	0	0	3	97
unidentified gull		1	15	0	0	1	22	0	0	2	37
Coots		**2**	**2**	**2**	**2**	**0**	**0**	**0**	**0**	**4**	**4**
American coot	*Fulica americana*	2	2	2	2	0	0	0	0	4	4
Diurnal Raptors		**14**	**14**	**19**	**20**	**28**	**28**	**4**	**4**	**65**	**66**
Accipiters		*0*	*0*	*1*	*1*	*0*	*0*	*0*	*0*	*1*	*1*
Cooper's hawk	*Accipiter cooperii*	0	0	1	1	0	0	0	0	1	1
Buteos		*11*	*11*	*15*	*15*	*19*	*19*	*3*	*3*	*48*	*48*
red-tailed hawk	*Buteo jamaicensis*	9	9	14	14	19	19	2	2	44	44
rough-legged hawk	*Buteo lagopus*	0	0	0	0	0	0	1	1	1	1
unidentified buteo	*Buteo spp*	1	1	1	1	0	0	0	0	2	2
Swainson's hawk	*Buteo swainsoni*	1	1	0	0	0	0	0	0	1	1
Northern Harrier		*2*	*2*	*3*	*4*	*6*	*6*	*0*	*0*	*11*	*12*
northern harrier	*Circus hudsonius*	2	2	3	4	6	6	0	0	11	12
Eagles		*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*	*1*	*1*
bald eagle	*Haliaeetus leucocephalus*	0	0	0	0	0	0	1	1	1	1
Falcons		*0*	*0*	*0*	*0*	*3*	*3*	*0*	*0*	*3*	*3*
American kestrel	*Falco sparverius*	0	0	0	0	3	3	0	0	3	3
Other Raptors		*1*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*
unidentified raptor		1	1	0	0	0	0	0	0	1	1
Owls		**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**
great horned owl	*Bubo virginianus*	0	0	1	1	0	0	0	0	1	1
Vultures		**4**	**8**	**43**	**44**	**17**	**17**	**0**	**0**	**64**	**69**
turkey vulture	*Cathartes aura*	4	8	43	44	17	17	0	0	64	69
Upland Game Birds		**37**	**39**	**66**	**67**	**4**	**5**	**1**	**1**	**108**	**112**
wild turkey	*Meleagris gallopavo*	1	1	0	0	0	0	0	0	1	1
ring-necked pheasant	*Phasianus colchicus*	35	37	66	67	4	5	1	1	106	110
sharp-tailed grouse	*Tympanuchus phasianellus*	1	1	0	0	0	0	0	0	1	1
Doves/Pigeons		**23**	**37**	**58**	**78**	**8**	**12**	**0**	**0**	**89**	**127**
rock pigeon	*Columba livia*	1	5	0	0	0	0	0	0	1	5
Eurasian collared-dove	*Streptopelia decaocto*	0	0	3	3	0	0	0	0	3	3

Appendix A1. Large bird types and species observed at the Sweetland Wind Energy Project during fixed-point bird use surveys, May 12, 2018 – April 31, 2019.

		Spring		Summer		Fall		Winter		Total	
Type/Species	**Scientific Name**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**
mourning dove	*Zenaida macroura*	22	32	55	75	8	12	0	0	85	119
Large Corvids		**2**	**9**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**9**
American crow	*Corvus brachyrhynchos*	2	9	0	0	0	0	0	0	2	9
Goatsuckers		**2**	**2**	**3**	**3**	**0**	**0**	**0**	**0**	**5**	**5**
common nighthawk	*Chordeiles minor*	2	2	3	3	0	0	0	0	5	5
Overall		**348**	**4,735**	**358**	**502**	**64**	**164**	**5**	**5**	**775**	**5,406**

Appendix A2. Small bird types and species observed at the Sweetland Wind Energy Project during fixed-point bird use surveys, May 12, 2018 – April 31, 2019

		Spring		Summer		Fall		Winter		Total	
Type/Common Name	**Scientific Name**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**
Passerines		**212**	**697**	**376**	**658**	**80**	**285**	**8**	**75**	**676**	**1,715**
red-winged blackbird	*Agelaius phoeniceus*	30	117	69	92	5	92	0	0	104	301
bobolink	*Dolichonyx oryzivorus*	3	5	10	11	0	0	0	0	13	16
Brewer's blackbird	*Euphagus cyanocephalus*	2	9	0	0	0	0	0	0	2	9
orchard oriole	*Icterus spurius*	2	2	0	0	0	0	0	0	2	2
brown-headed cowbird	*Molothrus ater*	26	74	33	120	2	20	0	0	61	214
common grackle	*Quiscalus quiscula*	14	68	19	32	0	0	0	0	33	100
eastern meadowlark	*Sturnella magna*	0	0	45	45	17	19	0	0	62	64
western meadowlark	*Sturnella neglecta*	61	72	19	23	7	7	0	0	87	102
European starling	*Sturnus vulgaris*	1	1	0	0	0	0	0	0	1	1
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	0	0	2	3	0	0	0	0	2	3
unidentified blackbird		0	0	6	9	0	0	0	0	6	9
American goldfinch	*Spinus tristis*	1	1	13	16	3	3	0	0	17	20
eastern kingbird	*Tyrannus tyrannus*	6	10	23	28	3	3	0	0	32	41
western kingbird	*Tyrannus verticalis*	4	6	4	4	0	0	0	0	8	10
grasshopper sparrow	*Ammodramus savannarum*	5	7	15	15	0	0	0	0	20	22
lark bunting	*Calamospiza melanocorys*	1	1	0	0	0	0	0	0	1	1
horned lark	*Eremophila alpestris*	15	218	3	3	15	36	8	75	41	332
dark-eyed junco	*Junco hyemalis*	1	1	0	0	0	0	0	0	1	1
song sparrow	*Melospiza melodia*	2	4	0	0	0	0	0	0	2	4
house sparrow	*Passer domesticus*	2	16	2	3	1	1	0	0	5	20
savannah sparrow	*Passerculus sandwichensis*	5	11	0	0	0	0	0	0	5	11
vesper sparrow	*Pooecetes gramineus*	3	5	0	0	0	0	0	0	3	5
dickcissel	*Spiza americana*	0	0	39	41	0	0	0	0	39	41
chipping sparrow	*Spizella passerina*	0	0	0	0	1	4	0	0	1	4
American tree sparrow	*Spizelloides arborea*	0	0	0	0	5	17	0	0	5	17
white-crowned sparrow	*Zonotrichia leucophrys*	1	1	0	0	0	0	0	0	1	1
Harris' sparrow	*Zonotrichia querula*	0	0	0	0	1	5	0	0	1	5

Appendix A2. Small bird types and species observed at the Sweetland Wind Energy Project during fixed-point bird use surveys, May 12, 2018 – April 31, 2019

		Spring		Summer		Fall		Winter		Total	
Type/Common Name	**Scientific Name**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**	**# Grps**	**# Obs**
unidentified sparrow		2	2	5	5	3	10	0	0	10	17
brown thrasher	*Toxostoma rufum*	2	3	1	1	0	0	0	0	3	4
barn swallow	*Hirundo rustica*	5	14	33	112	12	56	0	0	50	182
cliff swallow	*Petrochelidon pyrrhonota*	0	0	2	6	0	0	0	0	2	6
bank swallow	*Riparia riparia*	0	0	1	1	0	0	0	0	1	1
northern rough-winged swallow	*Stelgidopteryx serripennis*	0	0	6	46	0	0	0	0	6	46
unidentified swallow		0	0	4	19	0	0	0	0	4	19
western bluebird	*Sialia mexicana*	2	2	0	0	0	0	0	0	2	2
eastern bluebird	*Sialia sialis*	1	2	3	4	0	0	0	0	4	6
American robin	*Turdus migratorius*	14	44	18	18	2	9	0	0	34	71
yellow warbler	*Setophaga petechia*	1	1	1	1	0	0	0	0	2	2
blue jay	*Cyanocitta cristata*	0	0	0	0	3	3	0	0	3	3
Woodpeckers		**1**	**1**	**2**	**2**	**3**	**5**	**1**	**1**	**7**	**9**
northern flicker	*Colaptes auratus*	1	1	0	0	1	1	1	1	3	3
hairy woodpecker	*Dryobates villosus*	0	0	0	0	1	1	0	0	1	1
red-headed woodpecker	*Melanerpes erythrocephalus*	0	0	2	2	1	3	0	0	3	5
Unidentified Birds		**0**	**0**	**10**	**13**	**1**	**12**	**0**	**0**	**11**	**25**
unidentified bird (small)		0	0	10	13	1	12	0	0	11	25
Overall		**213**	**698**	**388**	**673**	**84**	**302**	**9**	**76**	**694**	**1,749**

Appendix B. Mean Use, Percent of Use, and Frequency of Occurrence Observed during Fixed-Point Large and Small Bird Use Surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019

Appendix B1. Mean large bird use (number of birds/800-meter plot/60-minute survey), percent of total use, and frequency of occurrence for each large bird type and raptor subtype by season during the fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

	Mean Use				Percent Use				Percent Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Waterbirds	**0.28**	**0.11**	**1.18**	**0**	**0.2**	**1.3**	**49.3**	**0**	**3.5**	**8.8**	**3.5**	**0**
sandhill crane	0.26	0	1.16	0	0.2	0	48.5	0	1.8	0	1.8	0
great blue heron	0.02	0.11	0.02	0	<0.1	1.3	0.7	0	1.8	8.8	1.8	0
Waterfowl	**111.86**	**0.98**	**0**	**0**	**93.8**	**11.8**	**0**	**0**	**64.8**	**19.3**	**0**	**0**
wood duck	0.04	0	0	0	<0.1	0	0	0	1.8	0	0	0
northern pintail	2.83	0	0	0	2.4	0	0	0	23.8	0	0	0
American wigeon	0.14	0	0	0	0.1	0	0	0	6.3	0	0	0
mallard	4.13	0.56	0	0	3.5	6.8	0	0	45.9	15.8	0	0
unidentified teal	0	0.04	0	0	0	0.4	0	0	0	1.8	0	0
lesser scaup	0.40	0	0	0	0.3	0	0	0	3.5	0	0	0
canvasback	0.18	0	0	0	0.1	0	0	0	1.8	0	0	0
Canada goose	47.58	0	0	0	39.9	0	0	0	29.7	0	0	0
unidentified goldeneye	2.84	0	0	0	2.4	0	0	0	1.8	0	0	0
snow goose	49.58	0	0	0	41.6	0	0	0	2.8	0	0	0
gadwall	0.07	0.11	0	0	<0.1	1.3	0	0	3.5	5.3	0	0
northern shoveler	0.37	0	0	0	0.3	0	0	0	15.8	0	0	0
blue-winged teal	0.82	0.05	0	0	0.7	0.6	0	0	22.8	3.5	0	0
unidentified duck	2.37	0.23	0	0	2.0	2.7	0	0	8.8	10.5	0	0
unidentified waterfowl	0.49	0	0	0	0.4	0	0	0	8.8	0	0	0
Shorebirds	**2.48**	**2.58**	**0.04**	**0**	**2.1**	**31.1**	**1.5**	**0**	**72.8**	**52.6**	**3.5**	**0**
upland sandpiper	0.30	0.74	0	0	0.3	8.9	0	0	17.5	21.1	0	0
killdeer	1.81	1.82	0.04	0	1.5	22.0	1.5	0	62.3	45.6	3.5	0
Wilson’s snipe	0.04	0	0	0	<0.1	0	0	0	3.5	0	0	0
marbled godwit	0.23	0.02	0	0	0.2	0.2	0	0	17.5	1.8	0	0
long-billed curlew	0.04	0	0	0	<0.1	0	0	0	1.8	0	0	0
lesser yellowlegs	0.05	0	0	0	<0.1	0	0	0	3.5	0	0	0
unidentified shorebird	0.02	0	0	0	<0.1	0	0	0	1.8	0	0	0
Gulls	**2.55**	**1.37**	**0.40**	**0**	**2.1**	**16.5**	**16.9**	**0**	**17.1**	**1.8**	**3.5**	**0**
ring-billed gull	0.59	1.37	0.02	0	0.5	16.5	0.7	0	13.6	1.8	1.8	0
Franklin’s gull	1.70	0	0	0	1.4	0	0	0	5.3	0	0	0
unidentified gull	0.26	0	0.39	0	0.2	0	16.2	0	1.8	0	1.8	0
Coots	**0.04**	**0**	**0**	**0**	**<0.1**	**0**	**0**	**0**	**1.8**	**0**	**0**	**0**
American coot	0.04	0	0	0	<0.1	0	0	0	1.8	0	0	0

Appendix B1. Mean large bird use (number of birds/800-meter plot/60-minute survey), percent of total use, and frequency of occurrence for each large bird type and raptor subtype by season during the fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

	Mean Use				Percent Use				Percent Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Diurnal Raptors	**0.30**	**0.30**	**0.44**	**0.08**	**0.2**	**3.6**	**18.4**	**75.3**	**21.3**	**21.1**	**38.6**	**7.8**
Accipiters	*0*	*0.02*	*0*	*0*	*0*	*0.2*	*0*	*0*	*0*	*1.8*	*0*	*0*
Cooper's hawk	0	0.02	0	0	0	0.2	0	0	0	1.8	0	0
Buteos	*0.24*	*0.21*	*0.28*	*0.06*	*0.2*	*2.5*	*11.8*	*58.4*	*16.1*	*15.8*	*26.3*	*6.1*
red-tailed hawk	0.21	0.21	0.28	0.04	0.2	2.5	11.8	33.8	12.6	15.8	26.3	3.5
rough-legged hawk	0	0	0	0.03	0	0	0	24.7	0	0	0	2.6
unidentified buteo	0.02	0	0	0	<0.1	0	0	0	1.8	0	0	0
Swainson's hawk	0.02	0	0	0	<0.1	0	0	0	1.8	0	0	0
Northern Harrier	*0.04*	*0.07*	*0.11*	*0*	*<0.1*	*0.8*	*4.4*	*0*	*3.5*	*3.5*	*10.5*	*0*
northern harrier	0.04	0.07	0.11	0	<0.1	0.8	4.4	0	3.5	3.5	10.5	0
Eagles	*0*	*0*	*0*	*0.02*	*0*	*0*	*0*	*16.9*	*0*	*0*	*0*	*1.8*
bald eagle	0	0	0	0.02	0	0	0	16.9	0	0	0	1.8
Falcons	*0*	*0*	*0.05*	*0*	*0*	*0*	*2.2*	*0*	*0*	*0*	*5.3*	*0*
American kestrel	0	0	0.05	0	0	0	2.2	0	0	0	5.3	0
Other Raptors	*0.02*	*0*	*0*	*0*	*<0.1*	*0*	*0*	*0*	*1.8*	*0*	*0*	*0*
unidentified raptor	0.02	0	0	0	<0.1	0	0	0	1.8	0	0	0
Owls	**0**	**0.02**	**0**	**0**	**0**	**0.2**	**0**	**0**	**0**	**1.8**	**0**	**0**
great horned owl	0	0.02	0	0	0	0.2	0	0	0	1.8	0	0
Vultures	**0.14**	**0.39**	**0.04**	**0**	**0.1**	**4.7**	**1.5**	**0**	**3.5**	**8.8**	**3.5**	**0**
turkey vulture	0.14	0.39	0.04	0	0.1	4.7	1.5	0	3.5	8.8	3.5	0
Upland Game Birds	**0.69**	**1.18**	**0.09**	**0.03**	**0.6**	**14.2**	**3.7**	**24.7**	**41.4**	**29.8**	**7.0**	**2.6**
wild turkey	0.03	0	0	0	<0.1	0	0	0	2.8	0	0	0
ring-necked pheasant	0.65	1.18	0.09	0.03	0.5	14.2	3.7	24.7	38.6	29.8	7.0	2.6
sharp-tailed grouse	0.02	0	0	0	<0.1	0	0	0	1.8	0	0	0
Doves/Pigeons	**0.65**	**1.33**	**0.21**	**0**	**0.5**	**16.1**	**8.8**	**0**	**24.6**	**50.9**	**12.3**	**0**
rock pigeon	0.09	0	0	0	<0.1	0	0	0	1.8	0	0	0
Eurasian collared-dove	0	0.02	0	0	0	0.2	0	0	0	1.8	0	0
mourning dove	0.56	1.32	0.21	0	0.5	15.9	8.8	0	22.8	50.9	12.3	0
Large Corvids	**0.23**	**0**	**0**	**0**	**0.2**	**0**	**0**	**0**	**4.5**	**0**	**0**	**0**
American crow	0.23	0	0	0	0.2	0	0	0	4.5	0	0	0
Goatsuckers	**0.04**	**0.05**	**0**	**0**	**<0.1**	**0.6**	**0**	**0**	**1.8**	**5.3**	**0**	**0**
common nighthawk	0.04	0.05	0	0	<0.1	0.6	0	0	1.8	5.3	0	0
Overall Large Birds*	**119.25**	**8.30**	**2.39**	**0.10**	**100**	**100**	**100**	**100**				

* Sums may not total values shown due to rounding.

Appendix B2. Mean small bird use (number of birds/100-meter plot/10-minute survey), percent of total use, and frequency of occurrence for each small bird type by season during the fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

	Mean Use				Percent Use				Percent Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
Passerines	**15.07**	**10.35**	**4.7**	**1.03**	**99.9**	**98.2**	**98.5**	**98.3**	**86.1**	**100**	**80.7**	**14.7**
red-winged blackbird	2.53	1.51	1.6	0	16.8	14.3	33.5	0	39.9	59.6	5.3	0
bobolink	0.09	0.16	0	0	0.6	1.5	0	0	5.3	10.5	0	0
Brewer’s blackbird	0.16	0	0	0	1	0	0	0	3.5	0	0	0
orchard oriole	0.04	0	0	0	0.2	0	0	0	3.5	0	0	0
brown-headed cowbird	1.3	2.11	0.35	0	8.6	20	7.4	0	40.4	40.4	3.5	0
common grackle	1.19	0.42	0	0	7.9	4	0	0	22.8	15.8	0	0
eastern meadowlark	0	0.67	0.33	0	0	6.3	7	0	0	36.8	26.3	0
western meadowlark	1.37	0.33	0.12	0	9.1	3.2	2.6	0	71.1	21.1	10.5	0
European starling	0.02	0	0	0	0.1	0	0	0	1.8	0	0	0
yellow-headed blackbird	0	0.04	0	0	0	0.3	0	0	0	1.8	0	0
unidentified blackbird	0	0.05	0	0	0	0.5	0	0	0	5.3	0	0
American goldfinch	0.02	0.28	0.05	0	0.1	2.7	1.1	0	1.8	22.8	5.3	0
eastern kingbird	0.18	0.49	0.05	0	1.2	4.7	1.1	0	7	33.3	5.3	0
western kingbird	0.11	0.07	0	0	0.7	0.7	0	0	5.3	7	0	0
grasshopper sparrow	0.12	0.26	0	0	0.8	2.5	0	0	8.8	19.3	0	0
lark bunting	0.02	0	0	0	0.1	0	0	0	1.8	0	0	0
horned lark	5.98	0.05	0.63	1.03	39.7	0.5	13.2	98.3	28.2	5.3	26.3	14.7
dark-eyed junco	0.03	0	0	0	0.2	0	0	0	2.8	0	0	0
song sparrow	0.07	0	0	0	0.5	0	0	0	1.8	0	0	0
house sparrow	0.28	0.05	0.02	0	1.9	0.5	0.4	0	3.5	3.5	1.8	0
savannah sparrow	0.19	0	0	0	1.3	0	0	0	8.8	0	0	0
vesper sparrow	0.09	0	0	0	0.6	0	0	0	5.3	0	0	0
dickcissel	0	0.72	0	0	0	6.8	0	0	0	38.6	0	0
chipping sparrow	0	0	0.07	0	0	0	1.5	0	0	0	1.8	0
American tree sparrow	0	0	0.3	0	0	0	6.2	0	0	0	8.8	0
white-crowned sparrow	0.02	0	0	0	0.1	0	0	0	1.8	0	0	0
unidentified sparrow	0.04	0.09	0.18	0	0.2	0.8	3.7	0	3.5	7	5.3	0
brown thrasher	0.05	0	0	0	0.3	0	0	0	3.5	0	0	0
barn swallow	0.25	1.49	0.82	0	1.6	14.1	17.3	0	8.8	38.6	19.3	0
cliff swallow	0	0.11	0	0	0	1	0	0	0	1.8	0	0
bank swallow	0	0.02	0	0	0	0.2	0	0	0	1.8	0	0
northern rough-winged swallow	0	0.74	0	0	0	7	0	0	0	8.8	0	0
unidentified swallow	0	0.33	0	0	0	3.2	0	0	0	7	0	0
western bluebird	0.04	0	0	0	0.2	0	0	0	3.5	0	0	0

Appendix B2. Mean small bird use (number of birds/100-meter plot/10-minute survey), percent of total use, and frequency of occurrence for each small bird type by season during the fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

	Mean Use				Percent Use				Percent Frequency			
Type/Species	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**
eastern bluebird	0.06	0.07	0	0	0.4	0.7	0	0	2.8	1.8	0	0
American robin	0.84	0.28	0.16	0	5.6	2.7	3.3	0	19.6	26.3	3.5	0
yellow warbler	0.02	0.02	0	0	0.1	0.2	0	0	1.8	1.8	0	0
blue jay	0	0	0.02	0	0	0	0.4	0	0	0	1.8	0
Woodpeckers	**0.02**	**0.04**	**0.07**	**0.02**	**0.1**	**0.3**	**1.5**	**1.7**	**1.8**	**3.5**	**3.5**	**1.8**
northern flicker	0.02	0	0	0.02	0.1	0	0	1.7	1.8	0	0	1.8
hairy woodpecker	0	0	0.02	0	0	0	0.4	0	0	0	1.8	0
red-headed woodpecker	0	0.04	0.05	0	0	0.3	1.1	0	0	3.5	1.8	0
Unidentified Birds	**0**	**0.16**	**0**	**0**	**0**	**1.5**	**0**	**0**	**0**	**8.8**	**0**	**0**
unidentified bird (small)	0	0.16	0	0	0	1.5	0	0	0	8.8	0	0
Overall Small Birds	**15.09**	**10.54**	**4.77**	**1.05**	**100**	**100**	**100**	**100**				

* Sums may not total values shown due to rounding.

Appendix C. Species Exposure Indices during Fixed-Point Large Bird and Small Bird Use Surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019

Appendix C1. Relative exposure index and flight characteristics for large bird species[a] during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

Species	Number of Groups Flying	Overall Mean Use	Percent Flying	Percent Flying within RSH[a] Based on Initial Observation	Exposure Index	Percent Within RSH at Anytime
snow goose	3	12.50	100	100	12.50	100
Canada goose	11	11.99	79.3	87.8	8.35	87.8
ring-billed gull	9	0.50	100	77.1	0.38	77.1
unidentified goldeneye	4	0.72	100	38.3	0.27	38.3
unidentified duck	11	0.65	100	25.0	0.16	30.4
turkey vulture	19	0.14	71.9	95.7	0.10	95.7
unidentified gull	2	0.16	100	40.5	0.07	40.5
red-tailed hawk	29	0.18	74.4	37.9	0.05	41.4
mallard	51	1.18	89.5	4.8	0.05	13.5
upland sandpiper	23	0.26	47.5	25.0	0.03	28.6
gadwall	4	0.04	80.0	62.5	0.02	62.5
killdeer	83	0.93	56.3	3.7	0.02	3.7
great blue heron	8	0.04	100	50.0	0.02	50.0
American wigeon	2	0.04	71.4	60.0	0.02	60.0
northern pintail	20	0.71	97.4	2.0	0.01	3.3
common nighthawk	3	0.02	60.0	100	0.01	100
marbled godwit	10	0.06	71.4	20.0	<0.01	30.0
unidentified waterfowl	7	0.12	100	7.1	<0.01	82.1
Cooper’s hawk	1	<0.01	100	100	<0.01	100
mourning dove	56	0.53	72.3	1.2	<0.01	4.7
northern harrier	11	0.05	100	8.3	<0.01	16.7
bald eagle	1	<0.01	100	100	<0.01	100
American crow	1	0.06	22.2	0	0	0
rock pigeon	1	0.02	100	0	0	0
ring-necked pheasant	7	0.49	7.3	0	0	0
unidentified raptor	1	<0.01	100	0	0	0
American kestrel	3	0.01	100	0	0	0
Swainson’s hawk	1	<0.01	100	0	0	0
unidentified buteo	1	<0.01	100	0	0	0
rough-legged hawk	1	<0.01	100	0	0	0
Franklin’s gull	3	0.43	100	0	0	0
long-billed curlew	1	<0.01	100	0	0	0
unidentified shorebird	1	<0.01	100	0	0	0
blue-winged teal	14	0.22	70.0	0	0	0
northern shoveler	6	0.09	57.1	0	0	0
unidentified teal	1	<0.01	100	0	0	0
wood duck	1	<0.01	100	0	0	0

[a] Based on current development plans rotor-swept height (RSH) for potential collision with a turbine blade, or 25 – 150 meters (82 – 492 feet) above ground level.

Appendix C2. Relative exposure index and flight characteristics for small bird species[a] observed within the 100-meter radius plot during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

Species	Number of Groups Flying	Overall Mean Use	Percent Flying	Percent Flying within RSH[a] Based on Initial Observation	Exposure Index	Percent Within RSH at Anytime
unidentified bird (small)	2	0.04	55.6	0	0	0
red-headed woodpecker	1	0.02	20.0	0	0	0
hairy woodpecker	1	<0.01	100	0	0	0
yellow warbler	2	<0.01	100	0	0	0
American robin	8	0.32	37.3	0	0	0
western bluebird	1	<0.01	50.0	0	0	0
northern rough-winged swallow	5	0.19	100	0	0	0
bank swallow	1	<0.01	100	0	0	0
cliff swallow	2	0.03	100	0	0	0
barn swallow	42	0.64	97.3	0	0	0
unidentified swallow	4	0.08	100	0	0	0
American tree sparrow	5	0.07	100	0	0	0
chipping sparrow	1	0.02	100	0	0	0
dickcissel	4	0.18	9.8	0	0	0
vesper sparrow	1	0.02	20.0	0	0	0
savannah sparrow	2	0.05	54.5	0	0	0
house sparrow	2	0.09	75.0	0	0	0
song sparrow	1	0.02	25.0	0	0	0
dark-eyed junco	1	<0.01	100	0	0	0
horned lark	25	1.93	70.7	0	0	0
grasshopper sparrow	1	0.10	13.6	0	0	0
unidentified sparrow	7	0.07	82.4	0	0	0
western kingbird	1	0.04	10.0	0	0	0
eastern kingbird	16	0.18	48.8	0	0	5.0
American goldfinch	9	0.09	60.0	0	0	0
yellow-headed blackbird	1	<0.01	100	0	0	0
western meadowlark	9	0.46	11.2	0	0	0
eastern meadowlark	23	0.25	43.9	0	0	0
common grackle	25	0.41	90.2	0	0	0
brown-headed cowbird	31	0.95	53.7	0	0	0
orchard oriole	1	<0.01	50.0	0	0	0
Brewer’s blackbird	1	0.04	88.9	0	0	0
bobolink	4	0.06	35.7	0	0	0
red-winged blackbird	34	1.42	62.2	0	0	0
unidentified blackbird	2	0.01	66.7	0	0	50.0

[a] Based on current development plans rotor-swept height (RSH) for potential collision with a turbine blade, or 25 – 150 meters (82 – 492 feet) above ground level.

Appendix D. Mean Use by Point for All Birds, Major Bird Types, and Diurnal Raptor Subtypes during Fixed-Point Large and Small Bird Use Surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019

Appendix D1. Mean use by point for major large bird types and diurnal raptor subtypes during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

	Survey Point Location									
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Waterbirds	0	1.25	0.08	0	5.50	0	0	0.22	0	0.08
Waterfowl	7.5	0.58	7	0.75	5.92	5.56	0.82	1.56	1.17	0.08
Shorebirds	1.42	2.08	1.83	0.5	2.33	0.78	1.18	1.33	0.17	0.42
Gulls	0	0	0.17	0	4.33	0	0	6.67	0	0
Coots	0.17	0	0	0	0	0	0	0	0	0
Diurnal Raptors	0.25	0.33	0.25	0.17	0.25	0.33	0.45	0.33	0.08	0.58
Accipiters	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Buteos	*0.17*	*0.17*	*0.08*	*0.17*	*0.17*	*0.33*	*0.45*	*0.33*	*0*	*0.58*
Northern Harrier	*0.08*	*0.17*	*0.08*	*0*	*0.08*	*0*	*0*	*0*	*0*	*0*
Eagles	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.08*	*0*
Falcons	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Other Raptors	*0*	*0*	*0.08*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Owls	0	0	0	0	0	0	0	0	0	0
Vultures	0	0.17	0	1.25	0	0	0.27	0	0	0
Upland Game Birds	1.17	1.17	0.67	0	0.25	0.33	0.27	1.78	0	0.25
Doves/Pigeons	0.42	1.5	1.83	0.25	0.92	0	0.27	1.11	0.17	1
Large Corvids	0	0	0.17	0	0	0	0	0	0	0
Goatsuckers	0	0	0	0	0	0	0	0.11	0	0
Overall Large Birds*	**10.92**	**7.08**	**12.00**	**2.92**	**19.50**	**7.00**	**3.27**	**13.11**	**1.58**	**2.42**

* Sums may not total values shown due to rounding.

Appendix D1. Mean use by point for major large bird types and diurnal raptor subtypes during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

	Survey Point Location								
Bird Type	**11**	**12**	**13**	**15**	**16**	**17**	**18**	**19**	**20**
Waterbirds	0	0.08	0.08	0	0.11	0.08	0	0	0
Waterfowl	2.78	2.92	279.00	3.44	3.44	1.00	4.11	4.83	39.5
Shorebirds	3.67	0.42	1.42	0.78	1.89	1.75	2.11	0.83	0.42
Gulls	0	1.08	9.33	0	0	0.08	0	0	0.25
Coots	0	0	0	0	0	0	0	0	0
Diurnal Raptors	0.33	0.25	0.75	0.22	0.22	0	0.33	0.17	0.17
Accipiters	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.08*	*0*
Buteos	*0.22*	*0.17*	*0.5*	*0.11*	*0.22*	*0*	*0.11*	*0*	*0.08*
Northern Harrier	*0*	*0.08*	*0.25*	*0*	*0*	*0*	*0.11*	*0.08*	*0.08*
Eagles	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Falcons	*0.11*	*0*	*0*	*0.11*	*0*	*0*	*0.11*	*0*	*0*
Other Raptors	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Owls	0	0	0.08	0	0	0	0	0	0
Vultures	0	0.42	0.5	0	0	0	0	0.08	0
Upland Game Birds	0	1.08	0.5	0.11	0.33	0.08	0.78	0.5	0.92
Doves/Pigeons	0.11	0.25	0.25	0.33	0.33	0.25	0.11	1.17	0.67
Large Corvids	0	0	0.58	0	0	0	0	0	0
Goatsuckers	0	0	0	0	0	0	0	0.25	0.08
Overall Large Birds*	**6.89**	**6.50**	**292.50**	**4.89**	**6.33**	**3.25**	**7.44**	**7.83**	**42.00**

* Sums may not total values shown due to rounding.

Appendix D2. Mean use by point for major small bird types during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

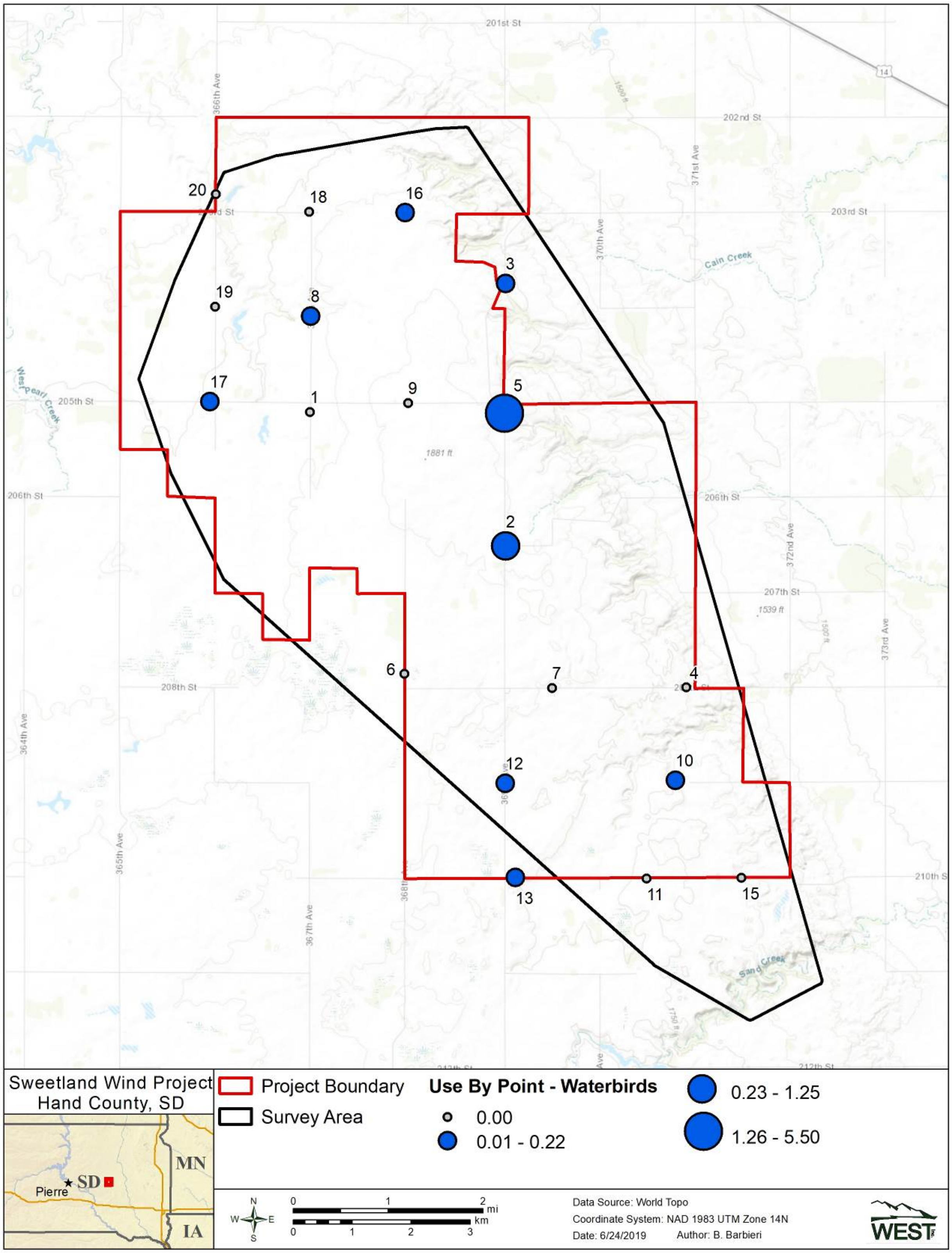
	Survey Point Location									
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Passerines	5.83	5.75	15.25	3.83	7.00	7.44	9.00	6.22	6.58	8.00
Woodpeckers	0	0.25	0	0	0	0.22	0	0	0	0
Unidentified Birds	0.08	0	0.08	0	0	0	0	0.11	0	0
Overall Small Birds*	**5.92**	**6.00**	**15.33**	**3.83**	**7.00**	**7.67**	**9.00**	**6.33**	**6.58**	**13.89**

* Sums may not total values shown due to rounding.

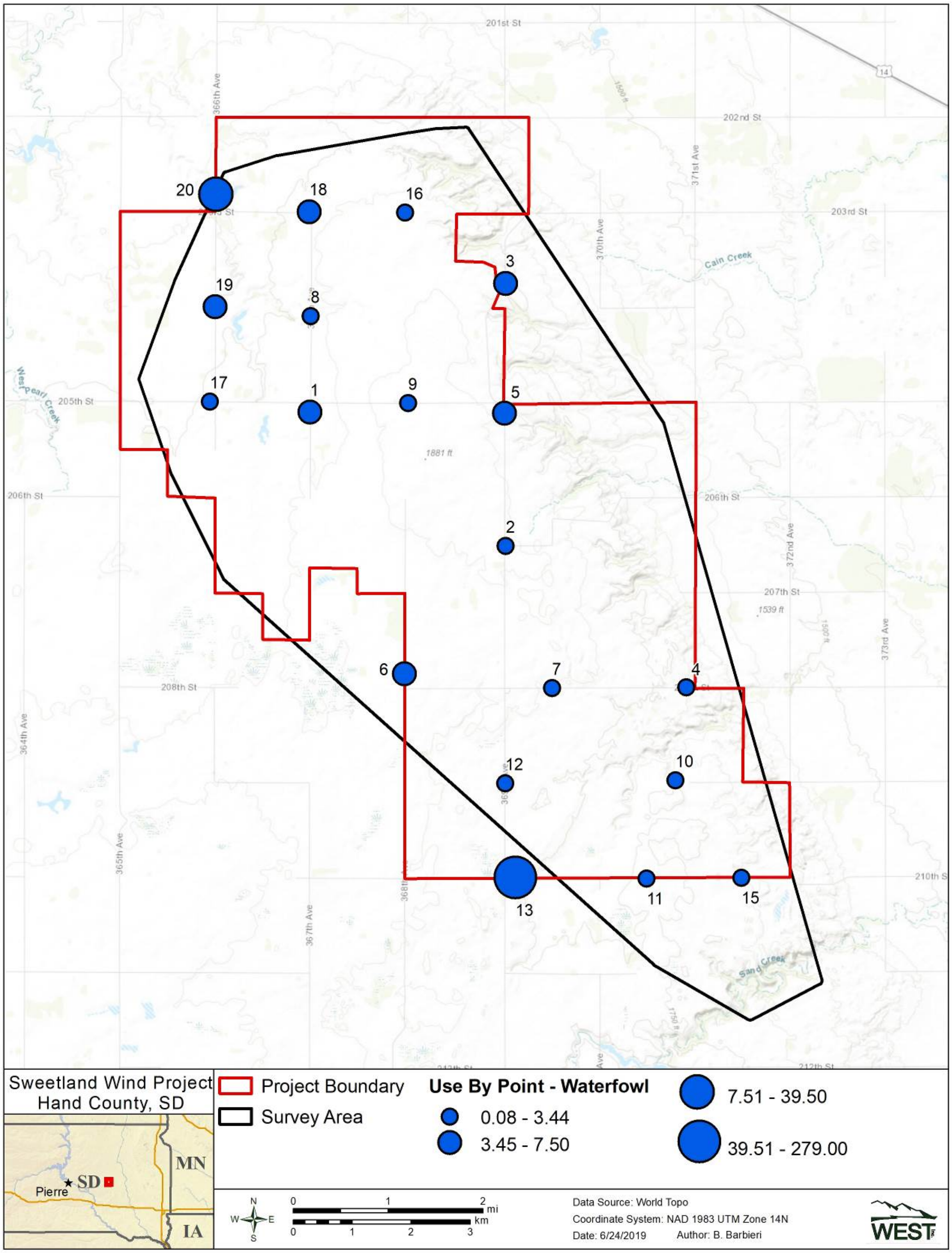
Appendix D2. Mean use by point for major small bird types during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

	Survey Point Location								
Bird Type	**11**	**12**	**13**	**15**	**16**	**17**	**18**	**19**	**20**
Passerines	13.89	10.25	4.67	3.56	5.67	9.83	5.11	12.67	4.58
Woodpeckers	0	0	0	0	0	0	0	0	0.25
Unidentified Birds	0	0	0.42	0	0.11	0	0	0	0
Overall Small Birds*	**13.89**	**10.25**	**5.08**	**3.56**	**5.78**	**9.83**	**5.11**	**12.67**	**4.83**

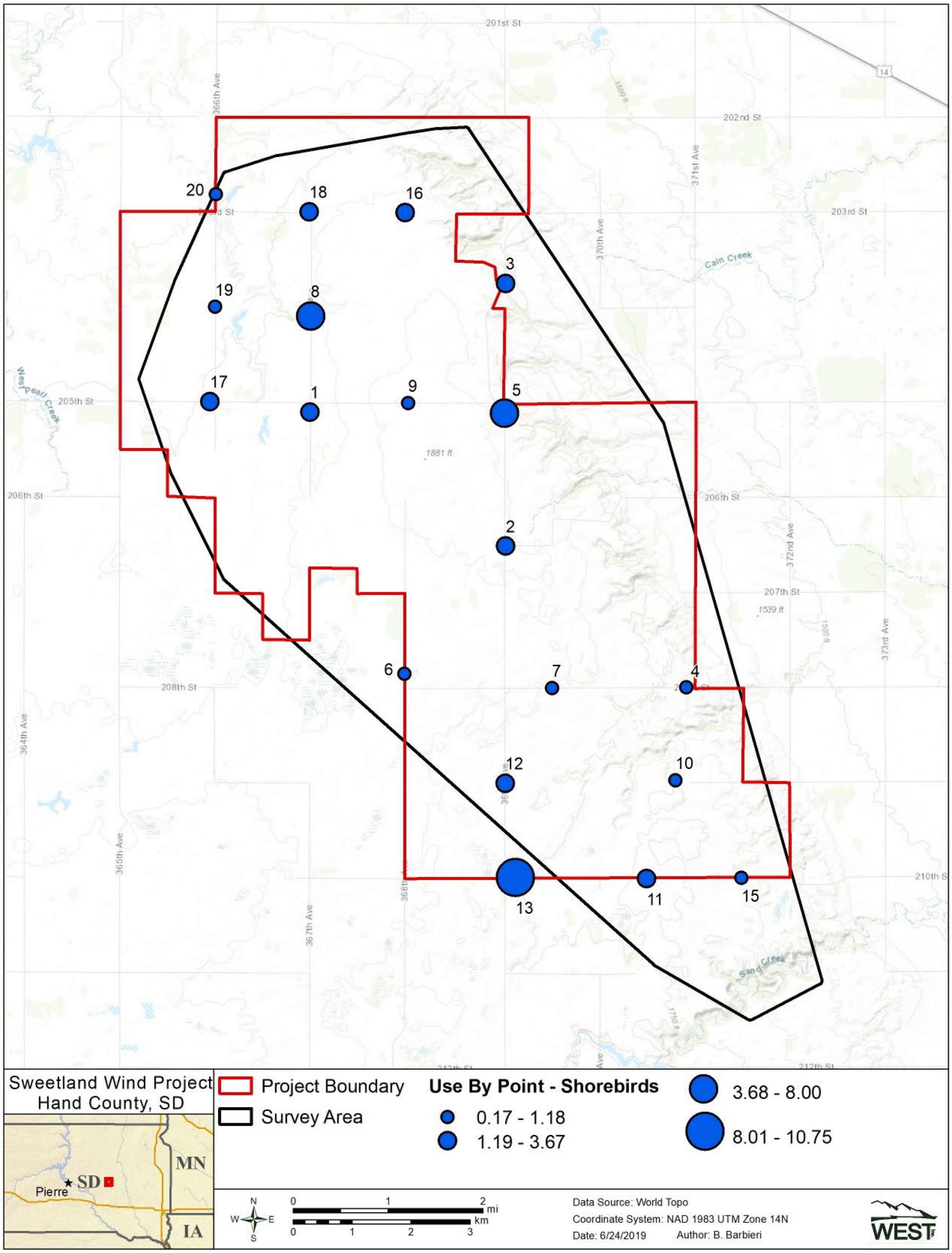
* Sums may not total values shown due to rounding.



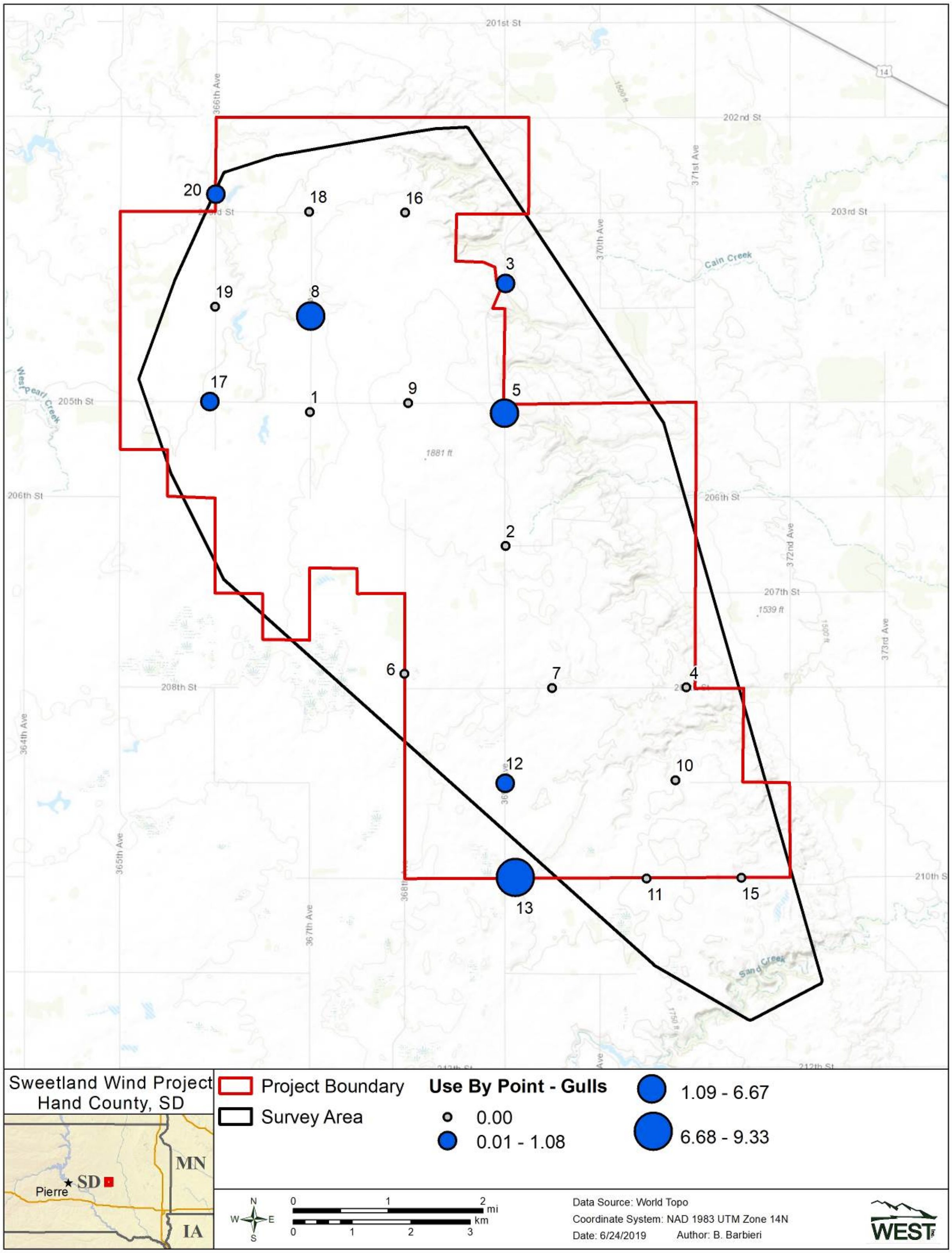
Appendix D3. Relative waterbird use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



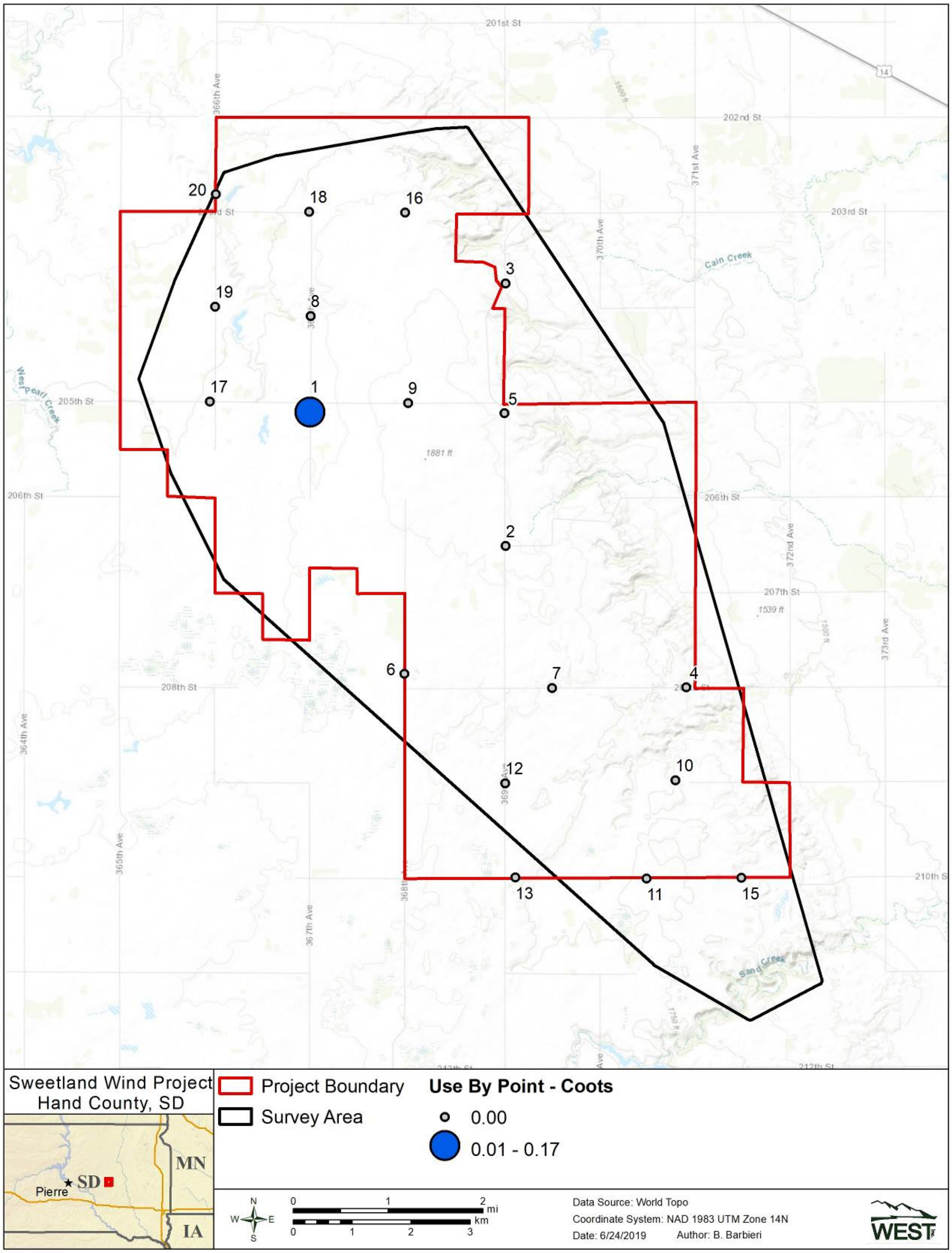
Appendix D3 (*continued*). Relative waterfowl use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



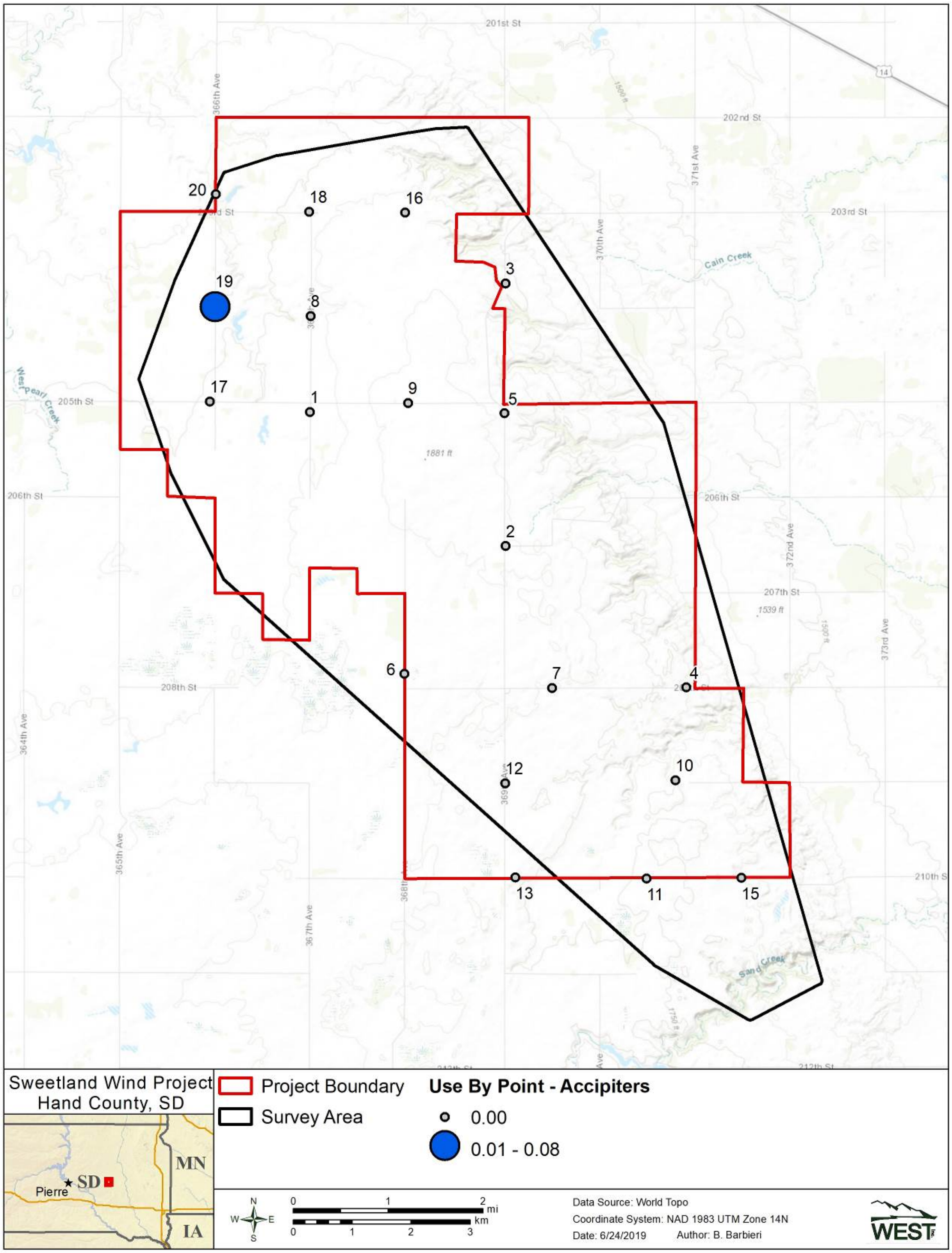
Appendix D3 (*continued*). Relative shorebird use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



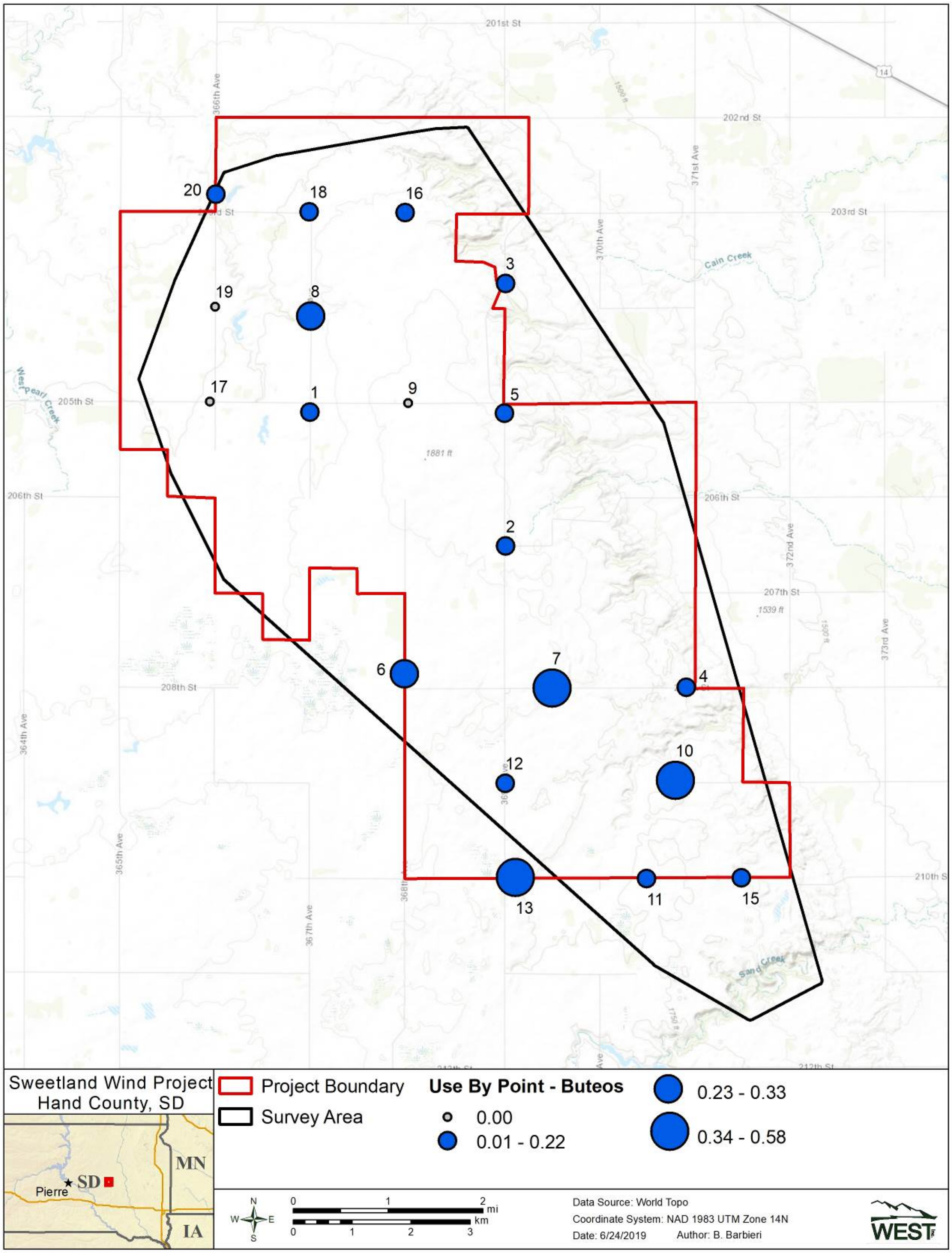
Appendix D3 (*continued*). Relative gull use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



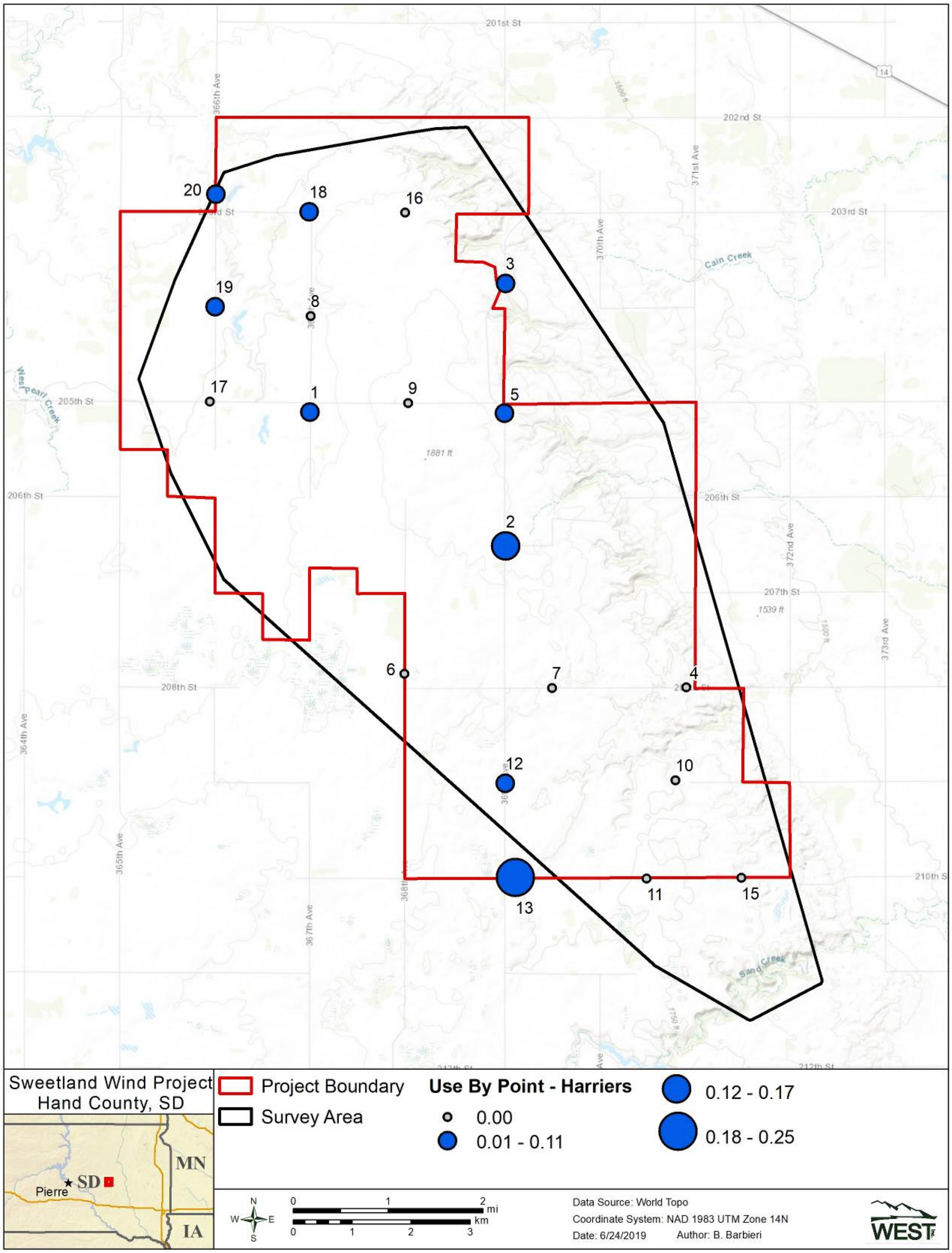
Appendix D3 (*continued*). Relative coot use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



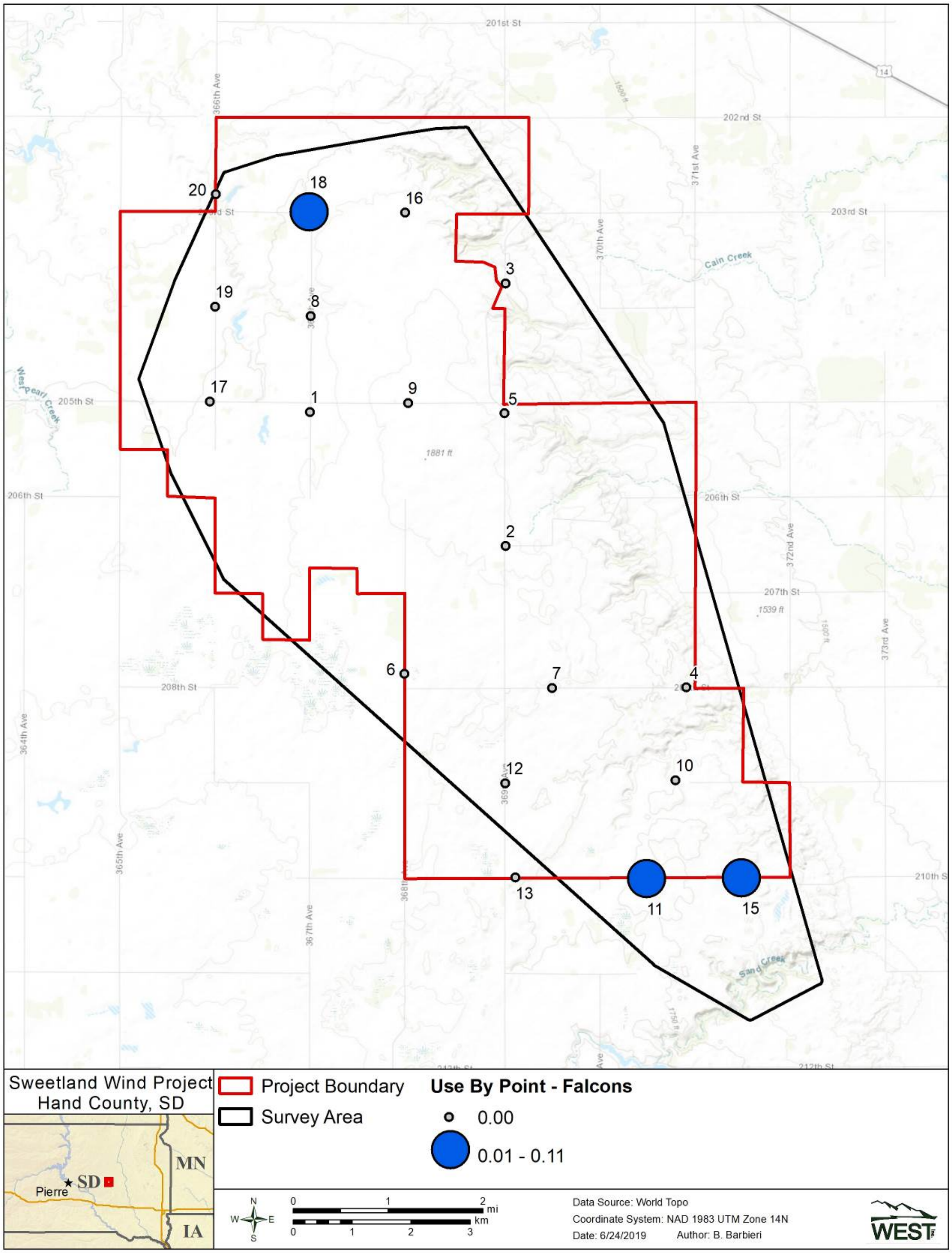
Appendix D3 (continued). Relative accipiter use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



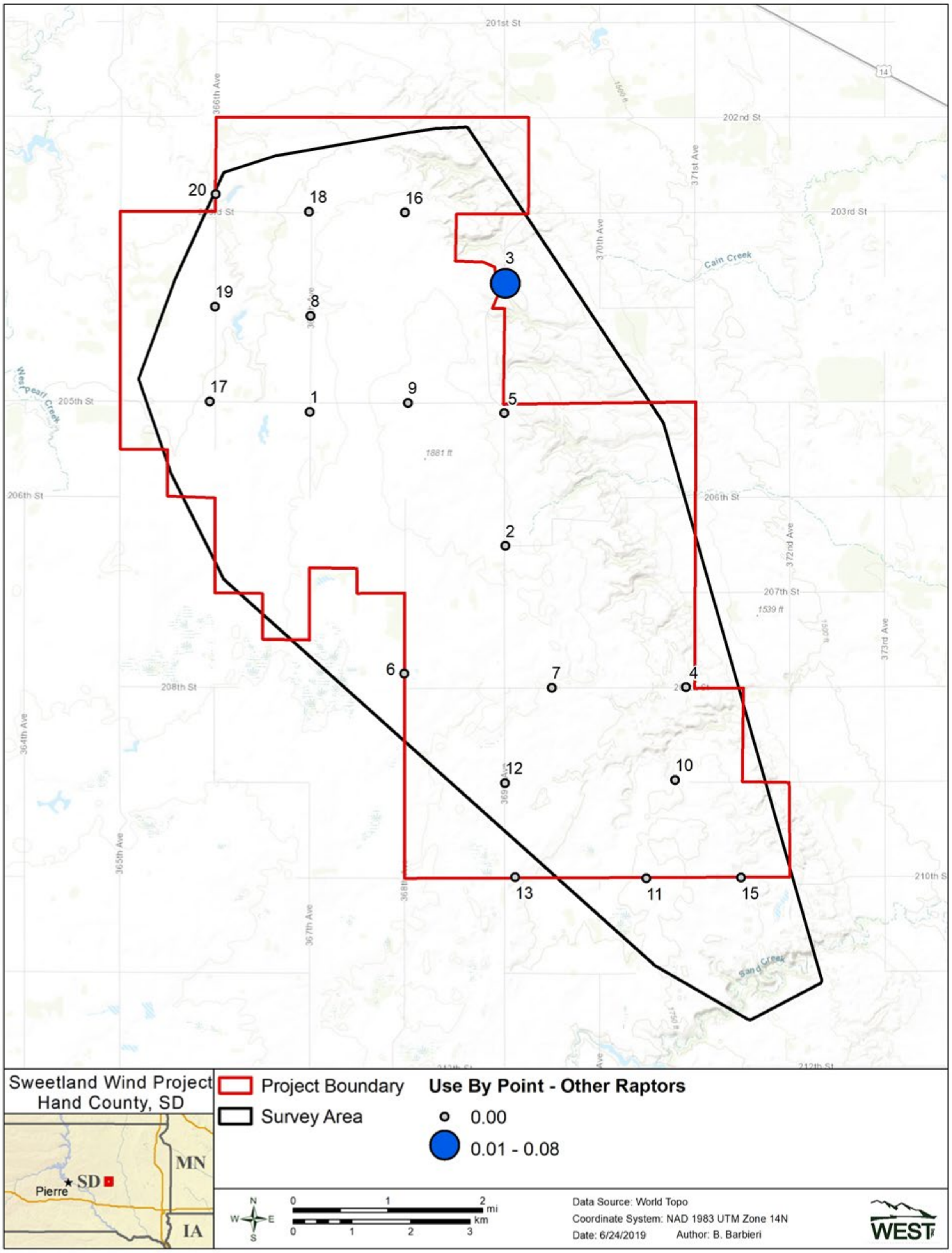
Appendix D3 (*continued*). Relative buteo use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



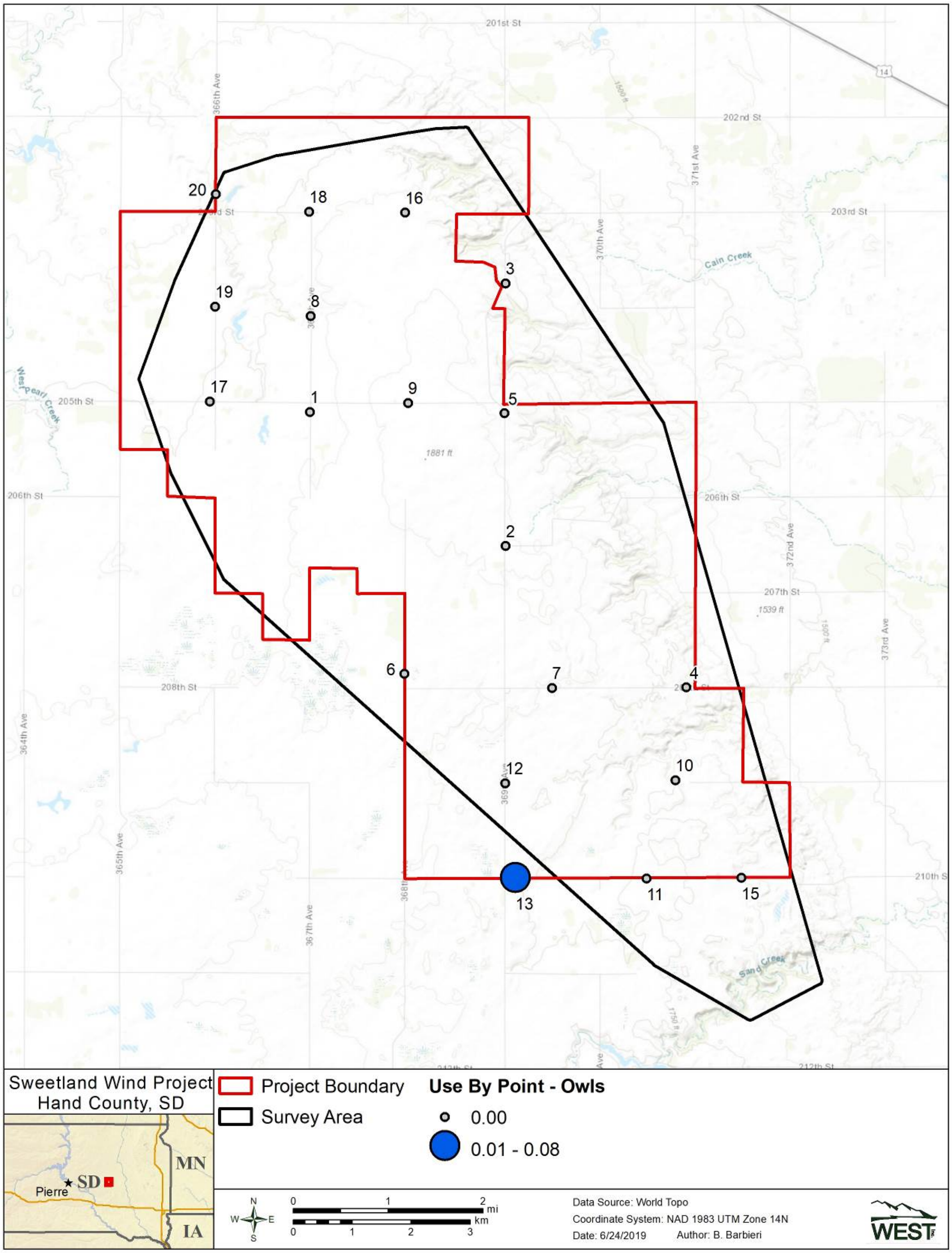
Appendix D3 (*continued*). Relative northern harrier use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



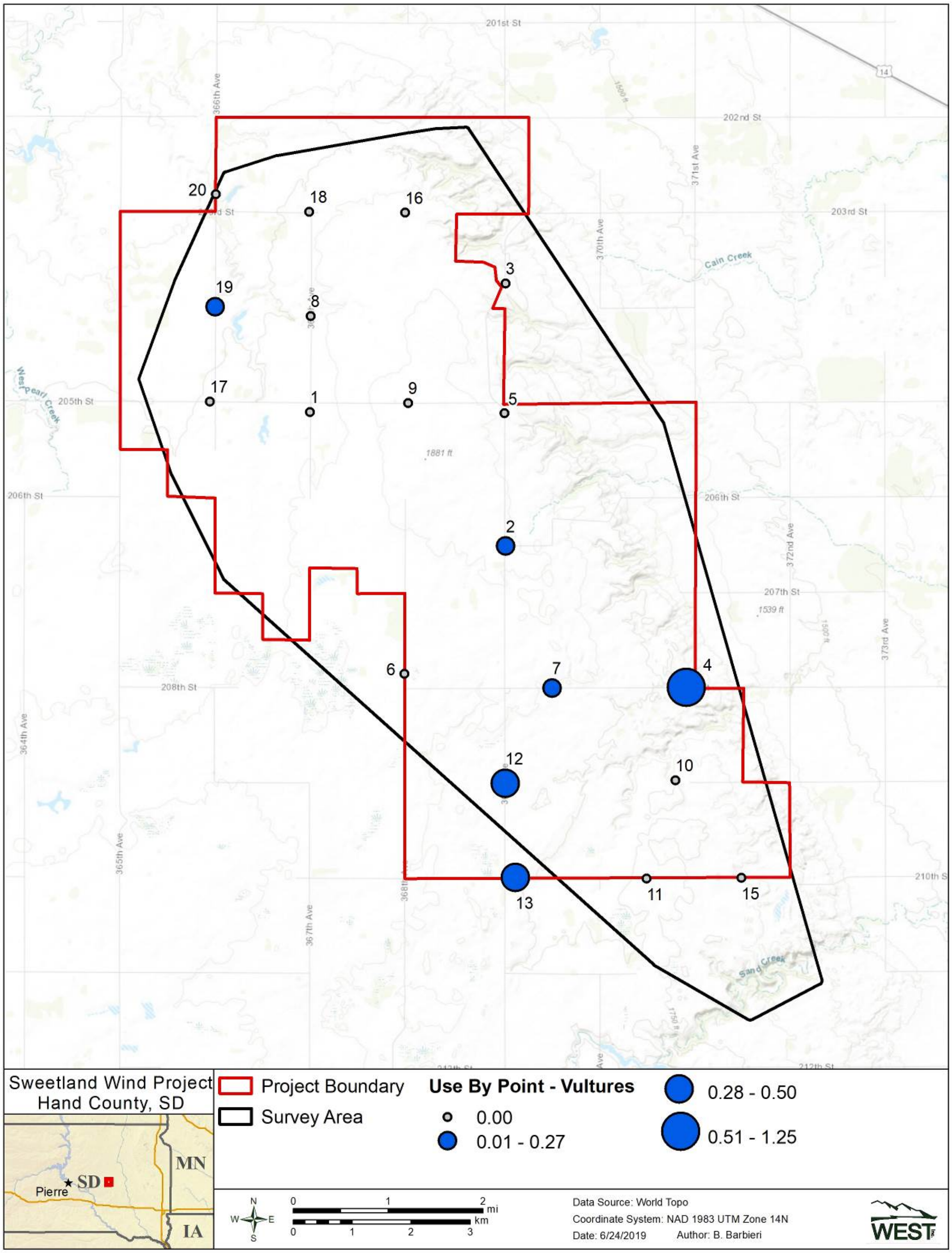
Appendix D3 (*continued*). Relative falcon use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



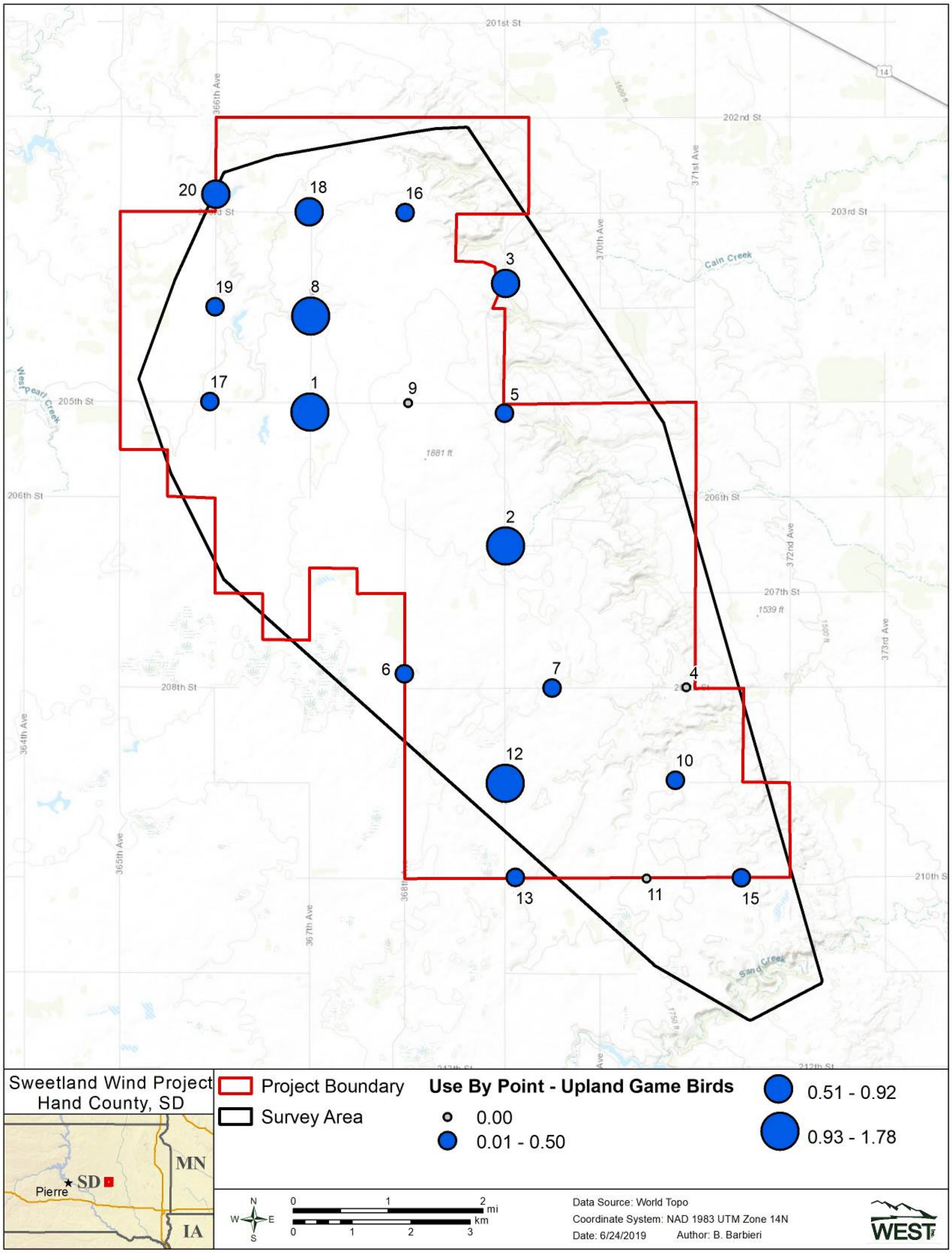
Appendix D3 (*continued*). Relative other raptors use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



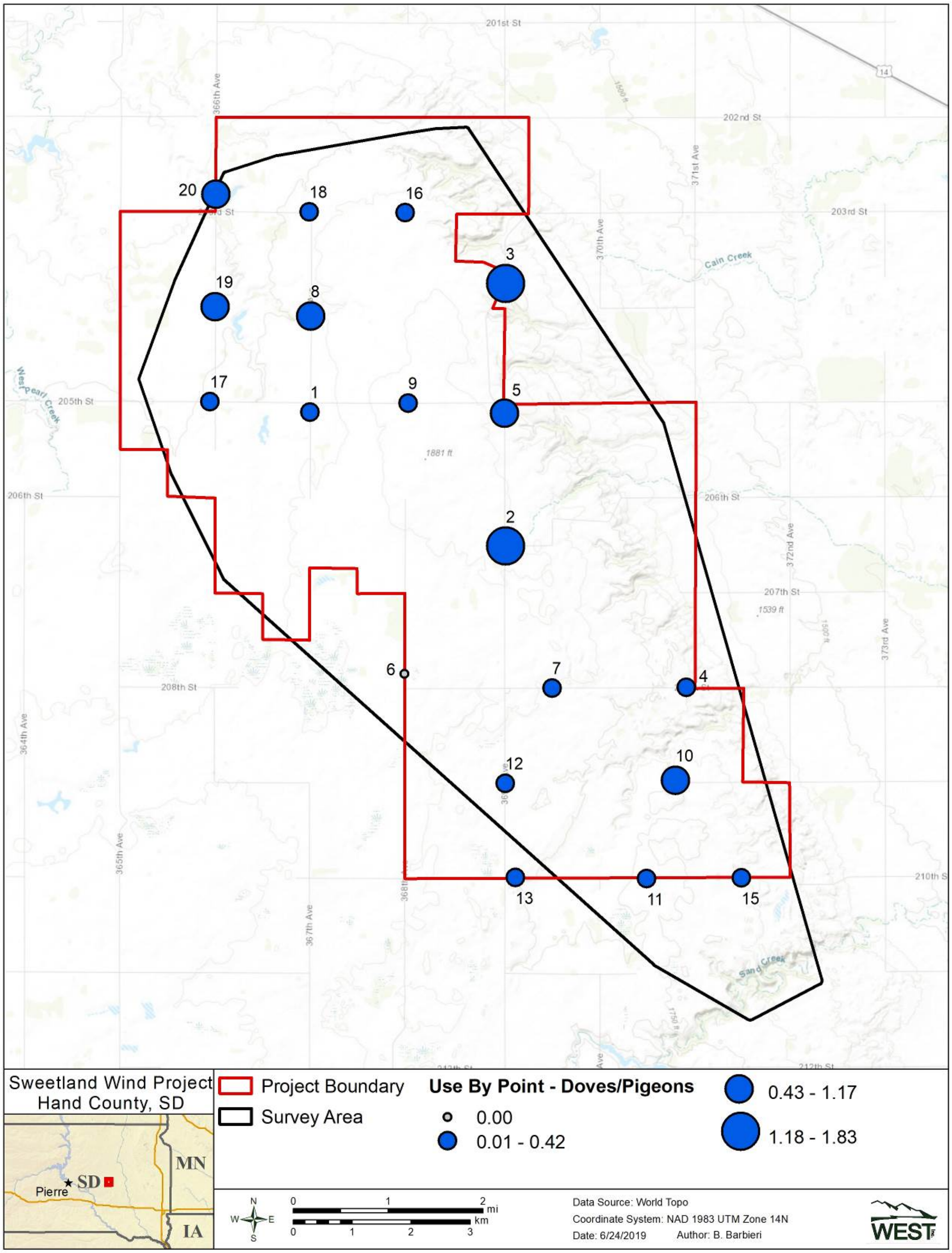
Appendix D3 (*continued*). Relative owls bird use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



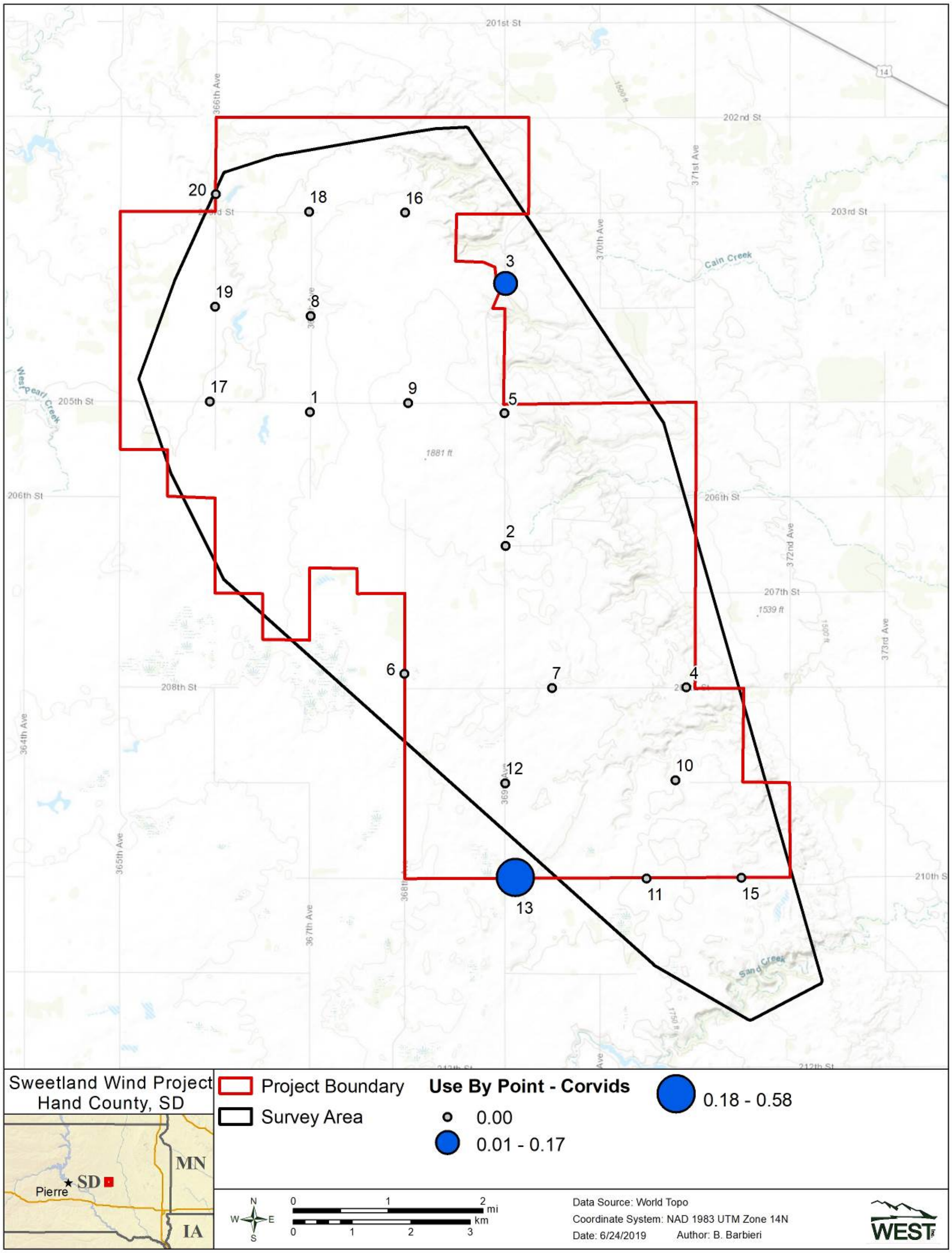
Appendix D3 (*continued*). Relative vulture use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



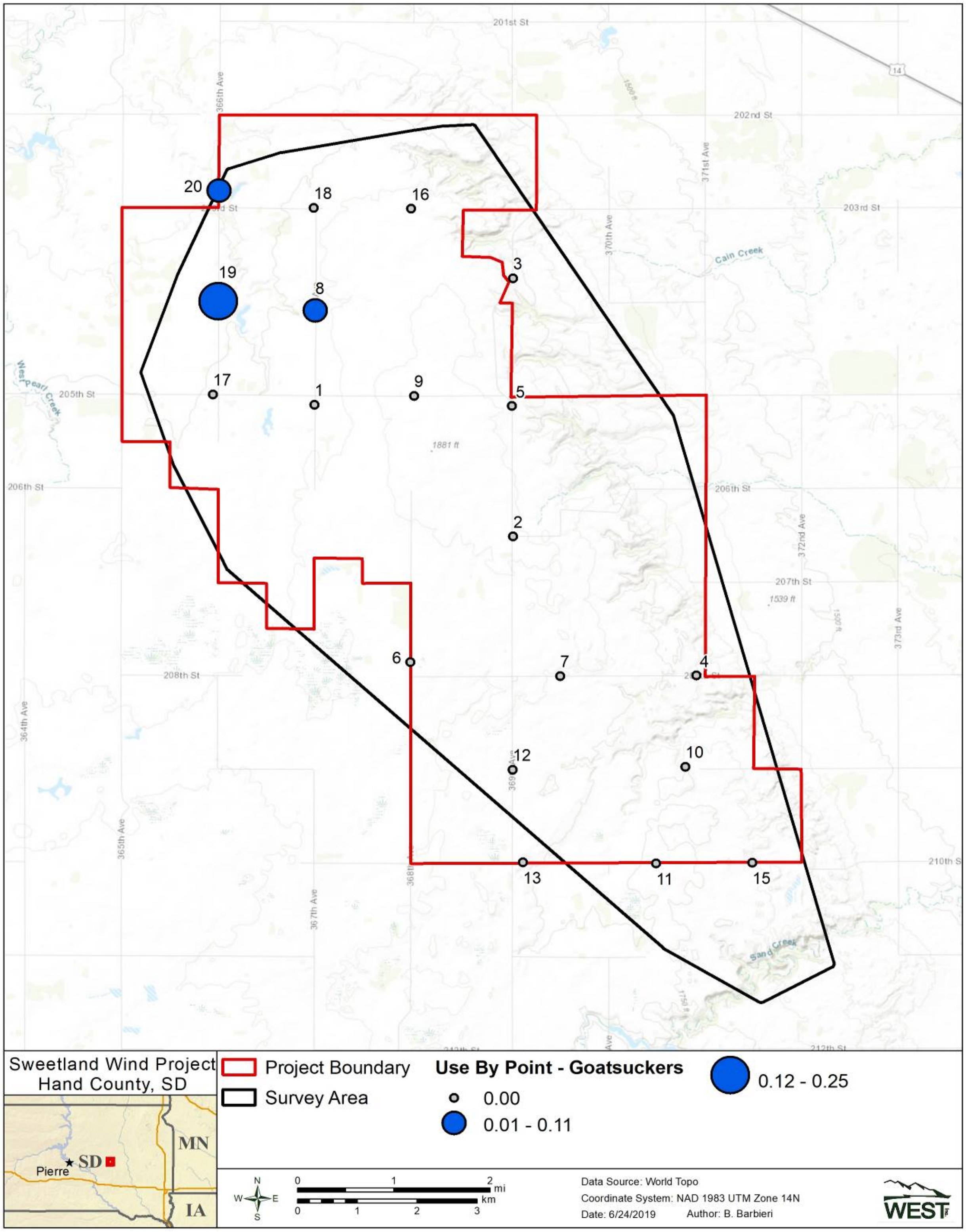
Appendix D3 (*continued*). Relative upland game bird use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31 2019.



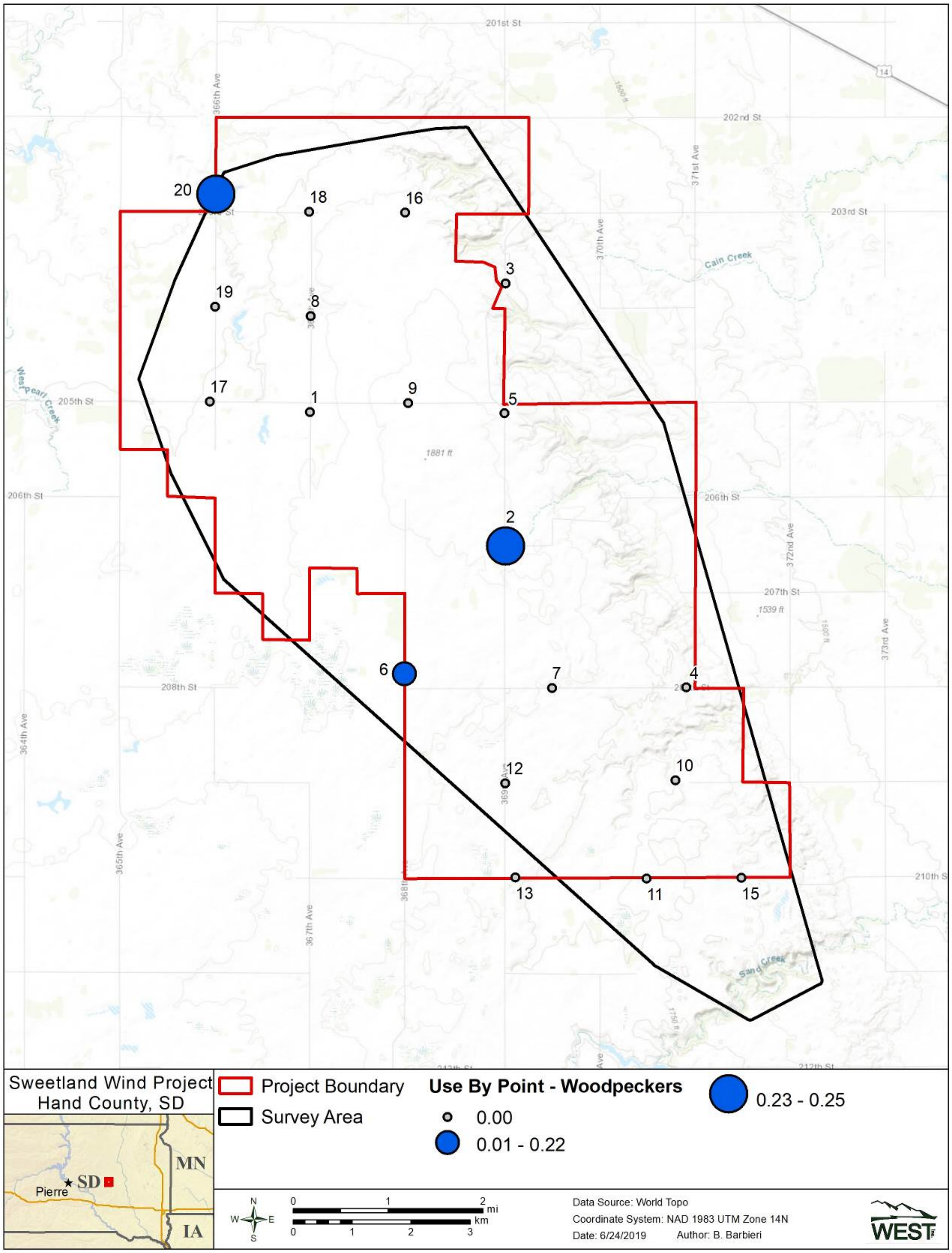
Appendix D3 (*continued*). Relative dove/pigeon bird use by observation point during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



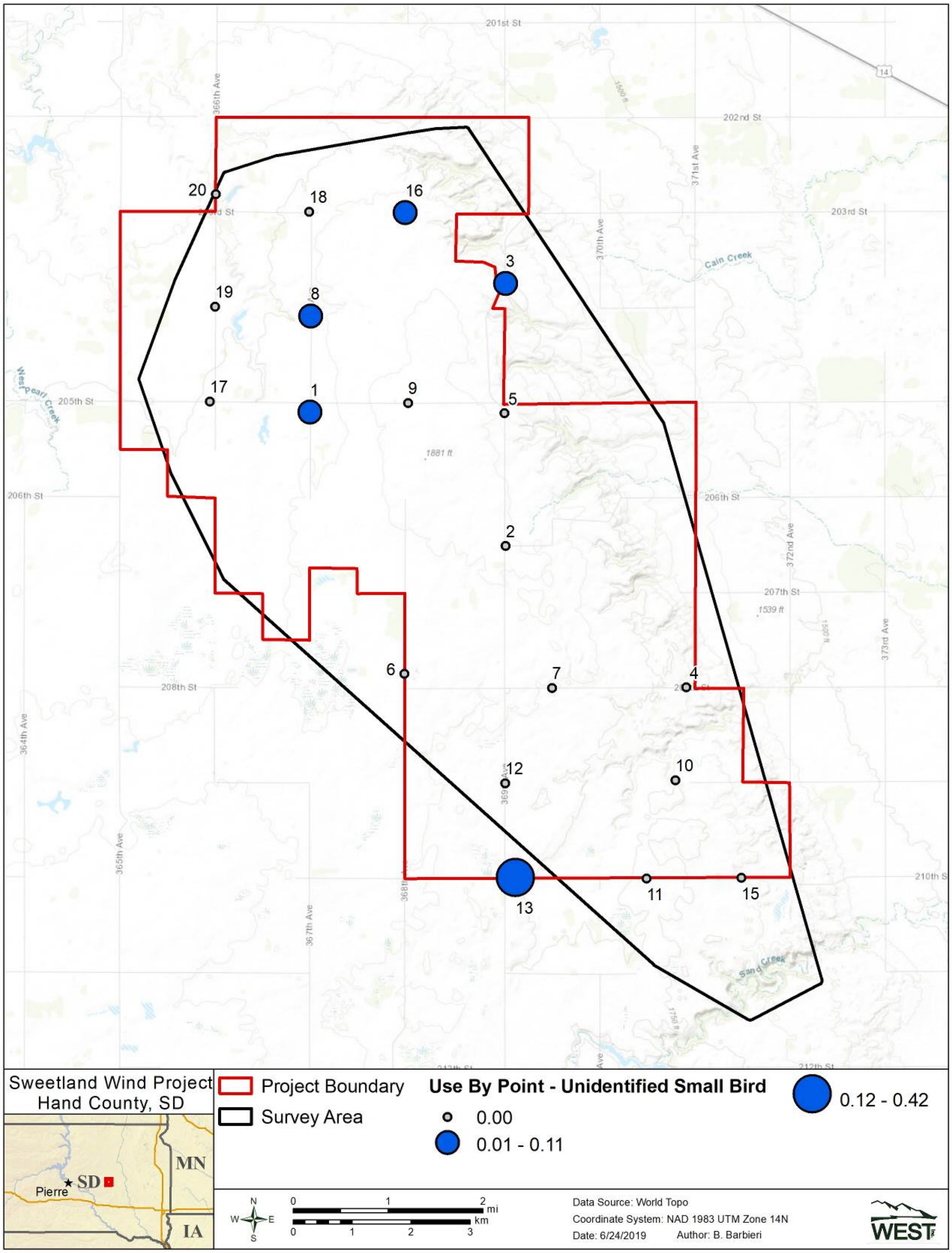
Appendix D3 (*continued*). Relative large corvid use by observation point during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



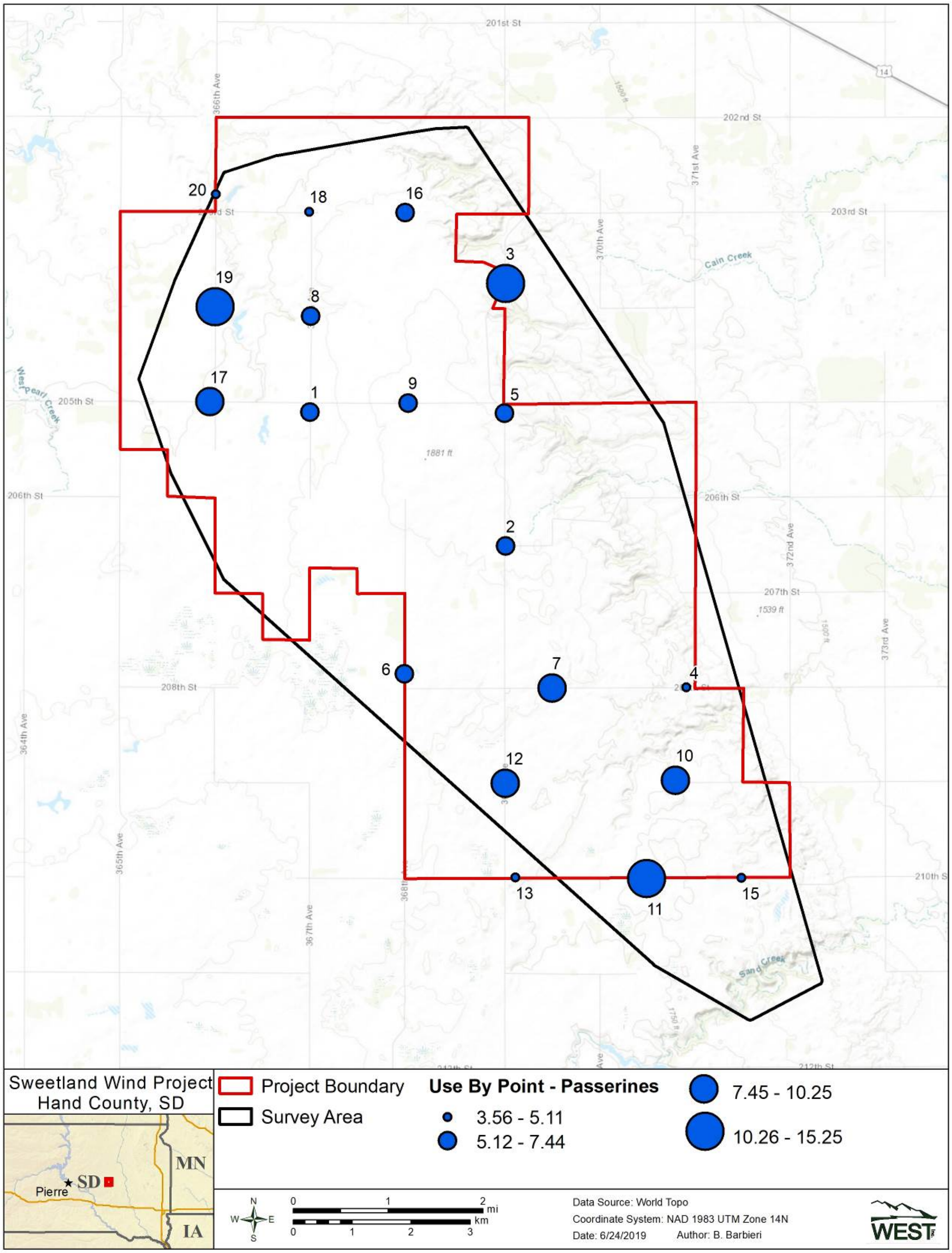
Appendix D3 (*continued*). Relative goatsucker use by observation point during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



Appendix D3 (*continued*). Relative woodpecker use by observation point during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

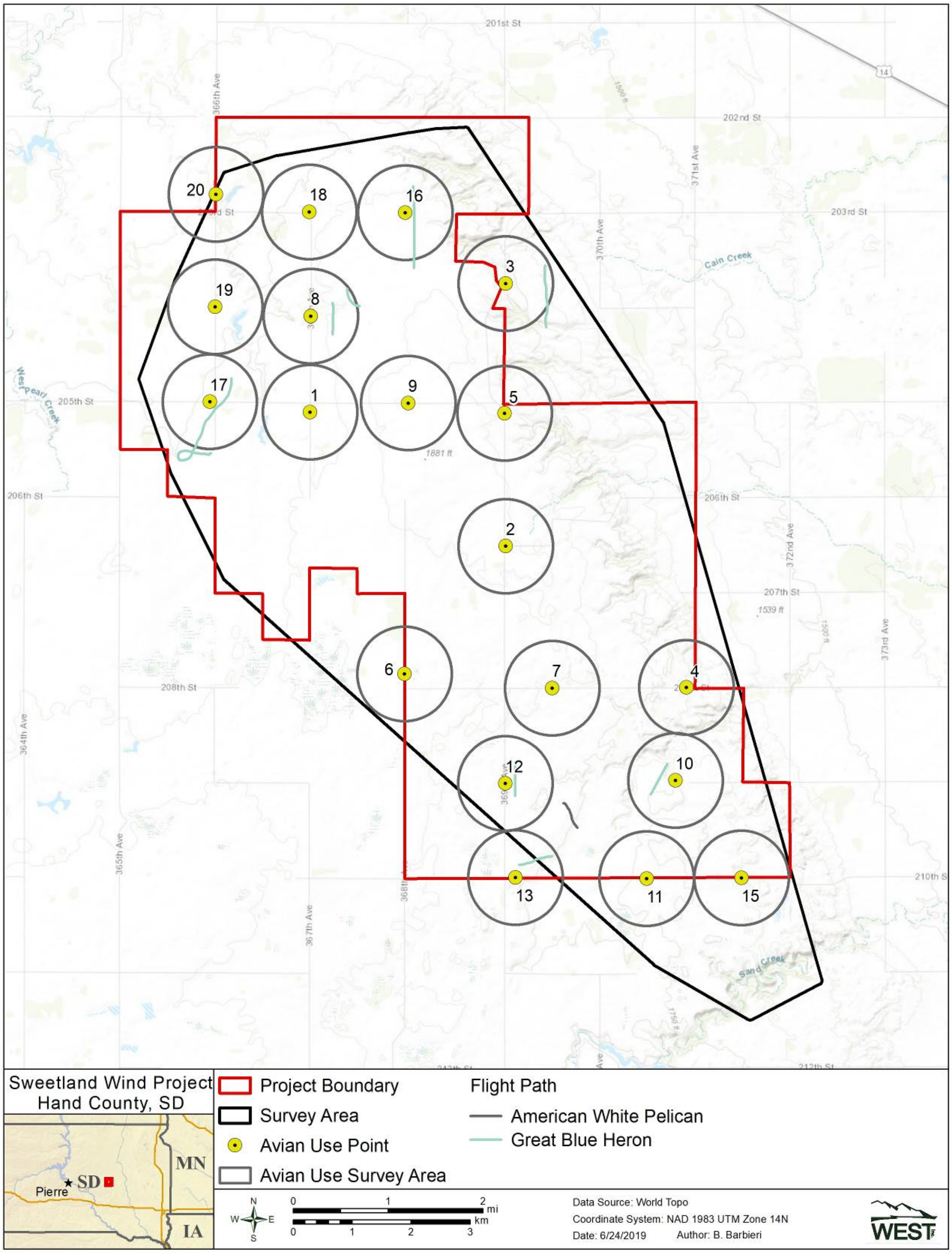


Appendix D3 (*continued*). Relative unidentified small bird use by observation point during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

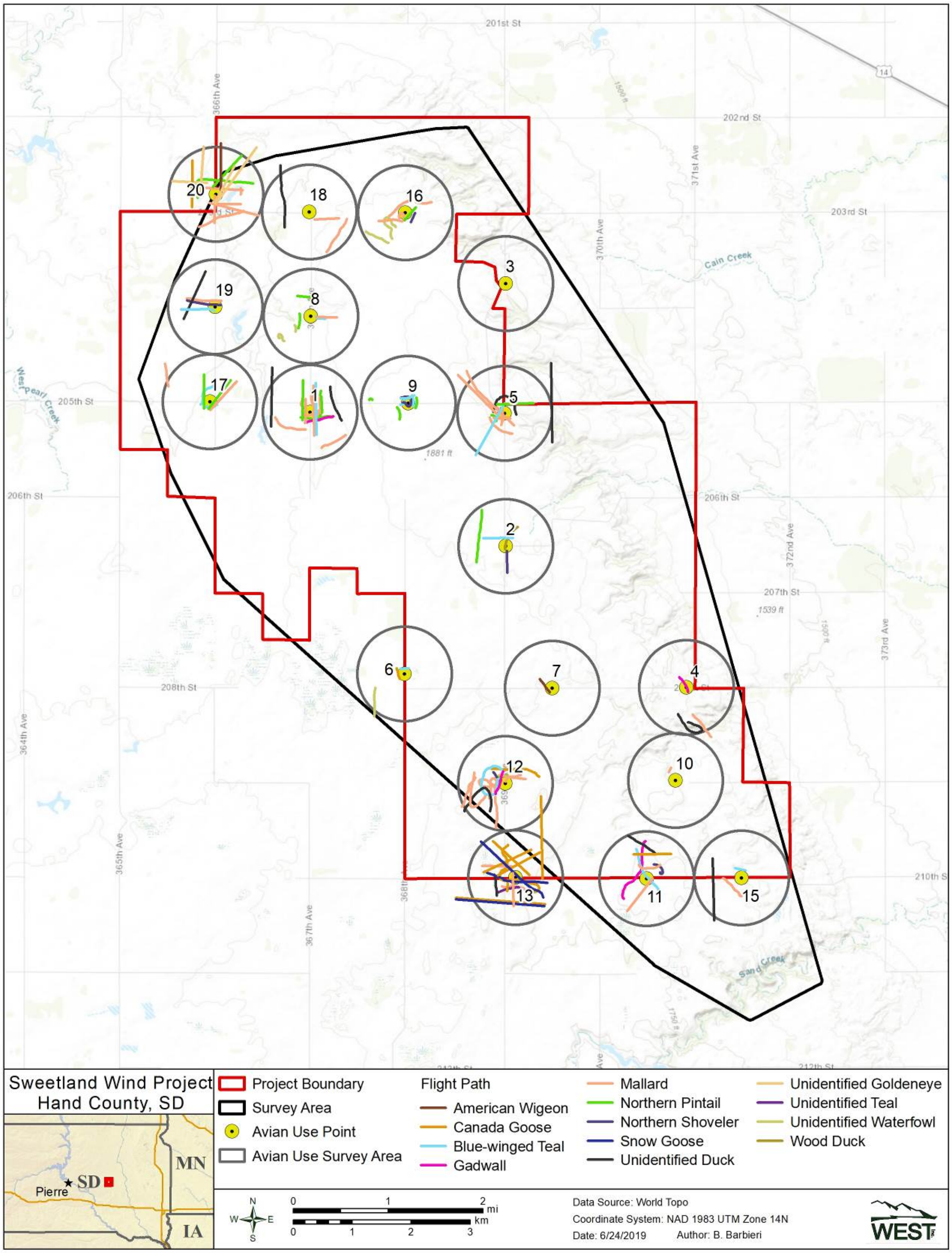


Appendix D3 (*continued*). Relative passerine use by observation point during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

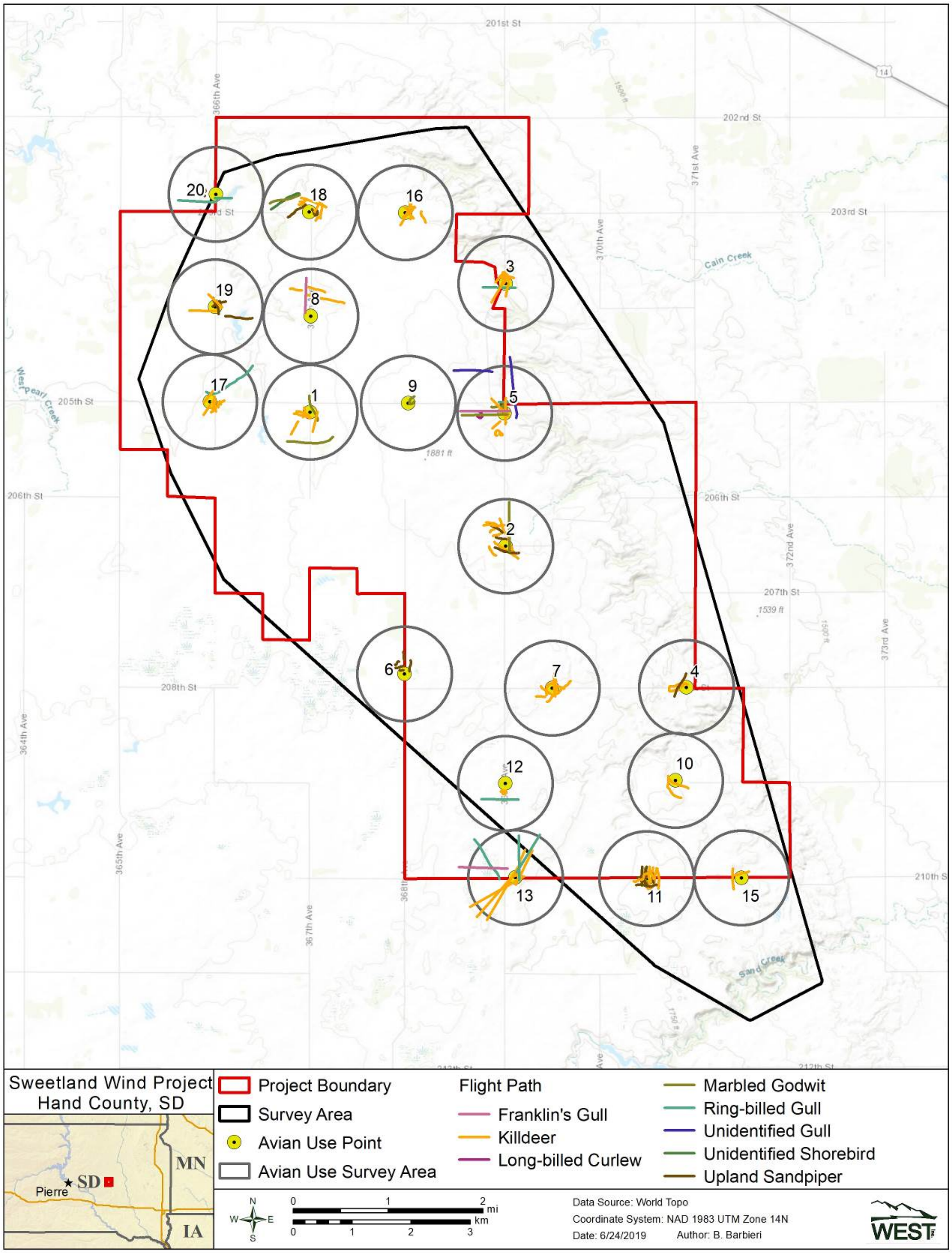
Appendix E. Large Bird Flight Paths Observed during Fixed-Point Large Bird Use Surveys at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019



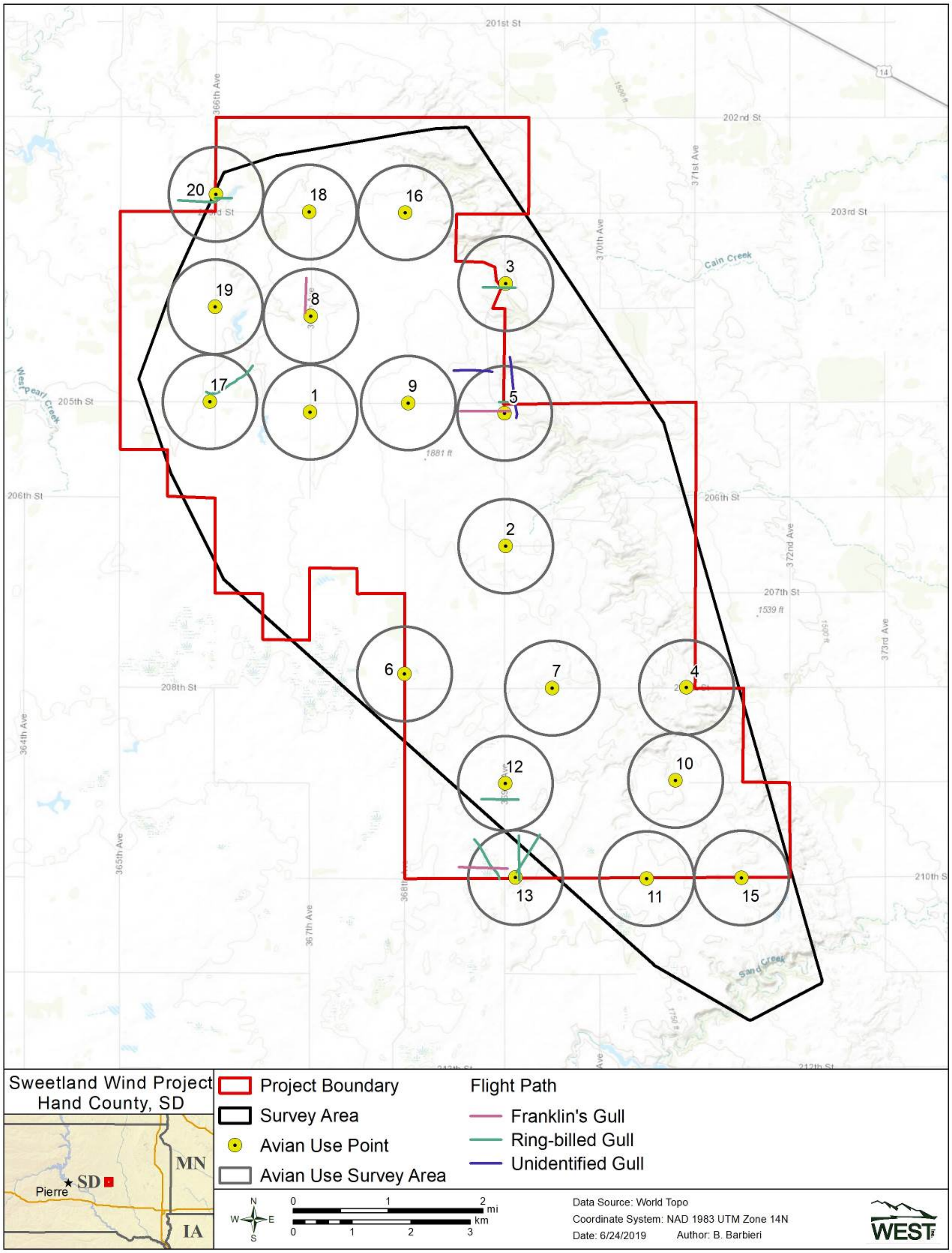
Appendix E. Waterbird flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



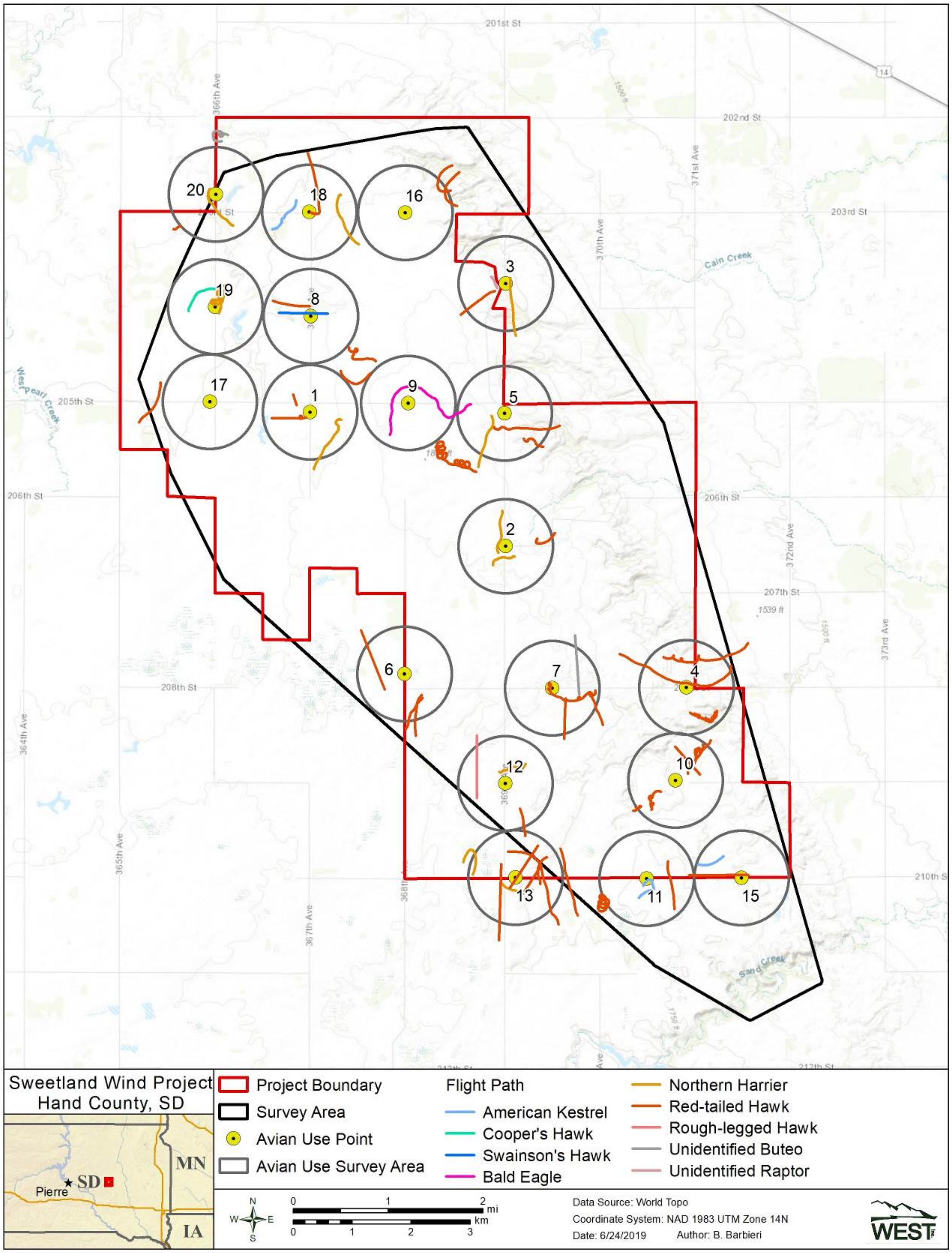
Appendix E (*continued*). Waterfowl flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 12, 2019.



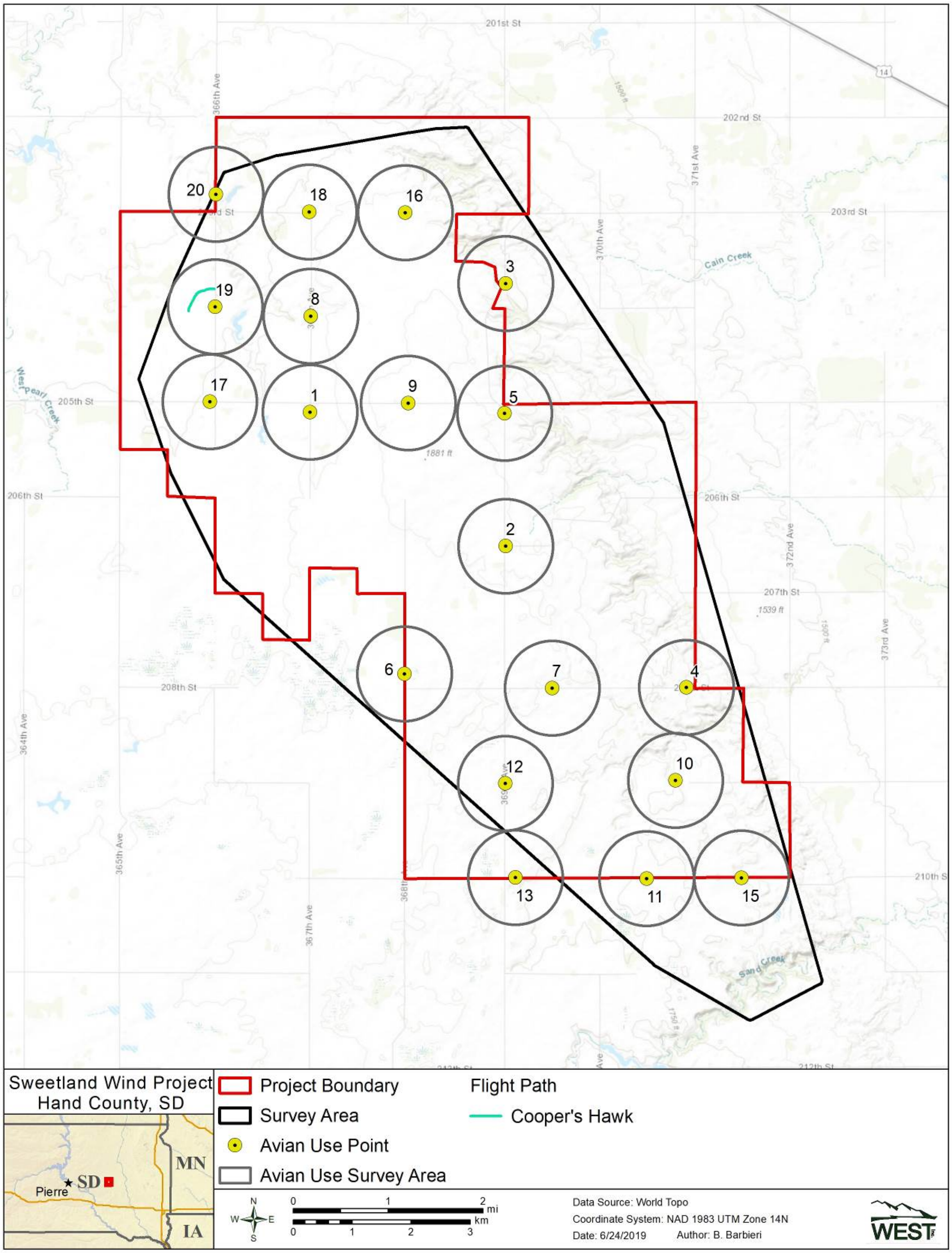
Appendix E (*continued*). Shorebird flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



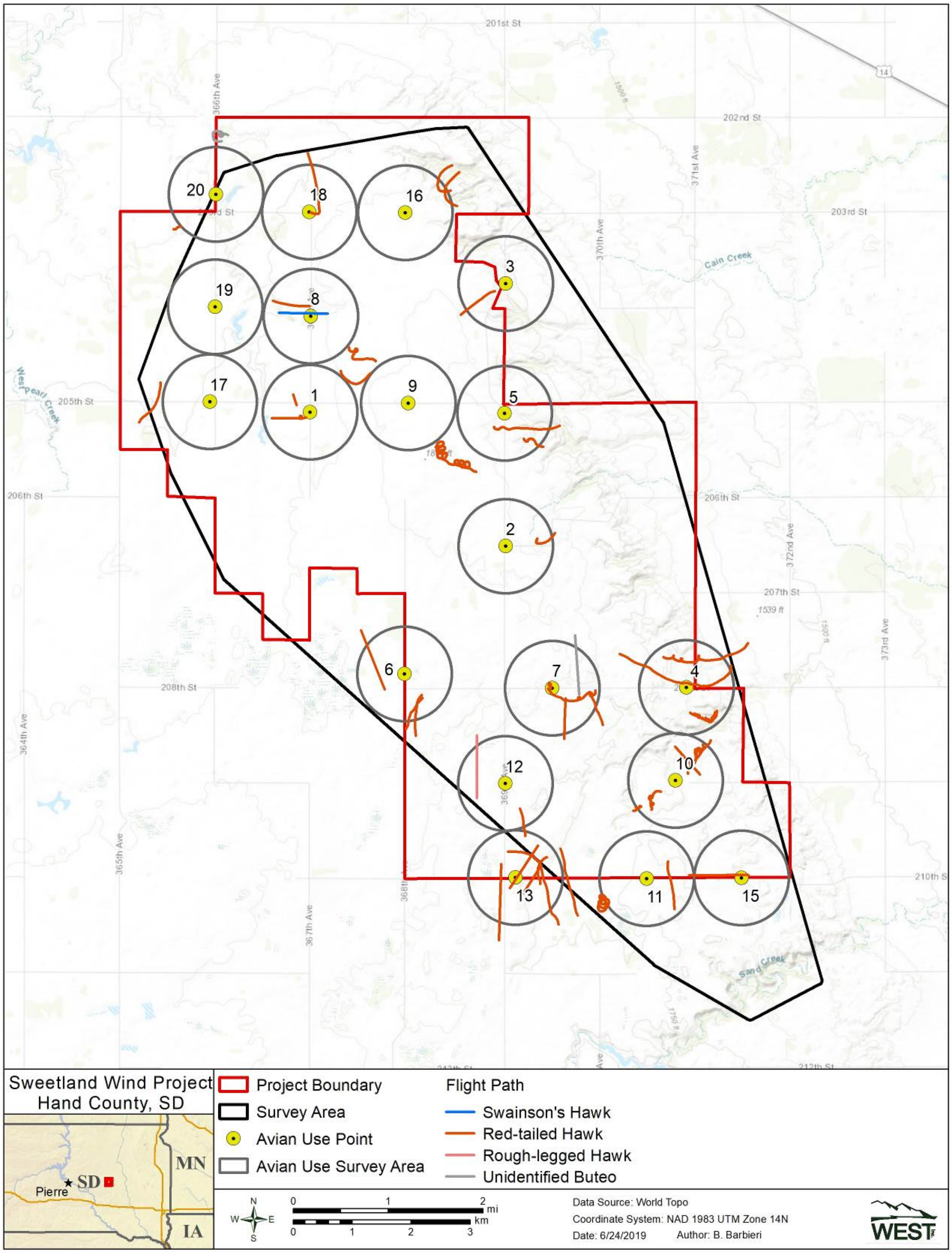
Appendix E (*continued*). Gull flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



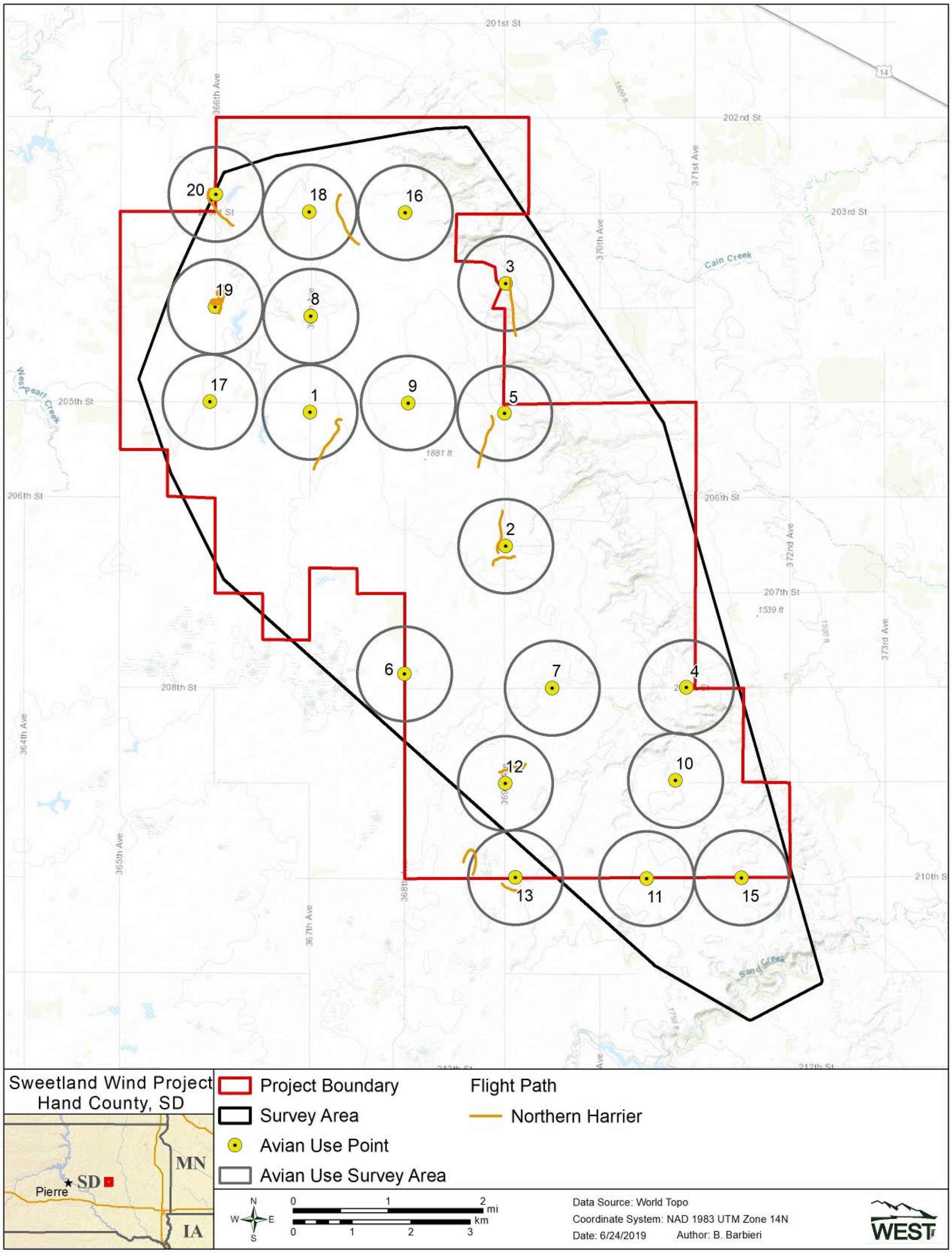
Appendix E (*continued*). Diurnal raptor flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



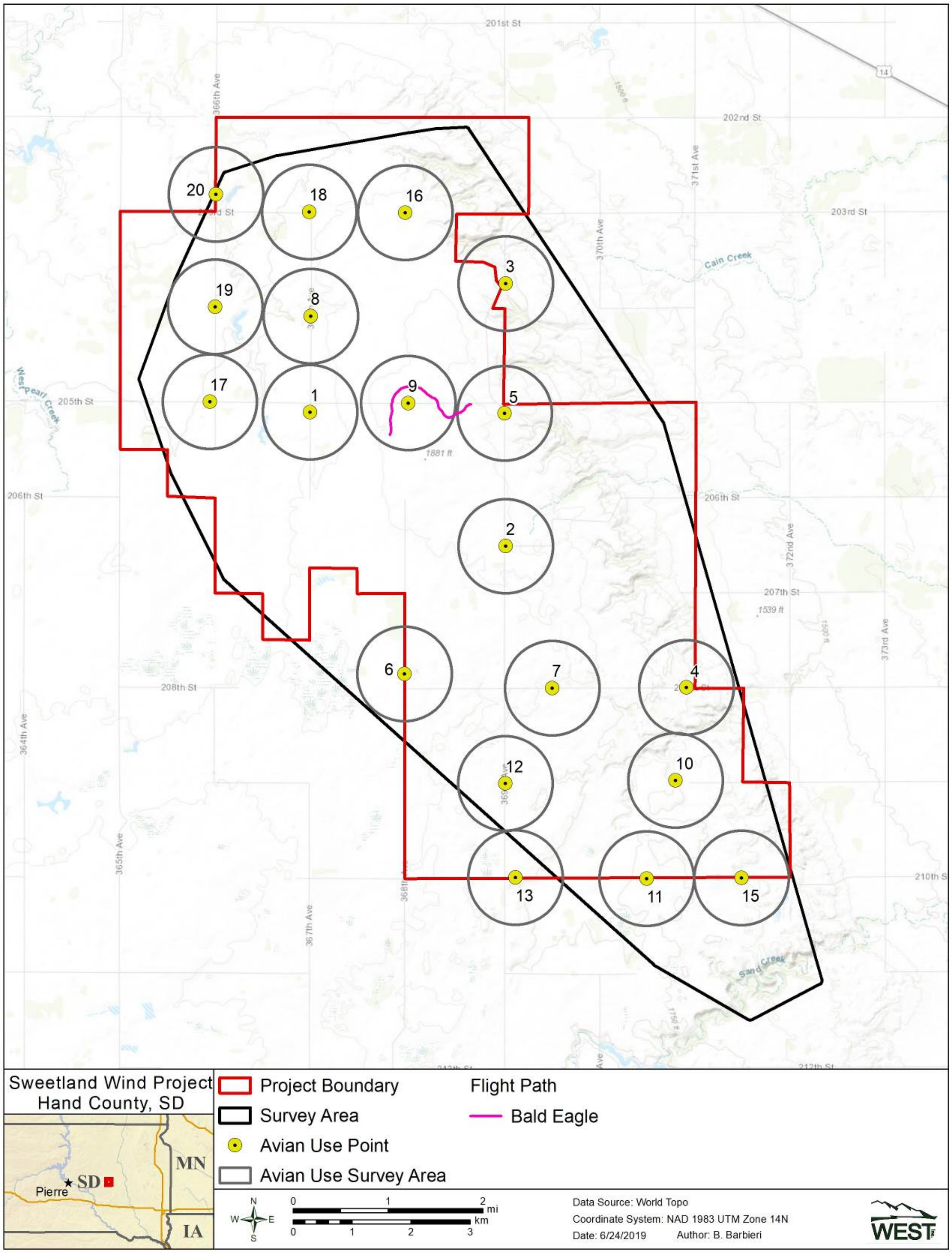
Appendix E (*continued*). Accipiter flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



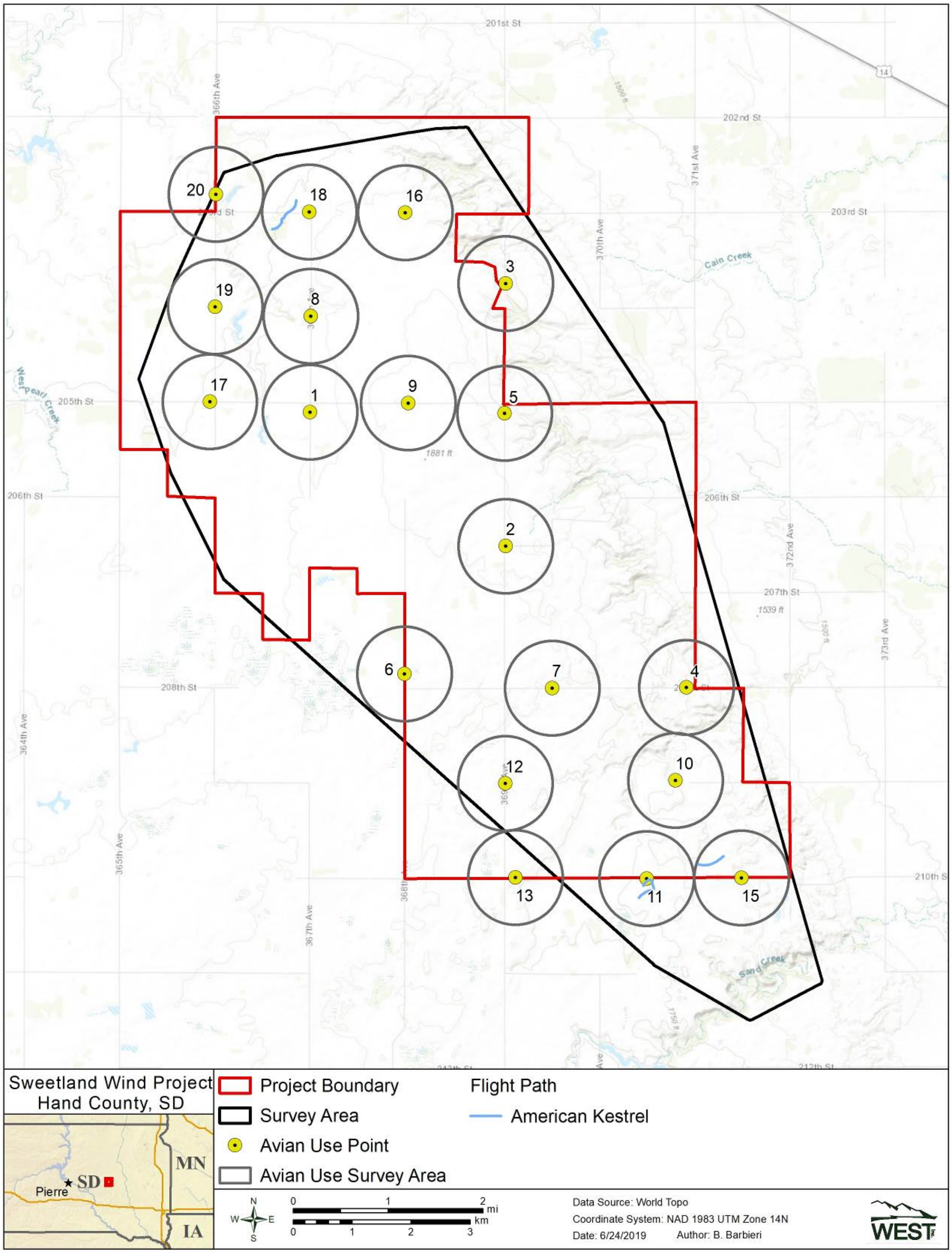
Appendix E (*continued*). Buteo flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



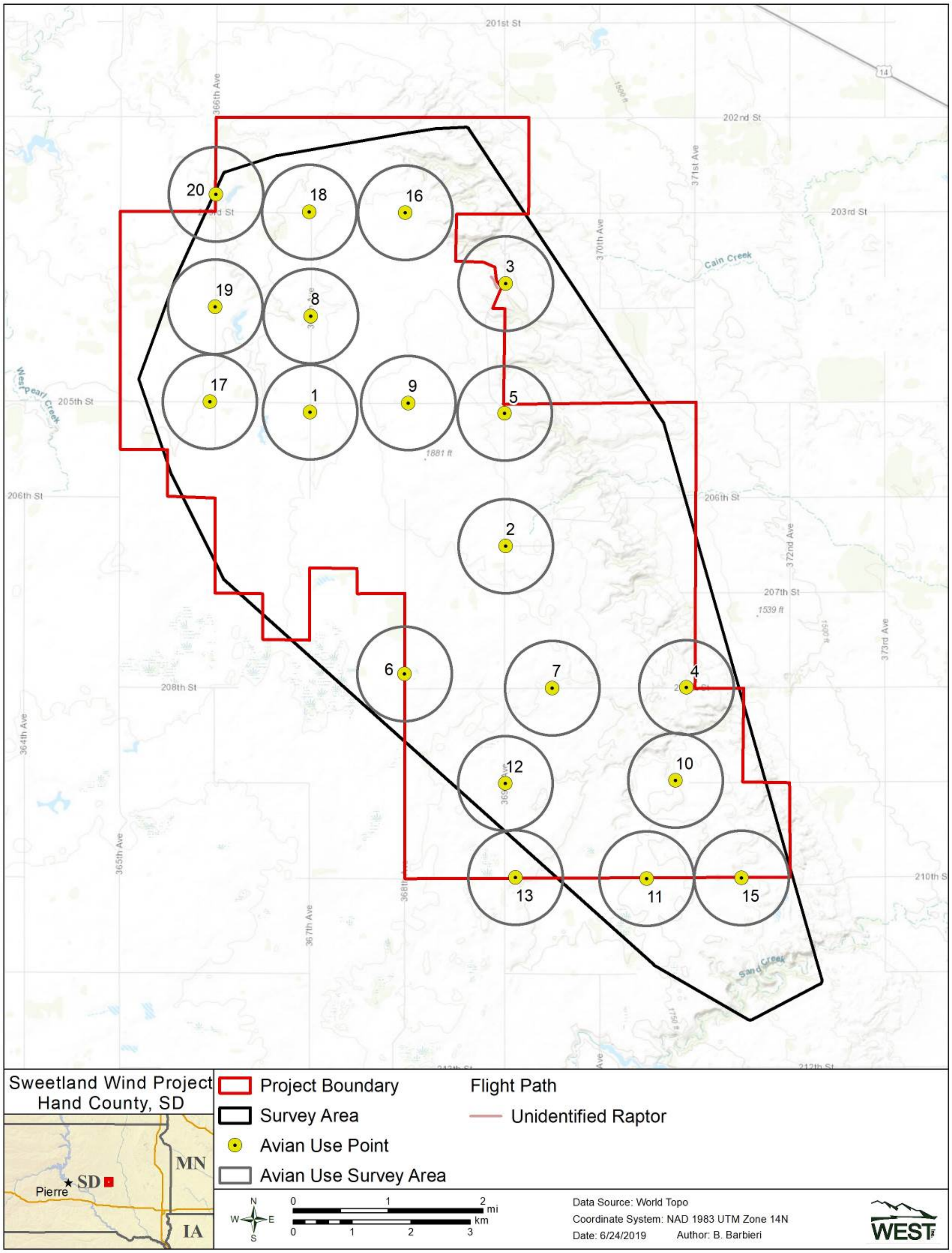
Appendix E (*continued*). Northern harrier flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



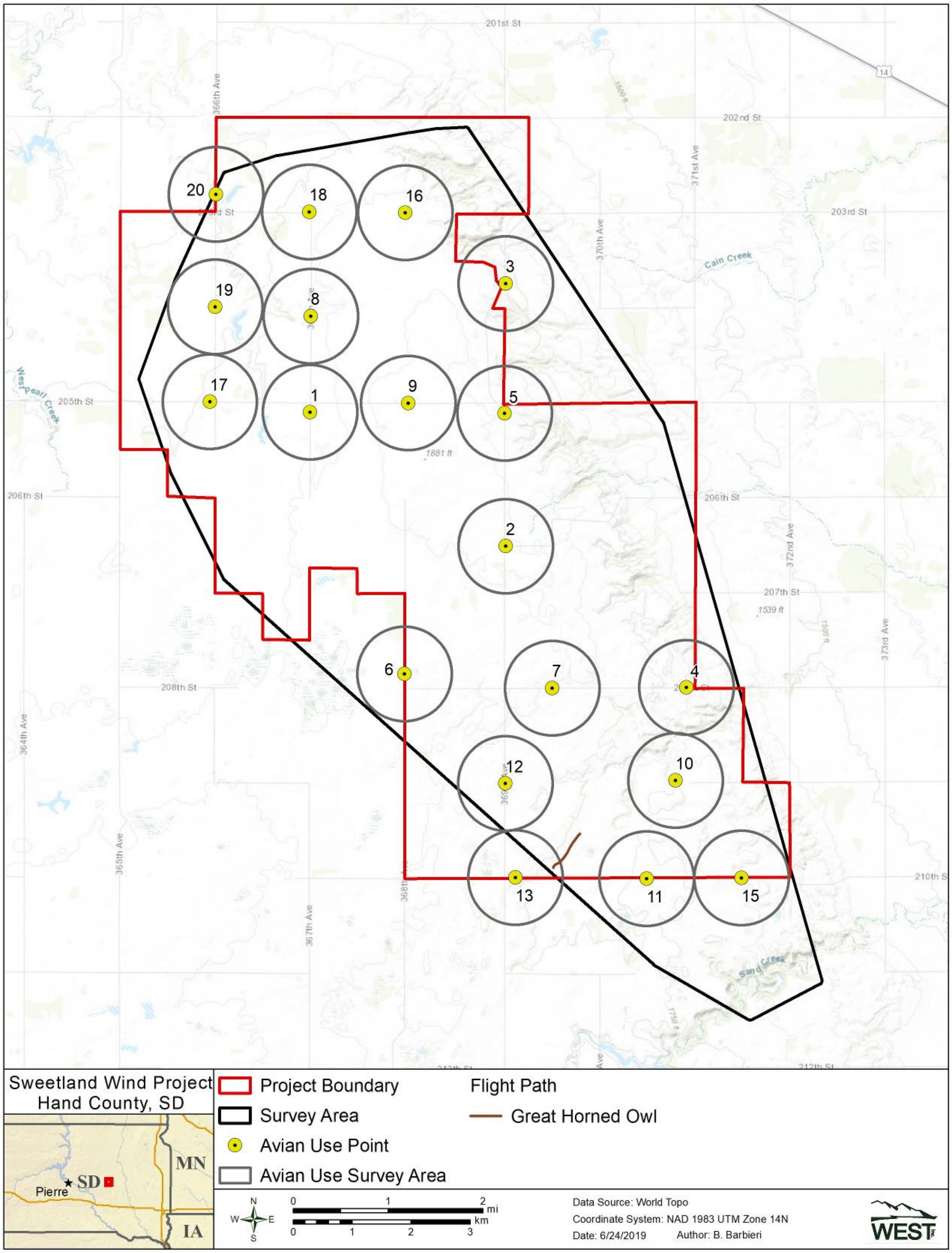
Appendix E (*continued*). Eagle flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



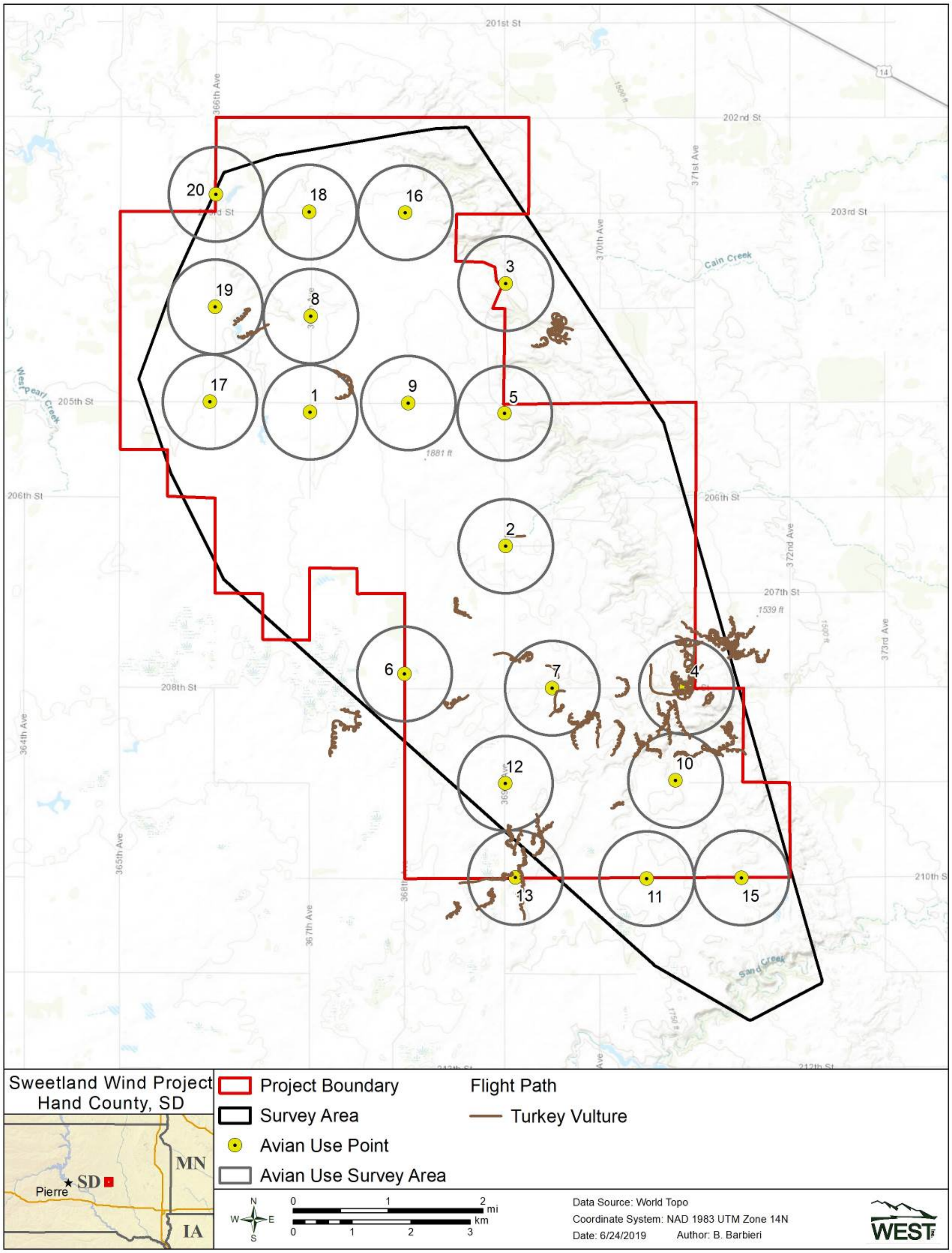
Appendix E (*continued*). Falcon flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



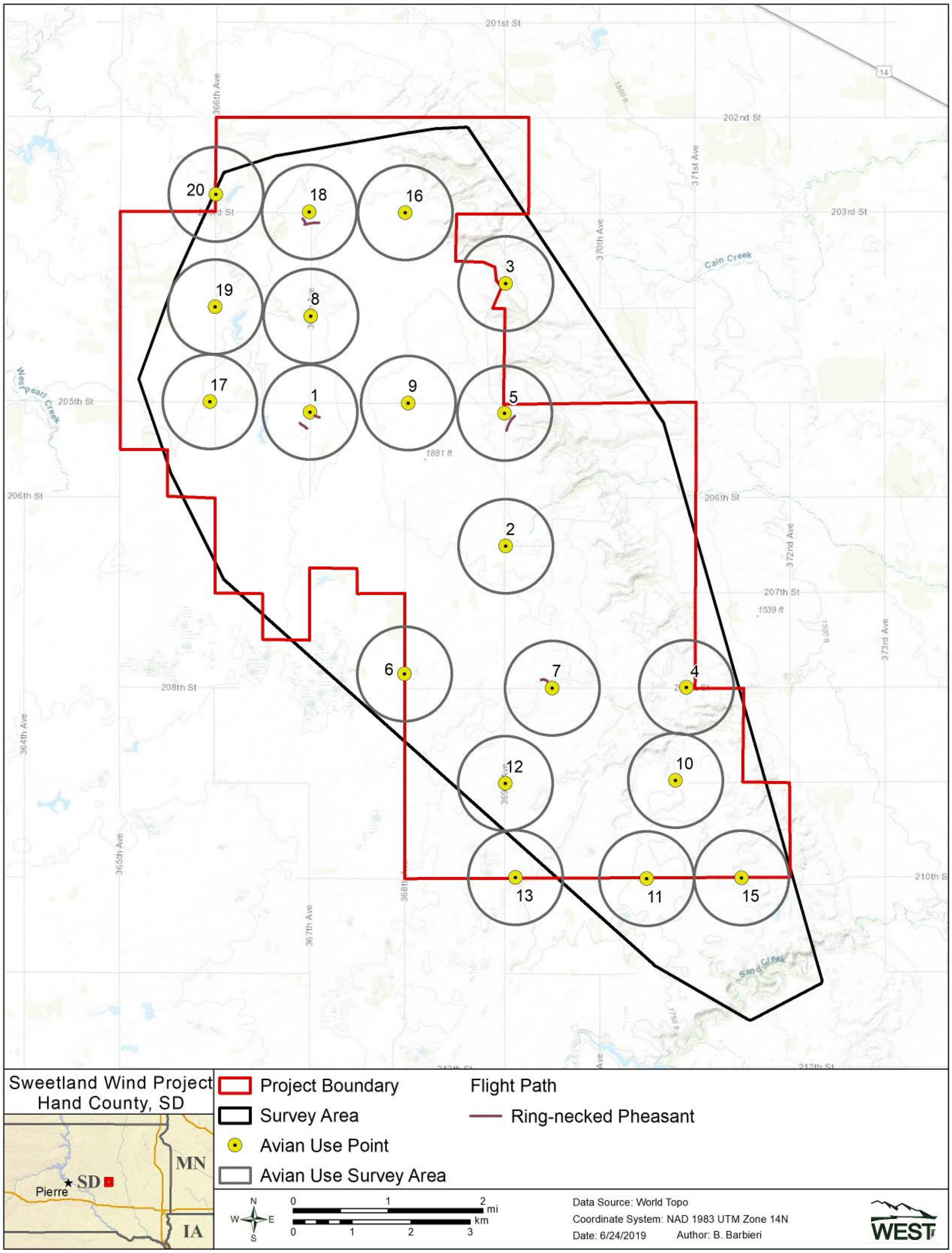
Appendix E (*continued*). Unidentified raptor flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



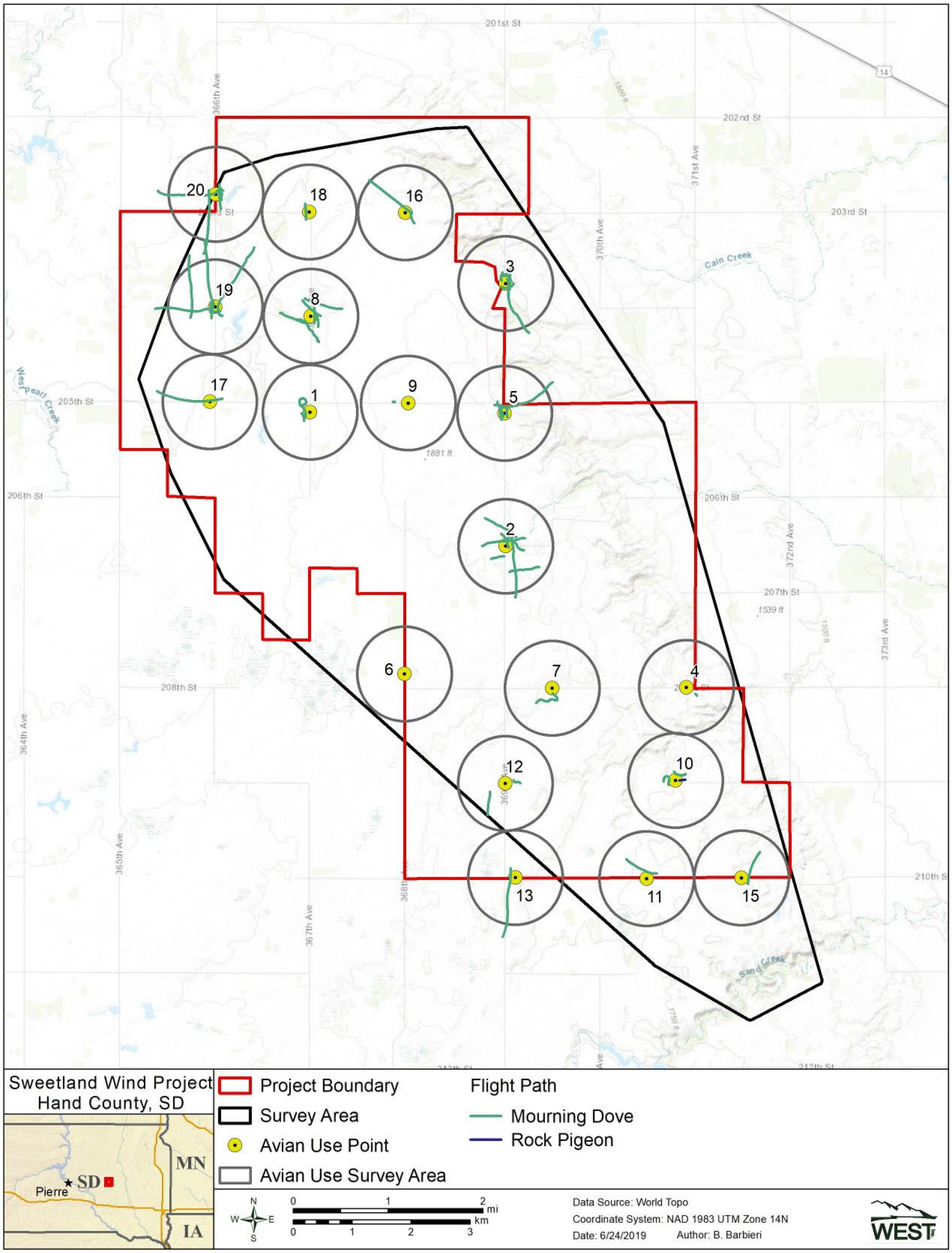
Appendix E (*continued*). Owl flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



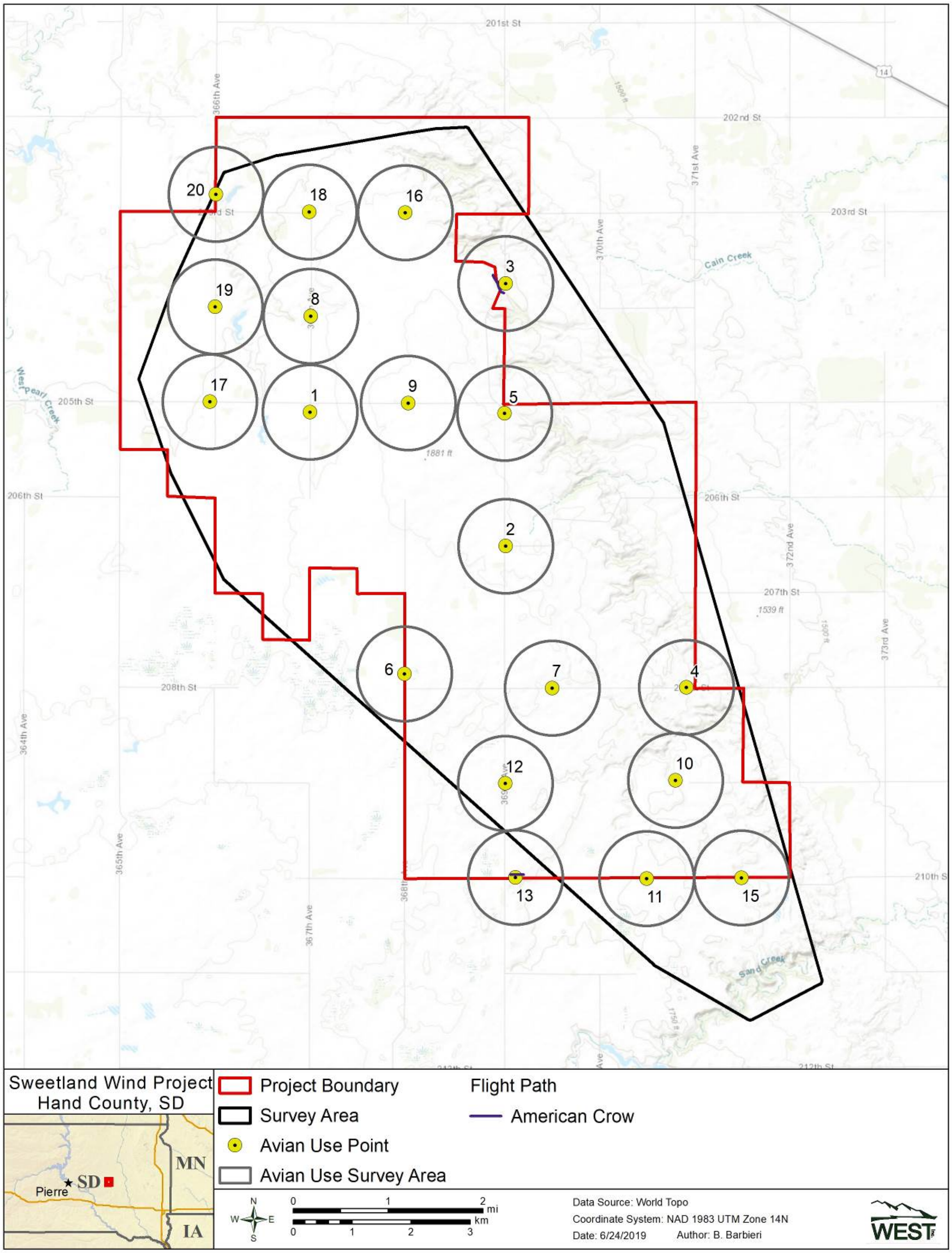
Appendix E (*continued*). Vulture flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



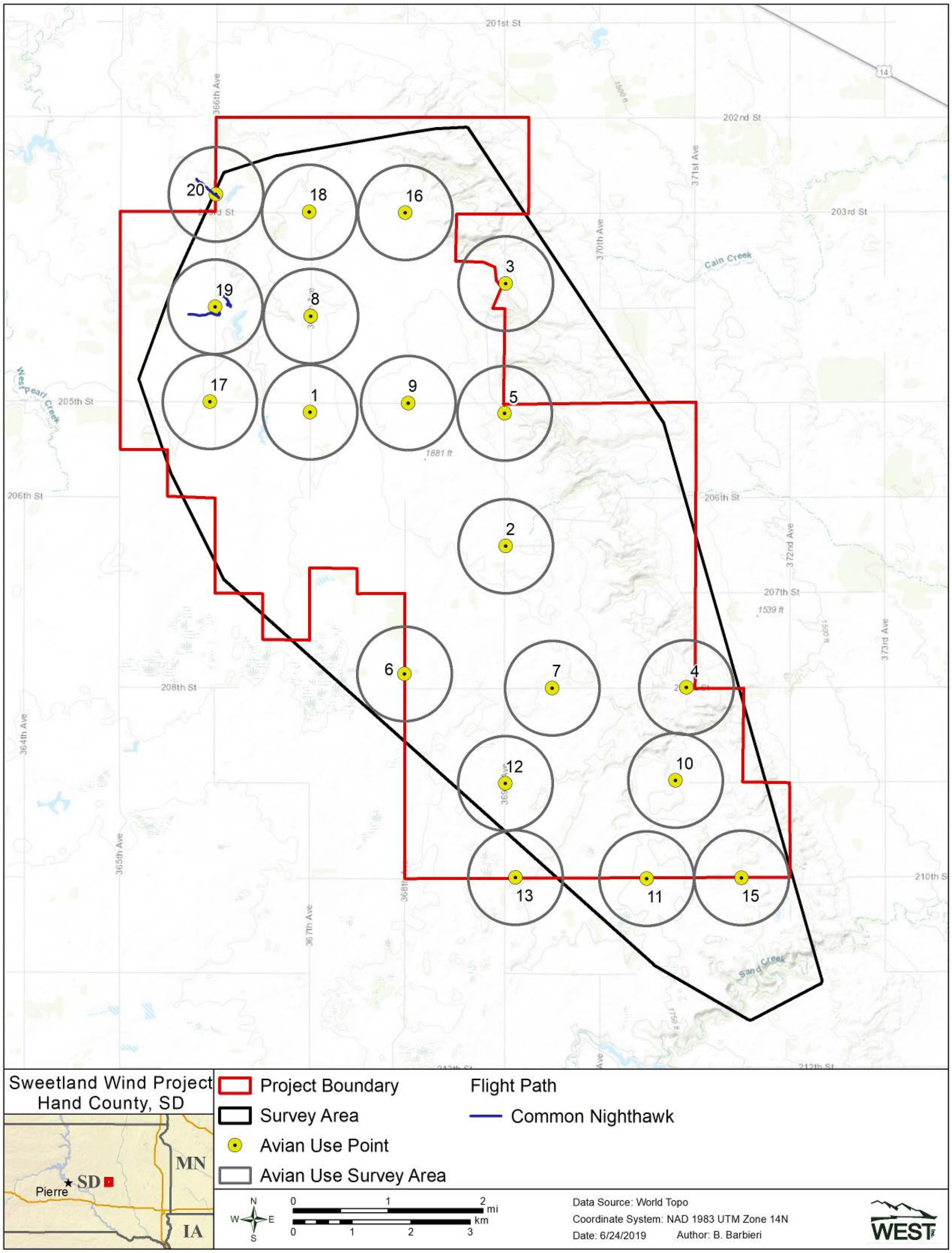
Appendix E (*continued*). Upland game bird flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



Appendix E (*continued*). Dove/pigeon flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



Appendix E (*continued*). Large corvid flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.



Appendix E (*continued*). Goatsucker flight paths recorded at the Sweetland Wind Energy Project from May 12, 2018 – April 31, 2019.

APPENDIX H – ACOUSTIC BAT SURVEYS

Bat Activity Studies for the
Sweetland Wind Energy Project
Hand County, South Dakota

Final Report

June 1 – October 15, 2017

Prepared for:

Sweetland Wind Farm, LLC

4865 Sterling Drive, Suite 200
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March 15, 2018

EXECUTIVE SUMMARY

In June 2017, Western EcoSystems Technology, Inc. initiated a bat acoustic survey for the proposed Sweetland Wind Energy Project (Project) in Hand County, South Dakota. The bat acoustic survey conducted at the Project was designed to estimate levels of bat activity throughout the Project during the summer and fall.

Acoustic surveys were conducted from June 1 to October 15, 2017, at a fixed, paired meteorological (met) tower station and at two temporary ground stations. All stations were located in grassland habitat generally representative of future turbine placement. Two fixed AnaBat® SD1 detectors were paired at the met tower, with one placed near ground level (1.5 meters [m; 5.0 feet (ft)] above ground level) and the other within the proposed rotor-swept height (45 m [148 ft]). A single AnaBat® SD1 detector was moved between the two temporary stations every two weeks during the study period.

The AnaBat unit at the fixed ground station recorded 100 bat passes on 137 detector nights for a mean (± standard error) of 0.73 ± 0.12 bat passes per detector night. The raised detector recorded 189 bat passes on 109 detector nights for a mean of 1.73 ± 0.29 per detector night. Bat pass rates were also higher at the raised detector when only comparing nights that the paired detectors were simultaneously operating. AnaBat units at temporary stations recorded 661 bat passes on 138 detector nights for a mean of 4.63 ± 0.54 bat passes per detector night.

At all stations, 55.7% of bat passes were classified as low frequency (e.g., big brown bats, hoary bats, and silver-haired bats), and 44.3% of bat passes were classified as high frequency (e.g., tri-colored bats, eastern red bats, and *Myotis* species). Hoary bats, eastern red bats, and silver-haired bats are the main casualties at other North American wind energy facilities, and it is expected these species will be the main bat casualties at the Project.

Bat activity at the fixed stations was similar between the summer and fall, peaking from August 20 – 26 (4.57 bat passes per detector night). This timing of high bat activity corresponds with the period of peak bat fatality at most wind-energy facilities and suggests most bat fatalities at the Project will occur during the late summer or early fall. The bat pass rate for the fixed ground detector during the standardized Fall Migration Period was 0.94 ± 0.19 bat passes per detector night. This activity rate was lower than the North American median (7.70 bat passes per detector night), and lower than all of the public studies from the Midwest region that have measured pre-construction bat activity and post-construction bat fatality. The Wessington Springs Wind Project, located 24 miles (mi; 38 kilometers [km]) southeast of the Project, and the Prairie Winds Wind Project, located 30 mi (48 km) south of the Project, are dominated by grassland habitat primarily used for cattle grazing and haying similar to the Project. The bat fatality rate at both projects was relatively low and decreased each year of operation, ranging from 0.41 – 1.48 bats per megawatt [MW] per year at Wessington Springs (Derby et al. 2010c, 2011a) and 0.52 – 1.23 bats/MW/year at Prairie Winds (Derby et al. 2012c, 2013a, 2014). Due to relatively low activity rates during the summer and fall at the Project, and due to the geographic proximity and habitat similarity of the Project with other active wind facilities in the

region, it is probable that bat mortality at the Project would be low and follow similar patterns as those observed at nearby facilities.

STUDY PARTICIPANTS

Western EcoSystems Technology

Chris Fritchman	Project Manager
Donald Solick	Bat Biologist
Larisa Bishop-Boros	Bat Biologist
Zoe Gustafson	Statistician
Jon Cicarelli	GIS Technician
Wendy Bruso	Technical Editing Manager
Katie Wynne	Technical Editing Coordinator and Technical Editor
Aaron Hoeing	Field Supervisor
Kaitlin Stair	Field Technician
Jen Sojka	Field Technician
Wendy Bragg	Field Technician

REPORT REFERENCE

Fritchman, C., D. Solick, and L. Bishop-Boros. 2017. Bat Activity Studies for the Sweetland Wind Energy Project, Hand County, South Dakota. Final Report: June 1 – October 15, 2017. Prepared for Sweetland Wind Farm, LLC, Boulder, Colorado. Prepared by Western EcoSystems Technology, Inc. (WEST), Fort Collins, Colorado. March 15, 2018.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Sweetland Wind Farm, LLC (Sweetland) is proposing to develop the Sweetland Wind Energy Project (Project) in Hand County, South Dakota. Sweetland contracted Western EcoSystems Technology, Inc. (WEST) to complete a study of bat activity following the recommendations of the US Fish and Wildlife Service (USFWS) *Land-Based Wind Energy Guidelines* (USFWS 2012a) and Kunz et al. (2007b). WEST conducted acoustic monitoring surveys to estimate levels of bat activity throughout the Project during the summer and fall. The following report describes the results of acoustic monitoring surveys conducted at the Project between June 1 and October 15, 2017.

STUDY AREA

The proposed Project is located in southeastern Hand County, South Dakota, southeast of the town of Miller, and southwest of Wessington. According to the US Geological Survey (USGS) National Land Cover Database, the Project is 56.2% herbaceous (grassland) land cover (Table 1, Figure 1). The next most common land cover types are hay or pastureland (21.2%) and cultivated crops (17.7%). The remaining 4.8% of the area includes developed open space, open water, deciduous forest, emergent herbaceous wetlands, developed low intensity, developed medium intensity, and developed high intensity (Table 1, Figure 1; USGS National Land Cover Database 2011, Homer et al. 2015).

Table 1. Land cover in the Sweetland Wind Energy Project according to the US Geological Survey National Land Cover Database (2011) and Homer et al. (2015).

Land Cover	Acres	% Composition
Grassland	9,349.39	56.2
Pasture/Hay	3,533.02	21.2
Crops	2,952.61	17.7
Developed Open Space	409.44	2.5
Open Water	228.59	1.4
Deciduous Forest	127.27	0.8
Emergent Wetlands	37.09	0.2
Developed Low Intensity	3.07	<0.1
Developed Medium Intensity	0.89	<0.1
Developed High Intensity	0.22	<0.1
Total	**16,641.59**	**100**

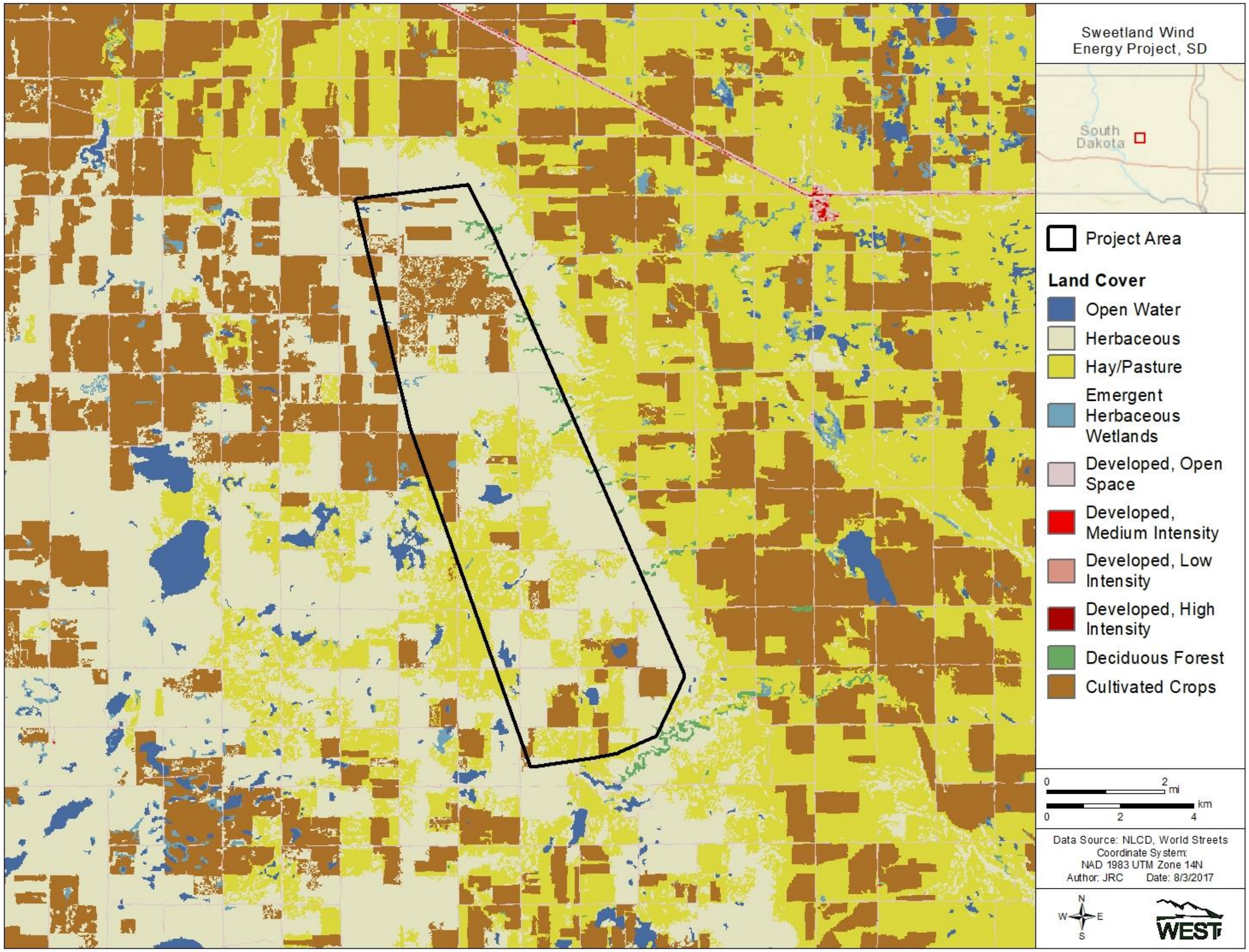

Figure 1. Land cover in the Sweetland Wind Energy Project (US Geological Survey National Land Cover Database 2011, Homer et al. 2015).

Overview of Bat Diversity

Seven species of bats potentially occur at the Project (Table 2). The northern long-eared bat (*Myotis septentrionalis*) is federally listed as threatened (USFWS 2016). None of the other species are considered sensitive in South Dakota. All of the species except for western small – footed bat (*Myotis ciliolabrum*) have been found as fatalities at wind-energy facilities (Table 2).

Table 2. Bat species with potential to occur within the Sweetland Wind Energy Project (US Fish and Wildlife Service (USFWS) 2016; International Union for Conservation of Nature 2017) categorized by echolocation call frequency.

Common Name	Scientific Name
High Frequency (>30 kHz)	
eastern red bat[1,3]	*Lasiurus borealis*
western small-footed bat	*Myotis ciliolabrum*
little brown bat[1]	*Myotis lucifugus*
northern long-eared bat[1,2]	*Myotis septentrionalis*
Low Frequency (≤30 kHz)	
big brown bat[1]	*Eptesicus fuscus*
silver-haired bat[1,3]	*Lasionycteris noctivagans*
hoary bat[1,3]	*Lasiurus cinereus*

[1] species known to have been killed at wind energy facilities;

[2] federally threatened species (USFWS 2016); and

[3] long-distance migrant.

Note: kHz = kilohertz

METHODS

Bat Acoustic Surveys

WEST conducted acoustic monitoring studies to estimate levels of bat activity throughout the Project during the study period. Although it remains unclear whether baseline acoustic data are able to adequately predict post-construction fatality (Hein et al. 2013a), ultrasonic detectors do collect information on the spatial distribution, timing, and species composition that can provide insights into the possible impacts of wind development on bats (Kunz et al. 2007a; Britzke et al. 2013) and inform potential mitigation strategies (Weller and Baldwin 2012).

Survey Stations

Three AnaBat SD1 ultrasonic bat detectors (Titley™ Scientific, Columbia, Missouri) were used during the study. Two of the detectors were paired at a meteorological (met) tower with one detector at ground level (approximately 1.5 meters [m; 5.0 feet (ft)] above ground level [AGL]) and another within the approximate rotor-swept zone (approximately 45 m [148 ft] AGL; Figure 2). Species activity levels and composition can vary with altitude (Baerwald and Barclay 2009; Collins and Jones 2009; Müeller et al. 2013). Therefore, it can be useful to monitor activity at different heights (Kunz et al. 2007a). Ground-based detectors likely detect a more complete sample of the bat species present within the Project, whereas elevated detectors may give a more accurate assessment of risk to bat species flying at rotor swept heights (Kunz et al. 2007a; Müeller et al. 2013; but see Amorim et al. 2012). The third detector was placed at two temporary acoustic monitoring stations to enhance spatial coverage of the Project. All stations were located in grassland habitat, which is the dominant land cover type (Table 1) and is representative of potential turbine locations.

Each AnaBat unit was placed inside a plastic weather-tight container that had a hole cut in the side through which the microphone extended. Each microphone was encased in a 45-degree angle poly-vinyl chloride (PVC) tube, and holes were drilled in the PVC tube to allow water to drain. The raised AnaBat microphone was elevated on the met tower using a pulley system. Standard Bat-Hat weatherproof housing was modified to use a 45-degree angle PVC elbow.

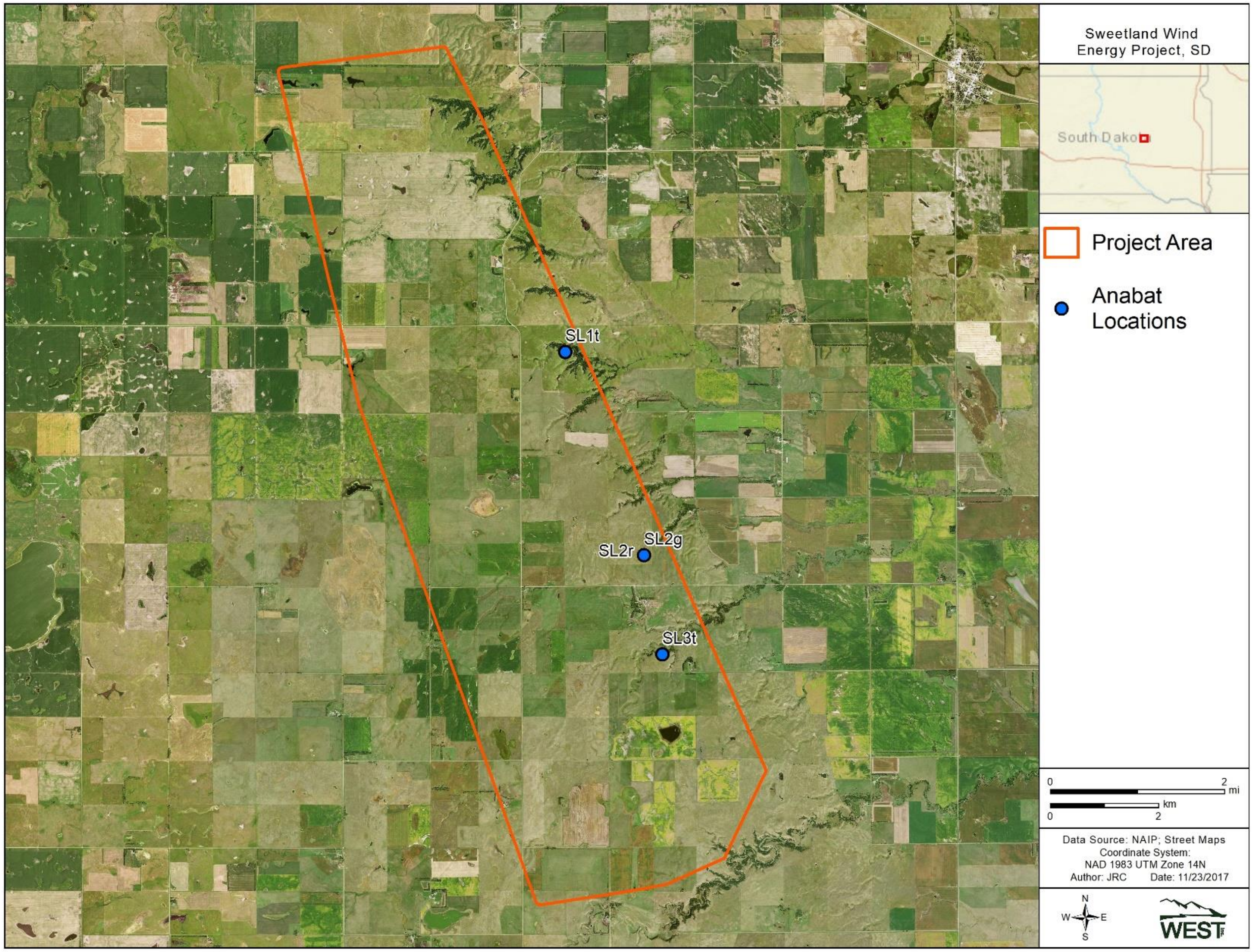

Figure 2. Location of fixed and temporary AnaBat stations in the Sweetland Wind Energy Project.

Survey Schedule

Bats were surveyed in the Project from June 1 to October 15, 2017, and detectors were programmed to turn on approximately 30 minutes (min) before sunset and turn off approximately 30 min after sunrise each night. To highlight seasonal activity patterns, the study was divided into two survey periods: summer (June 1 – August 14), and fall (August 15 – October 15). Mean bat activity was also calculated for a standardized Fall Migration Period (FMP), defined here as July 30 – October 14. The FMP was defined by WEST as a standard for comparison with activity from other wind energy facilities. During this time bats begin moving toward wintering areas, and many species of bats initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (Arnett et al. 2008; Arnett and Baerwald 2013).

Data Collection and Call Analysis

AnaBat detectors use a broadband high-frequency microphone to detect the echolocation calls of bats. Incoming echolocation calls are digitally processed and stored on a high capacity compact flash card. The resulting files can be viewed in appropriate software (e.g., Analook©) as digital sonograms that show changes in echolocation call frequency over time. Frequency versus time displays were used to separate bat calls from other types of ultrasonic noise (e.g., wind, insects, etc.), to determine the call frequency category and, when identifiable, the species of bat that generated the calls.

To standardize acoustic sampling effort across the Project, AnaBat units were calibrated and sensitivity levels were set to six (Larson and Hayes 2000), a level that balanced the goal of recording bat calls against the need to reduce interference from other sources of ultrasonic noise (Brooks and Ford 2005).

For each survey location, bat passes were sorted into two groups based on their minimum frequency. High-frequency (HF) bats such as eastern red bats (*Lasiurus borealis*), and *Myotis* species have minimum frequencies greater than 30 kilohertz (kHz). Low frequency (LF) bats such as big brown bats (*Eptesicus fuscus*), silver-haired bats (*Lasionycteris noctivagans*), and hoary bats (*Lasiurus cinereus*) typically emit echolocation calls with minimum frequencies equal to or below 30 kHz. HF and LF species that may occur in the study area are listed in Table 2.

Statistical Analysis

The standard metric used for measuring bat activity is the number of bat passes per detector night, and this metric was used as an index of bat activity in the Project. A bat pass was defined as a sequence of at least two echolocation calls (pulses) produced by an individual bat with no pause between calls of more than one second (Fenton 1980). A detector night was defined as one detector operating for one entire night. The terms bat pass and bat call are used interchangeably. The number of bat passes per detector night was calculated for all bats, and for HF and LF bats. Bat pass rates represent indices of bat activity and do not represent numbers of individuals. The number of bat passes was determined by an experienced bat biologist using Analook.

The period of peak sustained bat activity was defined as the 7-day period with the highest average bat activity. If multiple 7-day periods equaled the peak sustained bat activity rate, all dates in these 7-day periods were reported. This and all multi-detector averages in this report were calculated as an unweighted average of total activity at each detector. Temporary stations were not sampled on a continuous basis throughout the survey period and were therefore excluded from temporal analyses.

Risk Assessment

To assess potential for bat fatalities, bat activity in the Project was compared to existing data at other wind energy facilities in the Midwest. Among studies measuring both activity and fatality rates, most data were collected during the fall using Anabat detectors placed near the ground. Therefore, to make valid comparisons to the publicly available data, this report uses the activity rate recorded at fixed, ground detectors during the FMP as a standard for comparison with activity data from other wind energy facilities. Given the relatively small number of publicly available studies and the significant ecological differences between geographically dispersed facilities, the risk assessment is qualitative, rather than quantitative.

RESULTS

Bat Acoustic Surveys

Bat activity was monitored at four sampling locations for a total of 384 detector nights between June 1 and October 15, 2017. AnaBat units were operating for 93.4% of the sampling period (Figure 3). Overall, the average bat pass rate (± standard error) was 2.93 ± 0.30 bat passes per detector night (Table 3).

Table 3. Results of acoustic bat surveys conducted at fixed and temporary stations within the Sweetland Wind Energy Project between June 1 and October 15, 2017. Passes are separated by call frequency: high frequency (HF) and low frequency (LF).

Anabat Station	Location	Type	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Night***
SL1t	Ground	temporary	255	255	510	74	6.89 ± 1.09
SL2g	Ground	fixed	35	65	100	137	0.73 ± 0.12
SL2r	Raised	fixed	62	127	189	109	1.73 ± 0.29
SL3t	Ground	temporary	69	82	151	64	2.36 ± 0.34
Total Fixed			**97**	**192**	**289**	**246**	**1.23 ± 0.17**
Total Temporary			**324**	**337**	**661**	**138**	**4.63 ± 0.54**
Total			**421**	**529**	**950**	**384**	**2.93 ± 0.30**

*** ± bootstrapped standard error.

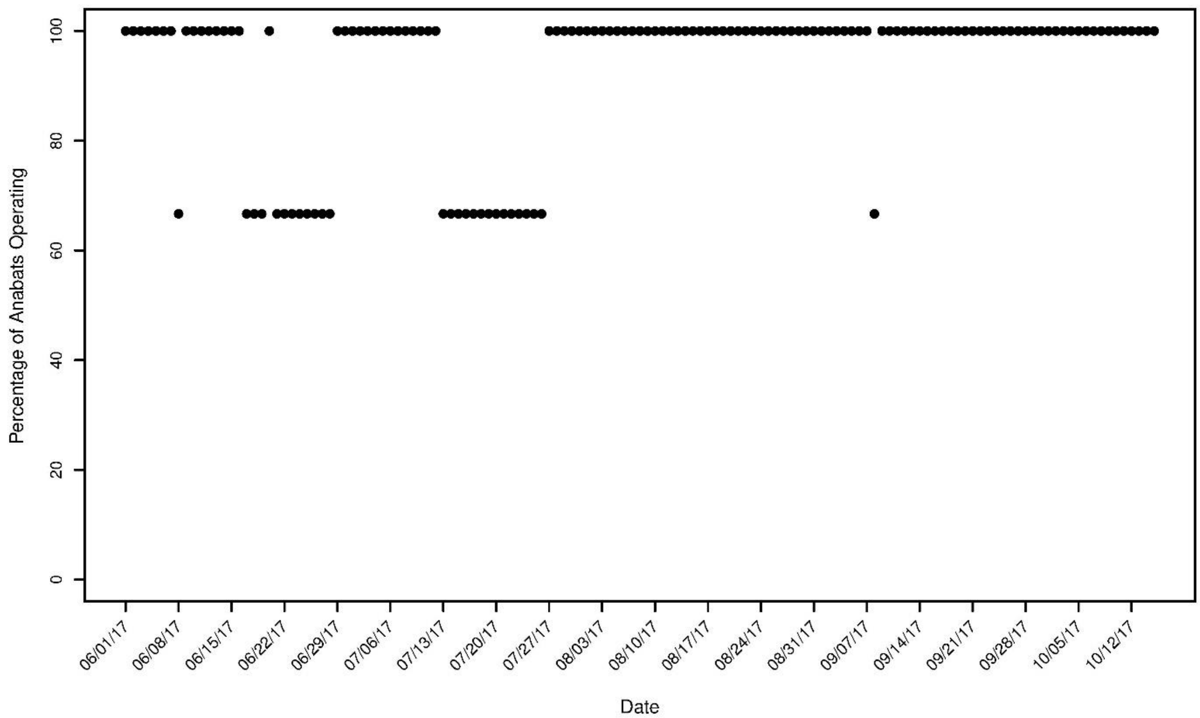

Figure 3. Operational status of bat detectors (n = 4) operating at the Sweetland Wind Energy Project during each night of the study period June 1 to October 15, 2017.

Spatial Variation

Overall, bat activity in the Project was higher at the temporary stations than at the fixed stations (Figures 4 and 5; Table 3). The AnaBat unit at the fixed ground station recorded 100 bat passes on 137 detector nights for a mean of 0.73 ± 0.12 bat passes per detector night. The raised detector recorded 189 bat passes on 109 detector nights for a mean of 1.73 ± 0.29 per detector night (Table 3). For the nights that the paired detectors were simultaneously operating (n = 109; Figure 5), bat pass rates were also higher at the raised station. AnaBat units at temporary stations recorded 661 bat passes on 138 detector nights for a mean of 4.63 ± 0.54 bat passes per detector night (Table 3).

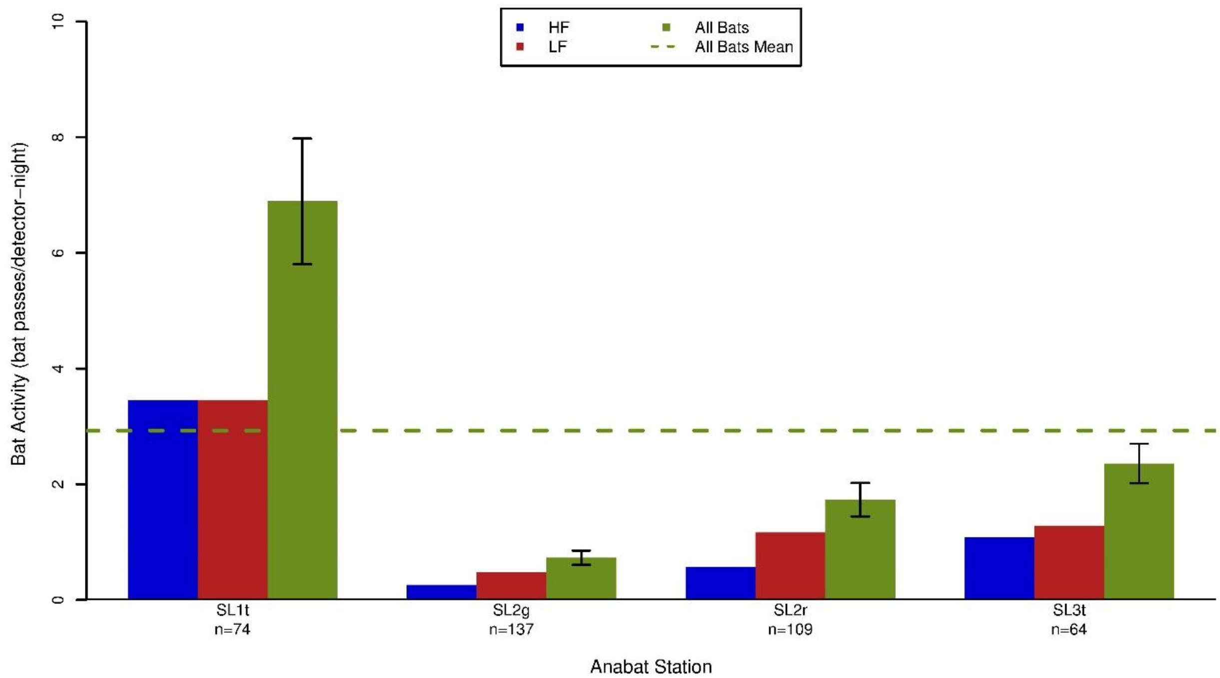

Figure 4. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector night recorded at AnaBat stations in the Sweetland Wind Energy Project between June 1 and October 15, 2017. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

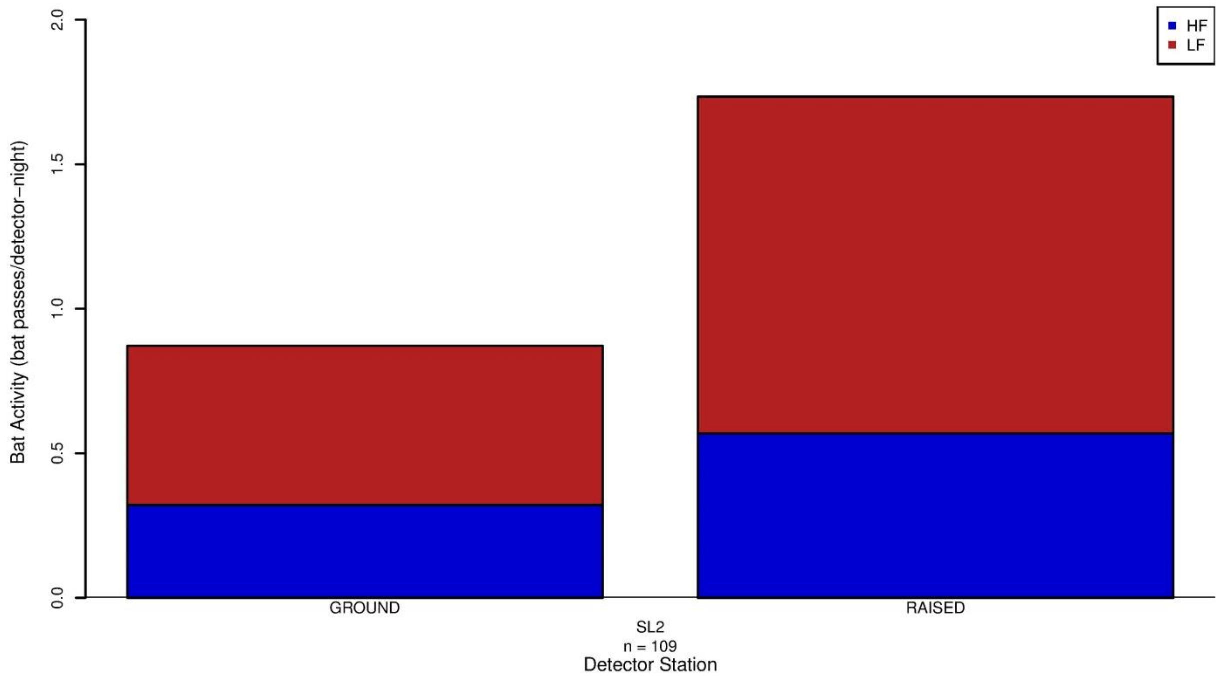

Figure 5. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector night recorded at the paired AnaBat stations in the Sweetland Wind Energy Project between June 1 and October 15, 2017.

Temporal Variation

Overall bat activity at fixed stations was relatively low throughout the study period, but was slightly higher in the summer (1.38 ± 0.21 bat passes per detector-night) than in the fall (1.17 ± 0.28 bat passes per detector-night; Table 4, Figure 6). Bat activity at the ground station was slightly higher in the fall whereas bat activity at the raised stations was slightly higher in the summer. The bat pass rate for the fixed ground detector during the standardized FMP was 0.94 ± 0.19 bat passes per detector night (Table 4). Weekly acoustic activity at fixed stations was highest in July and August (Figure 7), peaking from August 20 to 26 (4.57 bat passes per detector night; Table 5, Figure 7). Bat activity gradually decreased for the remainder of the study period (Figure 7).

At paired stations (Figure 8), weekly activity was higher at the raised detector for most of the study period with the exception of early July and mid-September through early October.

Table 4. The number of bat passes per detector night recorded at fixed stations in the Sweetland Wind Energy Project during each season in 2017, separated by call frequency: high frequency (HF), low frequency (LF), and all bats (AB).

Station	Call Frequency	Summer Jun 1 – Aug 14	Fall Aug 15 – Oct 15	Fall Migration Period Jul 30 – Oct 14
SL2g	LF	0.29	0.69	0.6
	HF	0.23	0.29	0.34
	AB	0.52	0.98	0.94
SL2r	LF	1.26	1.1	1.21
	HF	0.98	0.26	0.53
	AB	2.23	1.35	1.74
Ground Totals	**LF**	**0.29 ± 0.08**	**0.69 ± 0.20**	**0.60 ± 0.16**
	HF	**0.23 ± 0.07**	**0.29 ± 0.09**	**0.34 ± 0.08**
	AB	**0.52 ± 0.12**	**0.98 ± 0.22**	**0.94 ± 0.19**
Raised Totals	**LF**	**1.26 ± 0.23**	**1.10 ± 0.37**	**1.21 ± 0.31**
	HF	**0.98 ± 0.19**	**0.26 ± 0.09**	**0.53 ± 0.11**
	AB	**2.23 ± 0.38**	**1.35 ± 0.42**	**1.74 ± 0.38**
Overall	**LF**	**0.77 ± 0.14**	**0.90 ± 0.25**	**0.90 ± 0.21**
	HF	**0.60 ± 0.10**	**0.27 ± 0.06**	**0.44 ± 0.08**
	AB	**1.38 ± 0.21**	**1.17 ± 0.28**	**1.34 ± 0.24**

Table 5. Periods of peak activity for high frequency (HF), low frequency (LF), and all bats at fixed stations in the Sweetland Wind Energy Project between June 1 and October 15, 2017.

Species Group	Start Date of Peak Activity	End Date of Peak Activity	Bat Passes per Detector Night
HF	August 6	August 12	1.29
LF	August 20	August 26	3.79
All Bats	August 20	August 26	4.57

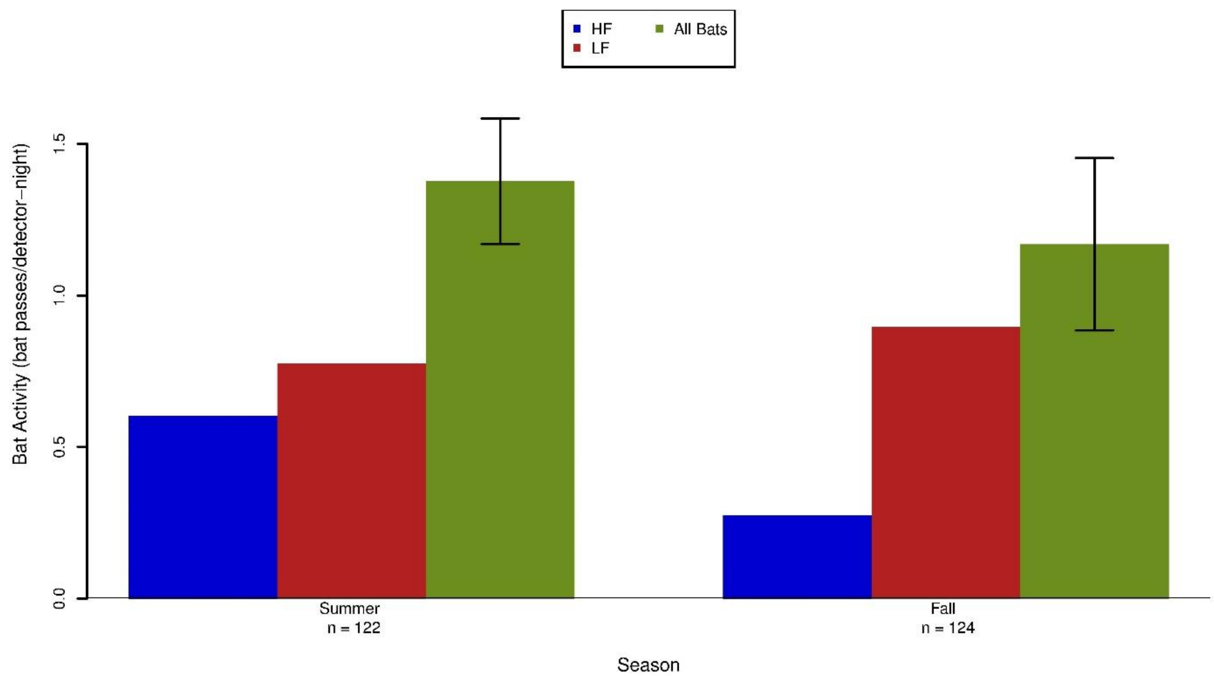

Figure 6. Seasonal bat activity by high frequency (HF), low frequency (LF), and all bats at fixed stations in the Sweetland Wind Energy Project between June 1 and October 15, 2017. The bootstrapped standard errors are represented on the 'All Bats' columns.

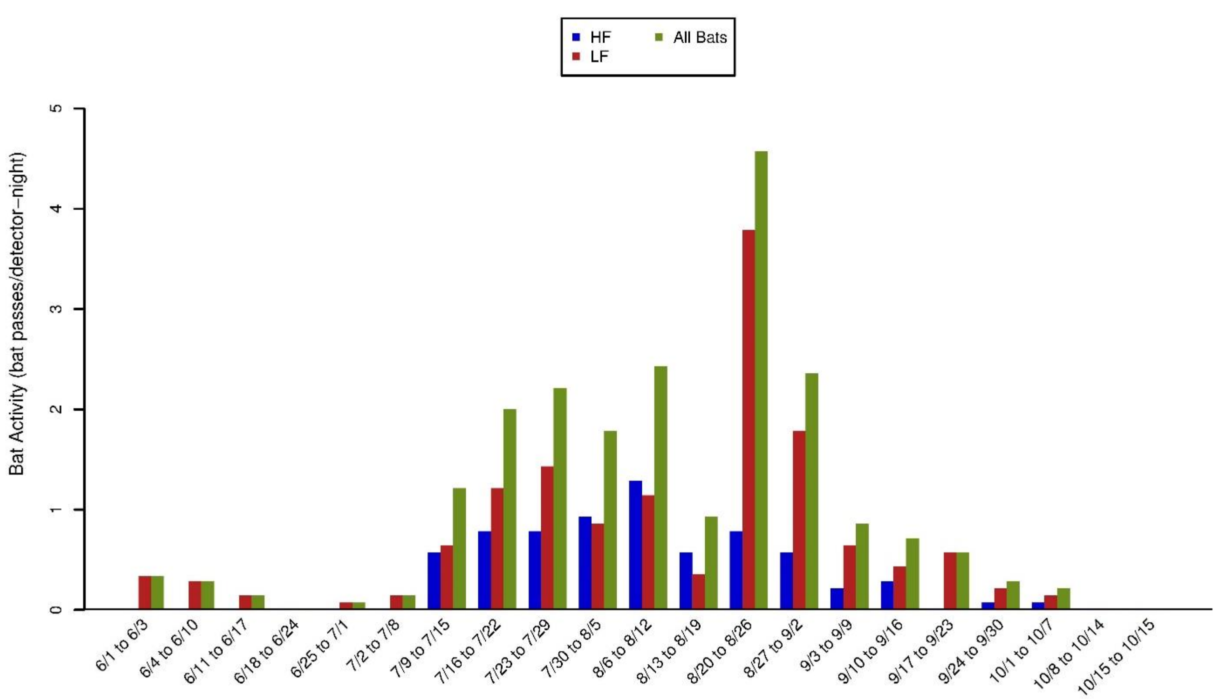

Figure 7. Weekly patterns of bat activity by high frequency (HF), low frequency (LF), and all bats at fixed stations in the Sweetland Wind Energy Project between June 1 and October 15, 2017.

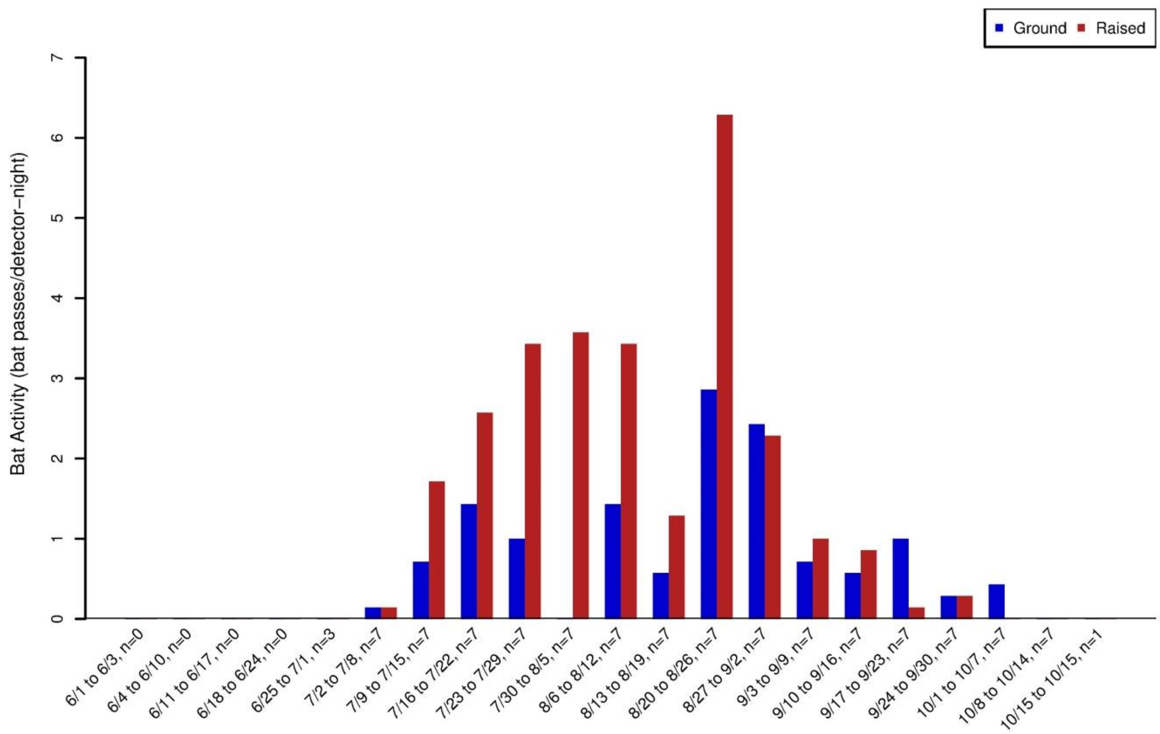

Figure 8. Weekly patterns of bat activity from June 1 to October 15, 2017, at ground and raised fixed stations at the Sweetland Wind Energy Project.

Species Composition

At all stations, 55.7% of bat passes were classified as LF, and 44.3% of bat passes were classified as HF (Tables 2 and 3). However, the proportion of LF and HF bats differed across station types. At the fixed ground and raised stations, LF and HF bat passes composed 66.4 and 33.6% of all bat passes, respectively (Table 3). At the temporary stations, 51.0% of bat passes were made by LF bats, while 49.0% were made by HF bats (Table 3).

DISCUSSION

Bat fatalities have been discovered at most wind energy facilities monitored in North America, ranging from zero (Chatfield and Bay 2014) to 40.2 bat fatalities per megawatt (MW) per year (Hein et al. 2013a; Appendix A). In 2012, an estimated 600,000 bats died as a result of interactions with wind turbines in the US (Hayes 2013). Proximate causes of bat fatalities are primarily due to collisions with moving turbine blades (Grodsky et al. 2011; Rollins et al. 2012) but to a limited extent may also be caused by barotrauma (Baerwald et al. 2008). The underlying reasons for why bats come near turbines are still largely unknown (Cryan and Barclay 2009). To date, post-construction monitoring studies of wind energy facilities show that migratory tree-roosting species (e.g., eastern red bat, hoary bat, and silver-haired bat) compose approximately 78% of reported bat fatalities; the majority of fatalities occur during the fall migration season (August and September); and most fatalities occur on nights with relatively low wind speeds (e.g., less than 6.0 meters per second; Arnett et al. 2008; Arnett and Baerwald 2013; Arnett et al. 2013a).

It is generally expected that pre-construction bat activity should be positively related to post-construction bat fatalities (Kunz et al. 2007a). However, to date, few studies of wind energy facilities have recorded both pre-construction bat passes per detector night and post-construction bat fatality rates (Appendix A). Given the limited availability of pre- and post-construction data sets, differences in protocols among studies (Ellison 2012), and significant ecological differences between geographically diverse facilities, the relationship between activity and fatalities has not yet been empirically established, though Baerwald and Barclay (2009) found a significant positive association between pass rates measured at 30 m and fatality rates for hoary and silver-haired bats across five sites in southern Alberta.

However, on a continental scale, a similar relationship has proven difficult to establish. The relatively few studies that have estimated both pre-construction activity and post-construction fatalities trend toward a positive association between activity and fatality rates, but they lack statistically significant correlations. Hein et al. (2013b) compiled data from wind projects that included both pre- and post-construction data from the same projects, as well as pre- and post-construction data from facilities within the same regions to assess if pre-construction acoustic activity predicted post-construction fatality rates. Based on data from 12 sites that had both pre- and post-construction data, they did not find a statistically significant relationship ($p=0.07$), although the trend was in the expected direction (i.e., low activity was generally associated with low fatalities and vice-versa). They concluded that pre-construction acoustic data could not currently predict bat fatalities, but acknowledged that the data set was limited and additional data may indicate a stronger relationship. Therefore, the current approach to assessing the risk to bats requires a qualitative analysis of activity levels, spatial and temporal relationships, species composition, and comparison to regional fatality patterns.

Mean bat activity during the FMP at fixed ground detectors (0.94 bat passes per detector night; Table 4) was lower than the North American median (7.7) and the majority of studies available from the Midwest region (Appendix A). Given the low bat pass rate, and that over two-thirds of bat fatality studies in the Midwest report fewer than five bat fatalities/MW/year (Appendix A; Figure 9), it is possible that similar fatality rates could be recorded at the Project.

On average, bat activity was four times higher at the temporary stations than at the fixed ground stations although this was primarily driven by station SL1t. All stations were in similar grassland habitat, and grassland is the dominant habitat type at the Project, so these data likely represent the range of bat activity across the Project. Some research suggests that bat activity in the rotor-swept zone may be more representative of bat exposure to turbines (Baerwald and Barclay 2009). At fixed stations in the Project, bat activity recorded by the raised detector (1.73 bat passes per detector night) was higher than activity recorded by the ground detector (0.73 bat passes per detector night). On nights that both detectors were operating, the raised detector also recorded more bat activity than the ground detector (Figure 5).

Approximately 56% of bat passes recorded in the Project were emitted by LF bats, suggesting a similar abundance of species such as big brown bats, silver-haired bats, and hoary bats (Table 3). LF species may become casualties because they fly at higher altitudes, as demonstrated by their greater prevalence at raised detectors (Table 3, Figure 5). Activity by HF bat species composed 44% of bat passes recorded at stations in the Project. Eastern red bats are usually the most common HF species found during carcass searches (Arnett et al. 2008; Arnett and Baerwald 2013). *Myotis* species are recorded less commonly than other species in the rotor-swept zone or as fatalities at most post-construction studies of wind energy facilities (Kunz et al. 2007a; Arnett et al. 2008), with a few notable exceptions (Kerns and Kerlinger 2004b; Jain 2005; Brown and Hamilton 2006; Gruver et al. 2009). Given that hoary bats, eastern red bats, and silver-haired bats are among the most common bat fatalities at many facilities (Arnett et al. 2008; Arnett and Baerwald 2013), it is expected that these three species would be the most common fatalities at the Project.

At fixed stations bat activity peaked during late August. This timing is consistent with peak fatality periods for most wind energy facilities in the US, and suggests that bat fatalities at the Project will be highest during late summer to early fall and may consist largely of migrating individuals. The Wessington Springs Wind Project (Wessington Springs), located approximately 24 miles (38 kilometers) southeast of the Project and the Prairie Winds Wind Project, located 30 mi (48 km) south of the Project, are dominated by grassland habitat primarily used for cattle grazing and haying with some patches of deciduous trees and open waterbodies available similar to the Project. Due to relatively low activity rates during the summer and fall at the Project, and due to the geographic proximity and habitat similarity of the Project to Wessington Springs and Prairie Winds, it is probable that bat mortality at the Project would be low and follow similar patterns as those observed at other facilities within the region (e.g., 0.41 – 1.48 bat fatalities/MW/year [Derby et al. 2010c, Derby et al. 2011a], 0.52 – 1.23 bats/MW/year [Derby et al. 2012c, 2013a, 2014]). The pre-construction bat studies completed at the Project will add to the growing body of research regarding the impacts of wind energy development on bats and will provide a valuable comparison to post-construction studies to be completed at Project.

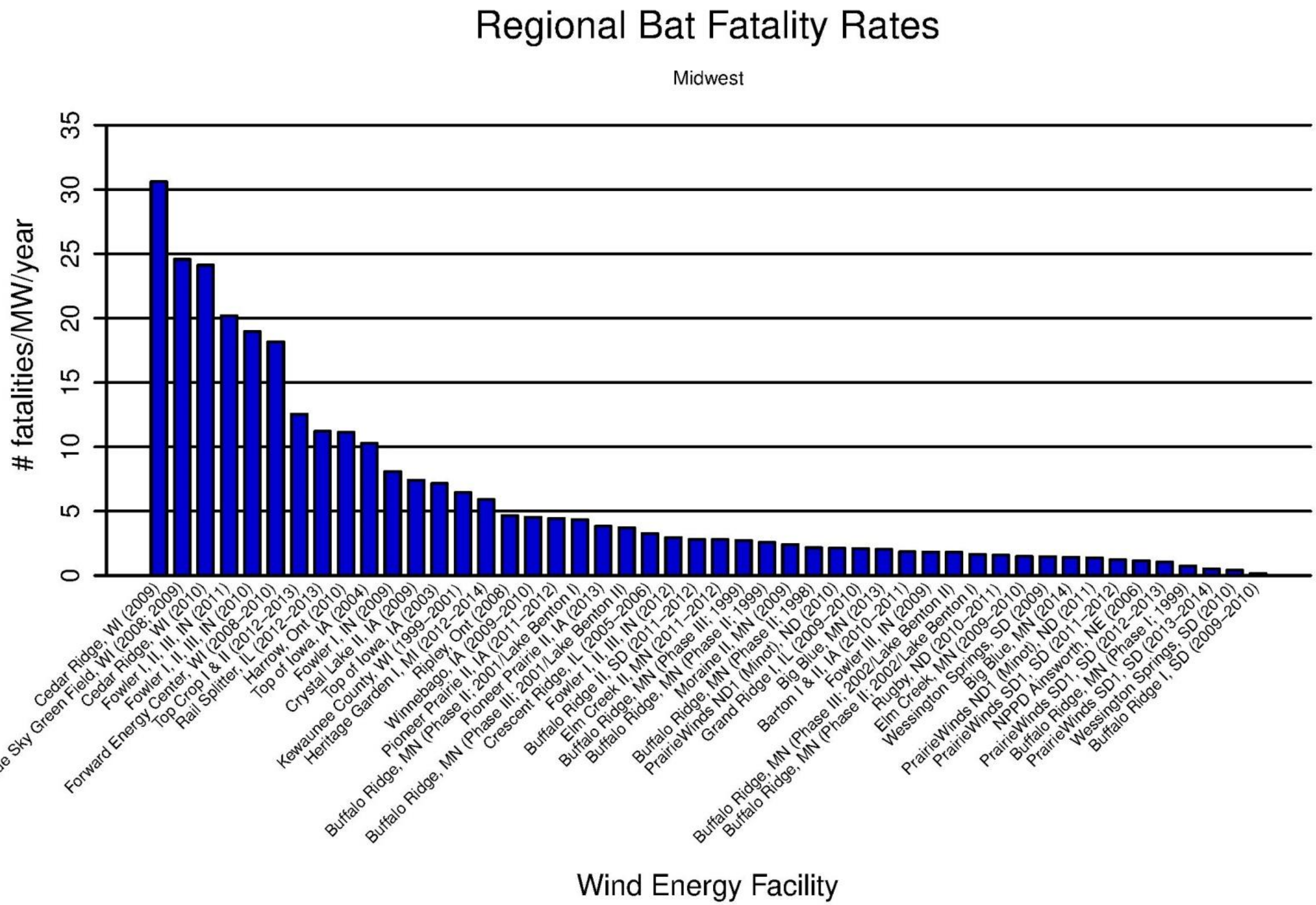

Figure 9. Fatality rates for bats (number of bats per megawatt per year) from publicly available wind energy facilities in the Midwest region of North America.

Figure 9. Fatality rates for bats (number of bats per megawatt per year) from publicly available wind energy facilities in the Midwest region of North America.

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Cedar Ridge, WI (09)	BHE Environmental 2010	Pioneer Prairie II, IA (11-12)	Chodachek et al. 2012	Fowler III, IN (09)	Johnson et al. 2010b
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004
Cedar Ridge, WI (10)	BHE Environmental 2011	Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003a	Milford I & II, UT (11-12)	Stantec 2012b
Fowler I, II, III, IN (11)	Good et al. 2012	Pioneer Prairie II, IA (13)	Chodachek et al. 2014	Dry Lake II, AZ (11-12)	Thompson and Bay 2012
Fowler I, II, III, IN (10)	Good et al. 2011	Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004
Forward Energy Center, WI (08-10)	Grodsky and Drake 2011	Dry Lake I, AZ (09-10)	Thompson et al. 2011	Rugby, ND (10-11)	Derby et al. 2011c
Top Crop I & II (12-13)	Good et al. 2013c	Crescent Ridge, IL (05-06)	Kerlinger et al. 2007	Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003a, 2003b
Summerview, Alb (06; 07)	Baerwald 2008	Judith Gap, MT (09)	Poulton and Erickson 2010	Elm Creek, MN (09-10)	Derby et al. 2010e
Rail Splitter, IL (12-13)	Good et al. 2013b	Fowler I, II, III, IN (12)	Good et al. 2013a	Wessington Springs, SD (09)	Derby et al. 2010c
Harrow, Ont (10)	NRSI 2011	Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Big Blue, MN (14)	Fagen Engineering 2015
Summerview, Alb (05-06)	Brown and Hamilton 2006	Elm Creek II, MN (11-12)	Derby et al. 2012b	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012d
Top of Iowa, IA (04)	Jain 2005	Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000	PrairieWinds SD1, SD (11-12)	Derby et al. 2012c
Judith Gap, MT (06-07)	TRC 2008	Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	NPPD Ainsworth, NE (06)	Derby et al. 2007
Fowler I, IN (09)	Johnson et al. 2010a	Moraine II, MN (09)	Derby et al. 2010f	Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003a, 2003b
Crystal Lake II, IA (09)	Derby et al. 2010b	Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000	PrairieWinds SD1, SD (12-13)	Derby et al. 2013a
Top of Iowa, IA (03)	Jain 2005	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011d	Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000
Kewaunee County, WI (99-01)	Howe et al. 2002	Grand Ridge I, IL (09-10)	Derby et al. 2010a	PrairieWinds SD1, SD (13-14)	Derby et al. 2014
Heritage Garden I, MI (12-14)	Kerlinger et al. 2014	Milford I, UT (10-11)	Stantec 2011b	Wessington Springs, SD (10)	Derby et al. 2011a
Ripley, Ont (08)	Jacques Whitford 2009	Big Blue, MN (13)	Fagen Engineering 2014	Buffalo Ridge I, SD (09-10)	Derby et al. 2010d
Winnebago, IA (09-10)	Derby et al. 2010g	Barton I & II, IA (10-11)	Derby et al. 2011b		

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Appendix A: North American Fatality Summary Tables

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as bat passes per detector night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Sweetland, SD	0.94	7/30/17 – 10/14/17			
Midwest					
Cedar Ridge, WI (2009)	9.97[A,B,C,D]	7/16/07-9/30/07	30.61	41	67.6
Blue Sky Green Field, WI (2008; 2009)	7.7[A]	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	9.97[A,B,C,D]	7/16/07-9/30/07	24.12	41	68
Fowler I, II, III, IN (2011)	NA	NA	20.19	355	600
Fowler I, II, III, IN (2010)	NA	NA	18.96	355	600
Forward Energy Center, WI (2008-2010)	6.97	8/5/08-11/08/08	18.17	86	129
Top Crop I & II, IL (2012-2013)	NA	NA	12.55	200 (68 Phase I, 132 Phase II)	300 (102 Phase I, 198 Phase II)
Rail Splitter, IL (2012-2013)	NA	NA	11.21	67	100.5
Harrow, Ont (2010)	NA	NA	11.13	24 (four 6-turbine facilities)	39.6
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Fowler I, IN (2009)	NA	NA	8.09	162	301
Crystal Lake II, IA (2009)	NA	NA	7.42	80	200
Top of Iowa, IA (2003)	NA	NA	7.16	89	80
Kewaunee County, WI (1999-2001)	NA	NA	6.45	31	20.46
Heritage Garden I, MI (2012-2014)	NA	NA	5.9	14	28
Ripley, Ont (2008)	NA	NA	4.67	38	76
Winnebago, IA (2009-2010)	NA	NA	4.54	10	20
Pioneer Prairie II, IA (2011-2012)	NA	NA	4.43	62	102.3
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2[B]	6/15/01-9/15/01	4.35	143	107.25
Pioneer Prairie II, IA (2013)	NA	NA	3.83	62	102.3
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2[B]	6/15/01-9/15/01	3.71	138	103.5
Crescent Ridge, IL (2005-2006)	NA	NA	3.27	33	49.5
Fowler I, II, III, IN (2012)	NA	NA	2.96	355	600
Elm Creek II, MN (2011-2012)	NA	NA	2.81	62	148.8
Buffalo Ridge II, SD (2011-2012)	NA	NA	2.81	105	210
Buffalo Ridge, MN (Phase III; 1999)	NA	NA	2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)	NA	NA	2.59	143	107.25
Moraine II, MN (2009)	NA	NA	2.42	33	49.5
Buffalo Ridge, MN (Phase II; 1998)	NA	NA	2.16	143	107.25
PrairieWinds ND1 (Minot), ND (2010)	NA	NA	2.13	80	115.5
Grand Ridge I, IL (2009-2010)	NA	NA	2.1	66	99
Big Blue, MN (2013)	NA	NA	2.04	18	36

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as bat passes per detector night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Barton I & II, IA (2010-2011)	NA	NA	1.85	80	160
Fowler III, IN (2009)	NA	NA	1.84	60	99
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9[B]	6/15/02-9/15/02	1.81	138	103.5
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9[B]	6/15/02-9/15/02	1.64	143	107.25
Rugby, ND (2010-2011)	NA	NA	1.6	71	149
Elm Creek, MN (2009-2010)	NA	NA	1.49	67	100
Wessington Springs, SD (2009)	NA	NA	1.48	34	51
Big Blue, MN (2014)	NA	NA	1.43	18	36
PrairieWinds ND1 (Minot), ND (2011)	NA	NA	1.39	80	115.5
PrairieWinds SD1, SD (2011-2012)	NA	NA	1.23	108	162
NPPD Ainsworth, NE (2006)	NA	NA	1.16	36	20.5
PrairieWinds SD1, SD (2012-2013)	NA	NA	1.05	108	162
Buffalo Ridge, MN (Phase I; 1999)	NA	NA	0.74	73	25
PrairieWinds SD1, SD (2013-2014)	NA	NA	0.52	108	162
Wessington Springs, SD (2010)	NA	NA	0.41	34	51
Buffalo Ridge I, SD (2009-2010)	NA	NA	0.16	24	50.4
Southern Plains					
Barton Chapel, TX (2009-2010)	NA	NA	3.06	60	120
Big Smile, OK (2012-2013)	NA	NA	2.9	66	132
Buffalo Gap II, TX (2007-2008)	NA	NA	0.14	155	233
Red Hills, OK (2012-2013)	NA	NA	0.11	82	123
Buffalo Gap I, TX (2006)	NA	NA	0.1	67	134
Southwest					
Dry Lake I, AZ (2009-2010)	8.8	4/29/10-11/10/10	3.43	30	63
Dry Lake II, AZ (2011-2012)	11.5	5/11/11-10/26/11	1.66	31	65
California					
Shiloh I, CA (2006-2009)	NA	NA	3.92	100	150
Shiloh II, CA (2010-2011)	NA	NA	3.8	75	150
Shiloh II, CA (2011-2012)	NA	NA	3.4	75	150
Shiloh II, CA (2009-2010)	NA	NA	2.6	75	150
High Winds, CA (2003-2004)	NA	NA	2.51	90	162
Dillon, CA (2008-2009)	NA	NA	2.17	45	45
Montezuma I, CA (2011)	NA	NA	1.9	16	36.8
High Winds, CA (2004-2005)	NA	NA	1.52	90	162
Alta I, CA (2011-2012)	4.42[E]	6/26/09 - 10/31/09	1.28	100	150
Montezuma II, CA (2012-2013)	NA	NA	0.91	34	78.2
Montezuma I, CA (2012)	NA	NA	0.84	16	36.8
Diablo Winds, CA (2005-2007)	NA	NA	0.82	31	20.46
Shiloh III, CA (2012-2013)	NA	NA	0.4	50	102.5
Solano III, CA (2012-2013)	NA	NA	0.31	55	128
Alite, CA (2009-2010)	NA	NA	0.24	8	24

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as bat passes per detector night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Alta I-V, CA (2013-2014)	NA	NA	0.2	290	720 (150 GE, 570 vestas)
Mustang Hills, CA (2012-2013)	NA	NA	0.1	50	150
Alta II-V, CA (2011-2012)	0.78	6/26/09 - 10/31/09	0.08	190	570
Pinyon Pines I & II, CA (2013-2014)	NA	NA	0.04	100	NA
Alta VIII, CA (2012-2013)	NA	NA	0	50	150
Pacific Northwest					
Palouse Wind, WA (2012-2013)	NA	NA	4.23	58	104.4
Biglow Canyon, OR (Phase II; 2009-2010)	NA	NA	2.71	65	150
Nine Canyon, WA (2002-2003)	NA	NA	2.47	37	48.1
Stateline, OR/WA (2003)	NA	NA	2.29	454	299
Elkhorn, OR (2010)	NA	NA	2.14	61	101
White Creek, WA (2007-2011)	NA	NA	2.04	89	204.7
Biglow Canyon, OR (Phase I; 2008)	NA	NA	1.99	76	125.4
Leaning Juniper, OR (2006-2008)	NA	NA	1.98	67	100.5
Big Horn, WA (2006-2007)	NA	NA	1.9	133	199.5
Combine Hills, OR (Phase I; 2004-2005)	NA	NA	1.88	41	41
Linden Ranch, WA (2010-2011)	NA	NA	1.68	25	50
Pebble Springs, OR (2009-2010)	NA	NA	1.55	47	98.7
Hopkins Ridge, WA (2008)	NA	NA	1.39	87	156.6
Harvest Wind, WA (2010-2012)	NA	NA	1.27	43	98.9
Elkhorn, OR (2008)	NA	NA	1.26	61	101
Vansycle, OR (1999)	NA	NA	1.12	38	24.9
Klondike III (Phase I), OR (2007-2009)	NA	NA	1.11	125	223.6
Stateline, OR/WA (2001-2002)	NA	NA	1.09	454	299
Stateline, OR/WA (2006)	NA	NA	0.95	454	299
Tuolumne (Windy Point I), WA (2009-2010)	NA	NA	0.94	62	136.6
Klondike, OR (2002-2003)	NA	NA	0.77	16	24
Combine Hills, OR (2011)	NA	NA	0.73	104	104
Hopkins Ridge, WA (2006)	NA	NA	0.63	83	150
Biglow Canyon, OR (Phase I; 2009)	NA	NA	0.58	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)	NA	NA	0.57	65	150
Hay Canyon, OR (2009-2010)	NA	NA	0.53	48	100.8
Windy Flats, WA (2010-2011)	NA	NA	0.41	114	262.2
Klondike II, OR (2005-2006)	NA	NA	0.41	50	75
Vantage, WA (2010-2011)	NA	NA	0.4	60	90
Wild Horse, WA (2007)	NA	NA	0.39	127	229
Goodnoe, WA (2009-2010)	NA	NA	0.34	47	94
Marengo II, WA (2009-2010)	NA	NA	0.27	39	70.2

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as bat passes per detector night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Biglow Canyon, OR (Phase III; 2010-2011)	NA	NA	0.22	76	174.8
Marengo I, WA (2009-2010)	NA	NA	0.17	78	140.4
Klondike IIIa (Phase II), OR (2008-2010)	NA	NA	0.14	51	76.5
Kittitas Valley, WA (2011-2012)	NA	NA	0.12	48	100.8
Rocky Mountains					
Summerview, Alb (2006; 2007)	7.65[B]	07/15/06-07-09/30/06-07	11.42	39	70.2
Summerview, Alb (2005-2006)	NA	NA	10.27	39	70.2
Judith Gap, MT (2006-2007)	NA	NA	8.93	90	135
Foote Creek Rim, WY (Phase I; 1999)	NA	NA	3.97	69	41.4
Judith Gap, MT (2009)	NA	NA	3.2	90	135
Milford I, UT (2010-2011)	NA	NA	2.05	58	145
Milford I & II, UT (2011-2012)	NA	NA	1.67	107	160.5 (58.5 Phase I, 102 Phase II)
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2[B,D]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2[B,D]	6/15/00-9/1/00	1.05	69	41.4
Southeast					
Buffalo Mountain, TN (2005)	NA	NA	39.7	18	28.98
Buffalo Mountain, TN (2000-2003)	23.7[D]		31.54	3	1.98
Northeast					
Pinnacle, WV (2012)	NA	NA	40.2	23	55.2
Mountaineer, WV (2003)	30.09	7/15/09-10/7/09	31.69	44	66
Mount Storm, WV (2009)	NA	NA	17.53	132	264
Noble Wethersfield, NY (2010)	NA	NA	16.3	84	126
Criterion, MD (2011)	36.67[F]	4/18/10-10/15/10	15.61	28	70
Mount Storm, WV (2010)	NA	NA	15.18	132	264
Locust Ridge, PA (Phase II; 2010)	NA	NA	14.38	51	102
Locust Ridge, PA (Phase II; 2009)	NA	NA	14.11	51	102
Casselman, PA (2008)	NA	NA	12.61	23	34.5
Maple Ridge, NY (2006)	NA	NA	11.21	120	198
Cohocton/Dutch Hills, NY (2010)	NA	NA	10.32	50	125
Wolfe Island, Ont (July-December 2010)	NA	NA	9.5	86	197.8
Cohocton/Dutch Hill, NY (2009)	NA	NA	8.62	50	125
Casselman, PA (2009)	NA	NA	8.6	23	34.5
Noble Bliss, NY (2008)	NA	NA	7.8	67	100
Criterion, MD (2012)	NA	NA	7.62	28	70
Mount Storm, WV (2011)	NA	NA	7.43	132	264
Maple Ridge, NY (2012)	35.2	7/20/08-10/12/08	7.3	195	321.75
Mount Storm, WV (Fall 2008)	NA	NA	6.62	82	164

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as bat passes per detector night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Maple Ridge, NY (2007)	NA	NA	6.49	195	321.75
Wolfe Island, Ont (July-December 2009)	NA	NA	6.42	86	197.8
Criterion, MD (2013)	NA	NA	5.32	28	70
Maple Ridge, NY (2007-2008)	1.9[C]	8/1/09-09/31/09	4.96	195	321.75
Noble Clinton, NY (2009)	NA	NA	4.5	67	100
Casselman Curtailment, PA (2008)	NA	NA	4.4	23	35.4
Noble Altona, NY (2010)	16.1[C]	8/16/09-09/15/09	4.34	65	97.5
Noble Ellenburg, NY (2009)	NA	NA	3.91	54	80
Noble Bliss, NY (2009)	NA	NA	3.85	67	100
Lempster, NH (2010)	NA	NA	3.57	12	24
Noble Ellenburg, NY (2008)	2.1[C]	8/8/08-09/31/08	3.46	54	80
Noble Clinton, NY (2008)	NA	NA	3.14	67	100
Lempster, NH (2009)	24.6	4/16/12-10/23/12	3.11	12	24
Record Hill, ME (2012)	NA	NA	2.96	22	50.6
Mars Hill, ME (2007)	NA	NA	2.91	28	42
Wolfe Island, Ont (July-December 2011)	NA	NA	2.49	86	197.8
Noble Chateaugay, NY (2010)	NA	NA	2.44	71	106.5
High Sheldon, NY (2010)	NA	NA	2.33	75	112.5
Stetson Mountain II, ME (2012)	NA	NA	2.27	17	25.5
Beech Ridge, WV (2012)	NA	NA	2.03	67	100.5
Munnsville, NY (2008)	NA	NA	1.93	23	34.5
High Sheldon, NY (2011)	NA	NA	1.78	75	112.5
Stetson Mountain II, ME (2010)	28.5; 0.3[G]	7/10/09-10/15/09	1.65	17	25.5
Stetson Mountain I, ME (2009)	NA	NA	1.4	38	57
Beech Ridge, WV (2013)	NA	NA	0.58	67	100.5
Record Hill, ME (2014)	NA	NA	0.55	22	50.6
Mars Hill, ME (2008)	NA	NA	0.45	28	42
Stetson Mountain I, ME (2011)	NA	NA	0.28	38	57
Stetson Mountain I, ME (2013)	NA	NA	0.18	38	57
Rollins, ME (2012)	NA	NA	0.18	40	60
Kibby, ME (2011)	NA	NA	0.12	44	132

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

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

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

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

E = Average of ground-based detectors at CPC Proper (Phase I) for late summer/fall period only

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

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

Appendix A1 (*continued*). Wind energy facilities in North America with comparable activity and fatality data for bats. Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Sweetland, SD	This study				
Alite, CA (09-10)		Chatfield et al. 2010	Lempster, NH (09)		Tidhar et al. 2010
Alta Wind I, CA (11-12)	Solick et al. 2010	Chatfield et al. 2012	Lempster, NH (10)		Tidhar et al. 2011
Alta Wind I-V, CA (13-14)		Chatfield et al. 2014	Linden Ranch, WA (10-11)		Enz and Bay 2011
Alta Wind II-V, CA (11-12)	Solick et al. 2010	Chatfield et al. 2012	Locust Ridge, PA (Phase II; 09)		Arnett et al.
Alta VIII, CA (12-13)		Chatfield and Bay 2014	Locust Ridge, PA (Phase II; 10)		Arnett et al.
Barton I & II, IA (10-11)		Derby et al. 2011b	Maple Ridge, NY (06)		Jain et al. 2007
Barton Chapel, TX (09-10)		WEST 2011	Maple Ridge, NY (07)		Jain et al. 2009a
Beech Ridge, WV (12)		Tidhar et al. 2013a	Maple Ridge, NY (07-08)		Jain et al. 2009b
Beech Ridge, WV (13)		Young et al. 2014a	Maple Ridge, NY (12)		Tidhar et al. 2013b
Big Blue, MN (13)		Fagen Engineering 2014	Marengo I, WA (09-10)		URS Corporation 2010b
Big Blue, MN (14)		Fagen Engineering 2015	Marengo II, WA (09-10)		URS Corporation 2010c
Big Horn, WA (06-07)		Kronner et al. 2008	Mars Hill, ME (07)		Stantec 2008a
Big Smile, OK (12-13)		Derby et al. 2013b	Mars Hill, ME (08)		Stantec 2009a
Biglow Canyon, OR (Phase I; 08)		Jeffrey et al. 2009b	Milford I, UT (10-11)		Stantec 2011b
Biglow Canyon, OR (Phase I; 09)		Enk et al. 2010	Milford I & II, UT (11-12)		Stantec 2012b
Biglow Canyon, OR (Phase II; 09-10)		Enk et al. 2011b	Montezuma I, CA (11)		ICF International 2012
Biglow Canyon, OR (Phase II; 10-11)		Enk et al. 2012b	Montezuma I, CA (12)		ICF International 2013
Biglow Canyon, OR (Phase III; 10-11)		Enk et al. 2012a	Montezuma II, CA (12-13)		Harvey & Associates 2013
Blue Sky Green Field, WI (08; 09)	Gruver 2008	Gruver et al. 2009	Moraine II, MN (09)		Derby et al. 2010f
Buffalo Gap I, TX (06)		Tierney 2007	Mount Storm, WV (Fall 08)	Young et al. 2009c	Young et al. 2009c
Buffalo Gap II, TX (07-08)		Tierney 2009	Mount Storm, WV (09)	Young et al. 2009a, 2010b	Young et al. 2009a, 2010b
Buffalo Mountain, TN (00-03)	Fiedler 2004	Nicholson et al. 2005	Mount Storm, WV (10)	Young et al. 2010a, 2011b	Young et al. 2010a, 2011b
Buffalo Mountain, TN (05)		Fiedler et al. 2007	Mount Storm, WV (11)		Young et al. 2011a, 2012a
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000	Mountaineer, WV (03)		Kerns and Kerlinger 2004a
Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000	Munnsville, NY (08)		Stantec 2009b
Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000	Mustang Hills, CA (12-13)		Chatfield and Bay 2014
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Nine Canyon, WA (02-03)		Erickson et al. 2003
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Noble Altona, NY (10)	Reynolds 2010c	Jain et al. 2011a
Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000	Noble Bliss, NY (08)		Jain et al.2009c
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Noble Bliss, NY (09)		Jain et al. 2010c
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Noble Chateaugay, NY (10)		Jain et al. 2011b
Buffalo Ridge I, SD (09-10)		Derby et al. 2010d	Noble Clinton, NY (08)	Reynolds 2010a	Jain et al. 2009d
Buffalo Ridge II, SD (11-12)		Derby et al. 2012a	Noble Clinton, NY (09)	Reynolds 2010a	Jain et al. 2010a
Casselman, PA (08)		Arnett et al. 2009b	Noble Ellenburg, NY (08)		Jain et al. 2009e
Casselman, PA (09)		Arnett et al. 2010	Noble Ellenburg, NY (09)	Reynolds 2010b	Jain et al. 2010b
Casselman Curtailment, PA (08)		Arnett et al. 2009a	Noble Wethersfield, NY (10)		Jain et al. 2011c
Cedar Ridge, WI (09)	BHE Environmental 2008	BHE Environmental 2010	NPPD Ainsworth, NE (06)		Derby et al. 2007
Cedar Ridge, WI (10)	BHE Environmental 2008	BHE Environmental 2011	Palouse Wind, WA (12-13)		Stantec 2013a
Cohocton/Dutch Hill, NY (09)		Stantec 2010	Pebble Springs, OR (09-10)		Gritski and Kronner 2010b
Cohocton/Dutch Hills, NY (10)		Stantec 2011a	Pinnacle, WV (12)		Hein et al. 2013b
Combine Hills, OR (Phase I; 04-05)		Young et al. 2006	Pinyon Pines I&II, CA (13-14)		Chatfield and Russo 2014
Combine Hills, OR (11)		Enz et al. 2012	Pioneer Prairie I, IA (Phase II; 11-12)		Chodachek et al. 2012
Crescent Ridge, IL (05-06)		Kerlinger et al. 2007	Pioneer Prairie II, IA (13)		Chodachek et al. 2014
Criterion, MD (11)		Young et al. 2012b	PrairieWinds ND1 (Minot), ND (10)		Derby et al. 2011d
Criterion, MD (12)		Young et al. 2013	PrairieWinds ND1 (Minot), ND (11)		Derby et al. 2012d
Criterion, MD (13)		Young et al. 2014b	PrairieWinds SD1 (Crow Lake), SD (11-12)		Derby et al. 2012c

Appendix A1 (*continued*). Wind energy facilities in North America with comparable activity and fatality data for bats. Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Crystal Lake II, IA (09)		Derby et al. 2010b	PrairieWinds SD1 (Crow Lake), SD (12-13)		Derby et al. 2013a
Diablo Winds, CA (05-07)		WEST 2006, 2008	PrairieWinds SD1, SD (13-14)		Derby et al. 2014
Dillon, CA (08-09)		Chatfield et al. 2009	Rail Splitter, IL (12-13)		Good et al. 2013b
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Thompson et al. 2011	Record Hill, ME (12)	Stantec 2008b	Stantec 2013b
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Thompson and Bay 2012	Record Hill, ME (14)		Stantec 2015
Elkhorn, OR (08)		Jeffrey et a. 2009a	Red Hills, OK (12-13)		Derby et al. 2013c
Elkhorn, OR (10)		Enk et al. 2011a	Ripley, Ont (08)		Jacques Whitford 2009
Elm Creek, MN (09-10)		Derby et al. 2010e	Rollins, ME (12)		Stantec 2013c
Elm Creek II, MN (11-12)		Derby et al. 2012b	Rugby, ND (10-11)		Derby et al. 2011c
Foote Creek Rim, WY (Phase I; 99)		Young et al. 2003a	Shiloh I, CA (06-09)		Kerlinger et al. 2009
Foote Creek Rim, WY (Phase I; 00)	Gruver 2002	Young et al. 2003a, 2003b	Shiloh II, CA (09-10)		Kerlinger et al. 2010, 2013a
Foote Creek Rim, WY (Phase I; 01-02)		Young et al. 2003a, 2003b	Shiloh II, CA (10-11)		Kerlinger et al. 2013a
Forward Energy Center, WI (08-10)	Watt and Drake 2011	Grodsky and Drake 2011	Shiloh II, CA (11-12)		Kerlinger et al. 2013a
Fowler I, IN (09)		Johnson et al. 2010a	Shiloh III, CA (12-13)		Kerlinger et al. 2013b
Fowler III, IN (09)		Johnson et al. 2010b	Solano III, CA (12-13)		AECOM 2013
Fowler I, II, III, IN (10)		Good et al. 2011	Stateline, OR/WA (01-02)		Erickson et al. 2004
Fowler I, II, III, IN (11)		Good et al. 2012	Stateline, OR/WA (03)		Erickson et al. 2004
Fowler I, II, III, IN (12)		Good et al. 2013a	Stateline, OR/WA (06)		Erickson et al. 2007
Goodnoe, WA (09-10)		URS Corporation 2010a	Stetson Mountain I, ME (09)	Stantec 2009c	Stantec 2009c
Grand Ridge I, IL (09-10)		Derby et al. 2010a	Stetson Mountain I, ME (11)		Normandeau Associates 2011
Harrow, Ont (10)		NRSI 2011	Stetson Mountain I, ME (13)		Stantec 2014
Harvest Wind, WA (10-12)		Downes and Gritski 2012a	Stetson Mountain II, ME (10)		Normandeau Associates 2010
Hay Canyon, OR (09-10)		Gritski and Kronner 2010a	Stetson Mountain II, ME (12)		Stantec 2013d
Heritage Garden I, MI (12-14)		Kerlinger et al. 2014	Summerview, Alb (05-06)		Brown and Hamilton 2006
High Sheldon, NY (10)		Tidhar et al. 2012a	Summerview, Alb (06; 07)	Baerwald 2008	Baerwald 2008
High Sheldon, NY (11)		Tidhar et al. 2012b	Top Crop I & II, IL (12-13)		Good et al. 2013c
High Winds, CA (03-04)		Kerlinger et al. 2006	Top of Iowa, IA (03)		Jain 2005
High Winds, CA (04-05)		Kerlinger et al. 2006	Top of Iowa, IA (04)	Jain 2005	Jain 2005
Hopkins Ridge, WA (06)		Young et al. 2007	Tuolumne (Windy Point I), WA (09-10)		Enz and Bay 2010
Hopkins Ridge, WA (08)		Young et al. 2009b	Vansycle, OR (99)		Erickson et al. 2000
Judith Gap, MT (06-07)		TRC 2008	Vantage, WA (10-11)		Ventus 2012
Judith Gap, MT (09)		Poulton and Erickson 2010	Wessington Springs, SD (09)		Derby et al. 2010c
Kewaunee County, WI (99-01)		Howe et al. 2002	Wessington Springs, SD (10)		Derby et al. 2011a
Kibby, ME (11)		Stantec 2012a	White Creek, WA (07-11)		Downes and Gritski 2012b
Kittitas Valley, WA (11-12)		Stantec Consulting Services 2012	Wild Horse, WA (07)		Erickson et al. 2008
Klondike, OR (02-03)		Johnson et al. 2003	Windy Flats, WA (10-11)		Enz et al. 2011
Klondike II, OR (05-06)		NWC and WEST 2007	Winnebago, IA (09-10)		Derby et al. 2010g
Klondike III (Phase I), OR (07-09)		Gritski et al. 2010	Wolfe Island, Ont (July-December 09)		Stantec Ltd. 2010
Klondike IIIa (Phase II), OR (08-10)		Gritski et al. 2011	Wolfe Island, Ont (July-December 10)		Stantec Ltd. 2011
Leaning Juniper, OR (06-08)		Gritski et al. 2008	Wolfe Island, Ont (July-December 11)		Stantec Ltd. 2012

Appendix A2. Bat fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (Bats/Megawatt/ Year)	Predominant Habitat Type	Citation
Alite, CA (2009-2010)	0.24	Shrub/scrub & grassland	Chatfield et al. 2010
Alta I, CA (2011-2012)	1.28	Woodland, grassland, shrubland	Chatfield et al. 2012
Alta I-V, CA (2013-2014)	0.2	NA	Chatfield et al. 2014
Alta II-V, CA (2011-2012)	0.08	Desert scrub	Chatfield et al. 2012
Alta VIII, CA (2012-2013)	0	Grassland and riparian	Chatfield and Bay 2014
Barton I & II, IA (2010-2011)	1.85	Agriculture	Derby et al. 2011b
Barton Chapel, TX (2009-2010)	3.06	Agriculture/forest	WEST 2011
Beech Ridge, WV (2012)	2.03	Forest	Tidhar et al. 2013a
Beech Ridge, WV (2013)	0.58	Forest	Young et al. 2014a
Big Blue, MN (2013)	2.04	Agriculture	Fagen Engineering 2014
Big Blue, MN (2014)	1.43	Agriculture	Fagen Engineering 2015
Big Horn, WA (2006-2007)	1.9	Agriculture/grassland	Kronner et al. 2008
Big Smile, OK (2012-2013)	2.9	Grassland, agriculture	Derby et al. 2013b
Biglow Canyon, OR (Phase I; 2008)	1.99	Agriculture/grassland	Jeffrey et al. 2009b
Biglow Canyon, OR (Phase I; 2009)	0.58	Agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009-2010)	2.71	Agriculture	Enk et al. 2011b
Biglow Canyon, OR (Phase II; 2010-2011)	0.57	Grassland/shrub-steppe, agriculture	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 2010-2011)	0.22	Grassland/shrub-steppe, agriculture	Enk et al. 2012a
Blue Sky Green Field, WI (2008; 2009)	24.57	Agriculture	Gruver et al. 2009
Buffalo Gap I, TX (2006)	0.1	Grassland	Tierney 2007
Buffalo Gap II, TX (2007-2008)	0.14	Forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	31.54	Forest	Nicholson et al. 2005
Buffalo Mountain, TN (2005)	39.7	Forest	Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 1999)	0.74	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1998)	2.16	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1999)	2.59	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	4.35	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.64	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 1999)	2.72	Agriculture	Johnson et al. 2000

Appendix A2. Bat fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (Bats/Megawatt/ Year)	Predominant Habitat Type	Citation
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	3.71	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.81	Agriculture	Johnson et al. 2004
Buffalo Ridge I, SD (2009-2010)	0.16	Agriculture/grassland	Derby et al. 2010d
Buffalo Ridge II, SD (2011-2012)	2.81	Agriculture, grassland	Derby et al. 2012a
Casselman, PA (2008)	12.61	Forest	Arnett et al. 2009b
Casselman, PA (2009)	8.6	Forest, pasture, grassland	Arnett et al. 2010
Casselman Curtailment, PA (2008)	4.4	Forest	Arnett et al. 2009a
Cedar Ridge, WI (2009)	30.61	Agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	24.12	Agriculture	BHE Environmental 2011
Cohocton/Dutch Hill, NY (2009)	8.62	Agriculture/forest	Stantec 2010
Cohocton/Dutch Hills, NY (2010)	10.32	Agriculture, forest	Stantec 2011a
Combine Hills, OR (Phase I; 2004-2005)	1.88	Agriculture/grassland	Young et al. 2006
Combine Hills, OR (2011)	0.73	Grassland/shrub-steppe, agriculture	Enz et al. 2012
Crescent Ridge, IL (2005-2006)	3.27	Agriculture	Kerlinger et al. 2007
Criterion, MD (2011)	15.61	Forest, agriculture	Young et al. 2012b
Criterion, MD (2012)	7.62	Forest, agriculture	Young et al. 2013
Criterion, MD (2013)	5.32	Forest, agriculture	Young et al. 2014b
Crystal Lake II, IA (2009)	7.42	Agriculture	Derby et al. 2010b
Diablo Winds, CA (2005-2007)	0.82	NA	WEST 2006, 2008
Dillon, CA (2008-2009)	2.17	Desert	Chatfield et al. 2009
Dry Lake I, AZ (2009-2010)	3.43	Desert grassland/forested	Thompson et al. 2011
Dry Lake II, AZ (2011-2012)	1.66	Desert grassland/forested	Thompson and Bay 2012
Elkhorn, OR (2008)	1.26	Shrub/scrub & agriculture	Jeffrey et al. 2009a
Elkhorn, OR (2010)	2.14	Shrub/scrub & agriculture	Enk et al. 2011a
Elm Creek, MN (2009-2010)	1.49	Agriculture	Derby et al. 2010e
Elm Creek II, MN (2011-2012)	2.81	Agriculture, grassland	Derby et al. 2012b
Foote Creek Rim, WY (Phase I; 1999)	3.97	Grassland	Young et al. 2003a
Foote Creek Rim, WY (Phase I; 2000)	1.05	Grassland	Young et al. 2003a
Foote Creek Rim, WY (Phase I; 2001-2002)	1.57	Grassland	Young et al. 2003a

Appendix A2. Bat fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (Bats/Megawatt/ Year)	Predominant Habitat Type	Citation
Forward Energy Center, WI (2008-2010)	18.17	Agriculture	Grodsky and Drake 2011
Fowler I, IN (2009)	8.09	Agriculture	Johnson et al. 2010a
Fowler I, II, III, IN (2010)	18.96	Agriculture	Good et al. 2011
Fowler I, II, III, IN (2011)	20.19	Agriculture	Good et al. 2012
Fowler I, II, III, IN (2012)	2.96	Agriculture	Good et al. 2013a
Fowler III, IN (2009)	1.84	Agriculture	Johnson et al. 2010b
Goodnoe, WA (2009-2010)	0.34	Grassland and shrub-steppe	URS Corporation 2010a
Grand Ridge I, IL (2009-2010)	2.1	Agriculture	Derby et al. 2010a
Harrow, Ont (2010)	11.13	Agriculture	Natural Resource Solutions Inc. (NRSI) 2011
Harvest Wind, WA (2010-2012)	1.27	Grassland/shrub-steppe	Downes and Gritski 2012a
Hay Canyon, OR (2009-2010)	0.53	Agriculture	Gritski and Kronner 2010a
Heritage Garden I, MI (2012-2014)	5.9	Agriculture	Kerlinger et al. 2014
High Sheldon, NY (2010)	2.33	Agriculture	Tidhar et al. 2012a
High Sheldon, NY (2011)	1.78	Agriculture	Tidhar et al. 2012b
High Winds, CA (2003-2004)	2.51	Agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2004-2005)	1.52	Agriculture/grassland	Kerlinger et al. 2006
Hopkins Ridge, WA (2006)	0.63	Agriculture/grassland	Young et al. 2007
Hopkins Ridge, WA (2008)	1.39	Agriculture/grassland	Young et al. 2009b
Judith Gap, MT (2006-2007)	8.93	Agriculture/grassland	TRC 2008
Judith Gap, MT (2009)	3.2	Agriculture/grassland	Poulton and Erickson 2010
Kewaunee County, WI (1999-2001)	6.45	Agriculture	Howe et al. 2002
Kibby, ME (2011)	0.12	Forest; commercial forest	Stantec 2012a
Kittitas Valley, WA (2011-2012)	0.12	Sagebrush-steppe, grassland	Stantec Consulting Services 2012
Klondike, OR (2002-2003)	0.77	Agriculture/grassland	Johnson et al. 2003
Klondike II, OR (2005-2006)	0.41	Agriculture/grassland	NWC and WEST 2007
Klondike III (Phase I), OR (2007-2009)	1.11	Agriculture/grassland	Gritski et al. 2010
Klondike IIIa (Phase II), OR (2008-2010)	0.14	Grassland/shrub-steppe and agriculture	Gritski et al. 2011
Leaning Juniper, OR (2006-2008)	1.98	Agriculture	Gritski et al. 2008
Lempster, NH (2009)	3.11	Grasslands/forest/rocky embankments	Tidhar et al. 2010

Appendix A2. Bat fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (Bats/Megawatt/Year)	Predominant Habitat Type	Citation
Lempster, NH (2010)	3.57	Grasslands/forest/rocky embankments	Tidhar et al. 2011
Linden Ranch, WA (2010-2011)	1.68	Grassland/shrub-steppe, agriculture	Enz and Bay 2011
Locust Ridge, PA (Phase II; 2009)	14.11	Grassland	Arnett et al. 2011
Locust Ridge, PA (Phase II; 2010)	14.38	Grassland	Arnett et al. 2011
Maple Ridge, NY (2006)	11.21	Agriculture/forested	Jain et al. 2007
Maple Ridge, NY (2007)	6.49	Agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007-2008)	4.96	Agriculture/forested	Jain et al. 2009b
Maple Ridge, NY (2012)	7.3	Agriculture/forested	Tidhar et al. 2013b
Marengo I, WA (2009-2010)	0.17	Agriculture	URS Corporation 2010b
Marengo II, WA (2009-2010)	0.27	Agriculture	URS Corporation 2010c
Mars Hill, ME (2007)	2.91	Forest	Stantec 2008a
Mars Hill, ME (2008)	0.45	Forest	Stantec 2009a
Milford I, UT (2010-2011)	2.05	Desert shrub	Stantec 2011b
Milford I & II, UT (2011-2012)	1.67	Desert shrub	Stantec 2012b
Montezuma I, CA (2011)	1.9	Agriculture and grasslands	ICF International 2012
Montezuma I, CA (2012)	0.84	Agriculture and grasslands	ICF International 2013
Montezuma II, CA (2012-2013)	0.91	Agriculture	Harvey & Associates 2013
Moraine II, MN (2009)	2.42	Agriculture/grassland	Derby et al. 2010f
Mount Storm, WV (Fall 2008)	6.62	Forest	Young et al. 2009c
Mount Storm, WV (2009)	17.53	Forest	Young et al. 2009a, 2010b
Mount Storm, WV (2010)	15.18	Forest	Young et al. 2010a, 2011b
Mount Storm, WV (2011)	7.43	Forest	Young et al. 2011a, 2012a
Mountaineer, WV (2003)	31.69	Forest	Kerns and Kerlinger 2004a
Munnsville, NY (2008)	1.93	Agriculture/forest	Stantec 2009b
Mustang Hills, CA (2012-2013)	0.1	Grasslands and Riparian	Chatfield and Bay 2014
Nine Canyon, WA (2002-2003)	2.47	Agriculture/grassland	Erickson et al. 2003
Noble Altona, NY (2010)	4.34	Forest	Jain et al. 2011a
Noble Bliss, NY (2008)	7.8	Agriculture/forest	Jain et al. 2009c
Noble Bliss, NY (2009)	3.85	Agriculture/forest	Jain et al. 2010c
Noble Chateaugay, NY (2010)	2.44	Agriculture	Jain et al. 2011b
Noble Clinton, NY (2008)	3.14	Agriculture/forest	Jain et al. 2009d

Appendix A2. Bat fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (Bats/Megawatt/ Year)	Predominant Habitat Type	Citation
Noble Clinton, NY (2009)	4.5	Agriculture/forest	Jain et al. 2010a
Noble Ellenburg, NY (2008)	3.46	Agriculture/forest	Jain et al. 2009e
Noble Ellenburg, NY (2009)	3.91	Agriculture/forest	Jain et al. 2010b
Noble Wethersfield, NY (2010)	16.3	Agriculture	Jain et al. 2011c
NPPD Ainsworth, NE (2006)	1.16	Agriculture/grassland	Derby et al. 2007
Palouse Wind, WA (2012-2013)	4.23	Agriculture and grasslands	Stantec 2013a
Pebble Springs, OR (2009-2010)	1.55	Grassland	Gritski and Kronner 2010b
Pinnacle, WV (2012)	40.2	Forest	Hein et al. 2013b
Pinyon Pines I & II, CA (2013-2014)	0.04	NA	Chatfield and Russo 2014
Pioneer Prairie II, IA (2011-2012)	4.43	Agriculture, grassland	Chodachek et al. 2012
Pioneer Prairie II, IA (2013)	3.83	Agriculture	Chodachek et al. 2014
PrairieWinds ND1 (Minot), ND (2010)	2.13	Agriculture	Derby et al. 2011d
PrairieWinds ND1 (Minot), ND (2011)	1.39	Agriculture, grassland	Derby et al. 2012d
PrairieWinds SD1, SD (2011-2012)	1.23	Grassland	Derby et al. 2012c
PrairieWinds SD1, SD (2012-2013)	1.05	Grassland	Derby et al. 2013a
PrairieWinds SD1, SD (2013-2014)	0.52	Grassland	Derby et al. 2014
Rail Splitter, IL (2012-2013)	11.21	Agriculture	Good et al. 2013b
Record Hill, ME (2012)	2.96	Forest	Stantec 2013b
Record Hill, ME (2014)	0.55	Forest	Stantec 2015
Red Hills, OK (2012-2013)	0.11	Grassland	Derby et al. 2013c
Ripley, Ont (2008)	4.67	Agriculture	Jacques Whitford 2009
Rollins, ME (2012)	0.18	Forest	Stantec 2013c
Rugby, ND (2010-2011)	1.6	Agriculture	Derby et al. 2011c
Shiloh I, CA (2006-2009)	3.92	Agriculture/grassland	Kerlinger et al. 2009
Shiloh II, CA (2009-2010)	2.6	Agriculture	Kerlinger et al. 2010, 2013a
Shiloh II, CA (2010-2011)	3.8	Agriculture	Kerlinger et al. 2013a
Shiloh II, CA (2011-2012)	3.4	Agriculture	Kerlinger et al. 2013a
Shiloh III, CA (2012-2013)	0.4	NA	Kerlinger et al. 2013b
Solano III, CA (2012-2013)	0.31	NA	AECOM 2013
Stateline, OR/WA (2001-2002)	1.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.29	Agriculture/grassland	Erickson et al. 2004

Appendix A2. Bat fatality estimates for North American wind-energy facilities.

Project	Bat Fatalities (Bats/Megawatt/ Year)	Predominant Habitat Type	Citation
Stateline, OR/WA (2006)	0.95	Agriculture/grassland	Erickson et al. 2007
Stetson Mountain I, ME (2009)	1.4	Forest	Stantec 2009c
Stetson Mountain I, ME (2011)	0.28	Forest	Normandeau Associates 2011
Stetson Mountain I, ME (2013)	0.18	Forest	Stantec 2014
Stetson Mountain II, ME (2010)	1.65	Forest	Normandeau Associates 2010
Stetson Mountain II, ME (2012)	2.27	Forest	Stantec 2013d
Summerview, Alb (2005-2006)	10.27	Agriculture	Brown and Hamilton 2006
Summerview, Alb (2006; 2007)	11.42	Agriculture/grassland	Baerwald 2008
Top Crop I & II, IL (2012-2013)	12.55	Agriculture	Good et al. 2013c
Top of Iowa, IA (2003)	7.16	Agriculture	Jain 2005
Top of Iowa, IA (2004)	10.27	Agriculture	Jain 2005
Tuolumne (Windy Point I), WA (2009-2010)	0.94	Grassland/shrub-steppe, agriculture and forest	Enz and Bay 2010
Vansycle, OR (1999)	1.12	Agriculture/grassland	Erickson et al. 2000
Vantage, WA (2010-2011)	0.4	Shrub-steppe, grassland	Ventus Environmental Solutions 2012
Wessington Springs, SD (2009)	1.48	Grassland	Derby et al. 2010c
Wessington Springs, SD (2010)	0.41	Grassland	Derby et al. 2011a
White Creek, WA (2007-2011)	2.04	Grassland/shrub-steppe, agriculture	Downes and Gritski 2012b
Wild Horse, WA (2007)	0.39	Grassland	Erickson et al. 2008
Windy Flats, WA (2010-2011)	0.41	Grassland/shrub-steppe, agriculture	Enz et al. 2011
Winnebago, IA (2009-2010)	4.54	Agriculture/grassland	Derby et al. 2010g
Wolfe Island, Ont (July-December 2009)	6.42	Grassland	Stantec Ltd. 2010
Wolfe Island, Ont (July-December 2010)	9.5	Grassland	Stantec Ltd. 2011
Wolfe Island, Ont (July-December 2011)	2.49	Grassland	Stantec Ltd. 2012

Bat Activity Studies for the

Sweetland Wind Energy Project

Hand County, South Dakota

Final Report

May 7 – October 15, 2018

Prepared for:

Sweetland Wind Farm, LLC

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December 14, 2018

WEST Inc.

EXECUTIVE SUMMARY

In May 2018, Western EcoSystems Technology, Inc. initiated a second year of bat acoustic surveys for the proposed Sweetland Wind Energy Project (Project) in Hand County, South Dakota. The bat acoustic survey reported here was designed to estimate levels of bat activity throughout the Project during the summer and fall of 2018.

Acoustic surveys were conducted from May 7 to October 15, 2018, at a fixed, paired meteorological (met) tower station and at two temporary ground stations. All stations were located predominately in grassland habitat generally representative of future turbine placement. Two fixed AnaBat SD1 and SD2 detectors were paired at a met tower, with one placed near ground level (1.5 meters [m; 5.0 feet (ft)] above ground level) and the other within the proposed rotor-swept height (45 m [148 ft]). A single AnaBat detector was moved between the two temporary stations every two weeks during the study period.

The AnaBat unit at the fixed ground station recorded 106 bat passes on 140 detector nights for a mean of 0.76 ± 0.13 bat passes per detector night. The raised detector recorded 152 bat passes on 161 detector nights for a mean of 0.94 ± 0.14 bat passes per detector night. Bat pass rates were similar between the ground and raised detector when only comparing nights that the paired detectors were simultaneously operating. AnaBat units at temporary stations recorded 1,051 bat passes on 139 detector nights for a mean of 6.40 ± 1.18 bat passes per detector night. Temporary stations were located near forested drainages, which may have attracted bats for roosting or foraging opportunities.

At all stations, 72.6% of bat passes were classified as calls from low frequency species (e.g., big brown bats, hoary bats, and silver-haired bats), and 27.4% of bat passes were classified as calls from high frequency species (e.g., eastern red bats, and *Myotis* species). Hoary bats, eastern red bats, and silver-haired bats are the most numerous casualties reported at North American wind energy facilities, and it is expected these species will likely be the most numerous bat casualties at the Project.

Bat activity at the fixed stations peaked from August 10 - 16 (4.00 bat passes/detector night) with a secondary peak in mid-September. This timing of higher bat activity corresponds with the period of peak bat fatality at most wind-energy facilities and suggests most bat fatalities at the Project will occur during the late summer or early fall. The bat pass rate for the fixed ground detector during the standardized Fall Migration Period was 1.21 ± 0.26 bat passes/detector night. This activity rate was lower than the North American median (7.7 bat passes/detector night), and lower than other publicly available studies from the Midwest region that have measured pre-construction bat activity and post-construction bat fatality. The Wessington Springs Wind Project, located 24 miles (mi; 38 kilometers [km]) southeast of the Project, and the PrairieWinds Wind Project, located 30 mi (48 km) south of the Project, are dominated by grassland habitat primarily used for cattle grazing and haying similar to the Project. The bat fatality rate at both projects was relatively low and decreased each year of operation, ranging

from 0.41 – 1.48 bats per megawatt [MW] per year at Wessington Springs and 0.52 – 1.23 bats/MW/year at Prairie Winds.

The results reported here are consistent with the rate, timing, and species composition of bat activity found during the 2017 bat acoustic surveys at the Project. Due to relatively low activity rates reported during the summer and fall at the Project, and due to the geographic proximity and habitat similarity of the Project with other operating wind facilities in the region, it is assumed that bat mortality at the Project would be relatively low and follow similar patterns as those observed at nearby facilities.

STUDY PARTICIPANTS

Western EcoSystems Technology

Chris Fritchman	Project Manager
Donald Solick	Bat Biologist
Larisa Bishop-Boros	Bat Biologist
Zoe Gustafson	Statistician
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Carmen Boyd	Project Tracking and Data Manager
Andrea Palochak	Technical Editor
Aaron Hoeing	Field Supervisor
Alex Hunley	Field Technician
Wendy Bragg	Field Technician

REPORT REFERENCE

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Sweetland Wind Farm, LLC (Sweetland) is proposing to develop the Sweetland Wind Energy Project (Project) in Hand County, South Dakota. Sweetland contracted Western EcoSystems Technology, Inc. (WEST) to complete a study of bat activity following the recommendations of the US Fish and Wildlife Service (USFWS) *Land-Based Wind Energy Guidelines* (USFWS 2012) and Kunz et al. (2007b). WEST conducted two years of acoustic monitoring surveys to estimate levels of bat activity throughout the Project during the summer and fall. Results from the 2017 field season are reported in Fritchman et al. (2018). The following report describes the results of acoustic monitoring surveys conducted at the Project between May 7 and October 15, 2018.

STUDY AREA

The proposed Project is located in southeastern Hand County, South Dakota, southeast of the town of Miller, and southwest of Wessington. According to the US Geological Survey (USGS) National Land Cover Database (NLCD), the Project is 54.3% herbaceous (grassland) land cover (Table 1, Figure 1). The next most common land cover types are cultivated crops (21.1%) and hay or pastureland (19.3%). Bats likely forage over these dominant land types, as well as around deciduous forest (1.3%) and over open water (1.2%) and wetlands (about 0.4%). Bats are most likely to roost in deciduous forest and developed areas (3.7%). The remaining land cover types each compose less than 0.1% of the Project and is composed of shrub/scrub and barren land (Table 1, Figure 1; USGS NLCD 2011, Homer et al. 2015).

Table 1. Land cover in the Sweetland Wind Energy Project, Hand County, South Dakota.

Land Cover	Acres	% Composition
Herbaceous (Grassland)	12,230.01	54.3
Cultivated Crops	4,744.64	21.1
Hay/Pasture	4,359.54	19.3
Developed	556.41	2.5
Deciduous Forest	286.24	1.3
Open Water	265.03	1.2
Emergent Herbaceous Wetlands	88.66	0.4
Shrub/Scrub	3.11	<0.1
Woody Wetlands	2.22	<0.1
Barren Land	2.22	<0.1
Total*	**22,538.08**	**100**

Source: US Geological Survey National Land Cover Database 2011, Homer et al. 2015.

* Sums may not total values shown due to rounding.

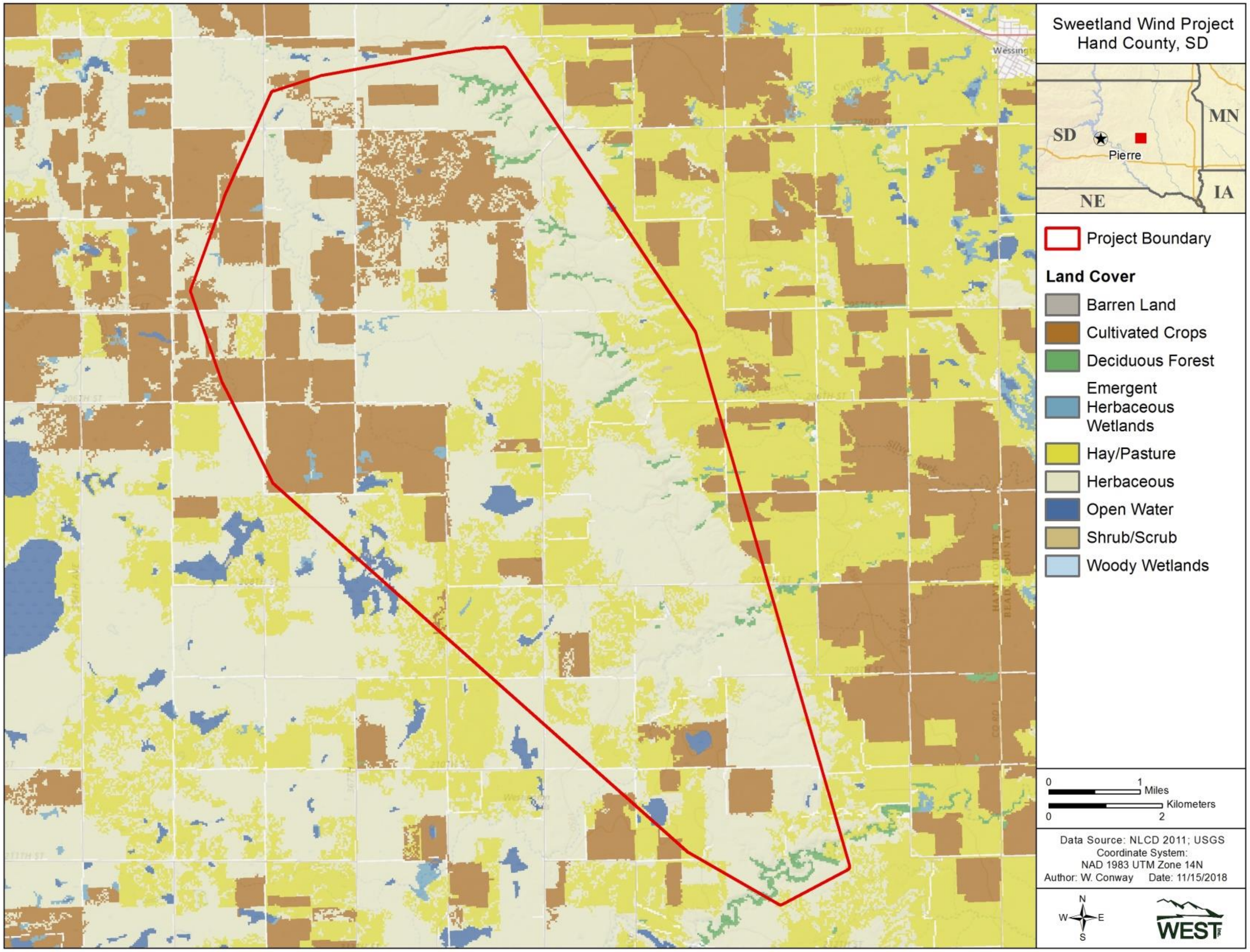

Figure 1. Land cover types within the Sweetland Wind Energy Project, Hand County, South Dakota (US Geological Survey National Land Cover Database 2011, Homer et al. 2015).

Overview of Bat Diversity

Seven species of bats potentially occur at the Project (Table 2). The northern long-eared bat (*Myotis septentrionalis*) is federally listed as threatened (USFWS 2015). None of the other species are considered sensitive in South Dakota as identified in the 2014 *South Dakota State Wildlife Action Plan* (South Dakota Game, Fish and Park [SDGFP 2014]) . All of the species except for western small-footed bat (*Myotis ciliolabrum*) have been found as fatalities at wind-energy facilities (Table 2).

Table 2. Bat species with potential to occur within the Sweetland Wind Energy Project, Hand County, South Dakota, categorized by echolocation call frequency.

Common Name	Scientific Name
High Frequency (>30 kHz)	
eastern red bat[a,b]	*Lasiurus borealis*
western small-footed bat	*Myotis ciliolabrum*
little brown bat[a]	*Myotis lucifugus*
northern long-eared bat[a,c]	*Myotis septentrionalis*
Low Frequency (≤30 kHz)	
big brown bat[a]	*Eptesicus fuscus*
silver-haired bat[a,b]	*Lasionycteris noctivagans*
hoary bat[a,c]	*Lasiurus cinereus*

[a] species known to have been killed at wind energy facilities (species found as fatalities reported by American Wind Wildlife Institute 2018);

[b] long-distance migrant; and

[c] federally threatened species (USFWS 2015).

Note: kHz = kilohertz

Range information from International Union for Conservation of Nature 2017, US Fish and Wildlife Service 2017.

METHODS

Bat Acoustic Surveys

WEST conducted acoustic monitoring to estimate levels of bat activity throughout the Project during the study period. Although it remains unclear whether baseline acoustic data are able to adequately predict post-construction fatality (Hein et al. 2013a), ultrasonic detectors do collect information on the spatial distribution, timing, and species composition of bats that can provide insights into the possible impacts of wind development (Kunz et al. 2007a, Britzke et al. 2013, Loeb et al. 2015) and inform potential mitigation strategies (Weller and Baldwin 2012).

Survey Stations

Three AnaBat™ SD1 and SD2 ultrasonic bat detectors (Titley Scientific™, Columbia, Missouri) were used during the study. Two of the detectors were paired at a meteorological (met) tower with one detector at ground level (approximately 1.5 meters [m; 5.0 feet (ft)] above ground level [AGL]; SL2g) and another within the approximate rotor-swept zone (approximately 45 m [148 ft] AGL; SL2r; Figure 2). Species activity levels and composition can vary with altitude (Baerwald and Barclay 2009, Collins and Jones 2009, Müeller et al. 2013). Therefore, it can be useful to monitor activity at different heights (Kunz et al. 2007a). Ground-based detectors likely detect a more complete sample of the bat species present within the Project, whereas elevated detectors may give a more accurate assessment of risk to bat species flying at rotor swept heights (Kunz et al. 2007a, Müeller et al. 2013; but see Amorim et al. 2012). The third detector was moved between two temporary acoustic monitoring stations (SL1t and SL3t) every 14 days to enhance spatial coverage of the Project (Figure 2). All stations were located predominately in herbaceous habitat, which is the most common land cover type (Table 1) and is representative of potential turbine locations. Temporary stations SL1t and SL3t were also located near forested drainages.

Each AnaBat unit was placed inside a plastic weather-tight container that had a hole cut in the side through which the microphone extended. Each microphone was encased in a 45-degree angle poly-vinyl chloride (PVC) tube, and holes were drilled in the PVC tube to allow water to drain. The raised AnaBat microphone was elevated on the met tower using a pulley system. Standard Bat-Hat (EME Systems, Berkley, California) weatherproof housing was modified to use a 45-degree angle PVC elbow.

Survey Schedule

Bats were surveyed in the Project from May 7 to October 15, 2018, and detectors were programmed to turn on approximately 30 minutes (min) before sunset and turn off approximately 30 min after sunrise each night. To highlight seasonal activity patterns, the study was divided into two survey periods: summer (May 7 – August 14), and fall (August 15 – October 15). Mean bat activity was also calculated for a standardized Fall Migration Period (FMP), defined here as July 30 – October 14. The FMP was defined by WEST as a standard for comparison with activity from other wind energy facilities. During this time bats begin moving toward wintering areas, and many species of bats initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (Arnett et al. 2008, Arnett and Baerwald 2013, Barclay et al. 2017).

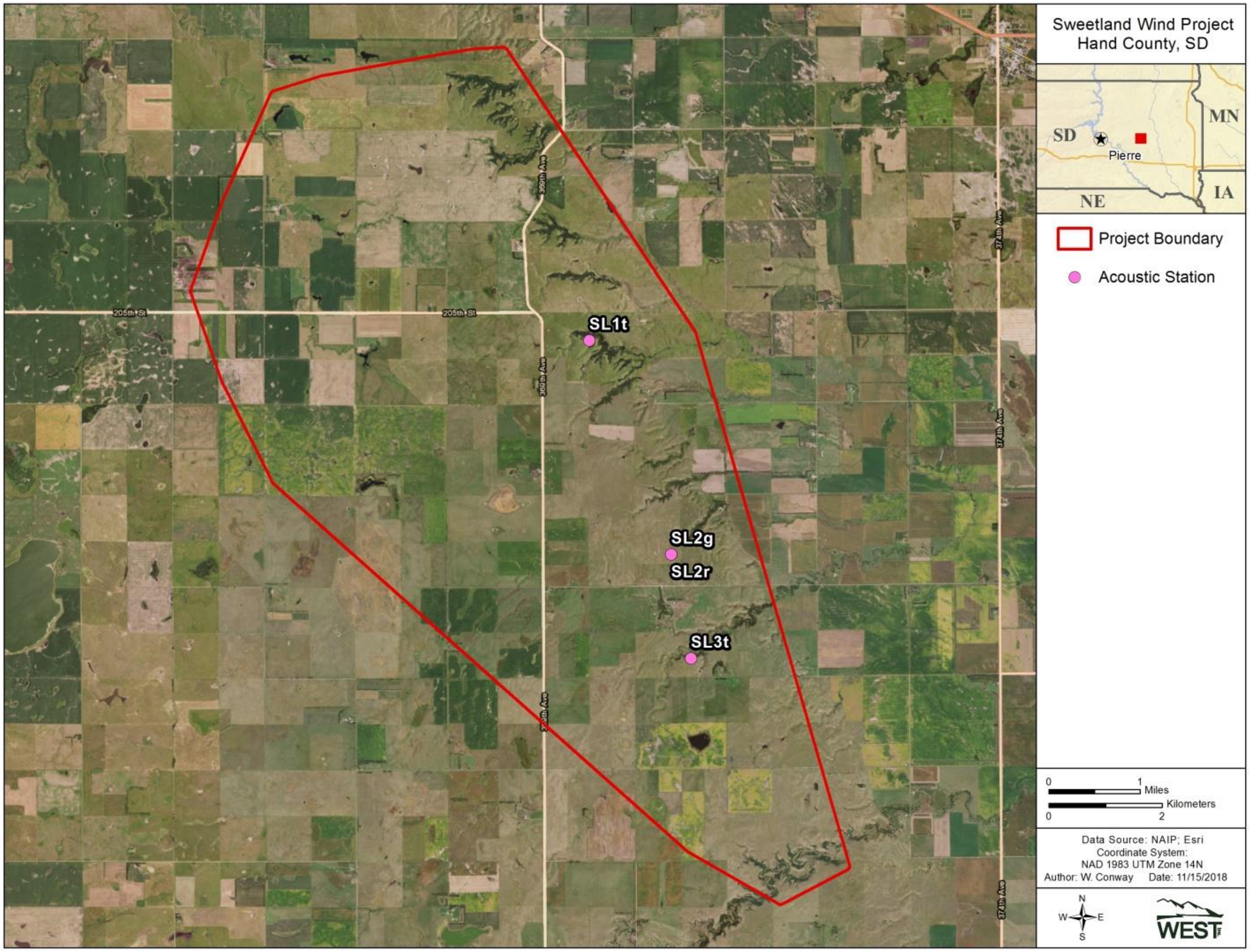

Figure 2. Location of bat monitoring stations in the Sweetland Wind Energy Project, Hand County, South Dakota.

Data Collection and Call Analysis

AnaBat detectors use a broadband high-frequency (HF) microphone to detect the echolocation calls of bats. Incoming echolocation calls are digitally processed and stored on a high-capacity compact flash card. The resulting files can be viewed in appropriate software (e.g., AnaLook©) as digital sonograms that show changes in echolocation call frequency over time. Frequency versus time displays were used to separate bat calls from other types of ultrasonic noise (e.g., wind, insects), to determine the call frequency category and, when identifiable, the species of bat that generated the calls. To standardize acoustic sampling effort across the Project, AnaBat units were calibrated and sensitivity levels were set to six (Larson and Hayes 2000), a level that balanced the goal of recording bat calls against the need to reduce interference from other sources of ultrasonic noise (Brooks and Ford 2005).

For each survey location, bat passes were sorted into two groups based on their minimum call frequency. HF bats, such as eastern red bats (*Lasiurus borealis*) and most *Myotis* species, have minimum frequencies greater than 30 kilohertz (kHz). Low-frequency (LF) bats, such as big brown bats (*Eptesicus fuscus*), silver-haired bats (*Lasionycteris noctivagans*), and hoary bats (*Lasiurus cinereus*), typically emit echolocation calls with minimum frequencies below 30 kHz. HF and LF species that may occur in the study area are listed in Table 2.

Statistical Analysis

The standard metric used for measuring bat activity is the number of bat passes per detector night, and this metric was used as an index of bat activity in the Project. A bat pass was defined as a sequence of at least two echolocation calls (pulses) produced by an individual bat with no pause between calls of more than one second (Fenton 1980). A detector night was defined as one detector operating for one entire night. The terms bat pass and bat call are used interchangeably. The number of bat passes per detector night was calculated for all bats and for HF and LF bats. Bat pass rates represent indices of bat activity and do not represent numbers of individuals. The number of bat passes was determined by an experienced bat biologist using AnaLook.

The period of peak sustained bat activity was defined as the 7-day period with the highest average bat activity. If multiple 7-day periods equaled the peak sustained bat activity rate, all dates in these 7-day periods were reported. This and all multi-detector averages in this report were calculated as an unweighted average of total activity at each detector. Temporary stations were not sampled on a continuous basis throughout the survey period and were therefore excluded from temporal analyses.

Risk Assessment

To assess potential for bat fatalities, bat activity in the Project was compared to existing data at other wind energy facilities in the Midwest. Among studies measuring both activity and fatality rates, most data were collected during the fall using AnaBat detectors placed near the ground. Therefore, to make valid comparisons to the publicly available data, this report uses the activity rate recorded at fixed, ground detectors during the FMP as a standard for comparison with activity data from other wind energy facilities. Given the relatively small number of publicly available studies and the significant ecological differences between geographically dispersed facilities, the risk assessment is qualitative, rather than quantitative.

RESULTS

Bat Acoustic Surveys

Bat activity was monitored at four sampling locations for a total of 440 detector nights between May 7 and October 15, 2018. AnaBat units were operating for 90.3% of the sampling period (Figure 3). Overall, the average bat pass rate (± standard error) was 3.63 ± 0.62 bat passes per detector night (Table 3).

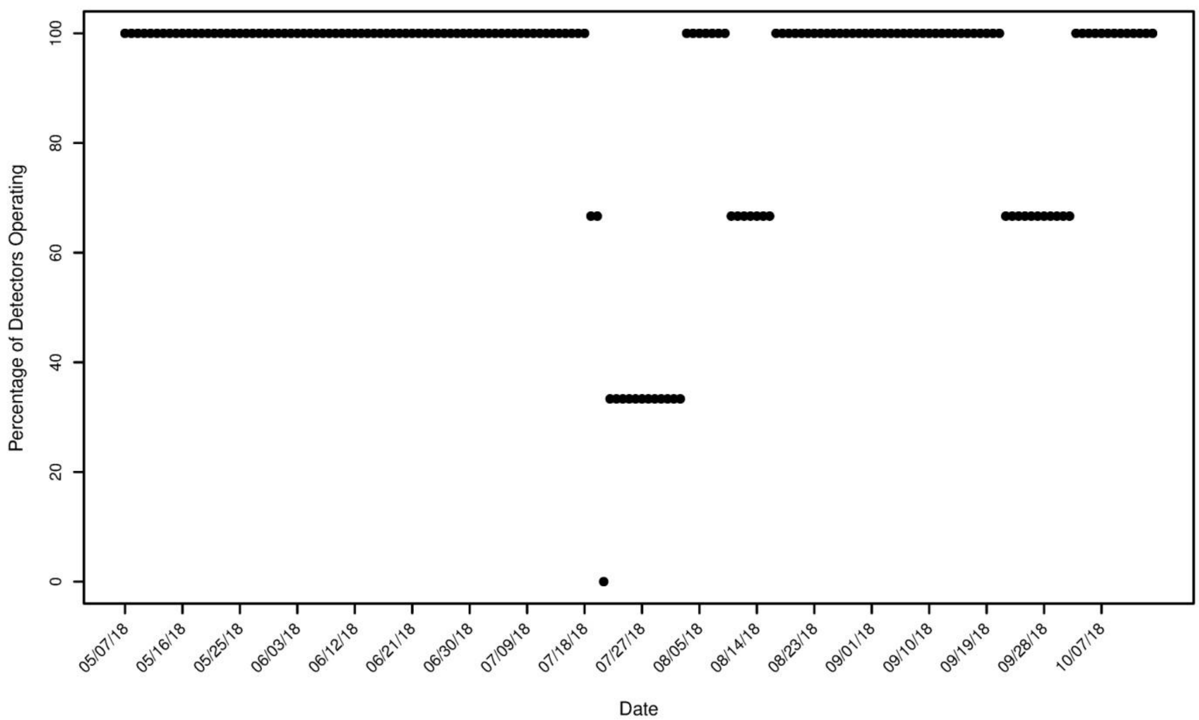

Figure 3. Operational status of bat detectors (n=4) operating at the Sweetland Wind Energy Project, Hand County, South Dakota, during each night of the study period from May 7 – October 15, 2018.

Table 3. Results of acoustic bat surveys conducted at monitoring stations within the Sweetland Wind Energy Project, Hand County, South Dakota, from May 7 to October 15, 2018. Passes were separated by call frequency: high frequency (HF) and low frequency (LF).

AnaBat Station	Location	Type	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Night [a]
SL1t	ground	temporary	301	685	986	85	11.60 ± 2.13
SL2g	ground	fixed	14	92	106	140	0.76 ± 0.13
SL2r	raised	fixed	23	129	152	161	0.94 ± 0.14
SL3t	ground	temporary	21	44	65	54	1.20 ± 0.22
Total Fixed			**37**	**221**	**258**	**301**	**0.85 ± 0.13**
Total Temporary			**322**	**729**	**1,051**	**139**	**6.40 ± 1.18**
Total			**359**	**950**	**1,309**	**440**	**3.63 ± 0.62**

[a] ± bootstrapped standard error.

Spatial Variation

Overall, bat activity in the Project was higher at the temporary stations than at the fixed stations (Figure 4, Table 3). Activity was higher at station SL1t, which recorded 11.60 bat passes/detector-night (Table 3). The AnaBat unit at the fixed ground station recorded 106 bat passes on 140 detector-nights, for a mean of 0.76 ± 0.13 bat passes/detector night. The raised detector recorded 152 bat passes on 161 detector-nights for a mean of 0.94 ± 0.14 bat passes/detector night (Table 3). For the nights that the paired detectors were simultaneously operating (n = 140; Figure 5), bat pass rates were nearly equal between the ground and raised detectors. AnaBat units at temporary stations recorded 1,051 bat passes on 139 detector-nights for a mean of 6.40 ± 1.18 bat passes/detector-night (Table 3).

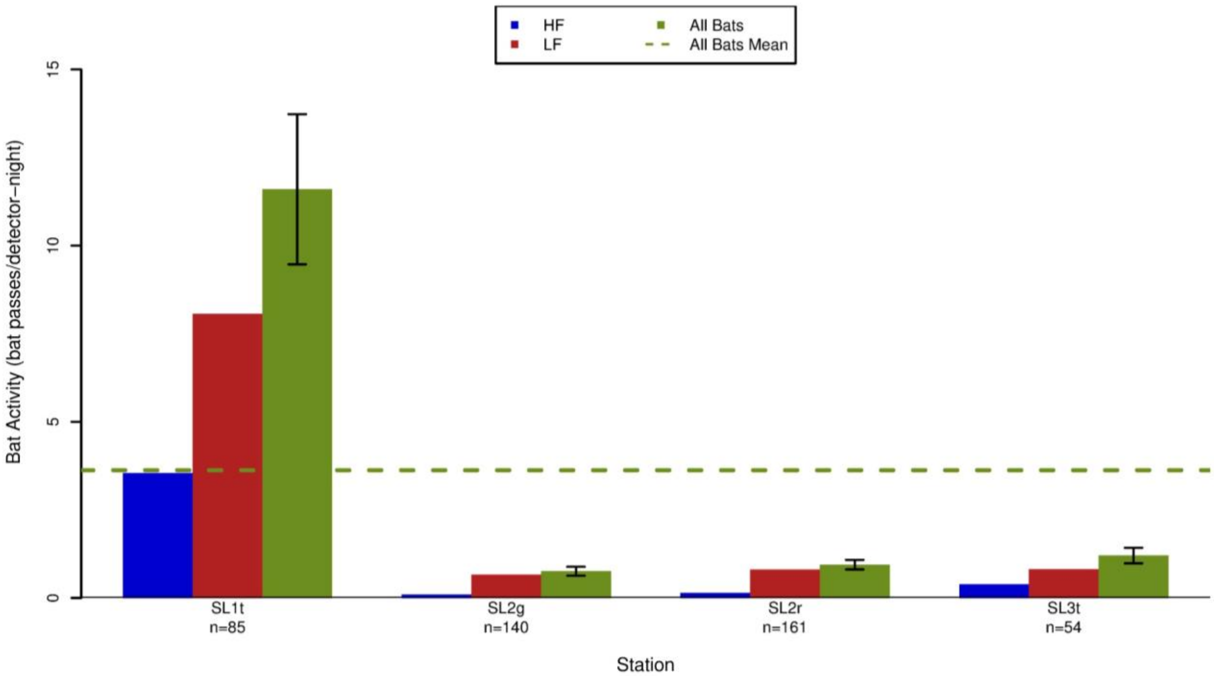

Figure 4. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at detectors within the Sweetland Wind Energy Project, Hand County, South Dakota, between May 7 – October 15, 2018. The bootstrapped standard errors are represented by the black error bars on the ‘All Bats’ columns.

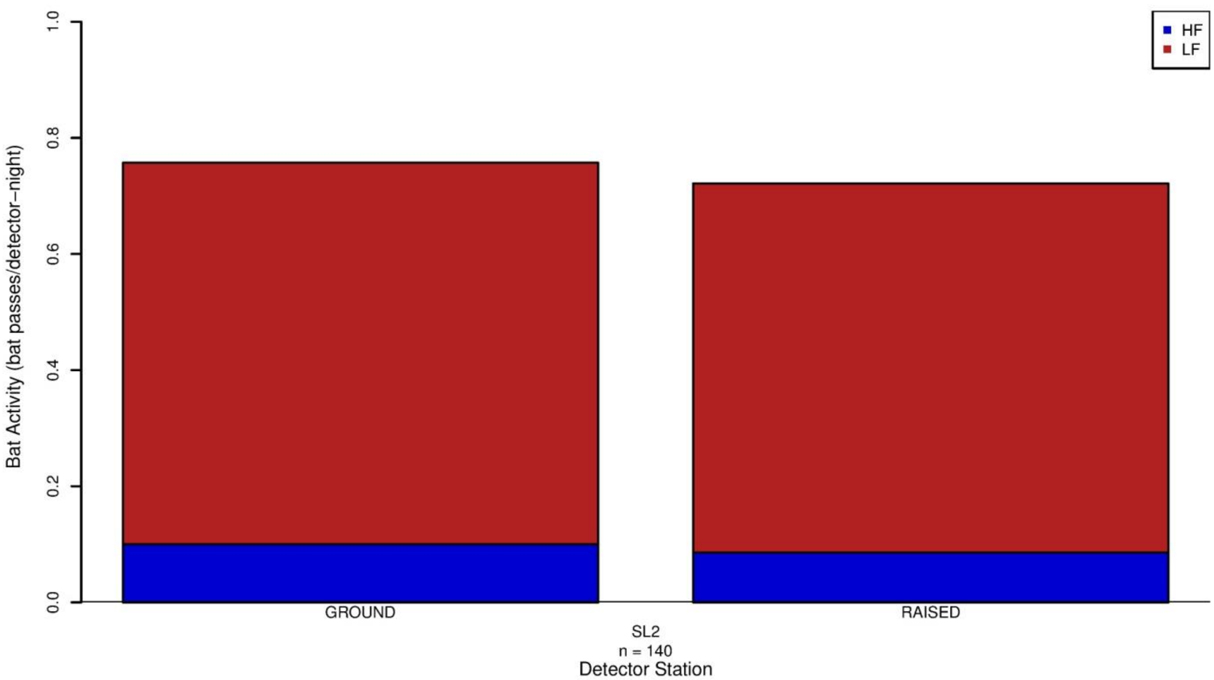

Figure 5. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at paired detectors within the Sweetland Wind Energy Project, Hand County, South Dakota, between May 7 – October 15, 2018.

Temporal Variation

Overall bat activity at fixed stations was relatively low throughout the study period, but was slightly higher in the fall (1.30 ± 0.24 bat passes/detector-night) than in the summer (0.53 ± 0.09 bat passes/detector-night; Table 4, Figure 6). The bat pass rate for the fixed ground detector during the standardized FMP was 1.21 ± 0.26 bat passes/detector night (Table 4). Weekly acoustic activity at fixed stations was highest from late July to mid-September (Figure 7), peaking from August 10 to 16 (4.00 bat passes per detector night; Table 5, Figure 7). Bat activity abruptly decreased for the remainder of the study period (Figure 7). At paired stations (Figure 8), weekly activity was similar between the ground and raised detectors for most of the study period.

Table 4. The number of bat passes per detector-night recorded at detector stations within the Sweetland Wind Energy Project, Hand County, South Dakota, during each season, separated by call frequency: high-frequency (HF), low-frequency (LF), and all bats (AB).

AnaBat Station	Call Frequency	Summer May 7 – August 14	Fall Aug 15 – October 15	Fall Migration Period Jul 30 – October 14
SL2g	LF	0.30	1.13	1.03
	HF	0.02	0.20	0.18
	AB	0.32	1.33	1.21
SL2r	LF	0.59	1.15	1.30
	HF	0.15	0.13	0.23
	AB	0.74	1.27	1.53
Ground Totals	**LF**	**0.30 ± 0.07**	**1.13 ± 0.26**	**1.03 ± 0.24**
	HF	**0.02 ± 0.02**	**0.20 ± 0.07**	**0.18 ± 0.07**
	AB	**0.32 ± 0.07**	**1.33 ± 0.27**	**1.21 ± 0.26**
Raised Totals	**LF**	**0.59 ± 0.12**	**1.15 ± 0.25**	**1.30 ± 0.25**
	HF	**0.15 ± 0.06**	**0.13 ± 0.05**	**0.23 ± 0.08**
	AB	**0.74 ± 0.17**	**1.27 ± 0.27**	**1.53 ± 0.29**
Overall	**LF**	**0.44 ± 0.07**	**1.14 ± 0.23**	**1.16 ± 0.21**
	HF	**0.09 ± 0.03**	**0.16 ± 0.05**	**0.21 ± 0.05**
	AB	**0.53 ± 0.09**	**1.30 ± 0.24**	**1.37 ± 0.23**

Sums may not equal values shown due to rounding.

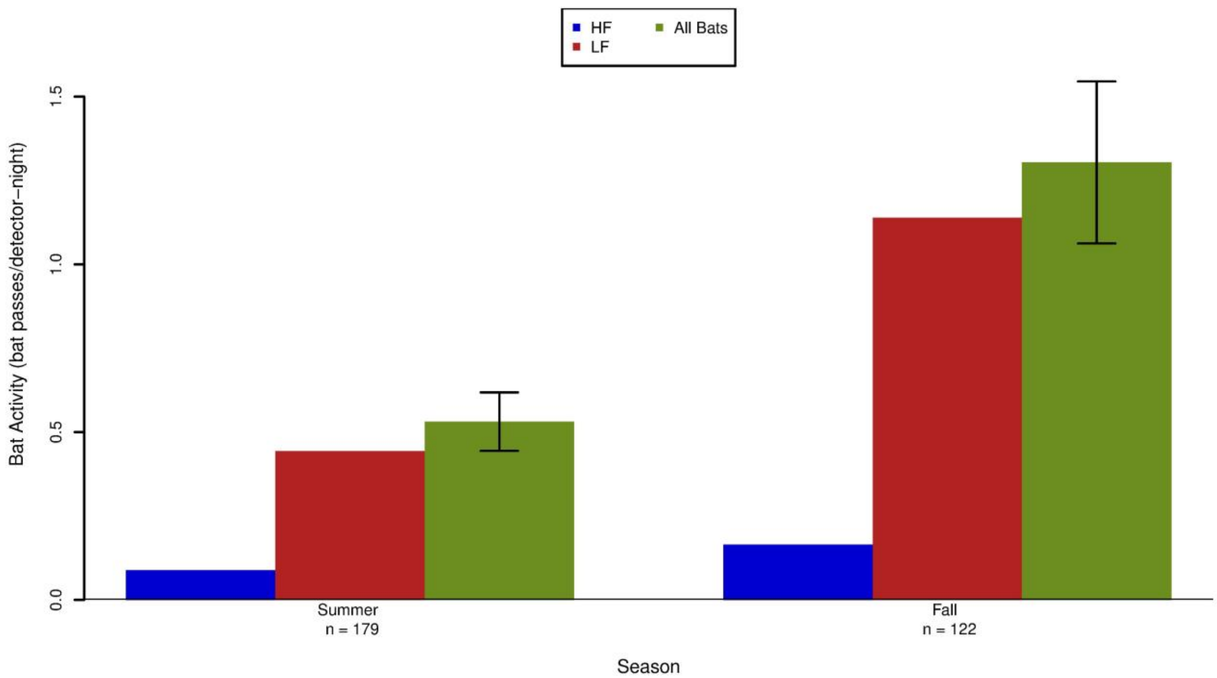

Figure 6. Seasonal bat activity by high frequency (HF), low frequency (LF), and all bats at fixed stations in the Sweetland Wind Energy Project, Hand County, South Dakota, between May 7 – October 15, 2018. The bootstrapped standard errors are represented on the 'All Bats' columns.

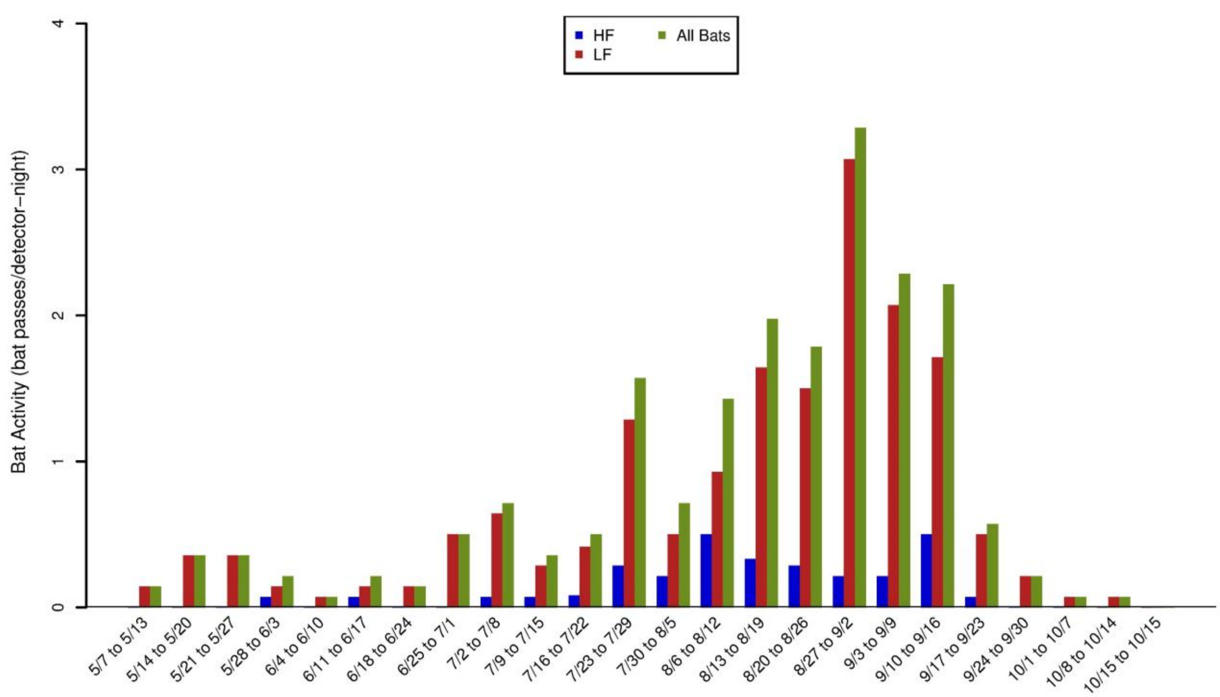

Figure 7. Weekly patterns of bat activity by high frequency (HF), low frequency (LF), and all bats at fixed stations in the Sweetland Wind Energy Project between May 7 – October 15, 2018.

Table 5. Periods of peak activity for low-frequency (LF) bats and all bats at fixed stations in the Sweetland Wind Energy Project, Hand County, South Dakota between May 7 – October 15, 2018. Peak activity was not calculated for high-frequency bats due to relatively low activity rates (less than 1.0 bat pass/detector-night).

Frequency Group	Start Date of Peak Activity	End Date of Peak Activity	Bat Passes/Detector-Night
LF	August 10	August 16	3.14
All Bats	August 10	August 16	4.00

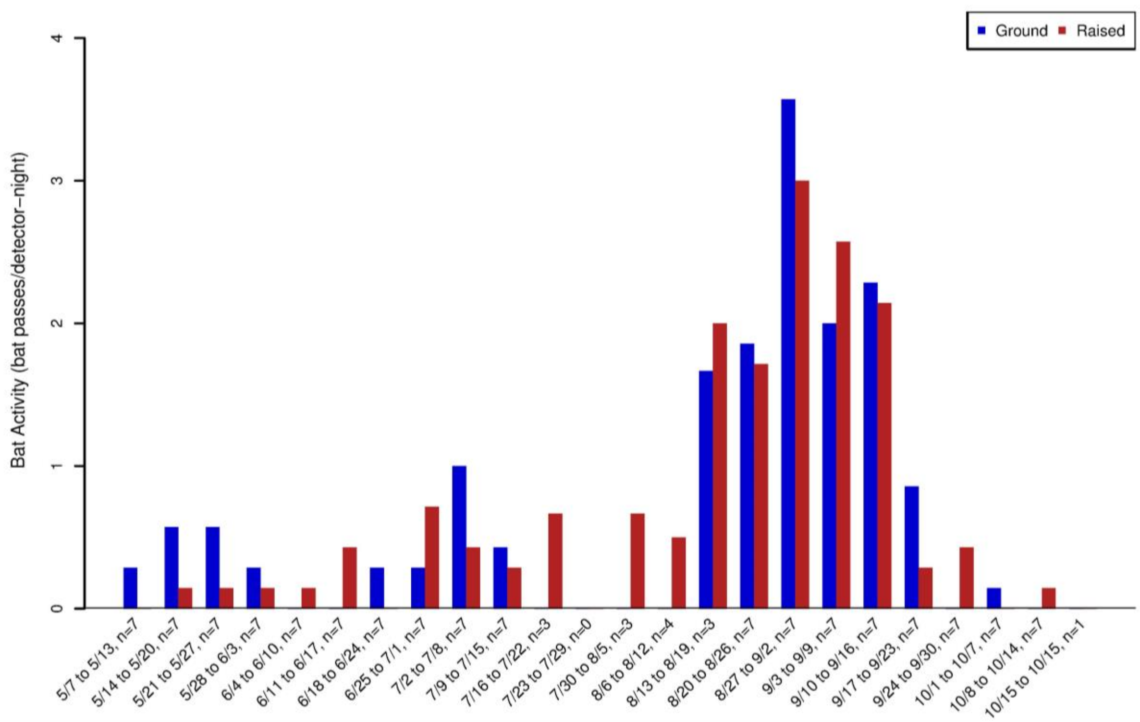

Figure 8. Weekly patterns of bat activity from May 7 – October 15, 2018, at ground and raised fixed stations at the Sweetland Wind Energy Project, Hand County, South Dakota.

Species Composition

At all stations, 72.6% of bat passes were classified as LF, and 27.4% of bat passes were classified as HF (Tables 2 and 3). Activity by LF bats was higher at all stations (Table 3, Figures 4 and 5), and throughout the study period (Figure 7).

DISCUSSION

Bat fatalities have been discovered at most wind energy facilities monitored in North America, with fatality estimates ranging from zero to 49.70 bat fatalities per megawatt (MW) per year (American Wind Wildlife Institute [AWWI] 2018). A summary of 202 studies at 137 wind energy facilities in the U.S. found that the majority reported fewer than five bat fatalities/MW/year, with a nationwide median of 2.66 bat fatalities/MW/year (AWWI 2018). In 2012, an estimated 600,000 bats died as a result of interactions with wind turbines in the US (Hayes 2013). Wind development may pose a threat to populations of migratory bats in particular. Projection models estimate that populations of hoary bats could decline as much as 90% in the next 50 years (Frick et al. 2017). Proximate causes of bat fatalities are primarily due to collisions with moving turbine blades (Grodsky et al. 2011, Rollins et al. 2012) but to a limited extent may also be caused by barotrauma (Baerwald et al. 2008). The underlying reasons for why bats come near turbines are still largely unknown (Cryan and Barclay 2009, Barclay et al. 2017). To date, post-construction monitoring studies of wind energy facilities in the US show that a) migratory tree-roosting species (e.g., eastern red bat, hoary bat, and silver-haired bat) compose approximately 72% of reported bat fatalities; b) the majority of fatalities occur during the fall migration season (August and September); and c) most fatalities occur on nights with relatively low wind speeds (e.g., less than 6.0 m/second (20 ft/second; Arnett et al. 2008, 2013; Arnett and Baerwald 2013; Thompson et al. 2017; AWWI 2018).

It is generally expected that pre-construction bat activity is positively related to post-construction bat fatalities (Kunz et al. 2007b). However, to date, relatively few studies of wind energy facilities that have recorded both bat activity and bat fatality rates are available (Appendix A). Complicating matters, recent evidence suggests that the most numerous of the species found as fatalities at wind turbines (hoary bats) sometimes fly without echolocation (Corcoran and Weller 2018) and therefore might not be recorded on ultrasonic detectors. Given the comparatively limited availability of pre- and post-construction data sets, differences in protocols among studies (Ellison 2012), and significant ecological differences between geographically diverse facilities, the relationship between activity and fatalities has not yet been empirically established (Hein et al. 2013a), though Baerwald and Barclay (2009) found a significant positive association between pass rates measured at 30 m (98 ft) and fatality rates for hoary and silver-haired bats across five sites in southern Alberta.

However, on a continental scale, a similar relationship has proven difficult to establish. The relatively few studies that have estimated both pre-construction activity and post-construction fatalities trend toward a positive association between activity and fatality rates, but they lack statistically significant correlations. Hein et al. (2013a) compiled data from wind projects that included both pre- and post-construction activity and fatality data to assess if pre-construction acoustic activity predicted post-construction fatality rates. Based on data from 12 sites that had both pre- and post-construction data, they did not find a statistically significant relationship ($p=0.07$), although the trend was in the expected direction (i.e., relatively low activity was generally associated with lower mortality and vice-versa). They concluded therefore, that pre-construction acoustic data could not currently predict bat fatalities, but acknowledged that the data set was limited and additional data may indicate a stronger relationship. Therefore, the current approach to assessing the risk to bats requires a qualitative analysis of activity levels, spatial and temporal relationships, species composition, and comparison to regional fatality patterns.

Compared to the results from acoustic bat surveys at the Project during 2017 (Fritchman et al. 2018), similar bat activity rates and patterns in timing and species composition were found during this study. As such, similar expectations of fatality rates, timing, and species affected after construction are consistent between studies. Mean bat activity during the FMP at fixed ground detectors (1.21 bat passes per detector night; Table 4) was lower than the North American median (7.7; Appendix A) and all of studies publicly available from the Midwest region (Appendix A). Given the relatively low bat pass rate, and that over two-thirds (69.1%) of bat fatality studies in the Midwest report fewer than five bat fatalities/MW/year (Appendix A; Figure 9), it is possible that similar fatality rates could be recorded at the Project.

On average, bat activity was nearly eight times higher at the temporary stations than at the fixed ground stations, although this was primarily driven by station SL1t. Both temporary stations SL1t and SL3t were located near forested drainages that bats may have used for roosting or foraging. All stations were in grassland habitat, and grassland is the dominant habitat type at the Project, so these data likely represent the range of bat activity across the Project. A review of 40 US studies found that bat mortality may be inversely related to the percent grassland cover surrounding wind facilities (Thompson et al. 2017). That is, the more open the landscape, the less risk of turbine collisions by bats. However, exceptions to this pattern exist (e.g., Jain 2005, Arnett and Baerwald 2013) and it may not be applicable to all regions (Thompson et al. 2017).

Approximately 73% of bat passes recorded in the Project were emitted by LF bats, suggesting a greater abundance of species such as big brown bats, silver-haired bats, and hoary bats (Table 3). LF species may become casualties because these species fly at higher altitudes, as demonstrated by their greater prevalence of LF bat calls at the raised detector (Table 3, Figure 5). Activity by HF bat species composed about 27% of bat passes recorded at stations in the Project. Eastern red bats are usually the most common HF species found during carcass searches (Arnett et al. 2008, Arnett and Baerwald 2013). *Myotis* species are recorded less commonly than other species in the rotor-swept zone or as fatalities at most post-construction studies of wind energy facilities (Kunz et al. 2007a, Arnett et al. 2008), with a few notable exceptions (Kerns and Kerlinger 2004, Jain 2005, Brown and Hamilton 2006a, Gruver et al. 2009). Given that hoary bats, eastern red bats, and silver-haired bats are among the most common bat fatalities at many facilities (Arnett et al. 2008, Arnett and Baerwald 2013), it is expected that these three species would likely be the most common fatalities found at the Project.

At fixed stations, bat activity peaked during mid-August to mid-September. This timing is consistent with peak fatality periods for most wind energy facilities in the US, and suggests that bat fatalities at the Project will likely be highest during late summer to early fall and may consist largely of migrating individuals. The Wessington Springs Wind Project (Wessington Springs), located approximately 24 miles (mi; 38 kilometers [km]) southeast of the Project (Derby et al. 2010c, 2011a) and the PrairieWinds Wind Project, located 30 mi (48 km) south of the Project (Derby et al. 2012c, 2013a, 2014), are dominated by grassland habitat primarily used for cattle (*Bos taurus*) grazing and haying, with some patches of deciduous trees and open waterbodies available, similar to the Project. Due to relatively low activity rates during the summer and fall at the Project, and due to the geographic proximity and habitat similarity of the Project to

Wessington Springs and PrairieWinds, it is assumed that bat mortality at the Project would be relativley low and follow similar patterns as those observed at other facilities within the region (e.g., 0.41 – 1.48 bat fatalities/MW/year [Derby et al. 2010c, 2011a], 0.52 – 1.23 bats/MW/year [Derby et al. 2012c, 2013a, 2014]; Figure 9). The pre-construction bat studies completed at the Project will add to the growing body of research regarding the impacts of wind energy development on bats and may provide a valuable comparison to post-construction studies to be completed at Project.

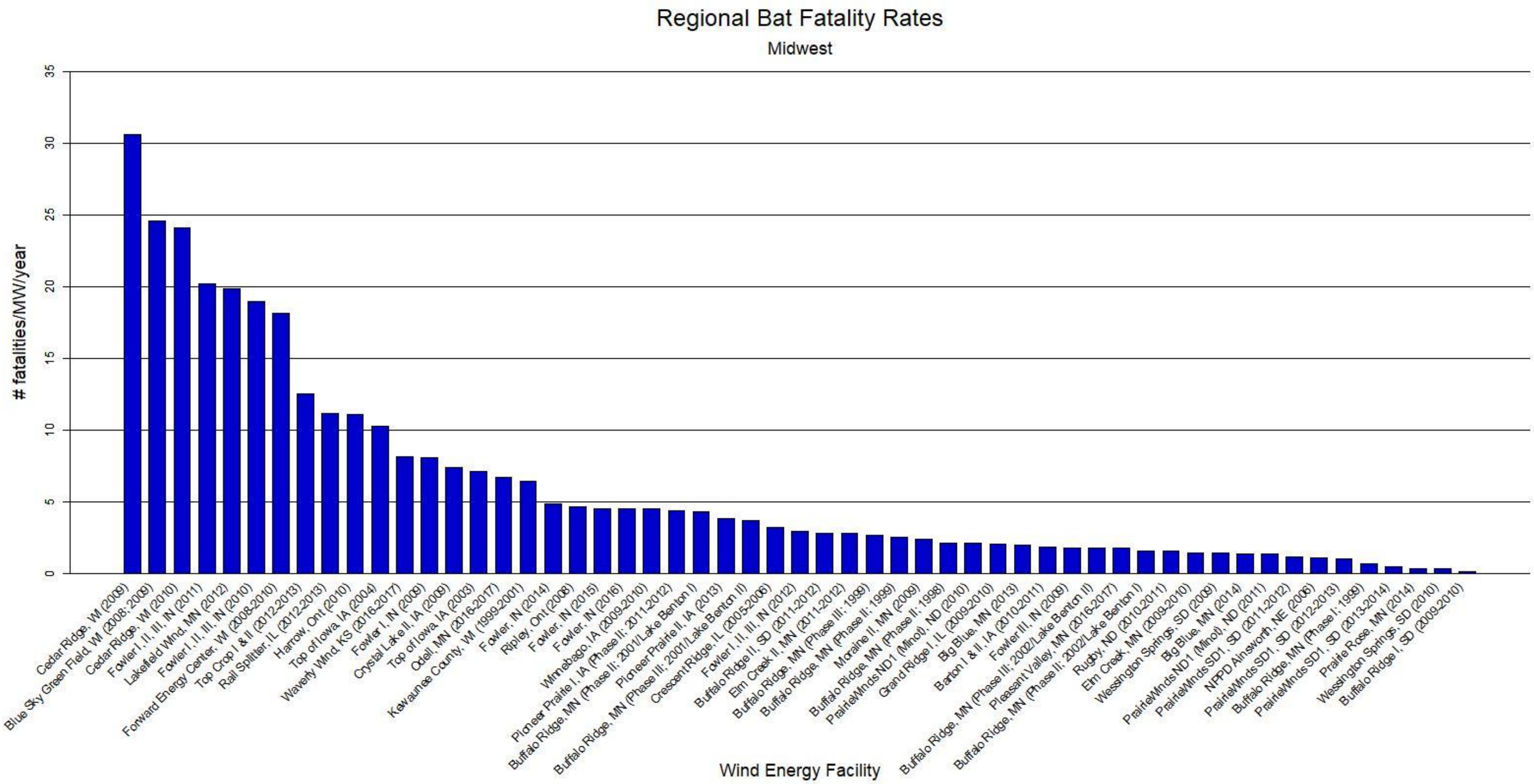

Figure 9. Fatality rates for bats (number of bats per megawatt per year) from publicly available studies at wind energy facilities in the Midwest region of North America.

Figure 9 (*continued*). Fatality rates for bats (number of bats per megawatt per year) from publicly available studies at wind energy facilities in the Midwest region of North America.

Facility Study	Citation	Facility Study	Citation
Cedar Ridge, WI (2009)	BHE Environmental 2010	Buffalo Ridge II, SD (2011-2012)	Derby et al. 2012a
Blue Sky Green Field, WI (2008; 2009)	Gruver et al. 2009	Elm Creek II, MN (2011-2012)	Derby et al. 2012b
Cedar Ridge, WI (2010)	BHE Environmental 2011	Buffalo Ridge, MN (Phase III; 1999)	Johnson et al. 2000
Fowler I, II, III, IN (2011)	Good et al. 2012	Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2000
Lakefield Wind, MN (2012)	Minnesota Public Utilities Commission 2012	Moraine II, MN (2009)	Derby et al. 2010f
Fowler I, II, III, IN (2010)	Good et al. 2011	Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000
Forward Energy Center, WI (2008-2010)	Grodsky and Drake 2011	PrairieWinds ND1 (Minot), ND (2010)	Derby et al. 2011d
Top Crop I & II, IL (2012-2013)	Good et al. 2013c	Grand Ridge I, IL (2009-2010)	Derby et al. 2010a
Rail Splitter, IL (2012-2013)	Good et al. 2013b	Big Blue, MN (2013)	Fagen Engineering 2014
Harrow, Ont (2010)	Natural Resources Solutions Inc. 2011	Barton I & II, IA (2010-2011)	Derby et al. 2011b
Top of Iowa, IA (2004)	Jain 2005	Fowler III, IN (2009)	Johnson et al. 2010b
Waverly Wind, KS (2016-2017)	Tetra Tech 2017a	Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	Johnson et al. 2004
Fowler I, IN (2009)	Johnson et al. 2010a	Pleasant Valley, MN (2016-2017)	Tetra Tech 2017b
Crystal Lake II, IA (2009)	Derby et al. 2010b	Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	Johnson et al. 2004
Top of Iowa, IA (2003)	Jain 2005	Rugby, ND (2010-2011)	Derby et al. 2011c
Odell, MN (2016-2017)	Chodachek and Gustafson 2018	Elm Creek, MN (2009-2010)	Derby et al. 2010e
Kewaunee County, WI (1999-2001)	Howe et al. 2002	Wessington Springs, SD (2009)	Derby et al. 2010c
Fowler, IN (2014)	Good et al. 2015	Big Blue, MN (2014)	Fagen Engineering 2015
Ripley, Ont (2008)	Jacques Whitford 2009	PrairieWinds ND1 (Minot), ND (2011)	Derby et al. 2012d
Fowler, IN (2015)	Good et al. 2016	PrairieWinds SD1, SD (2011-2012)	Derby et al. 2012c
Fowler, IN (2016)	Good et al. 2017	NPPD Ainsworth, NE (2006)	Derby et al. 2007
Winnebago, IA (2009-2010)	Derby et al. 2010g	PrairieWinds SD1, SD (2012-2013)	Derby et al. 2013a
Pioneer Prairie I, IA (Phase II; 2011-2012)	Chodachek et al. 2012	Buffalo Ridge, MN (Phase I; 1999)	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	Johnson et al. 2004	PrairieWinds SD1, SD (2013-2014)	Derby et al. 2014
Pioneer Prairie II, IA (2013)	Chodachek et al. 2014	Prairie Rose, MN (2014)	Chodachek et al. 2015
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	Johnson et al. 2004	Wessington Springs, SD (2010)	Derby et al. 2011a
Crescent Ridge, IL (2005-2006)	Kerlinger et al. 2007	Buffalo Ridge I, SD (2009-2010)	Derby et al. 2010d
Fowler I, II, III, IN (2012)	Good et al. 2013a		

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Appendix A. North American Bat Fatality Summary Tables

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as the bat passes per detector night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Sweetland, SD	1.21	7/30/18-10/14/18			
Midwest					
Cedar Ridge, WI (2009)	9.97[A,B,C,D]	7/16/07-9/30/07	30.61	41	67.6
Blue Sky Green Field, WI (2008; 2009)	7.7[A]	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	9.97[A,B,C,D]	7/16/07-9/30/07	24.12	41	68
Fowler I, II, III, IN (2011)	NA	NA	20.19	355	600
Lakefield Wind, MN (2012)	NA	NA	19.87	137	205.5
Fowler I, II, III, IN (2010)	NA	NA	18.96	355	600
Forward Energy Center, WI (2008-2010)	6.97	8/5/08-11/08/08	18.17	86	129
Top Crop I & II, IL (2012-2013)	NA	NA	12.55	200 (68 Phase I, 132 Phase II)	300 (102 Phase I, 198 Phase II)
Rail Splitter, IL (2012-2013)	NA	NA	11.21	67	100.5
Harrow, Ont (2010)	NA	NA	11.13	24 (four 6-turbine facilities)	39.6
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Waverly Wind, KS (2016-2017)	NA	NA	8.2	95	199
Fowler I, IN (2009)	NA	NA	8.09	162	301
Crystal Lake II, IA (2009)	NA	NA	7.42	80	200
Top of Iowa, IA (2003)	NA	NA	7.16	89	80
Odell, MN (2016-2017)	NA	NA	6.74	100	200
Kewaunee County, WI (1999-2001)	NA	NA	6.45	31	20.46
Fowler, IN (2014)	NA	NA	4.86	355	600
Ripley, Ont (2008)	NA	NA	4.67	38	76
Winnebago, IA (2009-2010)	NA	NA	4.54	10	20
Fowler, IN (2016)	NA	NA	4.54	420	750
Fowler, IN (2015)	NA	NA	4.54	420	NA
Pioneer Prairie I, IA (Phase II; 2011-2012)	NA	NA	4.43	62	102.3
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2[B]	6/15/01-9/15/01	4.35	143	107.25
Pioneer Prairie II, IA (2013)	NA	NA	3.83	62	102.3
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2[B]	6/15/01-9/15/01	3.71	138	103.5
Crescent Ridge, IL (2005-2006)	NA	NA	3.27	33	49.5
Fowler I, II, III, IN (2012)	NA	NA	2.96	355	600
Elm Creek II, MN (2011-2012)	NA	NA	2.81	62	148.8
Buffalo Ridge II, SD (2011-2012)	NA	NA	2.81	105	210
Buffalo Ridge, MN (Phase III; 1999)	NA	NA	2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)	NA	NA	2.59	143	107.25
Moraine II, MN (2009)	NA	NA	2.42	33	49.5
Buffalo Ridge, MN (Phase II; 1998)	NA	NA	2.16	143	107.25
PrairieWinds ND1 (Minot), ND (2010)	NA	NA	2.13	80	115.5
Grand Ridge I, IL (2009-2010)	NA	NA	2.1	66	99

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as the bat passes per detector night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Big Blue, MN (2013)	NA	NA	2.04	18	36
Barton I & II, IA (2010-2011)	NA	NA	1.85	80	160
Fowler III, IN (2009)	NA	NA	1.84	60	99
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9[B]	6/15/02-9/15/02	1.81	138	103.5
Pleasant Valley, MN (2016-2017)	NA	NA	1.8	100	200
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9[B]	6/15/02-9/15/02	1.64	143	107.25
Rugby, ND (2010-2011)	NA	NA	1.6	71	149
Elm Creek, MN (2009-2010)	NA	NA	1.49	67	100
Wessington Springs, SD (2009)	NA	NA	1.48	34	51
Big Blue, MN (2014)	NA	NA	1.43	18	36
PrairieWinds ND1 (Minot), ND (2011)	NA	NA	1.39	80	115.5
PrairieWinds SD1, SD (2011-2012)	NA	NA	1.23	108	162
NPPD Ainsworth, NE (2006)	NA	NA	1.16	36	20.5
PrairieWinds SD1, SD (2012-2013)	NA	NA	1.05	108	162
Buffalo Ridge, MN (Phase I; 1999)	NA	NA	0.74	73	25
PrairieWinds SD1, SD (2013-2014)	NA	NA	0.52	108	162
Prairie Rose, MN (2014)	NA	NA	0.41	119	200
Wessington Springs, SD (2010)	NA	NA	0.41	34	51
Buffalo Ridge I, SD (2009-2010)	NA	NA	0.16	24	50.4
Southern Plains					
Barton Chapel, TX (2009-2010)	NA	NA	3.06	60	120
Big Smile, OK (2012-2013)	NA	NA	2.9	66	132
Buffalo Gap II, TX (2007-2008)	NA	NA	0.14	155	233
Red Hills, OK (2012-2013)	NA	NA	0.11	82	123
Buffalo Gap I, TX (2006)	NA	NA	0.1	67	134
Southwest					
Spring Valley, NV (2012-2013)	NA	NA	3.73	NA	NA
Dry Lake I, AZ (2009-2010)	8.8	4/29/10-11/10/10	3.43	30	63
Dry Lake II, AZ (2011-2012)	11.5	5/11/11-10/26/11	1.66	31	65
California					
Hatchet Ridge, CA (2012)	NA	NA	5.22	44	101
Hatchet Ridge, CA (2012-2013)	NA	NA	4.2	44	NA
Shiloh I, CA (2006-2009)	NA	NA	3.92	100	150
Shiloh II, CA (2010-2011)	NA	NA	3.8	75	150
Shiloh II, CA (2011-2012)	NA	NA	3.4	75	150
Shiloh II, CA (2009-2010)	NA	NA	2.6	75	150
High Winds, CA (2003-2004)	NA	NA	2.51	90	162
Hatchet Ridge, CA (2011)	NA	NA	2.23	44	101
Lower West, CA (2012-2013)	NA	NA	2.17	7	14
Dillon, CA (2008-2009)	NA	NA	2.17	45	45
Montezuma I, CA (2011)	NA	NA	1.9	16	36.8
High Winds, CA (2004-2005)	NA	NA	1.52	90	162
Alta Wind I, CA (2011-2012)	4.42[E]	6/26/09-10/31/09	1.28	100	150
Lower West, CA (2014-2015)	NA	NA	1.13	7	14
Montezuma II, CA (2012-2013)	NA	NA	0.91	34	78.2
Montezuma I, CA (2012)	NA	NA	0.84	16	36.8

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as the bat passes per detector night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Diablo Winds, CA (2005-2007)	NA	NA	0.82	31	20.46
Alta X, CA (2015-2016)	NA	NA	0.8	48	137
Alta I, CA (2015-2016)	NA	NA	0.7	290	720
Alta X, CA (2014-2015)	NA	NA	0.42	48	137
Shiloh III, CA (2012-2013)	NA	NA	0.4	50	102.5
Alta I, CA (2013-2014)	NA	NA	0.36	290	720
Mustang Hills, CA (2016-2017)	NA	NA	0.33	100	300
Solano III, CA (2012-2013)	NA	NA	0.31	55	128
Alite, CA (2009-2010)	NA	NA	0.24	8	24
Pacific Wind, CA (2014-2015)	NA	NA	0.21	70	144
Cameron Ridge/Section 15, CA (2015-2016)	NA	NA	0.19	34	102
Pinyon Pines I & II, CA (2015-2016)	NA	NA	0.18	100	300
Alta VIII, CA (2014-2015)	NA	NA	0.17	100	300
Cameron Ridge/Section 15, CA (2014-2015)	NA	NA	0.15	34	102
Mustang Hills, CA (2012-2013)	NA	NA	0.1	50	150
Alta Wind II-V, CA (2011-2012)	0.78	6/26/09-10/31/09	0.08	190	570
Pinyon Pines I & II, CA (2013-2014)	NA	NA	0.04	100	NA
Windstar, CA (2012-2013)	NA	NA	0	53	106
Lower West, CA (2016-2017)	NA	NA	0	7	14
Pacific Wind, CA (2015-2016)	NA	NA	0	70	144
Alta VIII, CA (2012-2013)	NA	NA	0	50	150
Rising Tree, CA (2017-2018)	NA	NA	0	60	198
Mustang Hills, CA (2014-2015)	NA	NA	0	100	300
Alta II-V, CA (2013-2014)	NA	NA	0	290	720
Alta II-V, CA (2015-2016)	NA	NA	0	290	720
Pacific Northwest					
Palouse Wind, WA (2012-2013)	NA	NA	4.23	58	104.4
Biglow Canyon, OR (Phase II; 2009-2010)	NA	NA	2.71	65	150
Nine Canyon, WA (2002-2003)	NA	NA	2.47	37	48.1
Stateline, OR/WA (2003)	NA	NA	2.29	454	299
Tucannon River, WA (2015)	NA	NA	2.22	116	267
Elkhorn, OR (2010)	NA	NA	2.14	61	101
White Creek, WA (2007-2011)	NA	NA	2.04	89	204.7
Biglow Canyon, OR (Phase I; 2008)	NA	NA	1.99	76	125.4
Leaning Juniper, OR (2006-2008)	NA	NA	1.98	67	100.5
Chopin, OR (2016-2017)	NA	NA	1.9	6	10
Big Horn, WA (2006-2007)	NA	NA	1.9	133	199.5
Combine Hills, OR (Phase I; 2004-2005)	NA	NA	1.88	41	41
Linden Ranch, WA (2010-2011)	NA	NA	1.68	25	50
Pebble Springs, OR (2009-2010)	NA	NA	1.55	47	98.7
Hopkins Ridge, WA (2008)	NA	NA	1.39	87	156.6
Harvest Wind, WA (2010-2012)	NA	NA	1.27	43	98.9
Elkhorn, OR (2008)	NA	NA	1.26	61	101
Vansycle, OR (1999)	NA	NA	1.12	38	24.9

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as the bat passes per detector night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Klondike III (Phase I), OR (2007-2009)	NA	NA	1.11	125	223.6
Stateline, OR/WA (2001-2002)	NA	NA	1.09	454	299
Stateline, OR/WA (2006)	NA	NA	0.95	454	299
Tuolumne (Windy Point I), WA (2009-2010)	NA	NA	0.94	62	136.6
Klondike, OR (2002-2003)	NA	NA	0.77	16	24
Combine Hills, OR (2011)	NA	NA	0.73	104	104
Hopkins Ridge, WA (2006)	NA	NA	0.63	83	150
Biglow Canyon, OR (Phase I; 2009)	NA	NA	0.58	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)	NA	NA	0.57	65	150
Hay Canyon, OR (2009-2010)	NA	NA	0.53	48	100.8
Windy Flats, WA (2010-2011)	NA	NA	0.41	114	262.2
Klondike II, OR (2005-2006)	NA	NA	0.41	50	75
Vantage, WA (2010-2011)	NA	NA	0.4	60	90
Wild Horse, WA (2007)	NA	NA	0.39	127	229
Goodnoe, WA (2009-2010)	NA	NA	0.34	47	94
Marengo II, WA (2009-2010)	NA	NA	0.27	39	70.2
Biglow Canyon, OR (Phase III; 2010-2011)	NA	NA	0.22	76	174.8
Marengo I, WA (2009-2010)	NA	NA	0.17	78	140.4
Klondike IIIa (Phase II), OR (2008-2010)	NA	NA	0.14	51	76.5
Kittitas Valley, WA (2011-2012)	NA	NA	0.12	48	100.8
Rocky Mountains					
Summerview, Alb (2006; 2007)	7.65[B]	07/15/06-07-09/30/06-07	11.42	39	70.2
Summerview, Alb (2005-2006)	NA	NA	10.27	39	70.2
Judith Gap, MT (2006-2007)	NA	NA	8.93	90	135
Foote Creek Rim I, WY (1999)	NA	NA	3.97	69	41
Judith Gap, MT (2009)	NA	NA	3.2	90	135
Top of the World, WY (2010-2011)	NA	NA	2.74	110	200
Top of the World, WY (2011-2012)	NA	NA	2.43	110	200
Top of the World, WY (2012-2013)	NA	NA	2.34	110	200
Milford I, UT (2010-2011)	NA	NA	2.05	58	145
Milford I & II, UT (2011-2012)	NA	NA	1.67	107	160.5 (58.5 Phase I, 102 Phase II)
Foote Creek Rim I, WY (2001-2002)	2.2[A,B]	6/15/01-9/1/01	1.57	69	41
Foote Creek Rim I, WY (2000)	2.2[A,B]	6/15/00-9/1/00	1.05	69	41
Southeast					
Buffalo Mountain, TN (2005)	NA	NA	39.7	18	28.98
Buffalo Mountain, TN (2000-2003)	23.7[D]	NA	31.54	3	1.98
Northeast					
Pinnacle, WV (2012)	NA	NA	40.2	23	55.2
Mountaineer, WV (2003)	NA	NA	31.69	44	66
Mount Storm, WV (2009)	30.09	7/15/09-10/7/09	17.53	132	264
Noble Wethersfield, NY (2010)	NA	NA	16.3	84	126

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as the bat passes per detector night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Criterion, MD (2011)	NA	NA	15.61	28	70
Mount Storm, WV (2010)	36.67[F]	4/18/10-10/15/10	15.18	132	264
Locust Ridge, PA (Phase II; 2010)	NA	NA	14.38	51	102
Locust Ridge, PA (Phase II; 2009)	NA	NA	14.11	51	102
Casselman, PA (2008)	NA	NA	12.61	23	34.5
Maple Ridge, NY (2006)	NA	NA	11.21	120	198
Cohocton/Dutch Hills, NY (2010)	NA	NA	10.32	50	125
Howard, NY (2012)	NA	NA	10	27	54
Wolfe Island, Ont (July-December 2010)	NA	NA	9.5	86	197.8
Cohocton/Dutch Hill, NY (2009)	NA	NA	8.62	50	125
Casselman, PA (2009)	NA	NA	8.6	23	34.5
Noble Bliss, NY (2008)	NA	NA	7.8	67	100
Criterion, MD (2012)	NA	NA	7.62	28	70
Mount Storm, WV (2011)	NA	NA	7.43	132	264
Maple Ridge, NY (2012)	NA	NA	7.3	195	321.75
Mount Storm, WV (Fall 2008)	35.2	7/20/08-10/12/08	6.62	82	164
Maple Ridge, NY (2007)	NA	NA	6.49	195	321.75
Wolfe Island, Ont (July-December 2009)	NA	NA	6.42	86	197.8
Roth Rock, MD (2011)	NA	NA	6.24	20	50
Steel Winds I & II, NY (2013)	NA	NA	6.14	14	35
Criterion, MD (2013)	NA	NA	5.32	28	70
Maple Ridge, NY (2007-2008)	NA	NA	4.96	195	321.75
Noble Clinton, NY (2009)	1.9[C]	8/1/09-09/31/09	4.5	67	100
Casselman Curtailment, PA (2008)	NA	NA	4.4	23	35.4
Noble Altona, NY (2010)	NA	NA	4.34	65	97.5
Noble Ellenburg, NY (2009)	16.1[C]	8/16/09-09/15/09	3.91	54	80
Noble Bliss, NY (2009)	NA	NA	3.85	67	100
Lempster, NH (2010)	NA	NA	3.57	12	24
Noble Ellenburg, NY (2008)	NA	NA	3.46	54	80
Noble Clinton, NY (2008)	2.1[C]	8/8/08-09/31/08	3.14	67	100
Lempster, NH (2009)	NA	NA	3.11	12	24
Record Hill, ME (2012)	24.6	4/16/12-10/23/12	2.96	22	50.6
Mars Hill, ME (2007)	NA	NA	2.91	28	42
Wolfe Island, Ont (July-December 2011)	NA	NA	2.49	86	197.8
Noble Chateaugay, NY (2010)	NA	NA	2.44	71	106.5
High Sheldon, NY (2010)	NA	NA	2.33	75	112.5
Stetson Mountain II, ME (2012)	NA	NA	2.27	17	25.5
Howard, NY (2013)	NA	NA	2.13	27	54
Beech Ridge, WV (2012)	NA	NA	2.03	67	100.5
Munnsville, NY (2008)	NA	NA	1.93	23	34.5
High Sheldon, NY (2011)	NA	NA	1.78	75	112.5
Groton, NH (2015)	NA	NA	1.74	24	48
Stetson Mountain II, ME (2010)	NA	NA	1.65	17	25.5
Groton, NH (2014)	NA	NA	1.63	NA	48
Bull Hill, ME (2013)	NA	NA	1.62	19	34
Stetson Mountain I, ME (2009)	28.5; 0.3[G]	7/10/09-10/15/09	1.4	38	57

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. Activity estimate given as the bat passes per detector night. Fatality estimate given as the number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bat Activity Estimate	Bat Activity Dates	Fatality Estimate	No. of Turbines	Total MW
Cohocton/Dutch Hill, NY (2013)	NA	NA	1.37	50	125
Groton, NH (2013)	NA	NA	1.31	24	48
Record Hill, ME (2016)	NA	NA	1.25	22	51
Stetson II, ME (2014)	NA	NA	0.83	17	26
Beech Ridge, WV (2013)	NA	NA	0.58	67	100.5
Record Hill, ME (2014)	NA	NA	0.55	22	50.6
Oakfield, ME (2017)	NA	NA	0.51	48	148
Mars Hill, ME (2008)	NA	NA	0.45	28	42
Rollins, ME (2014)	NA	NA	0.33	40	60
Spruce Mountain Wind Project, ME (2014)	NA	NA	0.31	10	20
Hancock, ME (2017)	NA	NA	0.3	17	51
Stetson Mountain I, ME (2011)	NA	NA	0.28	38	57
Bingham Wind Project, ME (2017)	NA	NA	0.23	56	185
Stetson Mountain I, ME (2013)	NA	NA	0.18	38	57
Rollins, ME (2012)	NA	NA	0.18	40	60
Kibby, ME (2011)	NA	NA	0.12	44	132

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

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

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

D = Activity rate calculated by Western EcoSystems Technology, Inc. from data presented in referenced report

E = Average of ground-based detectors at CPC Proper (Phase I) for late summer/fall period only

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

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

Appendix A1 (*continued*). Wind energy facilities in North America with comparable activity and fatality data for bats. Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Sweetland, SD	**This study**				
Alite, CA (2009-2010)		Chatfield et al. 2010	Linden Ranch, WA (2010-2011)		Enz and Bay 2011
Alta Wind I, CA (2011-2012)	Solick et al. 2010	Chatfield et al. 2012	Locust Ridge, PA (Phase II; 2009)		Arnett et al. 2011
Alta Wind I, CA (2013-2014)		Chatfield et al. 2014	Locust Ridge, PA (Phase II; 2010)		Arnett et al. 2011
Alta I, CA (2015-2016)		Thompson et al. 2016a	Lower West, CA (2012-2013)		Levenstein and Bay 2013a
Alta Wind II-V, CA (2011-2012)	Solick et al. 2010	Chatfield et al. 2012	Lower West, CA (2014-2015)		Levenstein and DiDonato 2015
Alta II-V, CA (2013-2014)		Chatfield et al. 2014	Lower West, CA (2016-2017)		WEST 2017b
Alta II-V, CA (2015-2016)		Thompson et al. 2016a	Maple Ridge, NY (2006)		Jain et al. 2007
Alta VIII, CA (2012-2013)		Chatfield and Bay 2014	Maple Ridge, NY (2007)		Jain et al. 2009a
Alta VIII, CA (2014-2015)		Western EcoSystems Technology, Inc. (WEST) 2016c	Maple Ridge, NY (2007-2008)		Jain et al. 2009b
Alta X, CA (2014-2015)		Chatfield et al. 2015	Maple Ridge, NY (2012)		Tidhar et al. 2013b
Alta X, CA (2015-2016)		Thompson et al. 2016b	Marengo I, WA (2009-2010)		URS 2010b
Barton I & II, IA (2010-2011)		Derby et al. 2011b	Marengo II, WA (2009-2010)		URS 2010c
Barton Chapel, TX (2009-2010)		WEST 2011	Mars Hill, ME (2007)		Stantec 2008a
Beech Ridge, WV (2012)		Tidhar et al. 2013a	Mars Hill, ME (2008)		Stantec 2009a
Beech Ridge, WV (2013)		Young et al. 2014a	Milford I, UT (2010-2011)		Stantec 2011b
Big Blue, MN (2013)		Fagen Engineering 2014	Milford I & II, UT (2011-2012)		Stantec 2012b
Big Blue, MN (2014)		Fagen Engineering 2015	Montezuma I, CA (2011)		ICF International 2012
Big Horn, WA (2006-2007)		Kronner et al. 2008	Montezuma I, CA (2012)		ICF International 2013
Big Smile, OK (2012-2013)		Derby et al. 2013b	Montezuma II, CA (2012-2013)		Harvey & Associates 2013
Biglow Canyon, OR (Phase I; 2008)		Jeffrey et al. 2009b	Moraine II, MN (2009)		Derby et al. 2010f
Biglow Canyon, OR (Phase I; 2009)		Enk et al. 2010	Mount Storm, WV (Fall 2008)	Young et al. 2009c	Young et al. 2009c
Biglow Canyon, OR (Phase II; 2009-2010)		Enk et al. 2011b	Mount Storm, WV (2009)	Young et al. 2009a, 2010b	Young et al. 2009a, 2010b
Biglow Canyon, OR (Phase II; 2010-2011)		Enk et al. 2012b	Mount Storm, WV (2010)	Young et al. 2010a, 2011b	Young et al. 2010a, 2011b

Appendix A1 (*continued*). Wind energy facilities in North America with comparable activity and fatality data for bats. Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Biglow Canyon, OR (Phase III; 2010-2011)		Enk et al. 2012a	Mount Storm, WV (2011)		Young et al. 2011a, 2012a
Bingham Wind Project, ME (2017)		TRC 2017a	Mountaineer, WV (2003)		Kerns and Kerlinger 2004
Blue Sky Green Field, WI (2008; 2009)	Gruver 2008	Gruver et al. 2009	Munnsville, NY (2008)		Stantec 2009b
Buffalo Gap I, TX (2006)		Tierney 2007			
Buffalo Gap II, TX (2007-2008)		Tierney 2009	Mustang Hills, CA (2012-2013)		Chatfield and Bay 2014
Buffalo Mountain, TN (2000-2003)	Fiedler 2004	Nicholson et al. 2005	Mustang Hills, CA (2014-2015)		WEST 2016c
Buffalo Mountain, TN (2005)		Fiedler et al. 2007	Mustang Hills, CA (2016-2017)		WEST 2018
Buffalo Ridge, MN (Phase I; 1999)		Johnson et al. 2000	Nine Canyon, WA (2002-2003)		Erickson et al. 2003
Buffalo Ridge, MN (Phase II; 1998)		Johnson et al. 2000	Noble Altona, NY (2010)		Jain et al. 2011a
Buffalo Ridge, MN (Phase II; 1999)		Johnson et al. 2000	Noble Bliss, NY (2008)		Jain et al.2009c
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Noble Bliss, NY (2009)		Jain et al. 2010c
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Noble Chateaugay, NY (2010)		Jain et al. 2011b
Buffalo Ridge, MN (Phase III; 1999)		Johnson et al. 2000	Noble Clinton, NY (2008)	Reynolds 2010a	Jain et al. 2009d
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Noble Clinton, NY (2009)	Reynolds 2010a	Jain et al. 2010a
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Noble Ellenburg, NY (2008)		Jain et al. 2009e
Buffalo Ridge I, SD (2009-2010)		Derby et al. 2010d	Noble Ellenburg, NY (2009)	Reynolds 2010b	Jain et al. 2010b
Buffalo Ridge II, SD (2011-2012)		Derby et al. 2012a	Noble Wethersfield, NY (2010)		Jain et al. 2011c
Bull Hill, ME (2013)		Stantec Consulting (Stantec) 2014a	NPPD Ainsworth, NE (2006)		Derby et al. 2007
Cameron Ridge/Section 15, CA (2014-2015)		WEST 2016b	Oakfield, ME (2017)		TRC 2018
Cameron Ridge/Section 15, CA (2015-2016)		Rintz and Thompson 2017	Odell, MN (2016-2017)		Chodachek and Gustafson 2018
Casselman, PA (2008)		Arnett et al. 2009b	Pacific Wind, CA (2014-2015)		WEST 2016a
Casselman, PA (2009)		Arnett et al. 2010	Pacific Wind, CA (2015-2016)		WEST 2017a
Casselman Curtailment, PA (2008)		Arnett et al. 2009a	Palouse Wind, WA (2012-2013)		Stantec 2013a
Cedar Ridge, WI (2009)	BHE Environmental 2008	BHE Environmental 2010	Pebble Springs, OR (2009-2010)		Gritski and Kronner 2010b
Cedar Ridge, WI (2010)	BHE Environmental 2008	BHE Environmental 2011	Pinnacle, WV (2012)		Hein et al. 2013b
Chopin, OR (2016-2017)		Hallingstad and Riser-Espinoza 2017	Pinyon Pines I & II, CA (2013-2014)		Chatfield and Russo 2014

Appendix A1 (*continued*). Wind energy facilities in North America with comparable activity and fatality data for bats. Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Cohocton/Dutch Hill, NY (2009)		Stantec 2010	Pinyon Pines I & II, CA (2015-2016)		Rintz and Starcevich 2016
Cohocton/Dutch Hills, NY (2010)		Stantec 2011a	Pioneer Prairie I, IA (Phase II; 2011-2012)		Chodachek et al. 2012
Cohocton/Dutch Hill, NY (2013)		Stantec 2014b	Pioneer Prairie II, IA (2013)		Chodachek et al. 2014
Combine Hills, OR (Phase I; 2004-2005)		Young et al. 2006	Pleasant Valley, MN (2016-2017)		Tetra Tech 2017b
Combine Hills, OR (2011)		Enz et al. 2012	Prairie Rose, MN (2014)		Chodachek et al. 2015
Crescent Ridge, IL (2005-2006)		Kerlinger et al. 2007	PrairieWinds ND1 (Minot), ND (2010)		Derby et al. 2011d
Criterion, MD (2011)		Young et al. 2012b	PrairieWinds ND1 (Minot), ND (2011)		Derby et al. 2012d
Criterion, MD (2012)		Young et al. 2013	PrairieWinds SD1, SD (2011-2012)		Derby et al. 2012c
Criterion, MD (2013)		Young et al. 2014b	PrairieWinds SD1, SD (2012-2013)		Derby et al. 2013a
Crystal Lake II, IA (2009)		Derby et al. 2010b	PrairieWinds SD1, SD (2013-2014)		Derby et al. 2014
Diablo Winds, CA (2005-2007)		WEST 2006, 2008	Rail Splitter, IL (2012-2013)		Good et al. 2013b
Dillon, CA (2008-2009)		Chatfield et al. 2009	Record Hill, ME (2012)	Stantec 2008b	Stantec 2013b
Dry Lake I, AZ (2009-2010)	Thompson et al. 2011	Thompson et al. 2011	Record Hill, ME (2014)		Stantec 2015a
Dry Lake II, AZ (2011-2012)	Thompson and Bay 2012	Thompson and Bay 2012	Record Hill, ME (2016)		Stantec 2017
Elkhorn, OR (2008)		Jeffrey et a. 2009a	Red Hills, OK (2012-2013)		Derby et al. 2013c
Elkhorn, OR (2010)		Enk et al. 2011a	Ripley, Ont (2008)		Jacques Whitford 2009
Elm Creek, MN (2009-2010)		Derby et al. 2010e	Rising Tree, CA (2017-2018)		Chatfield et al. 2018
Elm Creek II, MN (2011-2012)		Derby et al. 2012b	Rollins, ME (2012)		Stantec 2013c
Foote Creek Rim I, WY (1999)		Young et al. 2003	Rollins, ME (2014)		Stantec 2015b
Foote Creek Rim I, WY (2000)	Gruver 2002	Young et al. 2003	Roth Rock, MD (2011)		Atwell, LLC 2012
Foote Creek Rim I, WY (2001-2002)	Gruver 2002	Young et al. 2003	Rugby, ND (2010-2011)		Derby et al. 2011c
Forward Energy Center, WI (2008-2010)	Watt and Drake 2011	Grodsky and Drake 2011	Shiloh I, CA (2006-2009)		Kerlinger et al. 2009
Fowler I, IN (2009)		Johnson et al. 2010a	Shiloh II, CA (2009-2010)		Kerlinger et al. 2010, 2013a
Fowler I, II, III, IN (2010)		Good et al. 2011	Shiloh II, CA (2010-2011)		Kerlinger et al. 2013a
Fowler I, II, III, IN (2011)		Good et al. 2012	Shiloh II, CA (2011-2012)		Kerlinger et al. 2013a
Fowler I, II, III, IN (2012)		Good et al. 2013a	Shiloh III, CA (2012-2013)		Kerlinger et al. 2013b
Fowler III, IN (2009)		Johnson et al. 2010b	Solano III, CA (2012-2013)		AECOM 2013
Fowler, IN (2014)		Good et al. 2015	Spring Valley, NV (2012-2013)		WEST 2014

Appendix A1 (*continued*). Wind energy facilities in North America with comparable activity and fatality data for bats. Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Fowler, IN (2015)		Good et al. 2016	Spruce Mountain Wind Project, ME (2014)		Tetra Tech 2015
Fowler, IN (2016)		Good et al. 2017	Stateline, OR/WA (2001-2002)		Erickson et al. 2004
Goodnoe, WA (2009-2010)		URS Corporation (URS) 2010a	Stateline, OR/WA (2003)		Erickson et al. 2004
Grand Ridge I, IL (2009-2010)		Derby et al. 2010a	Stateline, OR/WA (2006)		Erickson et al. 2007
Groton, NH (2013)		Stantec and WEST 2014	Steel Winds I & II, NY (2013)		Stantec 2014c
Groton, NH (2014)		Stantec and WEST 2015a	Stetson II, ME (2014)		Stantec 2015c
Groton, NH (2015)		Stantec and WEST 2015b	Stetson Mountain I, ME (2009)	Stantec 2009c	Stantec 2009c
Hancock, ME (2017)		TRC 2017b	Stetson Mountain I, ME (2011)		Normandeau Associates 2011
Harrow, Ont (2010)		Natural Resources Solutions Inc. (NRSI) 2011	Stetson Mountain I, ME (2013)		Stantec 2014d
Harvest Wind, WA (2010-2012)		Downes and Gritski 2012a	Stetson Mountain II, ME (2010)		Normandeau Associates 2010
Hatchet Ridge, CA (2011)		Tetra Tech 2013	Stetson Mountain II, ME (2012)		Stantec 2013d
Hatchet Ridge, CA (2012)		Tetra Tech 2013	Summerview, Alb (2005-2006)		Brown and Hamilton 2006b
Hatchet Ridge, CA (2012-2013)		Tetra Tech 2014	Summerview, Alb (2006; 2007)	Baerwald 2008	Baerwald 2008
Hay Canyon, OR (2009-2010)		Gritski and Kronner 2010a	Top Crop I & II, IL (2012-2013)		Good et al. 2013c
High Sheldon, NY (2010)		Tidhar et al. 2012a	Top of Iowa, IA (2003)		Jain 2005
High Sheldon, NY (2011)		Tidhar et al. 2012b	Top of Iowa, IA (2004)	Jain 2005	Jain 2005
High Winds, CA (2003-2004)		Kerlinger et al. 2006	Top of the World, WY (2010-2011)		Rintz and Bay 2012
High Winds, CA (2004-2005)		Kerlinger et al. 2006	Top of the World, WY (2011-2012)		Rintz and Bay 2013
Hopkins Ridge, WA (2006)		Young et al. 2007	Top of the World, WY (2012-2013)		Rintz and Bay 2014
Hopkins Ridge, WA (2008)		Young et al. 2009b	Tucannon River, WA (2015)		Hallingstad et al. 2016
Howard, NY (2012)		Tidhar et al. 2013c	Tuolumne (Windy Point I), WA (2009-2010)		Enz and Bay 2010
Howard, NY (2013)		Lukins et al. 2014	Vansycle, OR (1999)		Erickson et al. 2000
Judith Gap, MT (2006-2007)		TRC Environmental Corporation 2008	Vantage, WA (2010-2011)		Ventus Environmental Solutions 2012
Judith Gap, MT (2009)		Poulton and Erickson 2010	Waverly Wind, KS (2016-2017)		Tetra Tech 2017a
Kewaunee County, WI (1999-2001)		Howe et al. 2002	Wessington Springs, SD (2009)		Derby et al. 2010c
Kibby, ME (2011)		Stantec 2012a	Wessington Springs, SD (2010)		Derby et al. 2011a

Appendix A1 (*continued*). Wind energy facilities in North America with comparable activity and fatality data for bats. Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Kittitas Valley, WA (2011-2012)		Stantec Consulting Services 2012	White Creek, WA (2007-2011)		Downes and Gritski 2012b
Klondike, OR (2002-2003)		Johnson et al. 2003	Wild Horse, WA (2007)		Erickson et al. 2008
Klondike II, OR (2005-2006)		Northwest Wildlife Consultants (NWC) and WEST 2007	Windstar, CA (2012-2013)		Levenstein and Bay 2013b
Klondike III (Phase I), OR (2007-2009)		Gritski et al. 2010	Windy Flats, WA (2010-2011)		Enz et al. 2011
Klondike IIIa (Phase II), OR (2008-2010)		Gritski et al. 2011	Winnebago, IA (2009-2010)		Derby et al. 2010g
Lakefield Wind, MN (2012)		Minnesota Public Utilities Commission 2012	Wolfe Island, Ont (July-December 2009)		Stantec Ltd. 2010
Leaning Juniper, OR (2006-2008)		Gritski et al. 2008	Wolfe Island, Ont (July-December 2010)		Stantec Ltd. 2011
Lempster, NH (2009)		Tidhar et al. 2010	Wolfe Island, Ont (July-December 2011)		Stantec Ltd. 2012
Lempster, NH (2010)		Tidhar et al. 2011			

Appendix A2. Bat fatality estimates for North American wind-energy facilities.

Study	Bat Fatalities (Bats/Megawatt/ Year)	Predominant Habitat Type	Citation
Alite, CA (2009-2010)	0.24	Shrub/scrub & grassland	Chatfield et al. 2010
Alta I, CA (2011-2012)	1.28	Woodland, grassland, shrubland	Chatfield et al. 2012
Alta I, CA (2013-2014)	0.36	NA	Chatfield et al. 2014
Alta I, CA (2015-2016)	0.7	NA	Thompson et al. 2016a
Alta II-V, CA (2011-2012)	0.08	Desert scrub	Chatfield et al. 2012
Alta II-V, CA (2013-2014)	0	NA	Chatfield et al. 2014
Alta II-V, CA (2015-2016)	0	NA	Thompson et al. 2016a
Alta VIII, CA (2012-2013)	0	Grassland and riparian	Chatfield and Bay 2014
Alta VIII, CA (2014-2015)	0.17	NA	Western EcoSystems Technology, Inc. (WEST) 2016c
Alta X, CA (2014-2015)	0.42	NA	Chatfield et al. 2015
Alta X, CA (2015-2016)	0.8	Desert scrub	Thompson et al. 2016b
Barton I & II, IA (2010-2011)	1.85	Agriculture	Derby et al. 2011b
Barton Chapel, TX (2009-2010)	3.06	Agriculture/forest	WEST 2011
Beech Ridge, WV (2012)	2.03	Forest	Tidhar et al. 2013a
Beech Ridge, WV (2013)	0.58	Forest	Young et al. 2014a
Big Blue, MN (2013)	2.04	Agriculture	Fagen Engineering 2014
Big Blue, MN (2014)	1.43	Agriculture	Fagen Engineering 2015
Big Horn, WA (2006-2007)	1.9	Agriculture/grassland	Kronner et al. 2008
Big Smile, OK (2012-2013)	2.9	Grassland, agriculture	Derby et al. 2013b
Biglow Canyon, OR (Phase I; 2008)	1.99	Agriculture/grassland	Jeffrey et al. 2009b
Biglow Canyon, OR (Phase I; 2009)	0.58	Agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009-2010)	2.71	Agriculture	Enk et al. 2011b
Biglow Canyon, OR (Phase II; 2010-2011)	0.57	Grassland/shrub-steppe, agriculture	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 2010-2011)	0.22	Grassland/shrub-steppe, agriculture	Enk et al. 2012a
Bingham Wind Project, ME (2017)	0.23	NA	TRC 2017a
Blue Sky Green Field, WI (2008; 2009)	24.57	Agriculture	Gruver et al. 2009
Buffalo Gap I, TX (2006)	0.1	Grassland	Tierney 2007
Buffalo Gap II, TX (2007-2008)	0.14	Forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	31.54	Forest	Nicholson et al. 2005

Appendix A2. Bat fatality estimates for North American wind-energy facilities.

Study	Bat Fatalities (Bats/Megawatt/ Year)	Predominant Habitat Type	Citation
Buffalo Mountain, TN (2005)	39.7	Forest	Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 1999)	0.74	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1998)	2.16	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1999)	2.59	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	4.35	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.64	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 1999)	2.72	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	3.71	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.81	Agriculture	Johnson et al. 2004
Buffalo Ridge I, SD (2009-2010)	0.16	Agriculture/grassland	Derby et al. 2010d
Buffalo Ridge II, SD (2011-2012)	2.81	Agriculture, grassland	Derby et al. 2012a
Bull Hill, ME (2013)	1.62	Forest	Stantec Consulting (Stantec) 2014a
Cameron Ridge/Section 15, CA (2014-2015)	0.15	NA	WEST 2016b
Cameron Ridge/Section 15, CA (2015-2016)	0.19	NA	Rintz and Thompson 2017
Casselman, PA (2008)	12.61	Forest	Arnett et al. 2009b
Casselman, PA (2009)	8.6	Forest, pasture, grassland	Arnett et al. 2010
Casselman Curtailment, PA (2008)	4.4	Forest	Arnett et al. 2009a
Cedar Ridge, WI (2009)	30.61	Agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	24.12	Agriculture	BHE Environmental 2011
Chopin, OR (2016-2017)	1.9	Agriculture	Hallingstad and Riser-Espinoza 2017
Cohocton/Dutch Hill, NY (2009)	8.62	Agriculture/forest	Stantec 2010
Cohocton/Dutch Hills, NY (2010)	10.32	Agriculture/forest	Stantec 2011a
Cohocton/Dutch Hill, NY (2013)	1.37	Agriculture, forest	Stantec 2014b
Combine Hills, OR (Phase I; 2004-2005)	1.88	Agriculture/grassland	Young et al. 2006
Combine Hills, OR (2011)	0.73	Grassland/shrub-steppe, agriculture	Enz et al. 2012

Appendix A2. Bat fatality estimates for North American wind-energy facilities.

Study	Bat Fatalities (Bats/Megawatt/ Year)	Predominant Habitat Type	Citation
Crescent Ridge, IL (2005-2006)	3.27	Agriculture	Kerlinger et al. 2007
Criterion, MD (2011)	15.61	Forest, agriculture	Young et al. 2012b
Criterion, MD (2012)	7.62	Forest, agriculture	Young et al. 2013
Criterion, MD (2013)	5.32	Forest, agriculture	Young et al. 2014b
Crystal Lake II, IA (2009)	7.42	Agriculture	Derby et al. 2010b
Diablo Winds, CA (2005-2007)	0.82	NA	WEST 2006, 2008
Dillon, CA (2008-2009)	2.17	Desert	Chatfield et al. 2009
Dry Lake I, AZ (2009-2010)	3.43	Desert grassland/forested	Thompson et al. 2011
Dry Lake II, AZ (2011-2012)	1.66	Desert grassland/forested	Thompson and Bay 2012
Elkhorn, OR (2008)	1.26	Shrub/scrub & agriculture	Jeffrey et a. 2009a
Elkhorn, OR (2010)	2.14	Shrub/scrub & agriculture	Enk et al. 2011a
Elm Creek, MN (2009-2010)	1.49	Agriculture	Derby et al. 2010e
Elm Creek II, MN (2011-2012)	2.81	Agriculture, grassland	Derby et al. 2012b
Foote Creek Rim I, WY (1999)	3.97	Grassland	Young et al. 2003
Foote Creek Rim I, WY (2000)	1.05	Grassland	Young et al. 2003
Foote Creek Rim I, WY (2001-2002)	1.57	Grassland	Young et al. 2003
Forward Energy Center, WI (2008-2010)	18.17	Agriculture	Grodsky and Drake 2011
Fowler I, IN (2009)	8.09	Agriculture	Johnson et al. 2010a
Fowler I, II, III, IN (2010)	18.96	Agriculture	Good et al. 2011
Fowler I, II, III, IN (2011)	20.19	Agriculture	Good et al. 2012
Fowler I, II, III, IN (2012)	2.96	Agriculture	Good et al. 2013a
Fowler III, IN (2009)	1.84	Agriculture	Johnson et al. 2010b
Fowler, IN (2014)	4.86	Agriculture	Good et al. 2015
Fowler, IN (2015)	4.54	Agriculture	Good et al. 2016
Fowler, IN (2016)	4.54	Agriculture	Good et al. 2017
Goodnoe, WA (2009-2010)	0.34	Grassland and shrub-steppe	URS Corporation (URS) 2010a
Grand Ridge I, IL (2009-2010)	2.1	Agriculture	Derby et al. 2010a
Groton, NH (2013)	1.31	Foothills, forest	Stantec and WEST 2014
Groton, NH (2014)	1.63	Foothills, forest	Stantec and WEST 2015a
Groton, NH (2015)	1.74	Foothills, forest	Stantec and WEST 2015b
Hancock, ME (2017)	0.3	Gravel, grassland	TRC 2017b

Appendix A2. Bat fatality estimates for North American wind-energy facilities.

Study	Bat Fatalities (Bats/Megawatt/ Year)	Predominant Habitat Type	Citation
Harrow, Ont (2010)	11.13	Agriculture	Natural Resources Solutions Inc. 2011
Harvest Wind, WA (2010-2012)	1.27	Grassland/shrub-steppe	Downes and Gritski 2012a
Hatchet Ridge, CA (2011)	2.23	NA	Tetra Tech 2013
Hatchet Ridge, CA (2012)	5.22	NA	Tetra Tech 2013
Hatchet Ridge, CA (2012-2013)	4.2	NA	Tetra Tech 2014
Hay Canyon, OR (2009-2010)	0.53	Agriculture	Gritski and Kronner 2010a
High Sheldon, NY (2010)	2.33	Agriculture	Tidhar et al. 2012a
High Sheldon, NY (2011)	1.78	Agriculture	Tidhar et al. 2012b
High Winds, CA (2003-2004)	2.51	Agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2004-2005)	1.52	Agriculture/grassland	Kerlinger et al. 2006
Hopkins Ridge, WA (2006)	0.63	Agriculture/grassland	Young et al. 2007
Hopkins Ridge, WA (2008)	1.39	Agriculture/grassland	Young et al. 2009b
Howard, NY (2012)	10	Agriculture	Tidhar et al. 2013c
Howard, NY (2013)	2.13	Agriculture	Lukins et al. 2014
Judith Gap, MT (2006-2007)	8.93	Agriculture/grassland	TRC Environmental Corporation 2008
Judith Gap, MT (2009)	3.2	Agriculture/grassland	Poulton and Erickson 2010
Kewaunee County, WI (1999-2001)	6.45	Agriculture	Howe et al. 2002
Kibby, ME (2011)	0.12	Forest; commercial forest	Stantec 2012a
Kittitas Valley, WA (2011-2012)	0.12	Sagebrush-steppe, grassland	Stantec Consulting Services 2012
Klondike, OR (2002-2003)	0.77	Agriculture/grassland	Johnson et al. 2003
Klondike II, OR (2005-2006)	0.41	Agriculture/grassland	Northwest Wildlife Consultants (NWC) and WEST 2007
Klondike III (Phase I), OR (2007-2009)	1.11	Agriculture/grassland	Gritski et al. 2010
Klondike IIIa (Phase II), OR (2008-2010)	0.14	Grassland/shrub-steppe and agriculture	Gritski et al. 2011
Lakefield Wind, MN (2012)	19.87	Agriculture	Minnesota Public Utilities Commission 2012
Leaning Juniper, OR (2006-2008)	1.98	Agriculture	Gritski et al. 2008
Lempster, NH (2009)	3.11	Grasslands/forest/rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	3.57	Grasslands/forest/rocky embankments	Tidhar et al. 2011
Linden Ranch, WA (2010-2011)	1.68	Grassland/shrub-steppe, agriculture	Enz and Bay 2011

Appendix A2. Bat fatality estimates for North American wind-energy facilities.

Study	Bat Fatalities (Bats/Megawatt/ Year)	Predominant Habitat Type	Citation
Locust Ridge, PA (Phase II; 2009)	14.11	Grassland	Arnett et al. 2011
Locust Ridge, PA (Phase II; 2010)	14.38	Grassland	Arnett et al. 2011
Lower West, CA (2012-2013)	2.17	NA	Levenstein and Bay 2013a
Lower West, CA (2014-2015)	1.13	NA	Levenstein and DiDonato 2015
Lower West, CA (2016-2017)	0	Desert scrub, Joshua tree	WEST 2017b
Maple Ridge, NY (2006)	11.21	Agriculture/forested	Jain et al. 2007
Maple Ridge, NY (2007-2008)	4.96	Agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007)	6.49	Agriculture/forested	Jain et al. 2009b
Maple Ridge, NY (2012)	7.3	Agriculture/forested	Tidhar et al. 2013b
Marengo I, WA (2009-2010)	0.17	Agriculture	URS 2010b
Marengo II, WA (2009-2010)	0.27	Agriculture	URS 2010c
Mars Hill, ME (2007)	2.91	Forest	Stantec 2008a
Mars Hill, ME (2008)	0.45	Forest	Stantec 2009a
Milford I, UT (2010-2011)	2.05	Desert shrub	Stantec 2011b
Milford I & II, UT (2011-2012)	1.67	Desert shrub	Stantec 2012b
Montezuma I, CA (2011)	1.9	Agriculture and grasslands	ICF International 2012
Montezuma I, CA (2012)	0.84	Agriculture and grasslands	ICF International 2013
Montezuma II, CA (2012-2013)	0.91	Agriculture	Harvey & Associates 2013
Moraine II, MN (2009)	2.42	Agriculture/grassland	Derby et al. 2010f
Mount Storm, WV (Fall 2008)	6.62	Forest	Young et al. 2009c
Mount Storm, WV (2009)	17.53	Forest	Young et al. 2009a, 2010b
Mount Storm, WV (2010)	15.18	Forest	Young et al. 2010a, 2011b
Mount Storm, WV (2011)	7.43	Forest	Young et al. 2011a, 2012a
Mountaineer, WV (2003)	31.69	Forest	Kerns and Kerlinger 2004
Munnsville, NY (2008)	1.93	Agriculture/forest	Stantec 2009b
Mustang Hills, CA (2012-2013)	0.1	Grasslands and riparian	Chatfield and Bay 2014
Mustang Hills, CA (2014-2015)	0	Na	WEST 2016c
Mustang Hills, CA (2016-2017)	0.33	Desert scrub, Joshua tree	WEST 2018
Nine Canyon, WA (2002-2003)	2.47	Agriculture/grassland	Erickson et al. 2003
Noble Altona, NY (2010)	4.34	Forest	Jain et al. 2011a

Appendix A2. Bat fatality estimates for North American wind-energy facilities.

Study	Bat Fatalities (Bats/Megawatt/ Year)	Predominant Habitat Type	Citation
Noble Bliss, NY (2008)	7.8	Agriculture/forest	Jain et al.2009c
Noble Bliss, NY (2009)	3.85	Agriculture/forest	Jain et al. 2010c
Noble Chateaugay, NY (2010)	2.44	Agriculture	Jain et al. 2011b
Noble Clinton, NY (2008)	3.14	Agriculture/forest	Jain et al. 2009d
Noble Clinton, NY (2009)	4.5	Agriculture/forest	Jain et al. 2010a
Noble Ellenburg, NY (2008)	3.46	Agriculture/forest	Jain et al. 2009e
Noble Ellenburg, NY (2009)	3.91	Agriculture/forest	Jain et al. 2010b
Noble Wethersfield, NY (2010)	16.3	Agriculture	Jain et al. 2011c
NPPD Ainsworth, NE (2006)	1.16	Agriculture/grassland	Derby et al. 2007
Oakfield, ME (2017)	0.51	Grassland	TRC 2018
Odell, MN (2016-2017)	6.74	Agriculture	Chodachek and Gustafson 2018
Pacific Wind, CA (2014-2015)	0.21	NA	WEST 2016a
Pacific Wind, CA (2015-2016)	0	NA	WEST 2017a
Palouse Wind, WA (2012-2013)	4.23	Agriculture and grasslands	Stantec 2013a
Pebble Springs, OR (2009-2010)	1.55	Grassland	Gritski and Kronner 2010b
Pinnacle, WV (2012)	40.2	Forest	Hein et al. 2013b
Pinyon Pines I & II, CA (2013-2014)	0.04	NA	Chatfield and Russo 2014
Pinyon Pines I & II, CA (2015-2016)	0.18	NA	Rintz and Starcevich 2016
Pioneer Prairie I, IA (Phase II; 2011-2012)	4.43	Agriculture, grassland	Chodachek et al. 2012
Pioneer Prairie II, IA (2013)	3.83	Agriculture	Chodachek et al. 2014
Pleasant Valley, MN (2016-2017)	1.8	NA	Tetra Tech 2017b
Prairie Rose, MN (2014)	0.41	Agriculture	Chodachek et al. 2015
PrairieWinds ND1 (Minot), ND (2010)	2.13	Agriculture	Derby et al. 2011d
PrairieWinds ND1 (Minot), ND (2011)	1.39	Agriculture, grassland	Derby et al. 2012d
PrairieWinds SD1, SD (2011-2012)	1.23	Grassland	Derby et al. 2012c
PrairieWinds SD1, SD (2012-2013)	1.05	Grassland	Derby et al. 2013a
PrairieWinds SD1, SD (2013-2014)	0.52	Grassland	Derby et al. 2014
Rail Splitter, IL (2012-2013)	11.21	Agriculture	Good et al. 2013b
Record Hill, ME (2012)	2.96	Forest	Stantec 2013b
Record Hill, ME (2014)	0.55	Forest	Stantec 2015a
Record Hill, ME (2016)	1.25	Forest	Stantec 2017

Appendix A2. Bat fatality estimates for North American wind-energy facilities.

Study	Bat Fatalities (Bats/Megawatt/ Year)	Predominant Habitat Type	Citation
Red Hills, OK (2012-2013)	0.11	Grassland	Derby et al. 2013c
Ripley, Ont (2008)	4.67	Agriculture	Jacques Whitford 2009
Rising Tree, CA (2017-2018)	0	Desert scrub, woodland	Chatfield et al. 2018
Rollins, ME (2012)	0.18	Forest	Stantec 2013c
Rollins, ME (2014)	0.33	Gravel	Stantec 2015b
Roth Rock, MD (2011)	6.24	Rocky	Atwell, LLC 2012
Rugby, ND (2010-2011)	1.6	Agriculture	Derby et al. 2011c
Shiloh I, CA (2006-2009)	3.92	Agriculture/grassland	Kerlinger et al. 2009
Shiloh II, CA (2009-2010)	2.6	Agriculture	Kerlinger et al. 2010, 2013a
Shiloh II, CA (2010-2011)	3.8	Agriculture	Kerlinger et al. 2013a
Shiloh II, CA (2011-2012)	3.4	Agriculture	Kerlinger et al. 2013a
Shiloh III, CA (2012-2013)	0.4	NA	Kerlinger et al. 2013b
Solano III, CA (2012-2013)	0.31	NA	AECOM 2013
Spring Valley, NV (2012-2013)	3.73	Grassland, shrub steppe	WEST 2014
Spruce Mountain Wind Project, ME (2014)	0.31	NA	Tetra Tech 2015
Stateline, OR/WA (2001-2002)	1.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.29	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2006)	0.95	Agriculture/grassland	Erickson et al. 2007
Steel Winds I & II, NY (2013)	6.14	Steel Winds I: grassland, shrub forest; Steel Winds II: gravel, steel slag	Stantec 2014c
Stetson II, ME (2014)	0.83	Forest	Stantec 2015c
Stetson Mountain I, ME (2009)	1.4	Forest	Stantec 2009c
Stetson Mountain I, ME (2011)	0.28	Forest	Normandeau Associates 2011
Stetson Mountain I, ME (2013)	0.18	Forest	Stantec 2014d
Stetson Mountain II, ME (2010)	1.65	Forest	Normandeau Associates 2010
Stetson Mountain II, ME (2012)	2.27	Forest	Stantec 2013d
Summerview, Alb (2005-2006)	10.27	Agriculture	Brown and Hamilton 2006b
Summerview, Alb (2006; 2007)	11.42	Agriculture/grassland	Baerwald 2008
Top Crop I & II, IL (2012-2013)	12.55	Agriculture	Good et al. 2013c
Top of Iowa, IA (2003)	7.16	Agriculture	Jain 2005
Top of Iowa, IA (2004)	10.27	Agriculture	Jain 2005

Appendix A2. Bat fatality estimates for North American wind-energy facilities.

Study	Bat Fatalities (Bats/Megawatt/ Year)	Predominant Habitat Type	Citation
Top of the World, WY (2010-2011)	2.74	Scrub-shrub, grassland	Rintz and Bay 2012
Top of the World, WY (2011-2012)	2.43	Scrub-shrub, grassland	Rintz and Bay 2013
Top of the World, WY (2012-2013)	2.34	Scrub-shrub, grassland	Rintz and Bay 2014
Tucannon River, WA (2015)	2.22	Agriculture	Hallingstad et al. 2016
Tuolumne (Windy Point I), WA (2009-2010)	0.94	Grassland/shrub-steppe, agriculture and forest	Enz and Bay 2010
Vansycle, OR (1999)	1.12	Agriculture/grassland	Erickson et al. 2000
Vantage, WA (2010-2011)	0.4	Shrub-steppe, grassland	Ventus Environmental Solutions 2012
Waverly Wind, KS (2016-2017)	8.2	NA	Tetra Tech 2017a
Wessington Springs, SD (2009)	1.48	Grassland	Derby et al. 2010c
Wessington Springs, SD (2010)	0.41	Grassland	Derby et al. 2011a
White Creek, WA (2007-2011)	2.04	Grassland/shrub-steppe, agriculture	Downes and Gritski 2012b
Wild Horse, WA (2007)	0.39	Grassland	Erickson et al. 2008
Windstar, CA (2012-2013)	0	NA	Levenstein and Bay 2013b
Windy Flats, WA (2010-2011)	0.41	Grassland/shrub-steppe, agriculture	Enz et al. 2011
Winnebago, IA (2009-2010)	4.54	Agriculture/grassland	Derby et al. 2010g
Wolfe Island, Ont (July-December 2009)	6.42	Grassland	Stantec Consulting Ltd. (Stantec Ltd.) 2010
Wolfe Island, Ont (July-December 2010)	9.5	Grassland	Stantec Ltd. 2011
Wolfe Island, Ont (July-December 2011)	2.49	Grassland	Stantec Ltd. 2012

APPENDIX I – BIRD AND BAT CONSERVATION STRATEGY

Bird and Bat Conservation Strategy

Sweetland Wind Energy Project

Hand County, South Dakota

Prepared for:

Sweetland Wind Farm, LLC

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Boulder, Colorado 80301

Prepared by:

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September 11, 2019

WEST Inc.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Background and Purpose

Although wind energy facilities utilize a renewable-energy resource, potential impacts to birds and bats may result from their construction and operation. Interactions with wind turbines and the associated infrastructure such as energy transmission, distribution, or substations may result in fatalities or indirect effects that may include displacement or habitat loss. To address these concerns, Sweetland Wind Farm, LLC (Sweetland) contracted Western EcoSystems Technology, Inc. (WEST) to develop this site-specific Bird and Bat Conservation Strategy (BBCS) for the Sweetland Wind Farm (Project) in Hand County, South Dakota.

Federal laws and regulations protect the majority of birds found in and around the Project Area, including the Migratory Bird Treaty Act of 1918 (MBTA), the Bald and Golden Eagle Protection Act of 1940 (BGEPA), and the federal Endangered Species Act of 1973 (ESA). This BBCS has been voluntarily prepared as a good faith effort by Sweetland to meet the intent of these regulations by reducing and managing potential impacts to birds and bats that may result from the construction and operation of the Project.

This BBCS outlines various processes that Sweetland has or will employ to: 1) comply with all state and federal avian and bat conservation and protection laws and regulations applicable to the Project; 2) ensure that any effects to avian and bat resources are identified, quantified to the extent possible, and analyzed; and 3) avoid, and minimize potential impacts consistent with the US Fish and Wildlife Service (USFWS) *Land-Based Wind Energy Guidelines* (WEG; USFWS 2012).

1.2 Objectives

Sweetland has developed this BBCS to meet the following objectives:

1) Document and describe the scope of the Project, the biological survey work that was completed during pre-construction, and provide an assessment of risks to avian and bat resources posed by the Project. This objective includes providing a single point of reference for information related to avian and bat studies performed at the Project.
2) Provide a plan that avoids, minimizes, and monitors potential effects to avian and bat species resulting from the construction and operation of the Project consistent with the WEG.
3) Describe post-construction monitoring efforts that will be implemented at the Project to identify impacts to birds and bats, as well as the methods for reporting the results of monitoring.
4) Outline the adaptive management framework that Sweetland is committed to over the life of the Project, and how Sweetland plans to implement adaptive management during operation of the Project.

5) Provide an educational and practical reference for Sweetland's employees and contractors to facilitate the application of measures that avoid and minimize potential negative effects to avian and bat species at the Project.

2.0 SITE HISTORY AND PROJECT DESCRIPTION

Sweetland began initial discussions with the USFWS in 2016 to determine a suitable location for the Project. Based on recommendations from the USFWS, Sweetland identified the 23,642 acre (ac; 9,568 hectares [ha]) Project Area in Hand County, South Dakota. Through consultation with the USFWS and South Dakota Game Fish and Parks (SDGFP), the proposed Project location minimizes impacts to USFWS Wetland and Grassland Easements; avoids the Missouri River, reviewed historic prairie grouse (greater prairie chicken [*Tympanuchus cupido*] and sharp-tailed grouse [*Tympanuchus phasianellus*]) lek locations, and is in an area of compatible land use (i.e., farming and ranching). The current Project Area is 20,979 ac (8,490 ha) and is located on private land approximately 6.4 kilometers (km; 4 miles [mi]) southwest of Wessington, South Dakota (Figure 1, Burns and McDonnell Engineering Company, Inc. 2019).

The Project Area is in the James River Lowland and Southern Missouri Coteau Level IV Ecoregion within the Northern Glaciated Plains and Northwestern Glaciated Plains Level III Ecoregion (EPA 2019). The topography within the Project Area is generally characterized by gently rolling hills ranging from approximately 1,570 to 1,875 feet (ft; 479 to 572 meters [m]) above mean sea level (AMSL). The eastern edge of the Project Area contains some gullies and ravines, which offer some topographic relief compared to the surrounding landscape. Within the Project Area, streams and drainages bisect the terrain. According to the USGS National Land Cover Database (NLCD), herbaceous/grassland (51.9 percent), cultivated crop (24.2 percent), and hay/pasture (19.2 percent) compose the majority of the land cover within the Project Area, with developed land (2.6 percent), open water and wetlands (1.3 percent), deciduous forest (0.7 percent), and shrub/scrub (< 0.1 percent) composing the remaining cover types (USGS NLCD, 2011; Homer et al., 2015).

The Project would include up to 71 wind turbines with an aggregate nameplate capacity of approximately 200 megawatts (MW). The Project would also include electric underground collection lines and communication lines, a transmission line, a Project substation, a switchyard, an Operations and Maintenance (O&M) facility, access roads connecting turbines and associated facilities, up to four permanent meteorological towers, and a temporary laydown yard (Burns and McDonnell Engineering Company, Inc. 2019). Sweetland is considering using the GE 2.82/127 turbine model with a hub height of 290 or 374 ft (89 or 114 m), rotor diameter of 417 ft (127 m), and tip height of 499 or 584 ft (153 or 178 m). The addition of leased lands over time and the corresponding iterations of turbine layouts have led to revised project and survey areas over time (Figure 1), however, the baseline wildlife studies and their corresponding survey efforts were also adjusted to meet the regulatory guidelines (USFWS 2012, SDGFP 2018). Project Area is defined by leased lands whereas Survey Area can be defined by factors such as distance from turbine arrays or Project Area boundaries and are defined in the various baseline wildlife studies.

Table 1. Land cover types, coverage, and composition within the Sweetland Wind Farm, Hand County, South Dakota.

Land cover	Hectares	Acres	% Composition
Herbaceous/Grassland	4407.1	10,890.1	51.9
Cultivated Crops	2053.8	5,075.1	24.2
Hay/Pasture	1628.3	4,023.7	19.2
Developed, Open Space	218.7	540.4	2.6
Open Water	79.6	196.8	0.9
Deciduous Forest	63.4	156.7	0.7
Emergent Herbaceous Wetlands	34.7	85.7	0.4
Developed, Low Intensity	1.5	3.6	<0.1
Shrub/Scrub	1.3	3.1	<0.1
Woody Wetlands	0.9	2.2	<0.1
Developed, Medium Intensity	0.4	0.9	<0.1
Developed, High Intensity	<0.1	0.2	<0.1
Total[a]	**8,489.7**	**20,978.7**	**100**

Data from the US Geological Survey (USGS) National Land Cover Database (NLCD; USGS NLCD 2011, Homer et al. 2015).

[a] Sums of values may not add to total value shown, due to rounding.

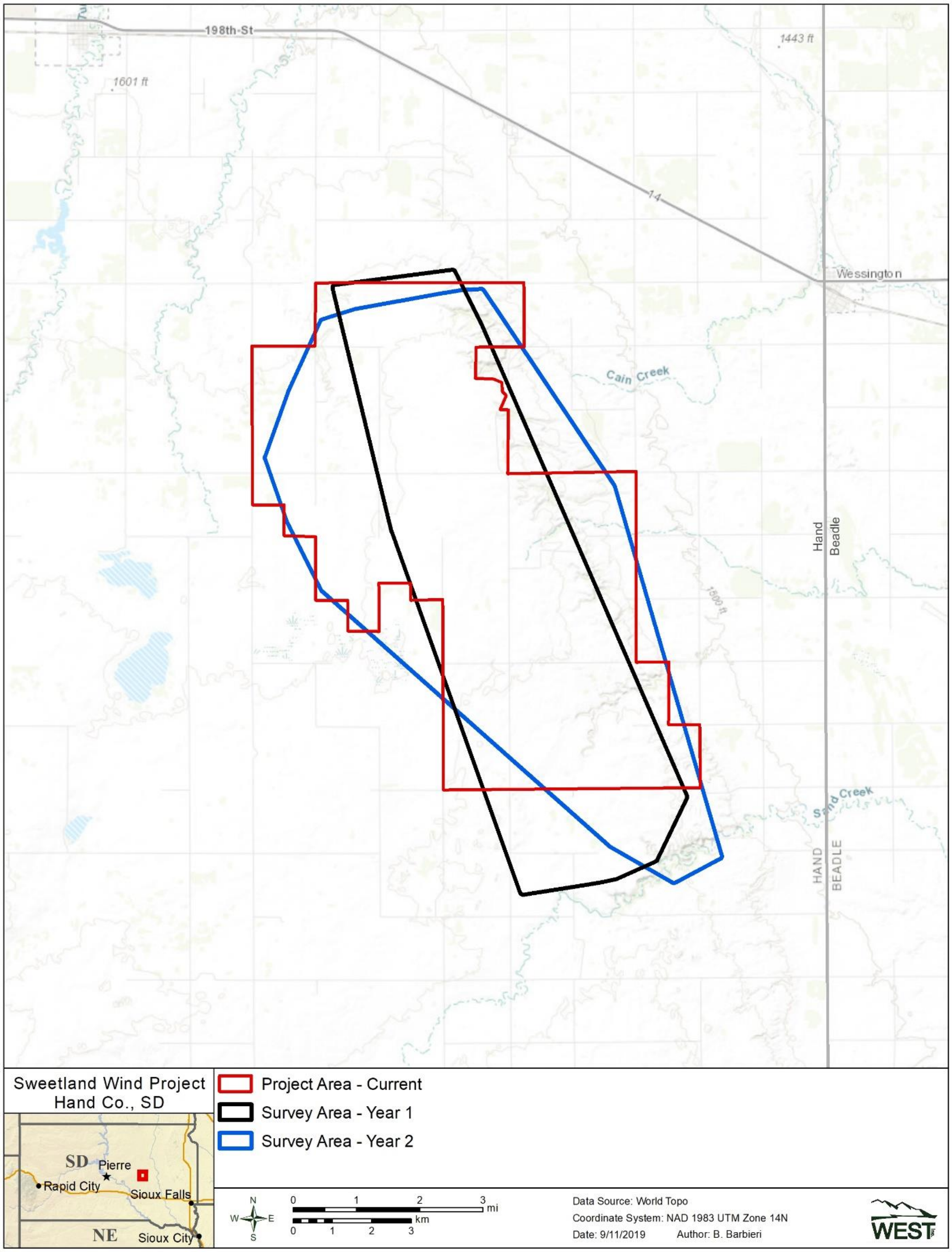

Figure 1. Location of the Sweetland Wind Farm in Hand County, South Dakota.

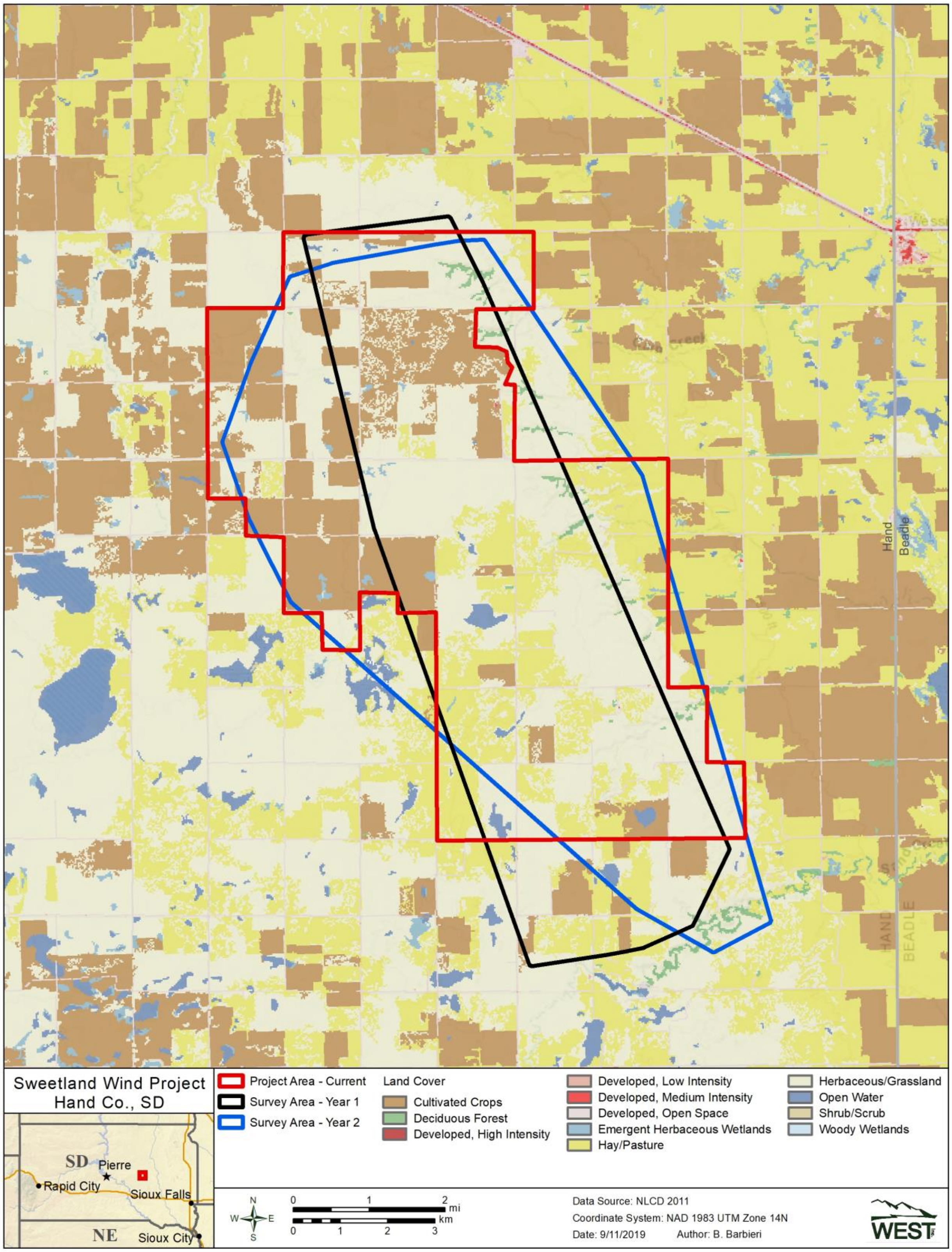

Figure 2. Land cover in the Sweetland Wind Farm (US Geological Survey National Land Cover Database 2011, Homer et al. 2015) in Hand County, South Dakota.

3.0 REGULATORY SETTING

3.1 Federal Endangered Species Act

Species at risk of extinction, including birds and bats, are protected under the federal ESA of 1973, as amended. The purpose of the ESA is to protect threatened and endangered species and to provide a means to conserve their habitats. Take under the ESA is defined as "…to harass, harm, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." Harm is an act that injures or kills a wildlife species, including significant habitat modification or degradation; whereas harass is defined as an intentional or negligent act or omission that creates the likelihood of injury by annoying the animal to the extent it significantly disrupts normal behavior patterns such as breeding, feeding, or sheltering. The ESA authorizes the USFWS to issue permits for "incidental take" of wildlife species, which is take resulting from an otherwise lawful activity.

3.2 Migratory Bird Treaty Act

The MBTA integrates and implements four international treaties that provide for the protection of migratory birds. The MBTA prohibits the taking, killing, possession, transportation, import and export of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior." (16 United States Code [USC] 703 [1918]). The word "take" is defined by regulation as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect." (50 Code of Federal Regulations [CFR] 10.12 [1973]). The USFWS maintains a list of all species protected by the MBTA at 50 CFR 10.13 (1973). This list includes over one thousand species of migratory birds, including eagles and other raptors, waterfowl, shorebirds, seabirds, wading birds, and passerines.

On December 22, 2017, the US Department of Interior (USDOI) issued a Solicitor's Opinion (USDOI 2017) followed by the USFWS Guidance Memorandum on April 11, 2018 (USFWS 2018b), both of which clarified the following with regards to enforcement of the MBTA: 1) the MBTA's take prohibitions only apply when the purpose of an action is take of migratory birds, their eggs, or their nests; 2) the project's impacts on migratory birds should still be considered during the National Environmental Policy Act of 1969 (NEPA) review process; 3) future settlement agreements for take of listed species or eagles should not include restrictions, minimization measures, or mitigation for purposes of MBTA compliance; 4) future permits under the ESA or Bald and Golden Eagle Protection Act (BGEPA), or inter-agency consultations under Section 7 of the ESA, should not include restrictions, minimization measures, or mitigation for purposes of MBTA compliance; and 5) the MBTA does not affect protections provided under the ESA or the BGEPA (Locke Lord 2018).

3.3 Bald and Golden Eagle Protection Act

The BGEPA, 16 USC 668-668d (1940), affords bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) additional legal protection. The BGEPA prohibits the take, sale, purchase, barter, offer of sale, transport, export or import, at any time or in any manner of any bald or golden eagle, alive or dead, or any part, nest, or egg thereof. The BGEPA also defines take to include "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb," (16 USC 668c [1940]), and includes criminal and civil penalties for violating the statute (see 16 USC 668 [1940]). The USFWS further defined the term "disturb" as agitating or bothering an eagle to a degree that causes, or is likely to cause, injury, or either a decrease in productivity or nest abandonment by substantially interfering with normal breeding, feeding, or sheltering behavior.

In September of 2009, the USFWS promulgated a final rule on two new permit regulations that specifically authorize under the BGEPA the non-purposeful (i.e., incidental) take of eagles and eagle nests in certain situations (see 50 CFR 22.26 [2009] and 22.27 [2009]). Revisions to the final rule were issued in December of 2016. The permits authorize limited take of bald and golden eagles; authorizing individuals, companies, government agencies and other organizations to disturb or otherwise take eagles in the course of conducting lawful activities. To facilitate issuance of Eagle Take Permits (ETPs) for wind energy facilities the USFWS finalized the Eagle Conservation Plan Guidance (ECPG) - Module 1 - Land-based Wind Energy Version 2 (USFWS 2013). If eagles are identified as a potential risk at a project site, developers are encouraged to follow the ECPG. The ECPG describes specific actions that are recommended to achieve compliance with the regulatory requirements in the BGEPA for an ETP, as described in 50 CFR 22.26 (2009) and 22.27 (2009). The ECPG provides a national framework for assessing and mitigating risk specific to eagles through development of Eagle Conservation Plans (ECPs) and issuance of programmatic ETPs for eagles at wind facilities.

3.4 South Dakota State Threatened and Endangered Species

South Dakota's Endangered Species Statute (South Dakota Statutes, Title 34A Chapter 8) requires the SDGFP and Department of Agriculture to perform those acts necessary for the conservation, management, protection, restoration, and propagation of endangered, threatened, and nongame species of wildlife. In accordance with this mandate, the SDGFP has drafted a Wildlife Action Plan, which includes a list of Species of Greatest Conservation Need (SGCN; SDGFP 2014). In addition to endangered and threatened species, the SGCN list includes species that are regionally or globally imperiled (or secure) and for which South Dakota represents an important portion of their remaining range and species with characteristics that make them vulnerable. The resulting List of Endangered, Threatened, and Special Concern Species (ETSC) is promulgated by the Game, Fish and Parks Commission and reviewed biennially. The Endangered Species Statute also authorizes the Secretary of Agriculture and the Secretary of GFP to enter cooperative agreements with federal or state agencies or private persons for management of nongame, endangered, or threatened species. The South Dakota Endangered Species Statute defines endangered, nongame, threatened, and wildlife species as follows:

- *Endangered (E)* – any species of wildlife or plants which is in danger of extinction throughout all or a significant part of its range other than a species of insects determined by the Game, Fish and Parks Commission or the secretary of the United States Department of Interior to constitute a pest whose protection under this chapter would present an overwhelming and overriding risk to man;

- *Nongame species (NG)* – any wildlife species not legally classified a game species, fur-bearer, threatened species, or as endangered by statute or regulations of this state;
- *Threatened (T)* – any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range;
- *Wildlife (WL)* – any nondomesticated animal, whether reared in captivity or not, and includes any part, product, egg, or offspring thereof, or the dead body or parts thereof.

4.0 AGENCY CONSULTATION

The WEG strongly encourages energy developers to coordinate with agencies to obtain information on bird, bat or other wildlife issues within a project area and vicinity. Agencies can help developers identify potential biological resource issues early in the development process. Throughout Project planning and development, Sweetland coordinated with various federal, state, and local agencies and governmental authorities to identify a preferred location for the Project and to address potential concerns. Sweetland convened multiple meetings with the USFWS, SDGFP, and Western Area Power Administration (WAPA) between October 12, 2016 and August 16, 2019 (Table 2). Additionally, after WAPA's public scoping meeting in August 7,2018 Sweetland has had weekly scheduled calls with WAPA and USFWS to discuss the EA and address any agency concerns. Bird and bat baseline studies were designed based on both the recommendations of SDGFP and USFWS, and in accordance with the USFWS WEG.

Table 2. Summary of USFWS and SDGFP Agency Coordination Activities

Date	Participants[a]	Event/Topic[b]	Discussion/Main Points
10/12/2016 and 10/14/2016	USFWS, Applicant	Project planning	In-person meeting at USFWS Huron Wetland Management District and subsequent email exchange regarding Project siting and avoidance of USFWS Easements
6/9/2017	USFWS, SDGFP, Applicant, WEST	Meeting	Email correspondence sent to USFWS and SDGFP to set up in-person meeting
8/14/2017	USFWS, SDGFP, Applicant, WEST	Grassland and Wetland Easements	USFWS Huron Wetland Management District provided known grassland and wetland easements within the proposed project boundary
8/15/2017	USFWS, SDGFP, Applicant, WEST	Meeting	Representatives from USFWS, SDGFP, Applicant, and WEST met in-person at the SDGFP Office in Pierre to discuss the Project and Tier 3 surveys planned for the Project

Table 2. Summary of USFWS and SDGFP Agency Coordination Activities

Date	Participants[a]	Event/Topic[b]	Discussion/Main Points
8/15/2017	USFWS, SDGFP, Applicant, WEST	Data received	SDGFP provided links to species monitored by the South Dakota Natural Heritage Program, South Dakota T&E Species, South Dakota Species of Greatest Conservation Need; quantifying undisturbed lands in eastern South Dakota (Bauman et al. 2016); and breeding bird atlas and species list from the two breeding bird blocks closest to the Project. SDGFP personnel also sent shapefiles of known prairie grouse locations with 2 miles of the Project
9/11/2017	USFWS, SDGFP, Applicant, WEST	Study Plan, 2017 Raptor Nest Report and Meeting notes	At the request of Applicant, WEST submitted draft copies of the Sweetland Wind Farm Baseline Wildlife Study Plan, 2017 Raptor Nest Report, and meeting notes from the August 2017 in-person meeting
9/18/2017	USFWS, SDGFP, Applicant, WEST	Study Plan, 2017 Raptor Nest Report and Meeting notes	USFWS South Dakota Ecological Services Field Office provided comments on the Baseline Wildlife Study Plan, 2017 Raptor Nest Report, and meeting notes
3/7/2018	USFWS, SDGFP, Applicant, WEST	Study Plan, 2017 Raptor Nest Report and Meeting notes	At the request of Applicant, WEST finalized versions of the Baseline Wildlife Study Plan, 2017 Raptor Nest Report, and meeting notes
5/22/2018	USFWS, SDGFP, Applicant, WEST, WAPA, Burns & McDonnell	Sweetland Environmental Assessment	Kick off call to discuss the Sweetland Environmental Assessment and WAPA interconnection
6/15/2018	USFWS, Applicant, WEST	NLEB surveys	At the request of Applicant, WEST contacted USFWS South Dakota Ecological Field Office personnel to discuss current plans for conducting NLEB bat surveys at the Project

Table 2. Summary of USFWS and SDGFP Agency Coordination Activities

Date	Participants[a]	Event/Topic[b]	Discussion/Main Points
6/29/2018	USFWS, Applicant, WEST	NLEB surveys	USFWS South Dakota Ecological Services Field Office indicated the current plans for NLEB surveys the Project were reasonable
7/31/2018	USFWS, Applicant, WEST	NLEB surveys	At the request of Applicant, WEST notified USFWS South Dakota Ecological Field Office personnel that no NLEB calls were detected during the 2018 surveys
8/7/2018	USFWS, Applicant, WEST, WAPA, Burns & McDonnell, Hand County Board of Commissioners	Site visit	Representatives from USFWS, Applicant, WEST, WAPA, Burns & McDonnell and Hand County Board of Commissioners Office participated in a tour of the Project Area.
8/7/2018	Applicant, WEST, WAPA, Burns & McDonnell	Public scoping meeting	Representatives from Applicant, WEST, WAPA, Hand County Board of Commissioners Office, and Burns & McDonnell participated in the public scoping meeting held in Miller, South Dakota.
12/14/18	USFWS and Applicant	Grassland Easements	Applicant received digitized Grassland Easements from USFWS.
1/11/19	SDGFP, Applicant, WEST	Prairie grouse surveys	The intent of the meeting was to provide SDGFP with a project introduction/update, discuss methods and results from the first year of prairie grouse surveys conducted at the Project, discuss recommended setbacks and seasonal timing stipulations, and obtain SDGFP feedback
1/25/2019	USFWS, Applicant, WEST	Northern Long-Eared Bat Report	At the request of Applicant, WEST submitted the Northern Long-Eared Bat report along with the USFWS Northern Long-Eared Bat reporting spreadsheets
2/25/2019	SDGFP, Applicant, WEST	Prairie Grouse surveys	At the request of Applicant, WEST submitted draft meeting notes from the January 11, 2019 conference call

Table 2. Summary of USFWS and SDGFP Agency Coordination Activities

Date	Participants[a]	Event/Topic[b]	Discussion/Main Points
2/25/2019	USFWS, SDGFP, Applicant, WEST	First Year Baseline Avian Studies Report, Whooping Crane Stop-Over Habitat Assessment, 2018 Raptor Nest Report, Sweetland Grassland Assessment, 2017 Acoustic Bat Activity Report, 2018 Acoustic Bat Activity Report	At the request of Applicant, WEST submitted the First Year Baseline Avian Studies Report, Whooping Crane Stop-Over Habitat Assessment, 2018 Raptor Nest Report, Sweetland Grassland Assessment, 2017 Acoustic Bat Activity Report, 2018 Acoustic Bat Activity Report
5/28/2019	USFWS, Applicant, WEST	Whooping Crane Monitoring Plan and Shut-Down Protocol	At the request of Applicant, WEST submitted a draft copy of the Sweetland Wind Farm Whooping Crane Monitoring Plan and Shut-Down Protocol
6/19/19	USFWS, Applicant, WEST	Whooping Crane Monitoring Plan and Shut-Down Protocol	USFWS South Dakota Ecological Services Field Office provided comments on the Sweetland Wind Farm Whooping Crane Monitoring Plan and Shut-Down Protocol
6/28/19	WAPA, Applicant, WEST	Whooping Crane Monitoring Plan and Shut-Down Protocol	At the request of Applicant, WEST finalized the Sweetland Wind Farm Whooping Crane Monitoring Plan and Shut-Down Protocol
7/24/19	SDGFP, Applicant, WEST	Prairie Grouse surveys	The Applicant received email notification about a potential post- construction lek monitoring partnering opportunity with SDGFP
8/1/19	SDGFP, Applicant, WEST	Prairie Grouse surveys	Conference call to discuss the potential post-construction lek monitoring partnering opportunity

Table 2. Summary of USFWS and SDGFP Agency Coordination Activities

Date	Participants[a]	Event/Topic[b]	Discussion/Main Points
8/16/19	SDGFP, Applicant, WEST	Prairie Grouse surveys	The Applicant received further information (via email) from SDGFP regarding the potential post-construction lek monitoring partnering opportunity.

(a) Applicant = Sweetland Wind Farm, LLC, WEST = WEST, Inc., USFWS = U.S. Fish and Wildlife Service, SDGFP = South Dakota Game, Fish and Parks, WAPA = Western Area Power Administration

(b) NLEB = northern long-eared bat

5.0 WILDLIFE AND HABITAT RESOURCES: TIERS 1-3

The WEG outlines a tiered approach that assesses the habitat suitability and risks to wildlife at a potential wind resource area. The “tiered” approach ensures that sufficient data are collected to enable project proponents to make informed decisions about continued development of a proposed project (USFWS 2012) while ensuring that Sweetland is complying with its corporate environmental policy. At each tier, potential issues associated with the development or operations of the project are identified and questions are formulated to guide the decision process. This process starts at a broad scale and provides more site-specific detail at each tier as more data are gathered and the potential for avian and bat issues are better understood.

5.1 Tiers 1 and 2 – Preliminary Site Evaluation and Characterization

As described in the WEG, the objective of a Tier 1 study is to assist the developer in further identifying a potential wind energy site through an evaluation of public data from federal, state, and tribal entities on species of concern. The objective of a Tier 2 study is to conduct a more detailed assessment on species of concern and to determine if Tier 3 studies are needed.

Sweetland began initial discussions with representatives from the USFWS and SDGFP in 2016 to determine a suitable location for the Project and selected a location based on input and recommendations from the agencies (Table 2). The meetings with the regulatory agencies and the subsequent selection of the site considering the potential species of concern at the Project met the intent of a Tier 1 study.

Sweetland continued to meet with USFWS and SDGFP to solicit comments and/or concerns on wildlife resources with potential to occur within the Project Area (Table 2). Additionally, a review of available desktop information was completed to assess species of concern and their habitats. Data sources included the USFWS Information for Planning and Conservation (IPaC) website, South Dakota Natural Heritage Database, USGS Breeding Bird Survey, and aerial imagery. Additional input was received from USFWS and SDGFP representatives on August 15, 2017, in relation to federally protected species, state-listed species, species of greatest conservation need, and significant important habitats associated with those species. Based on these initial data reviews and comments received from the USFWS and SDGFP, additional Tier 3 surveys were needed to further evaluate wildlife resources at the Project (Table 2). The meetings with the regulatory agencies and the identification of Tier 3 studies needed for the Project, met the objective of a Tier 2 study.

Table 3. Federal and state protected birds and migratory birds of conservation concern with the potential to occur at the Sweetland Wind Farm, Hand County, South Dakota.

Common Name	Scientific Name	Status
American bittern	*Botaurus lentiginosus*	BCC
bald eagle	*Haliaeetus leucocephalus*	BGEPA, BCC
black tern	*Chlidonias niger*	BCC
bobolink	*Dolichonyx oryzivorus*	BCC
burrowing owl	*Athene cunicularia*	BCC
chestnut-collared longspur	*Calcarius ornatus*	BCC
ferruginous hawk	*Buteo regalis*	BCC
franklin's gull	*Leucophaeus pipixcan*	BCC
golden eagle	*Aquila chrysaetos*	BGEPA
Hudsonian godwit	*Limosa haemastica*	BCC
lark bunting	*Calamospiza melanocorys*	BCC
lesser yellowlegs	*Tringa flavipes*	BCC
long-billed curlew	*Numenius americanus*	BCC
marbled godwit	*Limosa fedoa*	BCC
Nelson's sparrow	*Ammodramus nelson*	BCC
peregrine falcon	*Falco peregrinus*	SE, BCC
red-headed woodpecker	*Melanerpes erythrocephalus*	BCC
Rufa red knot	*Calidris canutus rufa*	FT
semipalmated sandpiper	*Calidris pusilla*	BCC
Whooping crane	*Grus americana*	FE, SE
willet	*Tringa semipalmata*	BCC

BGEPA = Bald and Golden Eagle Protection Act (1940), FE = Federally Endangered (USFWS 2018c), FT = Federally Threatened (USFWS 2015), SE = State Endangered (South Dakota Game, Fish, and Parks [SDGFP] 2018), BCC = Birds of Conservation Concern (IPaC)

Table 4. Bat species with potential to occur at the Sweetland Wind Farm, Hand County, South Dakota.

Common Name	Scientific Name	Habitat	Presence in Project Area
Big brown bat	*Eptesicus fuscus*	Common in most habitat, abundant in deciduous forests and suburban areas with agriculture; maternity colonies beneath bark, tree cavities, buildings, barns, and bridges.	Likely
Eastern red bat	*Lasiurus borealis*	Roosts in trees; solitary.	Likely
Hoary bat	*Lasiurus cinereus*	Usually not found in man-made structures; roosts in trees; very wide-spread	Likely
Silver-haired bat	*Lasionycteris noctivagans*	Common bat in forested areas, particularly old growth; maternity colonies in tree cavities or hollows; hibernates in forests or cliff faces.	Likely
Northern long-eared bat	*Myotis septentrionalis*	Associated with forests; chooses maternity roosts in buildings, under loose bark, and in the cavities of trees; caves and underground mines are	The Project Area lacks suitable summer habitat and probable summer absence was confirmed

Table 4. Bat species with potential to occur at the Sweetland Wind Farm, Hand County, South Dakota.

Common Name	Scientific Name	Habitat	Presence in Project Area
		their choice sites for hibernating. On western edge of range.	with surveys; potential seasonal migrant
Little brown bat	*Myotis lucifugus*	Commonly forages over water; roosts in attics, barns, bridges, snags, and loose bark; hibernacula in caves and mines.	Likely
Western small-footed bat	*Myotis ciliolabrum*	Found in mesic conifer forest, also riparian woodland; roosts in rock outcrops, clay banks, loose bark, buildings, bridges, caves, and mines	The Project Area lacks suitable habitat, potential seasonal migrant.

Source: South Dakota Bat Management Plan (South Dakota Bat Working Group, 2004)

5.2 Tier 3 – Baseline Wildlife Studies

The baseline wildlife studies and their corresponding survey efforts were designed to meet the regulatory guidelines in all years (USFWS 2012). This BBCS discusses all study results completed over the two year pre-construction period. Baseline desktop and wildlife studies include the following: 1) Avian Use Surveys; 2) Aerial Raptor Nest Surveys; 3) Prairie Grouse Surveys; 4) Whooping Crane Stopover Habitat Assessment; 5) Bat Acoustic Surveys; 6) Northern Long-eared Bat Presence/Absence Surveys; and 7) Grassland Habitat Assessment.

5.2.1 2017-2019 Avian Use Surveys

Avian/eagle use point-count surveys were completed for the Project to evaluate species composition, relative abundance, and spatial characteristics of avian use in accordance with agency recommendations (Appendix A and B). The avian use survey was completed following the study plan, as discussed with the USFWS and SDGFP on August 15, 2017. Fixed-point avian use surveys were completed approximately once monthly at 13 points during the first year (May 2017 to April 2018). Six additional points were added for the second year of surveys (May 2018 to April 2019) when the Project Area expanded (Figure 3). The previous and ongoing surveys contained points representative of the habitat within the Project Area, and survey coverage encompassed approximately 30 percent of the Project Area consistent with the WEG and ECPG.

Large bird surveys were completed for 60 minutes during each visit within an 800-meter survey radius. Small bird surveys were completed for 10 minutes before the 60-minute large bird surveys at the same survey points. The surveys provide standardized data for small and large bird species, eagles, and species of concern (i.e., federal- or state-listed threatened and endangered species [ESA 1973], USFWS Birds of Conservation Concern [BCC; USFWS 2008], and South Dakota Species of Greatest Conservation Need [SGCN; SDGFP 2014]).

Forty-three unique large bird species were identified during the 153 hours of surveys that occurred during the first year of large bird surveys. No federally listed species were observed and only one observation of a state endangered species (peregrine falcon [*Falco peregrinus*]) was observed during the surveys. The most common species groups observed included waterfowl, gulls/terns, and waterbirds. Six golden eagles, four bald eagles, and two unidentified eagles were observed within the Survey Area. Golden eagles were observed during the summer and winter seasons while bald eagles were observed during the spring and winter seasons. These eagles were observed in the southern and central portion of the Project Area. Forty-two unique small bird species were observed during the first year of small bird surveys. The most common small bird species included the barn swallow (*Hirundo rustica*), red-winged blackbird (*Agelaius phoeniceus*), and house sparrow (*Passer domesticus*).

Forty-seven unique large bird species were identified during the 209 hours of surveys that occurred during the second year of large bird surveys. No federally listed species were observed. Additionally no state listed species were observed during survey either. The most common species groups observed included waterfowl, shorebirds and gulls. A single bald eagle was observed during the winter in the central portion of the Project Area. No golden or unidentified eagles were observed during the second year of large bird surveys. Forty-two unique small bird species were observed during the second year of small bird surveys. The most common small bird species included horned lark (*Eremophila alpestris*), red-winged blackbird and brown-headed cowbird (*Molothrus ater*).

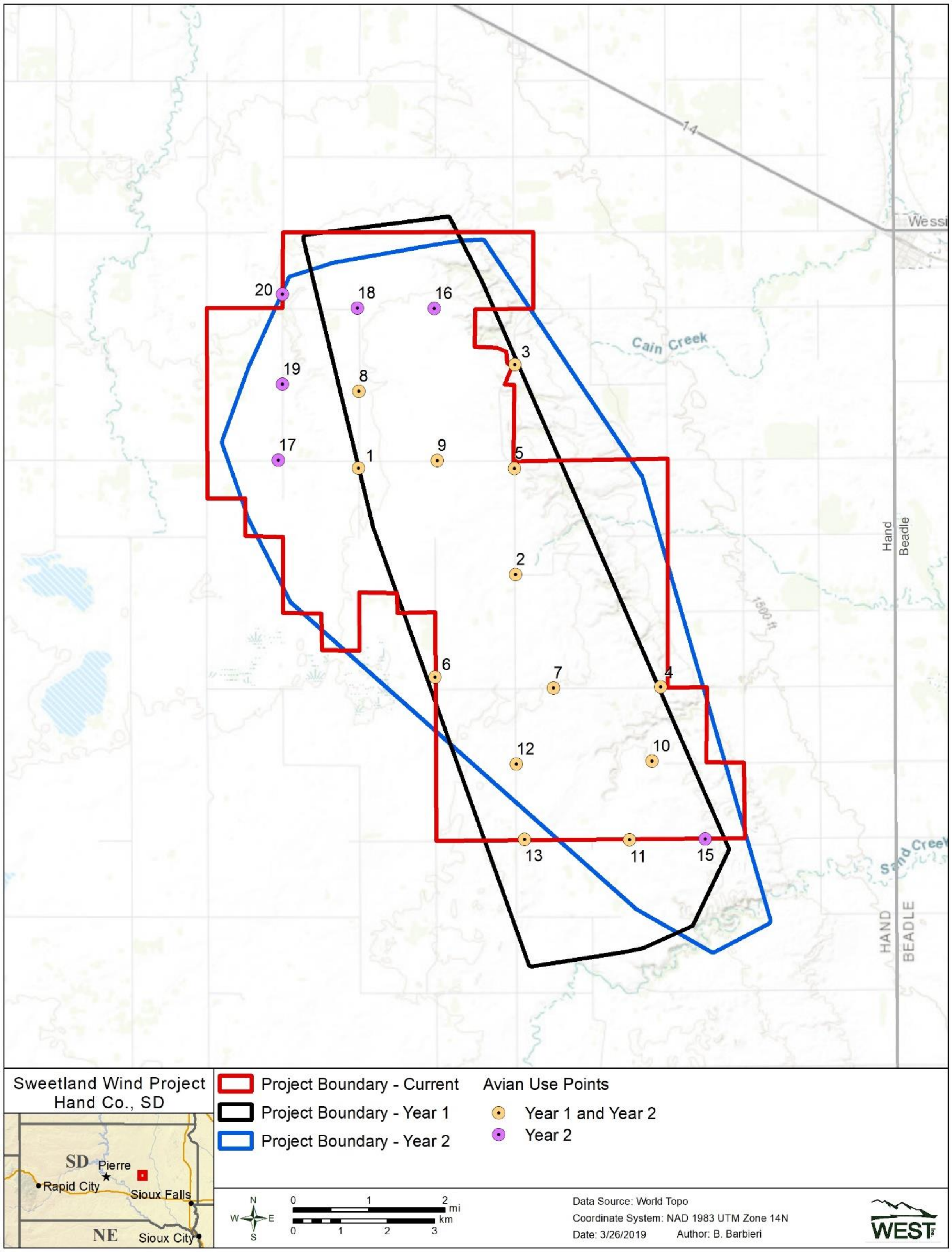

Figure 3. Location of fixed-point eagle and large bird use surveys at the Sweetland Wind Farm, Hand County, South Dakota.

5.2.2 2017/2018 Aerial Raptor Nest Surveys

Aerial raptor nest surveys were completed in spring of 2017 and 2018 (Appendix C and D) to characterize the raptor nesting community and locate raptor stick nests, including eagle nests. All nests located in 2017 were re-surveyed again in 2018, to the extent possible. Aerial surveys were completed prior to leaf-out and during the breeding season when raptors would be actively tending nests, incubating eggs, or brood-rearing. Raptor nest surveys focused on locating stick nest structures in suitable raptor nesting substrate (trees, transmission lines, shelter belts, etc.). The details of the 2017 and 2018 survey methods and results are found in Appendices C and D. The most recent survey (2018) is summarized for non-eagle nests and both years (2017 and 2018) are summarized for eagle nests in the following paragraphs.

5.2.2.1 Non-Eagle Raptor Nests

The raptor-nest survey area was defined as the wind turbine locations (at that time), along with the hazardous area around all the proposed turbine locations, and surrounding 1-mile buffer, although some raptor stick nests documented beyond the 1-mi (1.6-km) buffer were opportunistically recorded. During May 2018, occupied active nests documented during the survey included red-tailed hawk (*Buteo jamaicensis*; n=32) and great horned owl (*Bubo virginianus*; n= 15). The remaining documented raptor stick nests were of unidentified species, with the majority appearing to be unoccupied nests. Within the survey area of the March 2018 turbine layout, 5 active nests (4 red-tailed hawk nests and 1 great horned owl nest) and 13 unoccupied nests were recorded.

5.2.2.2 Eagle Nests

The 10-mile eagle nest survey area was defined as the MCP that encompassed the wind turbine locations (at that time), along with the hazardous area around all the proposed turbine locations, plus a surrounding 10-mile buffer. During 2017, no occupied bald eagle nests were observed. During 2018, one occupied active bald eagle nest (nest ID #69) was located within the 10-mile buffer. The bald eagle nest was over 5.5 miles north of the Project Area. One eagle chick was observed within the nest.

5.2.2.3 Incidental Observations of Eagles

During the 2017 surveys, 10 observations of bald eagles were recorded within the 10-mile buffer of the eagle nest survey area. These observations included 53 bald eagles but may have included multiple observations of the same individuals. Three observations were within 1.4 miles of each other and included 28, 12, and 3 bald eagles. The observations were located near a complex of small lakes approximately 8.2 miles south of the MCP. The remaining observations consisted of one to three bald eagles and were spread throughout the 10-mile survey area. No golden eagles were observed incidentally.

During the 2018 surveys, 38 observations of eagles were recorded within the 10-mile buffer of the eagle nest survey area. These observations included 45 bald eagles and 12 golden eagles but may have included multiple observations of the same individuals. Ten bald eagle observations occurred within 5 miles of the Project Area, with two of these observations within the MCP. Eight golden eagle observations occurred within 5 miles of the MCP, with five of those observations within the MCP. The remaining observations occurred at least 5 miles from the MCP. Group sizes ranged from 1 to 5 individuals.

5.2.3 2018/2019 Prairie Grouse Surveys

Prairie grouse lek surveys were completed from mid-April to mid-May in 2018 and 2019 in accordance with the study plan that was discussed with USFWS and SDGFP on August 15, 2017, and consistent with the SDGFP Wildlife Survey Manual (SDGFP, 2009; Appendix A). SDGFP provided four historic lek locations within and near the Project Area on August 15, 2017. The Project Area and associated 1-mi buffer were surveyed twice (April 6–7 and16 –17, 2018) via helicopter. All historic lek locations and additional sites identified as having displaying grouse during the aerial survey were also surveyed from the ground three times (April 29, May 5, and May 12, 2018). During the 2019 surveys, the Project Area and associated 1-mi buffer were surveyed twice (April 3–7 and 14–15, 2019) via helicopter. All historic lek locations and additional sites identified as having displaying grouse during the aerial survey were also surveyed from the ground three times (April 23–24, April 30–May 1, and May 9–10, 2019).

No prairie grouse were observed at the four historic lek locations in 2018 or 2019. During the 2018 aerial and ground surveys, 1–12 male sharp-tailed grouse were observed dancing/displaying at four locations (Appendix A) but could not be confirmed as leks according the SDGFP’s definition, which is the traditional display area where two or more male grouse have attended in two or more of the previous five years.

During the 2019 aerial and ground surveys 2–8 male sharp-tailed grouse were observed dancing/displaying at three locations identified in 2018, making them official lek locations. In addition, two male sharp-tailed grouse (one location) and 2–3 male greater prairie chickens (two locations) were observed dancing/displaying at new locations but these are not considered leks because only one year of data has been collected in the last five years at those locations.

5.2.4 Whooping Crane Stopover Habitat Assessment

The Applicant completed a site-specific whooping crane (*Grus Americana)* stopover habitat assessment (Appendix E) of the Project Area and surrounding 10-mi buffer. This assessment was done via desktop using a model developed by The Watershed Institute, Inc. (TWI). This model is recommended by the USFWS and was discussed with the USFWS South Dakota Ecological Services Field Office personnel during an in-person meeting on August 15, 2017. All wetlands within the Project Area and 10-mi buffer were assessed using the TWI model and scored based on the quality of the stopover habitat. The TWI model identified water features that could serve as potential stopover habitat for whooping cranes within the Project Area and the surrounding 10-mi buffer.

Suitable habitat for whooping cranes is scattered throughout the Project Area and is generally of lower quality than in surrounding areas. The highest concentration of higher quality suitable stopover habitat (primarily pothole wetlands) occurs along the southwestern edge of the Project Area, but these areas are relatively less dense than the higher quality stopover habitat in surrounding landscapes. There is the potential for whooping cranes to use or fly through the area during the life of the Project, but this is not expected to be frequent event given the low number of cranes in the population that migrates across the relatively wide (200+ miles) migration corridor, as well as the low number observed historically in the vicinity of the Project. Additionally, no whooping cranes have been observed, to date, during Tier 3 surveys occurring in the Project Area.

5.2.5 Bat Acoustic Surveys

The Applicant conducted general acoustic bat surveys for two years, 2017 and 2018, with three detectors. Two detectors were paired with one installed approximately 164 ft (50 m) aboveground on a meteorological tower and the other on the ground elevated about 1.5 meters. Another detector rotated between two locations, elevated about 5.0 ft (1.5 m). During 2017, surveys lasted from June 1 to October 15, and during 2018, surveys lasted from May 7 to October 15. Based on data collected at a single meteorological tower and temporary locations, both years showed similar results, with an average of 2.93 bat passes per detector night during 2017, and 3.63 bat passes per detector night during 2018 (Appendix F and G). AnaBat units at temporary stations recorded an average of 6.50 bat passes per detector night. Temporary stations were located near forested drainages, which may have attracted bats for roosting or foraging opportunities. Peak activity during both years occurred during the late summer/early fall timeframe. Based on data collected at the meteorological tower location, bat passes per detector night were also calculated during the bat fall migration period (FMP), defined as July 30 to October 14 for the Project Area. During the 2017 FMP, an average of 1.34 bat passes per detector night was estimated. The estimated average for the 2018 FMP was 1.37 bat passes per detector night. These estimates to other projects can been seen in Appendix A of both the 2017 and 2018 bat reports, included in this application as Appendix F and G.

5.2.6 Northern Long-eared Bat Presence Absence

The Applicant conducted site-specific acoustic presence/absence surveys for northern long-eared bat (NLEB; *Myotis septentrionalis*) during the summer of 2018 (Appendix H. All surveys followed the USFWS *Range-Wide Indiana Bat summer Survey Guidelines* (Guidelines; USFWS 2018a), which also applies to NLEB. A desktop assessment of the Project Area was done to determine potential suitable summer habitat and to identify appropriate habitat for three acoustic sites to sample. Three acoustic sites were sampled using two detectors deployed at each site for four nights, for 24 detector nights. Bats were surveyed using Song Meter full-spectrum ultrasonic detectors (SM4; Wildlife Acoustics, Inc., http://www.wildlifeacoustics.com).

Acoustic presence/probable absence surveys were conducted from July 5 to 10, 2018. Acoustic monitoring began before sunset and continued for the entire night. If weather conditions, such as persistent rain (30 or more minutes), strong sustained winds (greater than 9 miles per hour [mph; 14.5 kilometers per hour {kph}] for 30 or more minutes), or cold temperature (below 10 degrees Celsius [50 degrees Fahrenheit] for 30 or more minutes) occurred, then the acoustic site subject to those conditions was survey for an additional night. Omnidirectional detector microphones were positioned at least 9.8 ft (3.0 m) off the ground and oriented horizontally. For each acoustic detector, the date, site description, site coordinates, tree species composition, stand age, vegetation community type, and weather data were recorded. Representative photographs of each acoustic site were taken.

No potential NLEB calls were identified by the automated bat call identification feature in the software program Kaleidoscope (set to the versions approved by the USFWS for acoustic analysis of sensitive species); therefore, no qualitative review was necessary and no follow-up mist-net or telemetry surveys were performed. The acoustic survey results show probable absence of NLEB within the Project Area during the summer, but the species may pass through the Project Area as a seasonal migrant. There are no Natural Heritage Information System records of NLEB hibernacula within the vicinity of the Project; the nearest publicly available NLEB hibernaculum is in eastern Stearns County, Minnesota, more than 200 miles east (Minnesota DNR/USFWS, 2018).

5.2.7 Grassland Habitat Assessment

A site-specific grassland habitat assessment of the Project Area was conducted between July 17 and September 14, 2018, to provide an assessment of the quality of all potential Project grasslands, both disturbed and previously undisturbed (Appendix I) and to therefore provide information to the Applicant to avoid and minimize impacts to higher quality undisturbed grasslands. Potentially undisturbed grassland (i.e., grasslands that have not previously been tilled) were initially identified based on publicly available data in the Quantifying Undisturbed (Native) Land in Eastern South Dakota: 2013 digital data layer (Bauman et al. 2016) and recent aerial photography. All grassland tracts were field checked, either by traversing on foot, or making observations from adjacent public roads. This assessment defined "undisturbed native grasslands" as those grassland that (1) showed no evidence of previous tilling and (2) were dominated entirely by native tallgrass species; any grassland parcel with these characteristics in the Project Area would be given a Rank of 1, or Excellent (Appendix I). Parcels found to have introduced grasslands such as smooth brome (*Bromus inermis*) prevalent but still had common occurrences of native grasses were given a Rank of 2, or Above Average. Parcels dominated by introduced grasses with infrequent native grasses or no native grasses present were given ranks of 3 (Average) and 4 (Fair), respectively, Grassland classified as Rank 5 (Poor) included all those classified as hayfield as well as any grassland severely overgrazed by livestock (Appendix I).

This assessment determined that grassland tracts in the Project Area are dominated by a mix of non-native grasses such as smooth brome, Kentucky bluegrass (*Poa pratensis*), and fescue (*Festuca* spp.). Additional species documented in some of the grassland tracts included prairie coneflower (*Ratibida columnifera*) and thistle (*Cirsium* spp.). It was also determined during the field visit that some of the herbaceous/grassland tracts were planted with alfalfa (*Medicago sativa*).

Overall, the review of the grassland tracts in the Project Area reveals localized fragmentation impacts due to land conversion and vegetation loss primarily associated with agriculture, but also due to invasive and noxious species, pesticides; and urbanization through road construction, distribution and transmission lines, pipelines, fiber optic lines, gravel pits, and residential development. No undisturbed native grasslands (parcels ranked as Excellent) were documented in the Project Area, and only limited, isolated patches of Above Average grasslands were found, generally limited to the edges of ravines (Appendix I). Thirteen of the parcels evaluated appeared to be previously tilled but were planted in grasses dominated by smooth brome at the time of the evaluation; these disturbed grasslands were all ranked as 4 (Fair).

The limited numbers of trees within the Project Area are primarily found around residences and shelterbelts. Trees identified during the grassland habitat assessment include eastern red cedar (*Juniperus virginiana*) and Russian olive (*Eleagnus angustifolia*), which are invading some of the grassland tracts in the Project Area.

6.0 ASSESSMENT OF RISKS TO BIRDS AND BATS

Direct impacts to wildlife resources can occur at different temporal scales (e.g., during the construction, operation, and decommissioning phases of the Project) and spatial scales (e.g., within or outside the Project Area). Direct impacts include wildlife fatalities resulting from interactions with facility development or infrastructure. Some potential direct impacts from wind-energy development include:

- Collisions: turbines, overhead lines, vehicle and equipment collisions
- Avian power line interactions
- Habitat loss, fragmentation, and/or alteration during construction, operation, and decommissioning

Indirect impacts to wildlife resources can also occur at different temporal scales (e.g., during and after construction and operation) and spatial scales (e.g., within or outside the Project Area). Indirect impacts are often unintended, may produce unforeseen consequences to wildlife, and are difficult to predict. In this document, indirect impacts will focus on what could occur at the Project, particularly habitat loss and/or alteration.

The data from Tier 3 avian and bat surveys, publicly available information on post-construction mortality monitoring from other wind energy projects, and relevant literature were used to provide an assessment of risk to birds and bats at the Project.

6.1 BIRDS

Impacts to avian species from the construction and operation of the Wind Farm can be direct or indirect and can occur at different temporal scales (e.g., during and after construction and operation) and spatial scales (e.g., within or outside the Project Area).

6.1.1 Direct Impacts

6.1.1.1 <u>Collisions</u>

Potential direct impacts to birds as a result of collisions with wind turbines or associated project infrastructure is possible based on the studies to date. One of the closest operational wind energy facilities with publicly available data is the Wessington Springs facility in Jerauld County, South Dakota, approximately 24 mi (38.0 km) to the southeast. At the Wessington Springs facility, overall bird fatality estimates ranged from 0.89 to 8.25 fatalities/MW/year and averaged 4.57 fatalities/MW/year. In the Midwest, 38 comparable fatality rate estimates for all bird species combined are publicly available from studies of wind energy facilities. Overall bird fatality rates in the Midwest have ranged from 0.27 to 8.25 bird fatalities/MW/year and averaged 2.76 all bird fatalities/MW/year. The range of bird fatalities observed in the Midwest would be expected to encompass the impacts anticipated at the Project.

Most documented avian fatalities in North America are of passerines (e.g., songbirds) which composed about 62.5 percent of wind turbine fatalities in 116 studies included in a recent analysis (Erickson et al. 2014). A total of 3,110 fatalities represented by 156 species of passerines were found during the studies. From this research it was estimated that approximately 134,000 to 230,000 fatalities of small passerines occurred each year in the United States and Canada combined, equaling a rate of 2.10 to 3.35 small birds/MW of installed capacity.

Although passerines make up the majority of fatalities at wind projects, the fatalities are spread out among multiple species, with each species experiencing relatively low direct impacts, ranging from 0.008–0.043% of respective continental populations experiencing mortality each year from collisions with wind turbines. Similar effects (i.e., direct impacts spread across multiple species of small birds with negligible effects on overall populations of any one species) would be anticipated for this Project. In comparison, researchers estimated that 6.8 million birds were killed annually from collisions with communication towers (passerines composed 97 percent of all fatalities), and annual mortality for individual species ranged from 1.2 to 9.0% of their estimated total populations for the 20 species most affected (Longcore et al. 2012, 2013).

Several wind projects located in complexes of prairie pothole wetlands had relatively high use by waterfowl, but waterfowl-specific fatality estimates from these studies is limited. Publicly available data from the Prairie Wind Project in North Dakota estimated between 0.38 and 0.44 waterfowl fatalities/MW/year. The Prairie Wind Project in South Dakota is 27 mi (48 km) south of the Project and estimated between 0.45 to 0.78 large bird fatalities/MW/year, including waterfowl. Additional data from other projects in the Central Flyway with relatively high use by migratory birds and waterfowl (Rugby Wind Project in North Dakota, Tatanka Wind Project in North and South Dakota, Wessington Springs in South Dakota, and Top of Iowa in Iowa) show fatality estimates for all birds and large birds ranging from 0.38 to 8.25 bird fatalities/MW/year. Although wind projects located in proximity to waterfowl habitat can result in waterfowl fatalities, others do not (Top of Iowa) and the fatality rates do not appear to approach levels that would affect waterfowl populations. In 2016, there were 48.4 million breeding ducks and 11.8 million migrating mallards, as documented in USFWS Waterfowl Population Status report [USFWS 2016]).

Publicly available diurnal raptor use estimates coupled with publicly available diurnal raptor fatality estimates are only available for the Wessington Springs facility in South Dakota. At the Wessington Springs facility, the mean annual diurnal raptor use estimate was 0.24 diurnal raptor/800-m plot/20-minute survey similar to the 0.22 raptor/800-m plot/20-minute survey estimate at the Project and raptor fatality rates at the Wessington Spring facility averaged between 0.07 and 0.08 diurnal raptor fatalities/MW/year. Raptor fatality rates ranged from 0 to 0.20 raptor fatalities/MW/year in North and South Dakota and ranged from 0 to 0.47 raptor fatalities/MW/year in the Midwestand similar levels of raptor mortality might be expected for this Project. Population level effects have not been detected yet or reported in the studies/reviews that have evaluated the issue for raptors (Bay et al 2017), nor would they be anticipated for the Project. PCM would occur to confirm the pre-construction risk analysis for all birds, and adaptive management measures as documented in the BBCS would be implemented if needed (see Section 9).

6.1.1.2 Avian Power Line Interactions

Potential impacts to birds from power line operation include electrocution and collision and depend on voltage, configurations, and location relative to area habitats and bird presence/use. For this Project, the 34.5kV collector lines from the turbines to the Project substation will be buried, eliminating the electrocution or collision risk from these undergrounded lines.

Electrocution risk to birds on the 230kV transmission line would not apply, given line size and clearances required by the National Electrical Safety Code for 230kV transmission lines exceed the necessary clearances for the largest birds in this region (e.g., golden eagle). The necessary clearances to prevent avian electrocutions for 230kV transmission voltages would equal 94 inches (in; 237 centimeter [cm]) horizontal and 74 in (187 cm) vertical for phase-to-phase (i.e., energized-to-energized) contacts and 75 in (189 cm) horizontal and 55 in (139 cm) vertical for phase-to-ground contact points (APLIC 2006; Nielsen and Ehmke pers. comm., WEST). Although the design of the 230kV transmission line is pending, it can be assumed no electrocution risk to perching birds from power line operation would apply (APLIC 2006).

The potential risk of bird collisions with the overhead transmission line for this Project would be based on a number of site-specific factors. These factors would include line design, line orientation and placement, at-risk bird species present, topography, habitats, weather and seasonality, bird morphology, flight characteristics, land uses, and human influences (APLIC 2012). Based on the committed conservation measure listed in Section 7, avian flight diverters would be installed along the entire transmission line’s overhead ground wire(s) to increase line visibility and reduce avian collision risk during transmission line operation. Marking overhead power lines has been shown to reduce bird collision risk anywhere from 29% to 89% (Beaulaurier 1981, Morkill and Anderson 1991, Crowder 2000, Yee 2008, Murphy et al. 2009, Ventana Wildlife Society 2009, APLIC 2012, Sporer et al. 2013).

6.1.1.3 Habitat Loss or Alteration

Construction of the Project will result in habitat impacts that could lead to direct impacts of local avian species such as in injury or mortality resulting from collisions with construction equipment in the Project Area. These impacts are unlikely, however, based on the current plan of development and the wildlife conservation and mitigation measures intended to offset these impacts (see Section 7).

6.1.2 Indirect Impacts

Indirect impacts are often unintended, may produce unforeseen consequences to wildlife, and are difficult to predict. Indirect impacts will focus on what could occur for the Project, particularly habitat loss and/or alteration and the potential temporary or permanent displacement of avian species. Construction and operation of the Project may result in grassland impacts that could lead to displacement of local avian species in the Project Area. The small amount of Above Average grasslands temporarily (12.1 ac [4.9 ha]) or permanently (1.3 ac [0.5 ha]) impacted by the Project minimized the potential impact to grassland birds using this habitat. The current plan of development will manage vegetation and weeds in an effort to minimize impacts and allow native vegetation to revegetate areas altered by construction.

Studies in the Great Plains on the effects of wind energy development on grassland breeding birds found immediate displacement effects (first year) for three species, attraction for two species, and no effect on four species (Shaffer and Buhl 2016). Over time, however, delayed effects (2 to 5 years post-construction) were observed for seven species that showed some displacement up to 300 meters from wind turbines, whereas no effects were observed for two species (killdeer, vesper sparrow; Shaffer and Buhl 2016). Of the seven grassland-breeding birds showing displacement in the Shaffer and Buhl (2016) study, grasshopper sparrow and upland sandpiper (Birds of Conservation Concern [BCC] but not Species of Greatest Conservation Need [SGCN]) were species of concern detected in the Project Area. The remaining five of the seven displaced species were either not detected at the Project (chestnut collared longspur), not displaced (bobolink) or not studied (clay-colored sparrow, savannah sparrow) at the South Dakota study site, or not listed as BCC or SGCN (western meadowlark). Displacement effects would not be anticipated at the population level in part because it is unknown if displaced birds have reduced reproductive fitness in their new locations.

Studies in the Great Plains on the effects of wind energy development on breeding density of waterfowl at two wind facilities in the Missouri Coteau of North Dakota and South Dakota found results consistent with displacement (Loesch et al. 2013). Five species of waterfowl showed a median displacement rate of 21 percent, with approximately half of the study sites showing a reduction in breeding pairs (Loesch et al., 2013). Identifying the ultimate cause of the reduced breeding density, however, was challenging because of the limited temporal duration of the study (three years), and confounding effects between land use and duration of development. This prevented the authors from assessing the potential for cumulative impacts of wind energy development on breeding waterfowl. (Loesch et al. 2013).

6.2 BATS

Impacts to bats from the construction and operation of the Project could include both direct and indirect impacts. Direct impacts to bats as a result of collisions with moving turbine blades is the main source of mortality at wind projects (Grodsky et al. 2011, Rollins et al. 2012), but the underlying reasons for why bats come near turbines are still largely unknown (Cryan and Barclay 2009).

Most bat fatality studies at wind energy facilities in the US have shown a peak in fatality during August and September and generally lower mortality earlier in the summer and very low mortality during the spring (Johnson 2005, Arnett et al. 2008, Derby et al. 2013c). Three species of migratory tree bats comprised the majority of all bat turbine fatalities in the U.S. and Canada between 2000 and 2011 including hoary bat (*Lasiurus cinereus*; 38% of fatalities), eastern red bat (*Lasiurus borealis*; 22%), and silver-haired bat (*Lasionycteris noctivagans*; 18.4%; Arnett and Baerwald 2013).

The Wessington Springs Project, located approximately 38 km (24 mi) southeast of the Project, and the Prairie Winds Wind Project, located 27 mi (48 km) south of the Project, both contain similar habitat types to the Project, with relatively scattered patches of deciduous trees and open waterbodies. Due to the geographic proximity and habitat similarity of the Project Area to Wessington Springs and Prairie Winds, it is assumed that bat mortality at the Project would be relatively low and follow similar patterns as those observed at these facilities (i.e., 0.41 to 1.48 bat fatalities/MW/year) and within the Midwest region (0.16 to 30.61 bat fatalities/MW/year, an average of 5.89 fatalities/MW/year).

Direct impacts would be minimized by feathering below the manufacturer's cut-in speed from July 15 to September 30, between sunset and sunrise when the temperature is above 50 degrees Fahrenheit, to reduce bat mortality. Indirect impacts (e.g., habitat loss or alteration) would be minimized by siting the Project in an area that has minimal wooded habitat. PCM would occur to confirm the pre-construction risk analysis for bats, and adaptive management measures as documented in the BBCS would be implemented if needed (see Section 9).

6.3 Potential Risk to Federal or State-listed Species and Species of Interest

6.3.1 Bald Eagle

The bald eagle is protected by the Bald and Golden Eagle Protection Act of 1940 (BGEPA) and is a resident species throughout South Dakota in suitable habitats. Bald eagles were observed within the Project Area infrequently during avian use surveys during spring (3 observations) and winter (1) of 2017–2018; and during winter (1) of 2018–2019 with none observed during summer and fall. Additionally, two unidentified eagle observations were observed during spring. There were no occupied nests identified in 2017 and the closest known occupied nest in 2018 was approximately 5.5 mi (8.9 km) north of the Project Area.

Bald eagles were also observed incidentally during the course of raptor nest surveys in 2017 and 2018, and these sightings may have multiple observations of the same individuals. In 2017, 53 bald eagles were observed: three observations totaling 43 bald eagles were clustered at small lakes within 1.5 miles of each other approximately 8.2 miles south of the Project Area, and seven instances totaling 10 bald eagles were observed throughout the Survey Area. In 2018, 45 bald eagles were observed: 10 bald eagle observations occurred within five miles of the Project Area, with the remaining 35 observations occurring at least five miles from the Project Area.

Preferred nesting, foraging, and roosting bald eagle habitats include large, mature trees near water with abundant fish and waterfowl prey, especially in areas with little disturbance. The small patches of isolated wooded habitat in the Project Area are not anticipated to be high quality or preferred nesting habitat for bald eagles; however, with increasing bald eagle populations, nesting eagles are also being found in areas away from major waterbodies. The larger wetlands in the Project Area provide potential foraging habitat for bald eagles. Bald eagles may also be found during migration and winter periods in areas away from major rivers if sufficient forage or prey (i.e. waterfowl) is available. Wintering bald eagles are often associated with lakes, rivers, and reservoirs where they feed primarily on fish or waterfowl and the nearest major river is the Missouri River, located approximately 35 mi west of the Project Area.

Potential direct impacts to breeding bald eagles as a result of construction and operation activities could include injury or mortality due to vehicle collisions, but is unlikely because of their low anticipated use of the Project Area. No electrocution or collision risk to bald eagles would apply to the buried 34.5kV collector lines, and no electrocution risk to eagles from operation of the 230kV transmission line would apply given line size. The potential for collision risk with the overhead 230kV transmission line would be low given the low probability of eagle use of the Project Area, the low incidence of power line collision for raptors, and because line collision risk for eagles has primarily been associated with crossing lines daily in concentrated movement corridors (Olendorff and Lehman 1986, Bevanger 1994, Mojica et al. 2009, APLIC 2012) a situation that does not occur at the Project. Additionally, avian flight diverters will be installed along the entire length of the transmission line (see Section 7) and marking overhead power lines has been shown to reduce bird collision risk anywhere from 29% to 89% (Beaulaurier 1981, Morkill and Anderson 1991, Crowder 2000, Yee 2008, Murphy et al. 2009, Ventana Wildlife Society 2009, APLIC 2012, Sporer et al. 2013).

Indirect impacts from the loss of foraging habitat are also unlikely because of the limited use of the Project Area and the prevalence of foraging habitat in the region. Overall impacts to bald eagles in the Project Area are expected to be minimal based on the following: low mean use, lack of eagle concentration areas, limited roost sites, and low nesting density outside the Project Area. Potential direct and indirect impacts to bald eagles would be reduced through implementation of conservation measures (see Section 7).

6.3.2 Golden Eagle

The golden eagle is also protected by the BGEPA and is also a resident species in South Dakota in suitable habitat such as prairie, but is more common in hilly or mountainous regions of western South Dakota. Golden eagles were observed within the Project Area infrequently during avian use surveys during summer (1 observation), winter (5) 2017–2018, and none during spring and fall. Additionally, two unidentified eagle observations were observed during spring. No golden eagles were observed during the second year of surveys (2018–2019). No nests were found within a 10 mi radius of the Project Area in 2017 or 2018.

Golden eagles were observed during the course of raptor nest surveys in 2018 (not in 2017), and these sightings may have multiple observations of the same individuals. In 2018, eight golden eagle observations occurred within five miles of the Project Area, while the remaining four observations occurred at least five miles from the Project Area.

Preferred nesting habitat includes rock outcrops, cliff ledges, and trees, while foraging habitat includes prairies, sagebrush, and open woodlands. While the Project Area does contain some small patches of isolated wooded habitat that may be suitable for nesting eagles, these areas are not anticipated to be high quality or preferred nesting habitat for golden eagles, and there are no cliffs or rocky outcrops. The grasslands within the Project Area could provide potential foraging habitat for golden eagles. Golden eagles may also pass through Project Area during migration and could also be found during winter in areas where sufficient prey (e.g., waterfowl) is available. The nearest location concentrating waterfowl during winter is the Missouri River, located approximately 35 mi west of the Project Area.

Potential direct impacts to breeding golden eagles as a result of construction and operation activities could include injury or mortality due to vehicle collisions, but is unlikely because of their low anticipated use of the Project Area. No electrocution or collision risk to golden eagles would apply to the buried 34.5kV collector lines, and no electrocution risk to eagles from operation of the 230kV transmission line would apply. The potential for collision risk with the overhead 230kV transmission line would be low given the low probability of eagle use of the Project Area, the low incidence of power line collision for raptors, and because line collision risk for eagles has primarily been associated with crossing lines daily in concentrated movement corridors (Olendorff and Lehman 1986, Bevanger 1994, Mojica et al. 2009, Avian Power Line Interaction Committee [APLIC] 2012) a situation that does not occur at the Project. Additionally, avian flight diverters will be installed along the entire length of the transmission line (see Section 7) and marking overhead power lines has been shown to reduce bird collision risk anywhere from 29% to 89% (Beaulaurier 1981, Morkill and Anderson 1991, Crowder 2000, Yee 2008, Murphy et al. 2009, Ventana Wildlife Society 2009, APLIC 2012, Sporer et al. 2013).

Indirect impacts from the loss of foraging habitat are also unlikely because of their limited use of the Project Area and the limited amount of suitable foraging habitat impacted in the Project Area (see 6.1.2) and the prevalence of foraging habitat in the region. Overall impacts to golden eagles in the Project Area are expected to be minimal based on the following: low mean use, lack of eagle concentration areas, limited roost sites, and no nests within a 10 mi radius of the Project Area. Potential impacts to golden eagles would be reduced through implementation of conservation measures (see Section 7).

6.3.3 Whooping Crane

The whooping crane is listed as endangered under the ESA, and endangered within the state according to the SDGFP. Whooping cranes migrate in a corridor between the Texas gulf coast and Canada's Northwest Territories and the Project Area is located in bands where 75 percent (Pearse et al. 2018) or 90 to 95 percent of migratory whooping crane observations have occurred (WAPA and USFWS, 2015b). or A desktop stopover habitat assessment of the Project Area and surrounding 10-mile buffer determined the highest quality suitable habitat for whooping cranes occurs in the southwestern edge of the Project Area; whereas, the remaining suitable habitat is scattered throughout the Project Area and is generally of lower quality than in surrounding areas (TWI 2012). A similar result was obtained using the predictive map of relative probability of occurrence by whooping cranes (Niemuth et al. 2018). Suitable stopover habitat for whooping cranes occurs in limited amounts within the Project and with low probability of occurrence when compared to the surrounding landscape.

There is potential for whooping cranes to use or fly through the area during the life of the Project, but this is not expected to be a frequent event given the low number of cranes in the population that migrate across the relatively wide (200+ miles) migration corridor, as well as the low number observed historically in the vicinity of the Project. According to the Cooperative Whooping Crane Tracking Project (CWCTP), no observations of whooping cranes have occurred within the Project Area and the nearest historical sighting occurred approximately 4 miles east of the Project Area (CWCTP 2016). Additionally, no whooping cranes were observed during Tier 3 surveys occurring in the Project Area and no crane fatalities have been documented at wind energy facilities (Derby et al. 2018).

Overall impacts to whooping cranes in the Project Area are expected to be minimal, based on the following: no observations of whooping cranes during the study period, limited high-quality suitable stopover habitat in the Project Area, the Project Area is outside of the species' breeding and wintering range, limiting potential occurrence to migration periods, and the 230kV transmission line will be marked with avian flight diverters to reduce avian collision risks, and no documented fatalities at wind energy facilities. Potential impacts to whooping cranes would be reduced through implementation of conservation measures (see Section 7).

6.3.4 Rufa Red Knot

The red knot (*Calidris canutus*) is listed as threatened under the ESA. The primary reason the red knot is listed as threatened is because of climate change and coastal development, in addition to overharvesting of the horseshoe crab. The red knot migration path can vary greatly, but they travel extreme distances, at times over 9,000 miles, from South America to North America. This species makes frequent stops to feed and rest during migration and prefers a habitat with their prey of choice, invertebrates, particularly small snails, crustaceans, and bivalves. This species is unlikely to occur in the Project Area, as it is primarily a coastal species and the Project Area lacks suitable stopover habitat in the form of intertidal, marine habitats. No red knots were observed during the avian use surveys. The nearest potential stopover habitat likely occurs along the Missouri River, which is approximately 35 mi (56 km) west of the Project Area.

Overall impacts to red knot in the Project Area are expected to be minimal based on the following: limited suitable habitat in the Project Area, and the Project Area is outside of the breeding and wintering range, limiting occurrence to migration periods. Potential impacts to red knot would be reduced through implementation of conservation measures (see Section 7).

6.3.5 Peregrine Falcon

Only one peregrine falcon was observed during migration during the avian use surveys. Overall impacts to peregrine falcon in the Project Area are expected to be minimal based on the following:

no breeding habitat, low mean use, and occurrence limited to migration periods. Potential impacts to peregrine falcon would be reduced through implementation of conservation measures (see Section 7).

6.3.6 Prairie Grouse

Prairie grouse lek surveys were completed in the Project Area and a 1-mile buffer in 2018 and 2019. Four historic lek locations provided by SDGFP were inactive in both years. Three sharp-tailed grouse locations met the definition of a lek according the SDGFP's definition, which is a traditional display area where two or more male grouse have attended in two or more of the previous five years. Two leks are within one mile of project infrastructure and one lek is greater than one mile from infrastructure (Appendix A). Additionally, there were four new locations of displaying/dancing birds in 2019: one sharp-tailed grouse and one greater prairie chicken location within one mile of project infrastructure; one greater prairie chicken location greater than one mile of infrastructure; and one sharp-tailed grouse location considered a satellite of a nearby lek site established in 2019 (Appendix A).

The indirect effects of wind energy development have been studied on three species of grouse in the U.S.: greater sage-grouse (*Centrocercus urophasianus*), greater prairie-chicken (*Tympanuchus cupido*), and Columbia sharp-tailed grouse (*Tympanuchus phasianellus columbianus*), but no studies have been conducted on plains sharp-tailed grouse (*Tympanuchus phasianellus*). Studies on greater sage-grouse and greater prairie-chicken concluded there were displacement effects from wind facilities, although they had no negative effect on population fitness. Greater sage-grouse brood and summer use decreased as density of turbines increased within 1,200 m of turbines (LeBeau et al. 2017a), and the probability of space use for greater prairie-chicken decreased within 2,170 m of turbines during the breeding season (Winder et al. 2014a). Greater sage-grouse nest site selection and nest survival were not affected by the presence of turbines (LeBeau et al. 2017a) nor were there significant differences in the number of males attending leks pre and post development between control and treatment sites (LeBeau et al. 2017b). Similarly, Columbia sharp-tailed grouse nest site selection and nest survival were not affected by the presence of turbines (Proett 2019).

Overall impacts to prairie grouse in the Project Area are expected to be minimal based on the following: two leks and two displaying/dancing locations within one mile of proposed infrastructure, one lek and one displaying/dancing location greater than one mile from proposed infrastructure, lek attendance not influenced by turbines for other species of grouse (greater sage-grouse), nest site selection and nest survival not affected by the presence of turbines, and suitable habitat for nesting, foraging, and brood rearing outside the Project. Potential impacts to prairie grouse would be reduced through implementation of conservation measures (see Section 7) and potential impacts to leks would be monitored for two years post-construction (see Section 8).

Further, the project sited wind turbines to the extent practicable to minimize impacts to leks. This was done by situating the strings of wind turbines to maximize wind turbine distance from displaying/dancing locations while avoiding placement of wind turbines (including turbine access roads and underground collection) that could impact sensitive cultural resource areas, delineated wetlands, USFWS Wetland and Grassland Easements while locating wind turbines on acreage under wind lease.

6.3.7 Northern Long-Eared Bat

The northern long-eared bat (*Myotis septentrionalis*; NLEB) is listed as threatened under the ESA; however, incidental take of the species due to operation of wind projects is exempt under a 4(d) rule (81 Federal Register 9: 1900-1922, 2016). The NLEB was listed as threatened under the ESA in 2015, and the USFWS issued the final 4(d) rule for the NLEB on April 2, 2015.
The NLEB is a forest bat species that roosts alone or in colonies under bark, cavities, or crevices in living or dead trees. The NLEB bat generally flies under a canopy, feeding on moths, fleas, leafhoppers, caddisflies, and beetles. The Project Area contains small amounts of generally isolated wooded land cover and therefore contains little suitable summer habitat for the NLEB.

The Applicant conducted site-specific acoustic presence/absence surveys for NLEB during the summer of 2018 and no potential NLEB calls were identified showing probable absence of NLEB within the Project Area during the summer. The species may pass through the Project Area as a seasonal migrant and the nearest NLEB hibernaculum is more than 200 miles east in Minnesota (Minnesota DNR/USFWS 2018). Overall impacts to NLEB in the Project Area are expected to be minimal based on the following: probably absence in the Project Area, limited foraging and roost sites, and nearest hibernacula more than 200 mi from Project. Potential impacts to NLEB would be reduced through implementation of conservation measures (see Section 7).

7.0 AVOIDANCE AND MINIMIZATION MEASURES

Information gathered during Tier 1, 2, and 3 studies will be used during the Project design and turbine and infrastructure siting process to reduce potential impacts to birds and bats and their habitats. As part of the NEPA process for approval of the WAPA interconnection, the Project will implement the applicable best management practices (BMPs) and mitigation measures specified in the UGP PEIS. The Applicant is committed to avoiding and/or minimizing impacts to wildlife through Project design, construction, and operation by implementing the following Conservation Measures.

7.1 Conservation Measures Implemented During Site Selection and Project Design

Sweetland will make efforts during initial site selection and during project design to locate and select wind turbines, met towers, and other infrastructure such that bird and bat collisions are minimized. Project design and siting measures to avoid or minimize risk to avian and bat species will include the following:

- To the extent commercially reasonable, maximize power generation per turbine to reduce the number of turbines needed to achieve maximum energy production.
- Locate the up to 7.0-mi (11.3-km) transmission line in areas where Sweetland has site control and to the extent possible in areas where previous disturbance has occurred, thereby minimizing impacts to trees and associated wildlife.

- Where applicable, the Project's aboveground power lines shall be designed and constructed to minimize avian electrocution and collision risks, referencing guidelines outlined in the Avian Power Line Interaction Committee's (APLIC) *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006* and *Reducing Avian Collisions with Power Lines: The State of the Art in 2012*.

- To the extent commercially reasonable, use un-guyed met towers for permanent monitoring. Schedule the installation of meteorological towers and other characterization activities (i.e., field surveys and to avoid disruption of wildlife reproductive activities or other important behaviors (e.g., do not install towers during periods of prairie-grouse nesting).

- Use the existing road network to reduce the need for road construction.
- Avoid siting project components in wetlands and waterbodies.
- Site turbines and access roads to avoid USFWS Grassland or Wetland Easements.
- Minimize disturbance to Above Average grasslands.
- Minimize siting turbines in wooded patches.
- Locate the Project in an area with minimal bat habitat (limited wooded areas in isolated small patches).
- Site turbines and other above-ground wind facility infrastructure away from prairie grouse leks to the extent possible; conduct 2 years of post-construction lek/grouse monitoring. To the extent practicable, limit construction and disruptive activities from three hours after sunrise to one hour before sunset
- Turn off unnecessary lighting at night to limit attraction of migratory birds. Follow lighting guidelines, where applicable, from the Wind Energy Guidelines Handbook (*U.S. Fish and Wildlife* Service *Land Based Wind Energy Guidelines* (WEG). This includes using lights with timed shutoff, downward-directed lighting to minimize horizontal or skyward illumination, and avoidance of steady-burning, high-intensity lights. Extinguish all internal turbine nacelle and tower lighting when unoccupied.
- Light the wind turbines and met towers in accordance with the Federal Aviation Administration requirements.

7.2 Conservation Measures to be Implemented during Construction

Construction of the Project is expected to begin in Q4 2019 and occur over a period of approximately 12 months (excluding times when the weather prevents construction activities). The following Conservation Measures will be implemented to avoid or minimize risk to avian and bat species during construction:

- Prepare a BBCS in accordance with the USFWS WEG that will be implemented to minimize impacts to avian and bat species during construction and operation of the Project.

- Avoid tree removal from June 1 through July 31 to reduce potential impacts to roosts and other tree roosting habitats for NLEBs and other bat species.
- Minimize tree removal as much as feasible to reduce impacts to bat roosting habitat.
- Establish wind turbine buffer zones around known raptor nests (0.25-mile) and bat roosts if site evaluations show that proposed construction activities would pose a significant risk to avian or bat species of concern.
- Conduct construction monitoring during whooping crane migration seasons, and stop construction activities within 2.0 mi (1.6 km) of observed whooping cranes until the crane leaves (see Appendix K);
- Install avian flight diverters along the entire length of the transmission line using appropriate marking devices and device spacing to minimize potential collision impacts to whooping cranes and other avian species. Devices will be installed on the overhead ground wire/optical ground wire (as appropriate) to increase wire visibility (APLIC 2012).
- To the extent feasible, the area required for Project construction and operation will be minimized. Sweetland will develop a restoration plan for restoring all areas of temporary disturbance to their previous condition, including the use of native species when seeding or planting during restoration. The restoration plan will ensure:
    - All areas disturbed temporarily by Project construction will be restored including temporary disturbance areas around structure construction sites, laydown/ staging areas, and temporary access roads,
    - Topsoil salvage will be included in all grading activities.
    - Conduct restoration activities in accordance with the wind leases and in consultation with the NRCS.
- Use natural fiber erosion control methods during construction to eliminate or minimize runoff and avoid impacts to hydrology.
- Following Project construction, roads not needed for site operations will be restored to native vegetation.
- Vehicle speeds will be limited to 25 mph (40 kph) to avoid wildlife collisions and construction vehicles will be restricted to pre-designated access routes.
- Gravel will be placed at least 5.0 ft (1.5 m) around each turbine foundation to discourage small mammals and reptiles from burrowing under or near turbine bases.
- All trash will be covered in containers and work sites will be cleared regularly of any garbage and debris related to food.
- Pets shall not be allowed in the Project Area.

7.3 Conservation Measures to be Implemented during Operations

- Vehicle speeds will be limited to 25 mph to avoid wildlife collisions.
- Fire hazards from vehicles and human activities will be reduced (e.g., use of spark arrestors on power equipment, avoiding driving vehicles off roads, allowing smoking in designated areas only).
- Sweetland will develop and implement a noxious weed control plan in accordance with the wind lease agreements.
- Pest and weed control measures will be implemented as specified by county, state, and federal requirements.
- Other than maintenance vehicles, which will park at the entrance of turbines for maintenance purposes, parts and equipment which may be used as cover for prey will not be stored at the base of wind turbines while a turbine is operational.
- A carcass removal program will be implemented to minimize potential attractants for carrion-feeding raptors.
- Feather blades to manufacturer's cut in speed from sunset to sunrise, when the temperature is above 50 degrees Fahrenheit from July 15 to September 30.
- Conduct operational monitoring during whooping crane migration seasons; operations staff will be trained to identify whooping cranes, and if any are noted in the Project Area, turbines will be shut down within two miles of the crane until it leaves (see Appendix K).
- Conduct post-construction fatality monitoring for two years to assess impacts.
- All of Sweetland's employees and contractors working on site will receive worker awareness training for identifying and responding to encounters with sensitive biological resources, including avian and bat species. The training:
    - Will be conducted by Sweetland or their designee.
    - Instruct employees, contractors, and site visitors to avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship and nesting) seasons.
    - Will include instruction on identification and values of plant and wildlife species and significant natural plant community habitats, the issue of microtrash and its effects, fire protection measures and measures to minimize the spread of weeds during construction as well as hazardous material spill and containment measures.
    - Will include a flyer in the O&M building and/or construction trailer(s) detailing information on potential state and federal special-status animal and plant species that might be discovered on the Project site.
    - Will include an overview of the distribution, general behavior, and ecology of golden and bald eagles. Employees will be informed that they are not authorized to approach, handle, or otherwise move any eagles that might be encountered

during construction or operation, whether alive, injured, or deceased. Operations personnel will be instructed to report any finding of an injured or deceased eagle to USFWS within 24 hours of positive identification by a qualified biologist.

8.0 POST-CONSTRUCTION MONITORING: TIER 4

8.1 Tier 4a – Avian and Bat Fatality Monitoring

Post-construction fatality monitoring is a critical component of this BBCS. The primary objective of fatality monitoring is to estimate avian and bat mortality at the Project and to determine whether the estimated mortality is lower, similar to, or higher than the average mortality observed at other regional projects, and consistent with the levels of mortality predicted during the pre-construction risk assessments (see Section 6.0).

8.1.1 Baseline Monitoring

Baseline monitoring consists of short-term intensive surveys involving standardized carcass searches, bias trials for searcher efficiency, and carcass removal trials conducted by trained biologists. Baseline fatality monitoring will be conducted during the first two years of commercial operations of the Project. The monitoring study design will be consistent with the recommendations for operations monitoring included in the WEG. Additionally, the scope and duration of the fatality monitoring study will be developed to be consistent with, and within the range of, monitoring programs that have been conducted at other wind projects in the Great Plains.

8.1.1.1 Monitoring Activities

Baseline fatality monitoring will be conducted during all seasons of the first two years of commercial operations of the Project. Baseline avian and bat monitoring will consist of the following components:

1) Standardized carcass searches of selected turbines in a plot centered on the turbine;
2) Searcher efficiency trials to estimate the percentage of carcasses found by searchers;
3) Carcass persistence trials to estimate the length of time that a carcass remains in the field for possible detection;
4) Data analysis and calculation of fatality rates.

Following the first year of monitoring, Sweetland will coordinate with the USFWS and the SDGFP to discuss results.

8.1.1.2 Reporting

Annual reports will be completed following each year of fatality monitoring and submitted to the USFWS and the SDGFP within three months of completion of surveys. The report will detail the results of mortality surveys, as well as the results of searcher efficiency and carcass removal trials. Fatality rates will be estimated following the most recent and acceptable methods.

8.1.2 Long Term Monitoring

O&M staff will be specifically trained to monitor for dead or injured golden eagles, bald eagles, and other sensitive wildlife species during their work activities. A data sheet that describes how Project personnel can recognize an injured or dead eagle or sensitive species will be posted in the maintenance facility. The data sheet will include instructions and the procedures that personnel shall take in the event an injured or dead golden eagle, bald eagle, or other protected species is discovered onsite, including whom to notify and what actions shall be taken. Any incident involving a state or federally listed threatened or endangered species or a golden or bald eagle will be reported to the USFWS and the SDGFP within 24 hours of identification.

8.2 Tier 5 – Prairie Grouse Lek Monitoring

Sweetland is involved with ongoing discussions with SDGFP to conduct a collaborative study on prairie grouse during post-construction lek monitoring at the Project.

9.0 ADAPTIVE MANAGEMENT

Within the WEG, the USFWS defines adaptive management as “an iterative decision process that promotes flexible decision-making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Comprehensively applying the tiered approach embodies the adaptive management process” (USFWS 2012). The WEG further notes that adaptive management at most wind facilities is unlikely to be needed if they are sited in accordance with the tiered approach. Nevertheless, Sweetland recognizes the value of applying this approach to its Project activities that include some uncertainty. As such, Sweetland will incorporate an adaptive approach for the conservation of wildlife potentially impacted by the Project.

Section 5.0 of this BBCS describes the tiered approach used to study pre-construction wildlife conditions and section 6.0 predicts potential Project impacts. Based on Project siting, the results of pre-construction wildlife studies, and an assessment of risks to birds and bats, no significant adverse impacts are anticipated from the Project and mortality is expected to be within the range of other projects discussed in Section 6.0. Tier 4 post-construction fatality monitoring will be conducted to estimate the actual level of avian and bat mortality at the Project. If impacts are determined to be minimal, no further action may be needed. Should the results of the Tier 4 studies indicate higher than anticipated impacts, however, adaptive management measures could be considered to further avoid, minimize, or compensate for unanticipated and significant project impacts to wildlife. Thresholds for considering an adaptive response may include:

- Mortality of an eagle or a species listed as state or federal endangered/threatened; or

- Significant levels of mortality of unlisted species of birds or bats. Significance will be determined by qualified biologists and will be based on species' population sizes and trends. For example, even relatively high levels of mortality of the most common species may not be significant. Conversely, lower levels of mortalities of less common species may be of more concern, particularly if these species appear to be at risk (e.g., USFWS Birds of Conservation Concern).

If effects are determined to be higher than anticipated, an assessment of why effects are occurring will be conducted to aid in developing appropriate mitigation actions. If causation of effects is unknown, further monitoring efforts may be implemented to help understand effects. Some of the adaptive management options that could be considered depending on the results of the post-construction mortality monitoring and taking into account economic feasibility[1] include:

- Additional on-site studies (e.g., more intensive use studies, prey base studies);
- Addition or modification of anti-perching, anti-nesting, collision, or electrocution protection devices on "problem" project facilities;
- Experimentation with visual and/or auditory bird flight diverters;
- Prey-base management through habitat alteration; and
- Operational curtailment

Once the mitigation measures are put into place, additional monitoring to determine the effectiveness of the mitigation measures may be conducted, and, depending on the results, further remedial measures may or may not be warranted.

10.0 CONCLUSIONS

This BBCS was written to provide guidance for avoiding, minimizing, and monitoring potential effects to avian and bat species at the Sweetland Wind Farm. The measures described in this document are intended to help protect and reduce effects to avian and bat species during the construction phase of the Project, as well as to monitor potential effects to avian and bat species following implementation of the Project. Further, it is anticipated that this BBCS will facilitate adaptive management at the Project based on information gathered following construction of the Project.

[1] Once a project is operational there is a fixed amount of capital expenditure and the only available source of funding is from operational budgets, which must be within the economic parameters of the Project.

11.0 KEY RESOURCES

Key wildlife resource personnel involved with the Project include the following:

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Appendix A. Baseline Avian Studies for the Sweetland Wind Energy Project, Hand County, South Dakota: Final Report May 2017 – April 2018:

All Appendices are part of the Sweetland Wind Farm Project Draft Environmental Assessment (see Appendix G)

Appendix B. Baseline Avian Studies for the Sweetland Wind Energy Project, Hand County, South Dakota: Final Report May 2018 – April 2019

All Appendices are part of the Sweetland Wind Farm Project Draft Environmental Assessment (see Appendix G)

Appendix C. Sweetland Wind Energy Project Eagle and Raptor Nest Survey Memorandum: Year One Final Report February 2018

All Appendices are part of the Sweetland Wind Farm Project Draft Environmental Assessment (see Appendix F)

Appendix D. Sweetland Wind Energy Project Eagle and Raptor Nest Survey Memorandum: Year Two Final Report September 2018

All Appendices are part of the Sweetland Wind Farm Project Draft Environmental Assessment (see Appendix F)

Appendix E. Sweetland Wind Energy Project Whooping Crane Stopover Habitat Assessment: Final Report December 2018

All Appendices are part of the Sweetland Wind Farm Project Draft Environmental Assessment (see Appendix K)

Appendix F. Bat Activity Studies for the Sweetland Wind Energy Project, Hand County, South Dakota: Year One Final Report June – October 2017

All Appendices are part of the Sweetland Wind Farm Project Draft Environmental Assessment (see Appendix H)

Appendix G. Bat Activity Studies for the Sweetland Wind Energy Project, Hand County, South Dakota: Year Two Final Report May – October 2018

All Appendices are part of the Sweetland Wind Farm Project Draft Environmental Assessment (see Appendix H)

Appendix H. Bat Summer Presence/Absence Surveys Sweetland Wind Energy Project, Hand County, South Dakota: Final Report July 2018

All Appendices are part of the Sweetland Wind Farm Project Draft Environmental Assessment (see Appendix J)

Appendix I. Sweetland Wind Energy Project 2018 Grassland Habitat Assessment: Final Report February 2019

All Appendices are part of the Sweetland Wind Farm Project Draft Environmental Assessment (see Appendix E)

Appendix K. Whooping Crane Monitoring Plan and Shut-Down Protocol Sweetland Wind Energy Project: Final Plan June 2019

All Appendices are part of the Sweetland Wind Farm Project Draft Environmental Assessment (see Appendix M)

APPENDIX J – PRESENCE/ABSENCE SURVEYS FOR NORTHERN LONG-EARED BAT

Bat Summer Presence/Absence Surveys
Sweetland Wind Project
Hand County, South Dakota

Final Report

July 5 – July 10, 2018

Prepared for:

Scout Clean Energy

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November 14, 2018

Privileged and Confidential- Not for Distribution

EXECUTIVE SUMMARY

Scout Clean Energy (Scout) is developing the Sweetland Wind Project (Project) in Hand County, South Dakota. Scout contracted Western EcoSystems Technology, Inc. to conduct bat presence/probable absence surveys in the proposed Project footprint. The objective of the bat surveys was to determine presence or probable absence of the federally threatened northern long-eared bat (NLEB) in the Project footprint during the summer maternity season.

Acoustic surveys were completed at three sites (24 detector nights) at the Project from July 5 – July 10, 2018. Bat call identification software found no NLEB calls in the acoustic data, supporting probable absence of NLEB in the Project footprint.

STUDY PARTICIPANTS

Western EcoSystems Technology, Inc.

Chris Fritchman	Project Manager
Kevin Murray	Senior Report Review
Ashley Matteson	Acoustic Analyst, Permitted Bat Biologist
Jolie Blevins	Project and Data Coordinator, Report Writer
Steven Neumann	Acoustic Technician
Kristen Klaphake	GIS Specialist
Jeanette Haddock	Technical Editor

REPORT REFERENCE

Fritchman, C., J. Blevins 2018. Bat Summer Presence/Absence Surveys for the Sweetland Wind Project in Hand County, South Dakota. Final Report: July 5 – July 10, 2018. Prepared for Scout Clean Energy, Boulder, Colorado. Prepared by Western EcoSystems Technology, Inc. (WEST), Bloomington, Indiana. November 1, 2018.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Scout Clean Energy (Scout) is developing the Sweetland Wind Project (Project) in Hand County, South Dakota (Figure 1). Scout contracted Western EcoSystems Technology, Inc. (WEST) to conduct bat surveys in the proposed Project footprint during summer 2018. The objective of the bat surveys was to determine presence or probable absence of the federally threatened northern long-eared bat (NLEB; *Myotis septentrionalis*) in the Project footprint during the summer maternity season.

METHODS

All surveys followed the current US Fish and Wildlife Service (USFWS) *Range-Wide Indiana Bat Summer Survey Guidelines* (Guidelines; USFWS 2018), which apply to NLEB surveys. The USFWS Guidelines for NLEB surveys recommend: 1) desktop habitat assessment and 2) presence/probable absence acoustic or mist-net surveys.

Desktop Habitat Assessment

The desktop habitat assessment for the Project footprint showed there were approximately 280 acres (ac; 113 hectares [ha]) of forest habitat in the Project footprint. The USFWS Guidelines (2018) recommend a minimum of eight detector nights per 123 ac (50 ha) of suitable summer habitat for non-linear projects.

Acoustic Surveys

The objective of the acoustic surveys was to assess the potential for presence of NLEB in the Project footprint. The Project footprint was defined as the minimum-convex polygon (MCP) that encompasses the proposed wind turbine locations along with the hazardous area around all proposed turbine locations.

Three acoustic sites were sampled, using two detectors deployed at each site for four nights, for a total of 24 detector nights. Bats were surveyed using Song Meter full-spectrum ultrasonic detectors (SM4; Wildlife Acoustics, Inc.; http://www.wildlifeacoustics.com).

Acoustic surveys were conducted from July 5 – July 10, 2018. Acoustic monitoring began before sunset and continued for the entire night. If weather conditions such as persistent rain (30 or more minutes), strong sustained winds (greater than nine miles per hour [mph] for 30 or more minutes), or cold temperature (below 10 degrees Celsius [50 degrees Fahrenheit] for 30 or more minutes) occurred, then the acoustic site subject to those conditions was surveyed for an additional night. Omnidirectional detector microphones were positioned at least 9.8 feet (ft; 3.0 meters [m]) off the ground and oriented horizontally. For each acoustic detector, the date, site description, site coordinates, tree species composition, stand age, vegetation community type, and weather data were recorded. Representative photographs of each acoustic site also were taken.

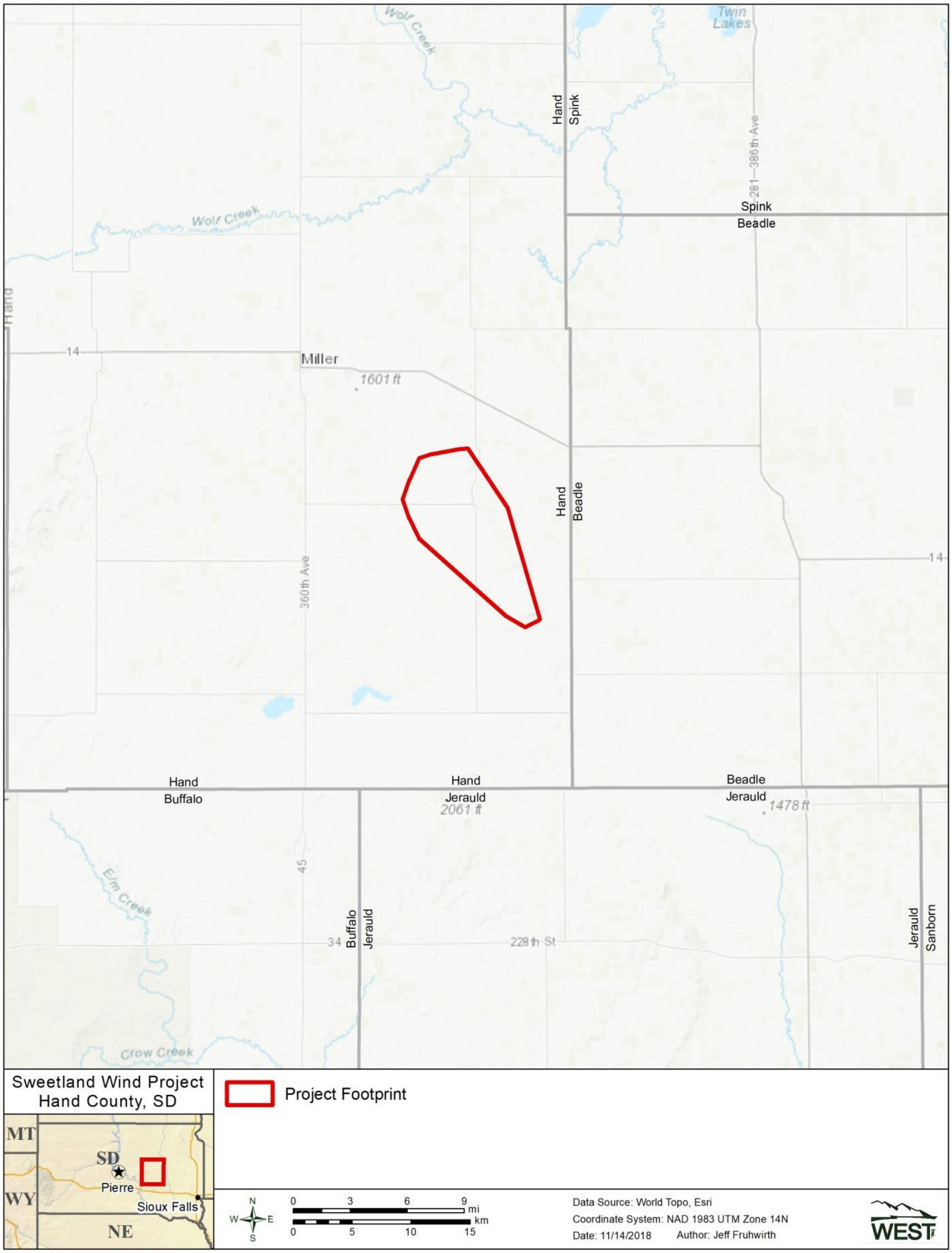

Figure 1. Location of the Sweetland Wind Project in Hand County, South Dakota.

Bat calls were identified using USFWS-approved quantitative identification methods (Kaleidoscope Pro© version 4.2.0; Wildlife Acoustics Inc.; [Kaleidoscope]). The Bats of North America classifier 4.2.0 was used within Kaleidoscope. Kaleidoscope output generated a list of maximum likelihood estimates (MLE) for each species with the potential to occur in the Project footprint. The following species were included in the Kaleidoscope model: big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), eastern red bat (*Lasiurus borealis*), hoary bat (*L. cinereus*), little brown bat (*Myotis lucifugus*), western small-footed bat (*Myotis ciliolabrum*), and NLEB.

All calls identified as NLEB by automated identification software were examined and verified by a qualified biologist with extensive acoustic identification experience. For each night that Kaleidoscope considered NLEB presence likely (MLE p-value <0.05), WEST reviewed all calls from the night. WEST also reviewed all calls identified as NLEB by Kaleidoscope regardless of whether the MLE p-value for the night was significant or not. If call sequences were not characteristic of NLEB, contained distinct calls produced by species other than NLEB or were of insufficient quality, they were reclassified.

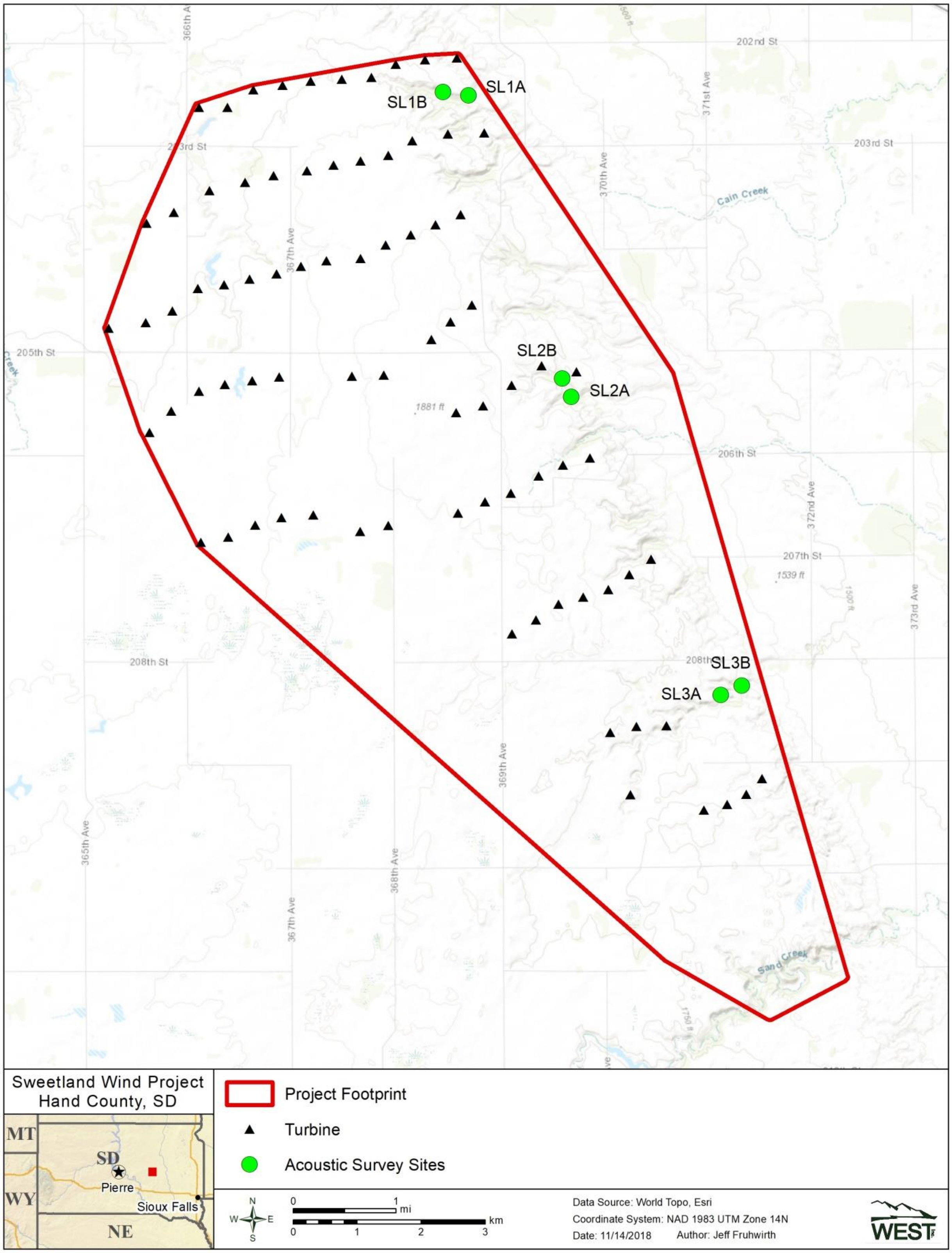

Figure 2. Acoustic survey sites at the Sweetland Wind Project in Hand County, South Dakota.

RESULTS

Acoustic Surveys

Locations and descriptions of acoustic survey sites are provided in Table 1. Photographs of detector setups are included in Appendix A. Acoustic detectors were deployed for a total of 24 valid detector nights including July 5, 6, 8, and 9 for all three sites. The night of July 7 was invalid due to wind speeds greater than nine mph for more than 30 minutes. Detectors were retrieved from deployment on July 10.

Kaleidoscope recognized a total of 3,726 bat calls and identified 3,010 of those calls (80.8%). Hoary bats (1,485 calls [39.9%]) were the most commonly identified species, followed by eastern red bats (1,072 calls [28.8%]), big brown bats (237 calls [6.4%]), silver-haired bat (167 calls [4.5%]), little brown bats (25 calls [0.7%]), and western small-footed bats (24 calls [0.6%]; Table 2).

The Project is on the edge of the geographic range of the western small-footed bat and this species is not expected to occur within the Project footprint. Kaleidoscope call identifications of this species were reviewed by an acoustic expert and determined to be incorrectly classified. Western small-footed bats were not detected in the Project footprint. Additionally no NLEB calls were identified by Kaleidoscope; therefore, no qualitative review was necessary and no follow-up mist-net or telemetry surveys were performed. The acoustic survey results support probable absence of NLEB within the Project footprint.

Table 1. Acoustic survey site coordinates, descriptions, and results of Kaleidoscope identification software at the Sweetland Wind Project in Hand county, South Dakota.

Site ID	County	Zone*	Easting*	Northing*	Acoustic Detector Site Description	Total Bat Calls	Bat Calls Identified**	Total Detector Nights	Bat Calls per Detector Night
SL1A	Hand	14	515228	4921870	Bottomland forest	1,013	733	4	253.25
SL1B	Hand	14	514829	4921924	Bottomland forest	861	661	4	215.25
SL2A	Hand	14	516828	4917161	Upland forest	210	183	4	52.50
SL2B	Hand	14	516690	4917453	Bottomland forest	963	879	4	240.75
SL3A	Hand	14	519164	4912510	Pond	280	228	4	70.00
SL3B	Hand	14	519497	4912653	Bottomland forest	399	326	4	99.75
Total						**3,726**	**3,010**	**24**	**155.25**

*Coordinate system and datum: Universal Transverse Mercator North American Datum 1983.
**Number of calls identified to species by the acoustic software.

Table 2. Bat calls identified by Kaleidoscope Pro® Version 4.2.0 at the Sweetland Wind Project in Hand county, South Dakota.

Site ID	LACI	LABO	EPFU	LANO	MYLU	MYCI	NLEB	UNKN
SL1A	412	231	38	43	8	1	***0***	280
SL1B	539	32	32	58	0	0	***0***	200
SL2A	100	38	29	13	1	2	***0***	27
SL2B	108	666	53	28	12	12	***0***	84
SL3A	101	36	79	10	1	1	***0***	52
SL3B	225	69	6	15	3	8	***0***	73
Total	**1,485 (39.9%)**	**1,072 (28.8%)**	**237 (6.4%)**	**167 (4.5%)**	**25 (0.7%)**	**24 (0.6 %)**	***0 (0%)***	**716 (19.2%)**

LACI = hoary bat (*Lasiurus cinereus*); LABO = eastern red bat (*Lasiurus borealis*); EPFU = big brown bat (*Eptesicus fuscus*); LANO = silver-haired bat (*Lasionycteris noctivagans*); MYLU = little brown bat (*Myotis lucifugus*); MYCI = western small-footed bat (*Myotis ciliolabrum*); NLEB = northern long-eared bat (*Myotis septentrionalis*); UNKN = unknown.

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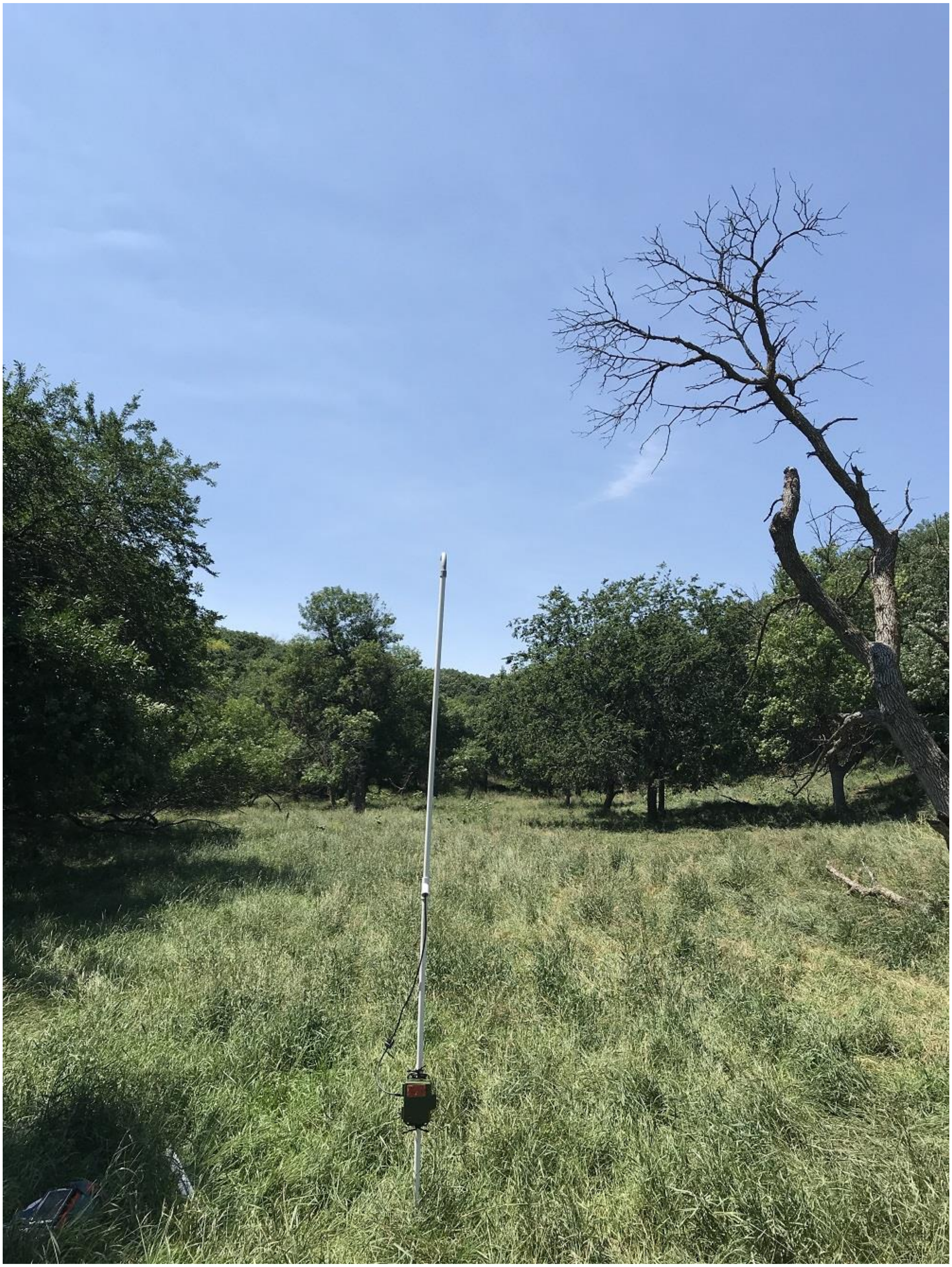
Appendix A. Photographs of Acoustic Survey Detector Setups, Sweetland Wind Project, Hand County, South Dakota

Appendix A1-a. Acoustic Survey Location SL1A. Cone of detection



Appendix A1-a. Acoustic Survey Location SL1A. Cone of detection

Appendix A1-b. Acoustic Survey Location SL1A. Microphone orientation.

Appendix A1-c. Acoustic Survey Location SL1A.Detector placement.

Appendix A2-a. Acoustic Survey Location SL1B. Cone of detection.

Appendix A2-b. Acoustic Survey Location SL1B. Microphone orientation.


Appendix A2-c. Acoustic Survey Location SL1B. Detector placement.


Appendix A3-a. Acoustic Survey Location SL2A. Cone of detection.

Appendix A3-b. Acoustic Survey Location SL2A. Microphone orientation.

Appendix A3-c. Acoustic Survey Location SL2A. Detector placement.

Appendix A4-a. Acoustic Survey Location SL2B. Cone of detection.

Appendix A4-b. Acoustic Survey Location SL2B. Microphone orientation.

Appendix A4-b. Acoustic Survey Location SL2B. Microphone orientation.

Appendix A4-c Acoustic Survey Location SL2B. Detector placement.

Appendix A5-a. Acoustic Survey Location SL3A. Cone of detection.

Appendix A5-b. Acoustic Survey Location SL3A. Microphone orientation.

Appendix A5-c. Acoustic Survey Location SL3A. Detector placement.

Appendix A6-a. Acoustic Survey Location SL3B. Cone of detection.

Appendix A6-b. Acoustic Survey Location SL3B. Microphone orientation.

Appendix A6-c. Acoustic Survey Location SL3B. Detector placement.

Appendix A6-c. Acoustic Survey Location SL3B. Detector placement.