APPENDIX I – AVIAN STUDIES

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.

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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%).

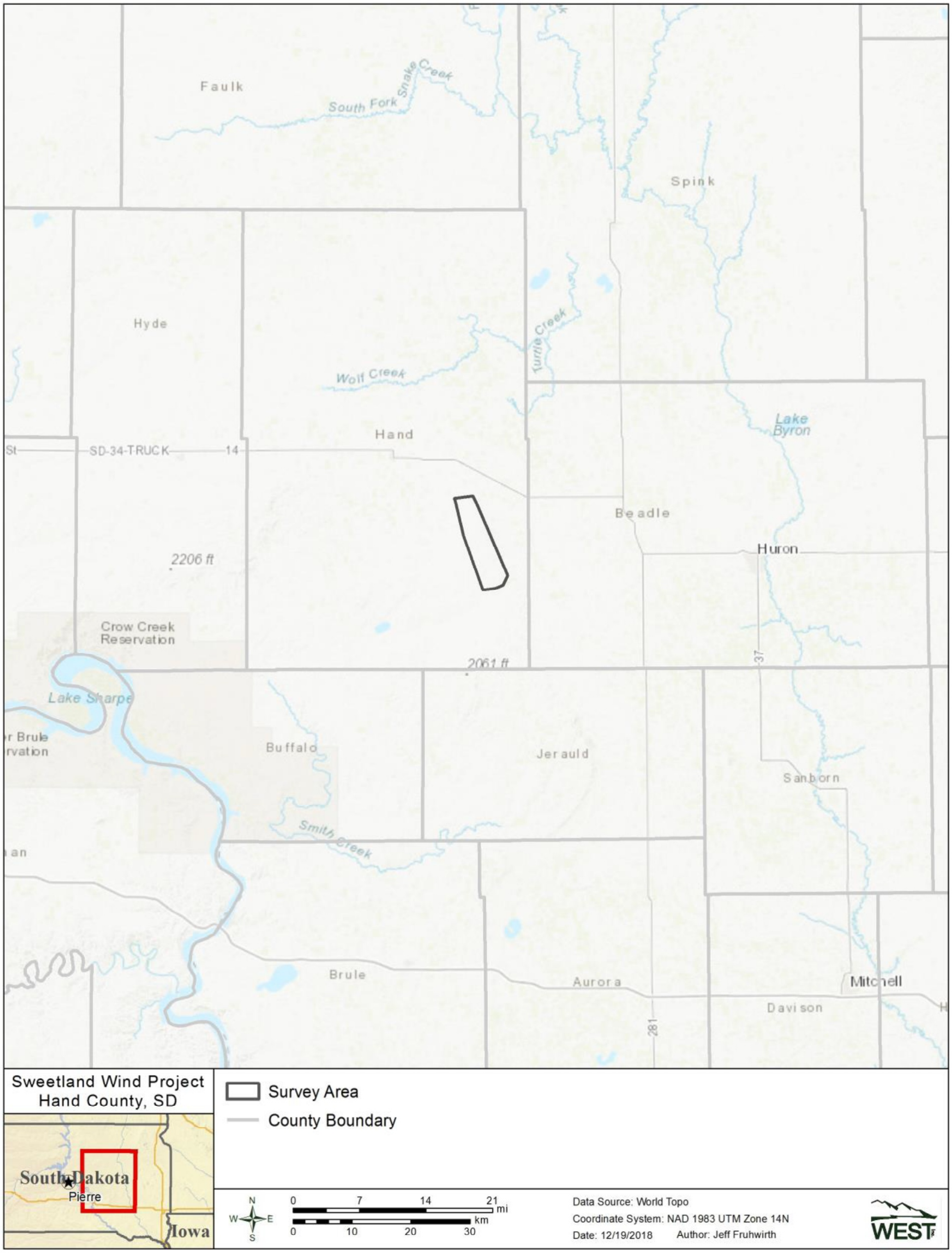

Figure 1. General location of the Sweetland Wind Energy Project.

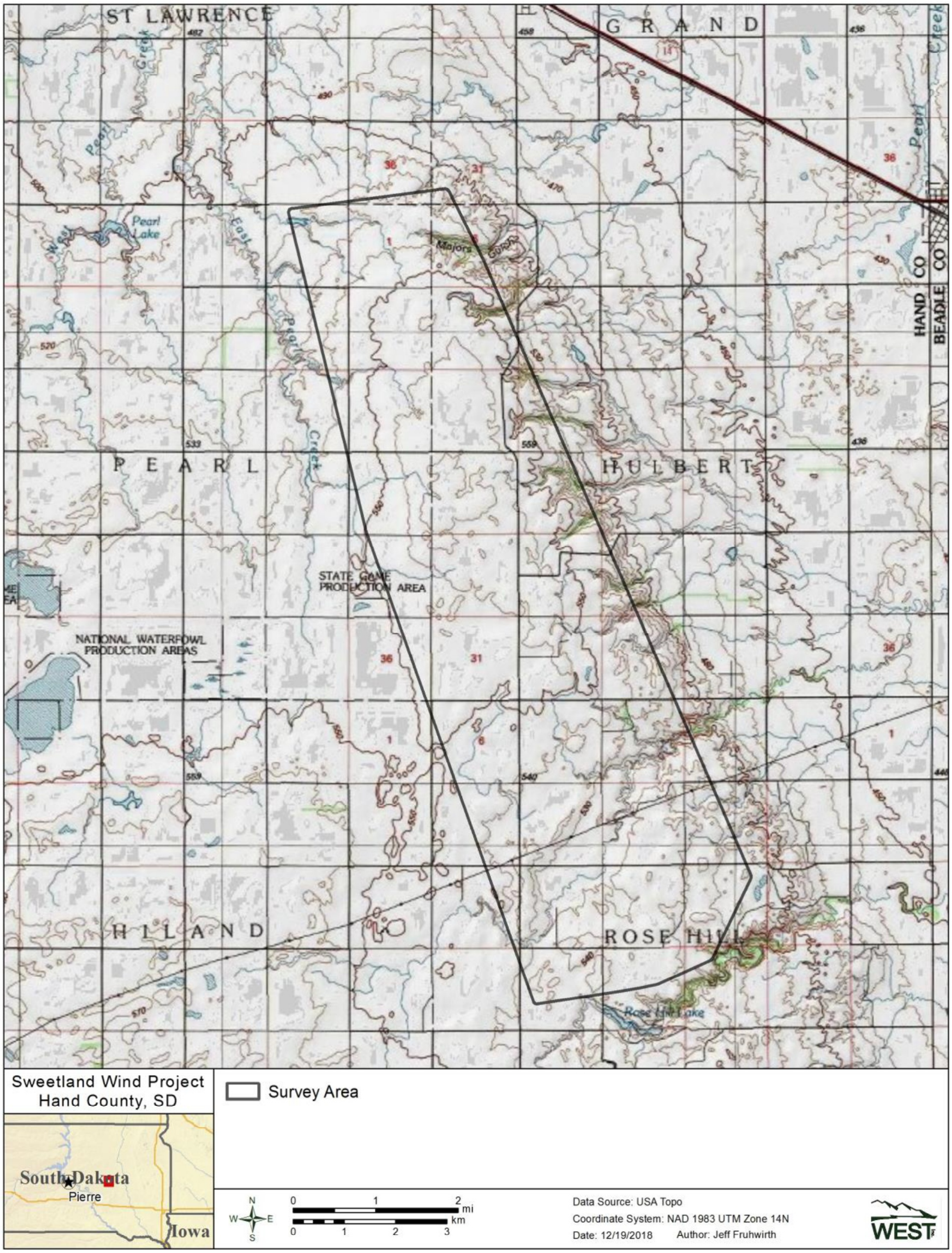

Figure 2. Topographic map of the Sweetland Wind Energy Project.

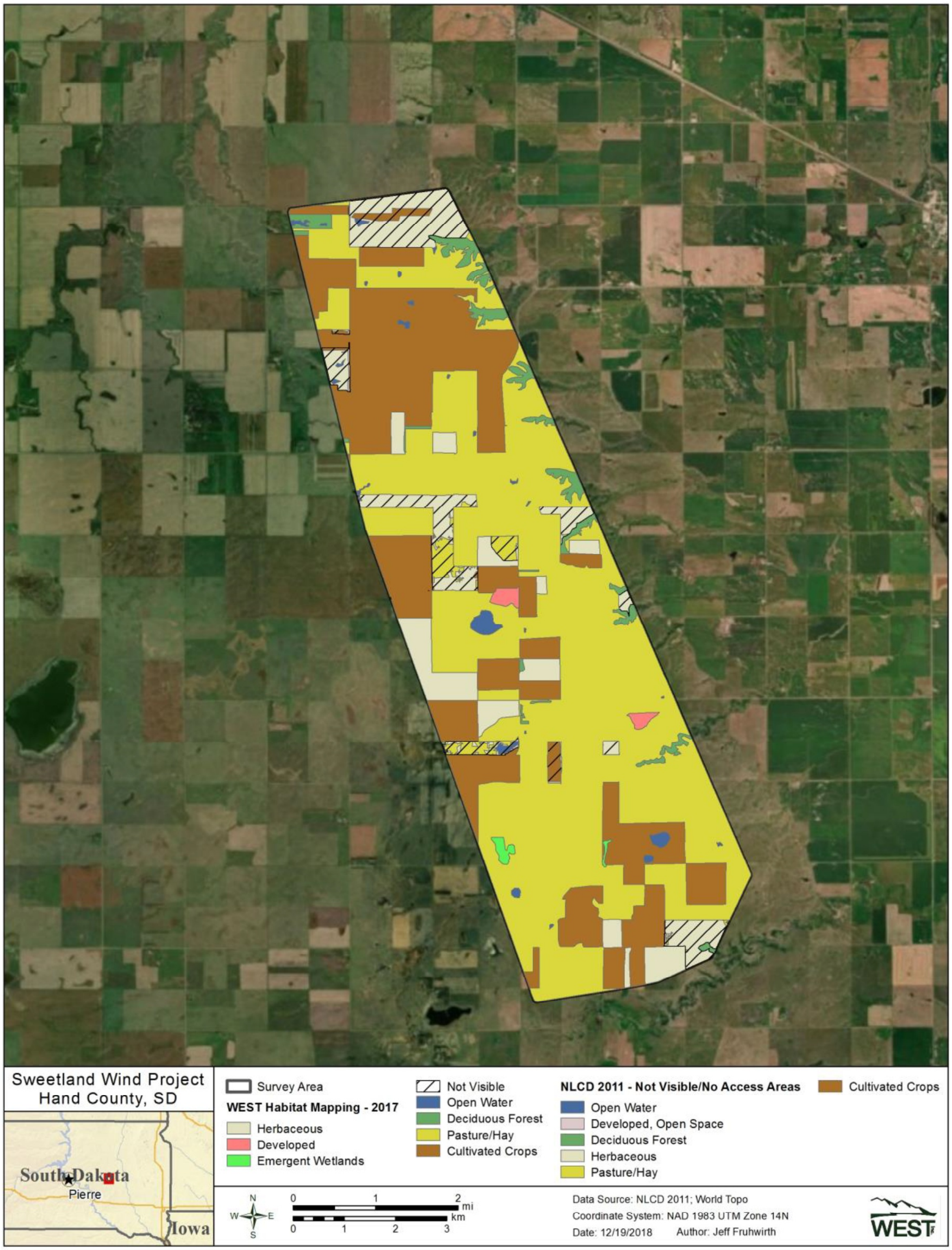

Figure 3. The land cover types and coverage based on vegetation mapping within the Sweetland Wind Energy Survey area, combined with National Land Cover Database (US Geological Survey National Land Cover Database 2011, Homer et al. 2015) types for areas not accessible or not visible from a public road.

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.

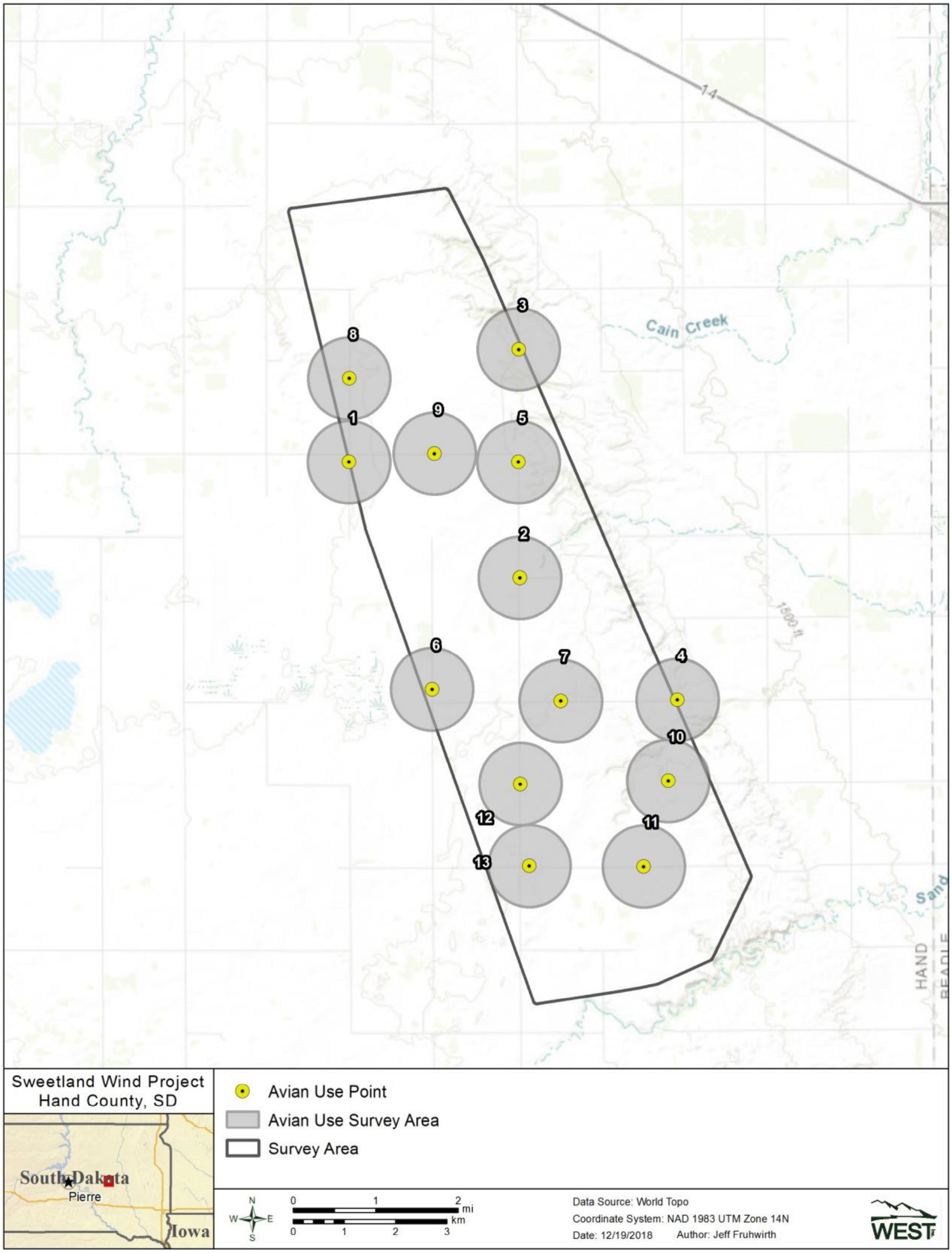

Figure 4. Location of fixed-point bird use survey stations at the Sweetland Wind Energy Project.

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.

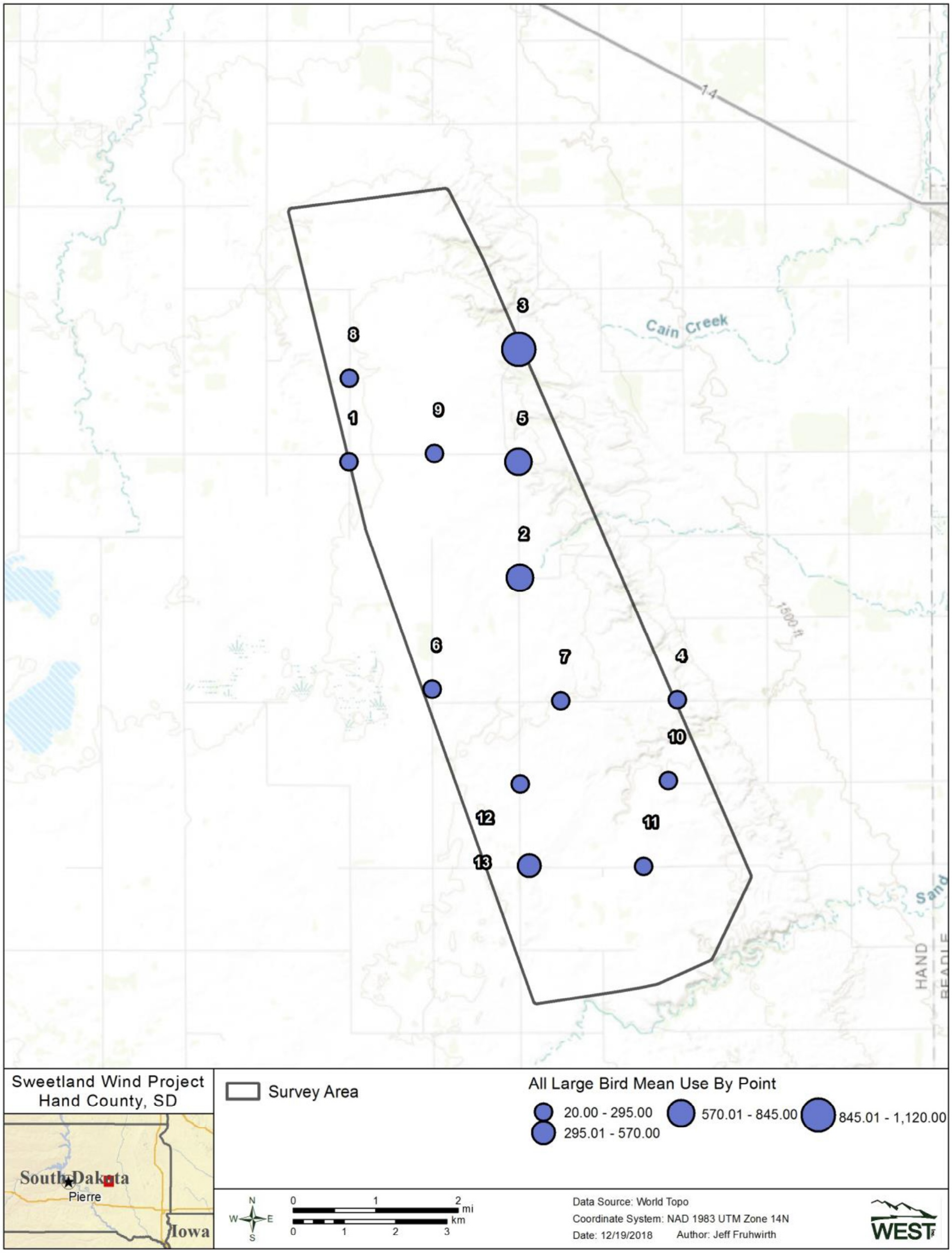

Figure 5. Large bird use by point recorded during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 - April 28, 2018.

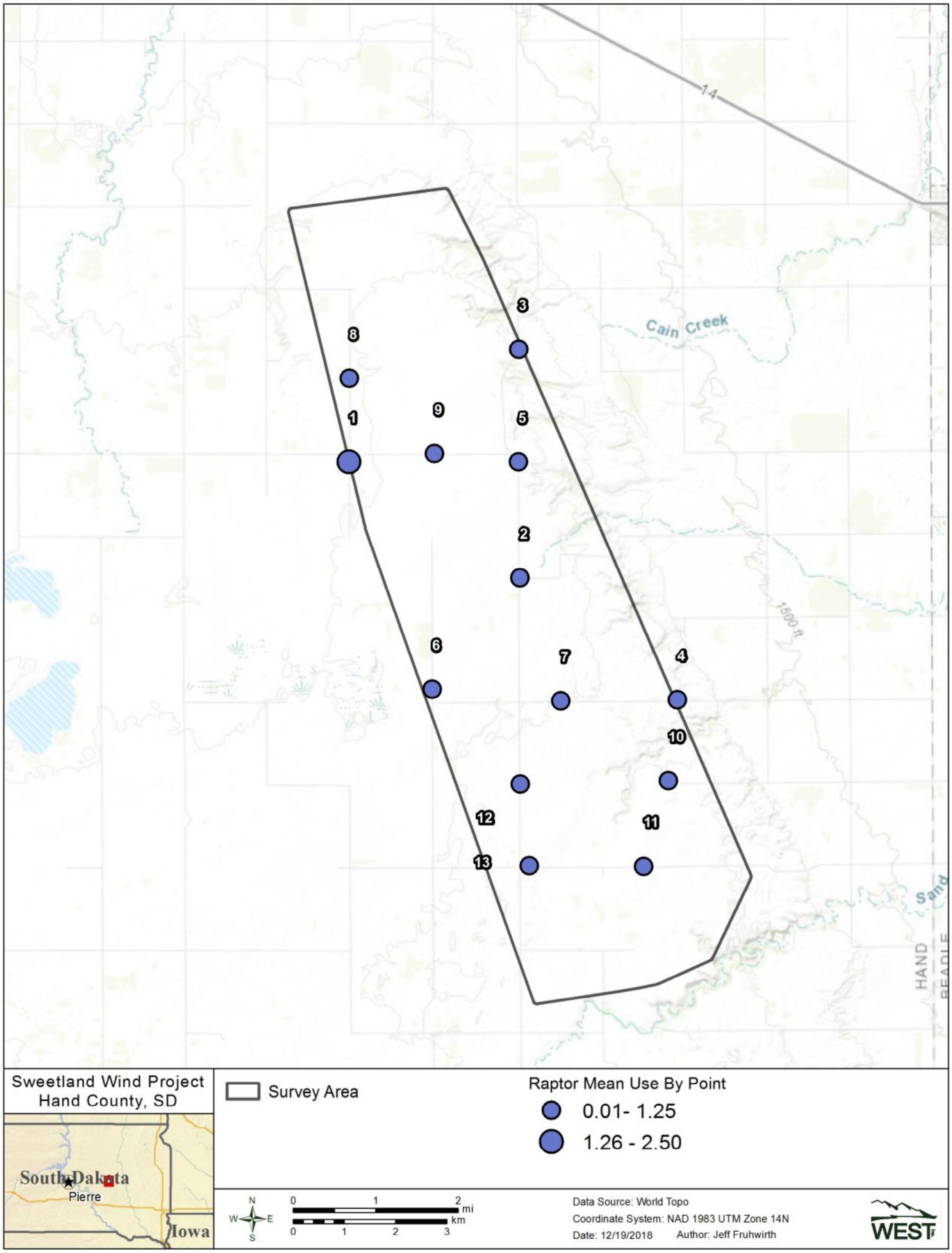

Figure 6. Diurnal raptor use by point recorded during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

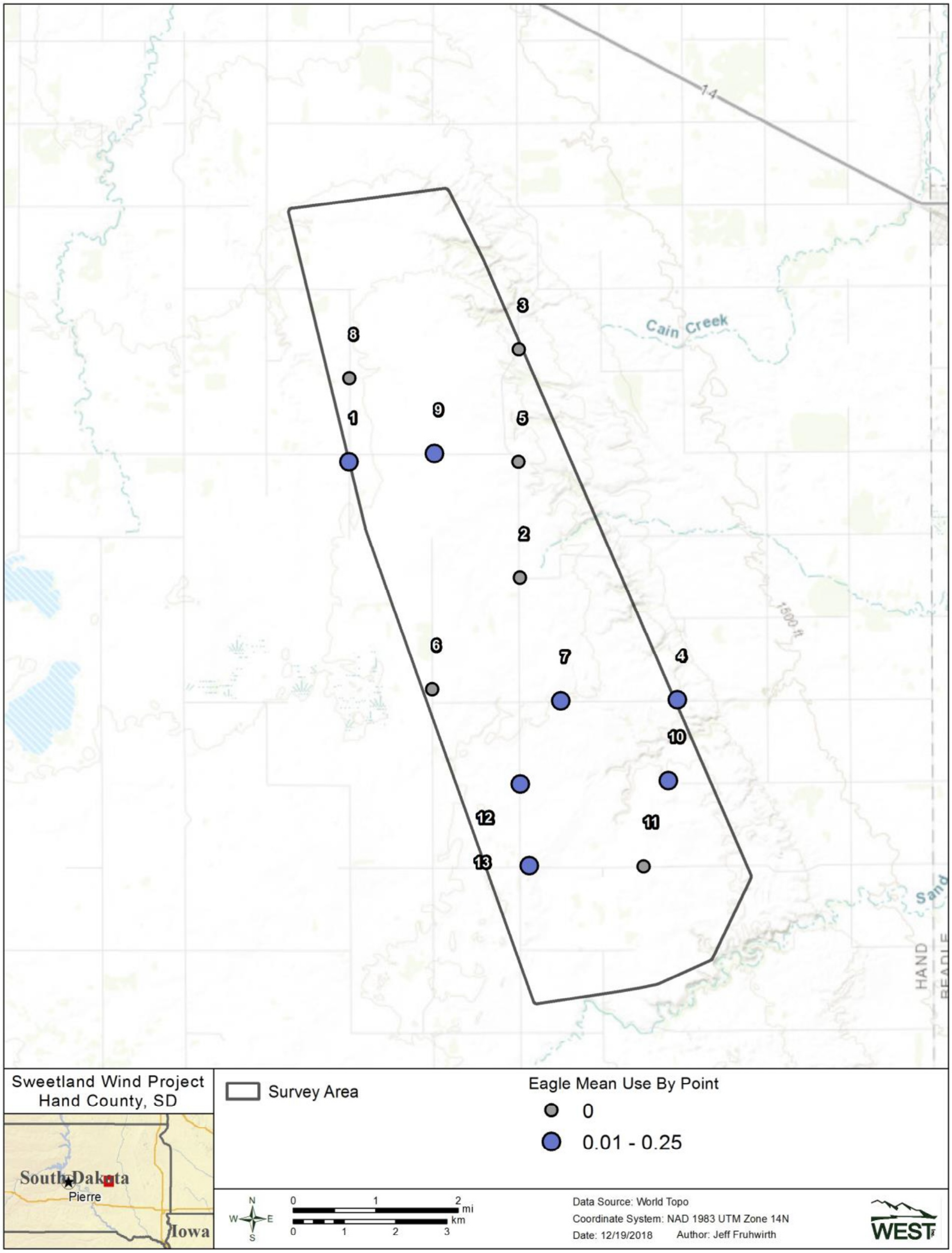

Figure 7. Eagle use by point recorded during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2018 – April 28, 2018.

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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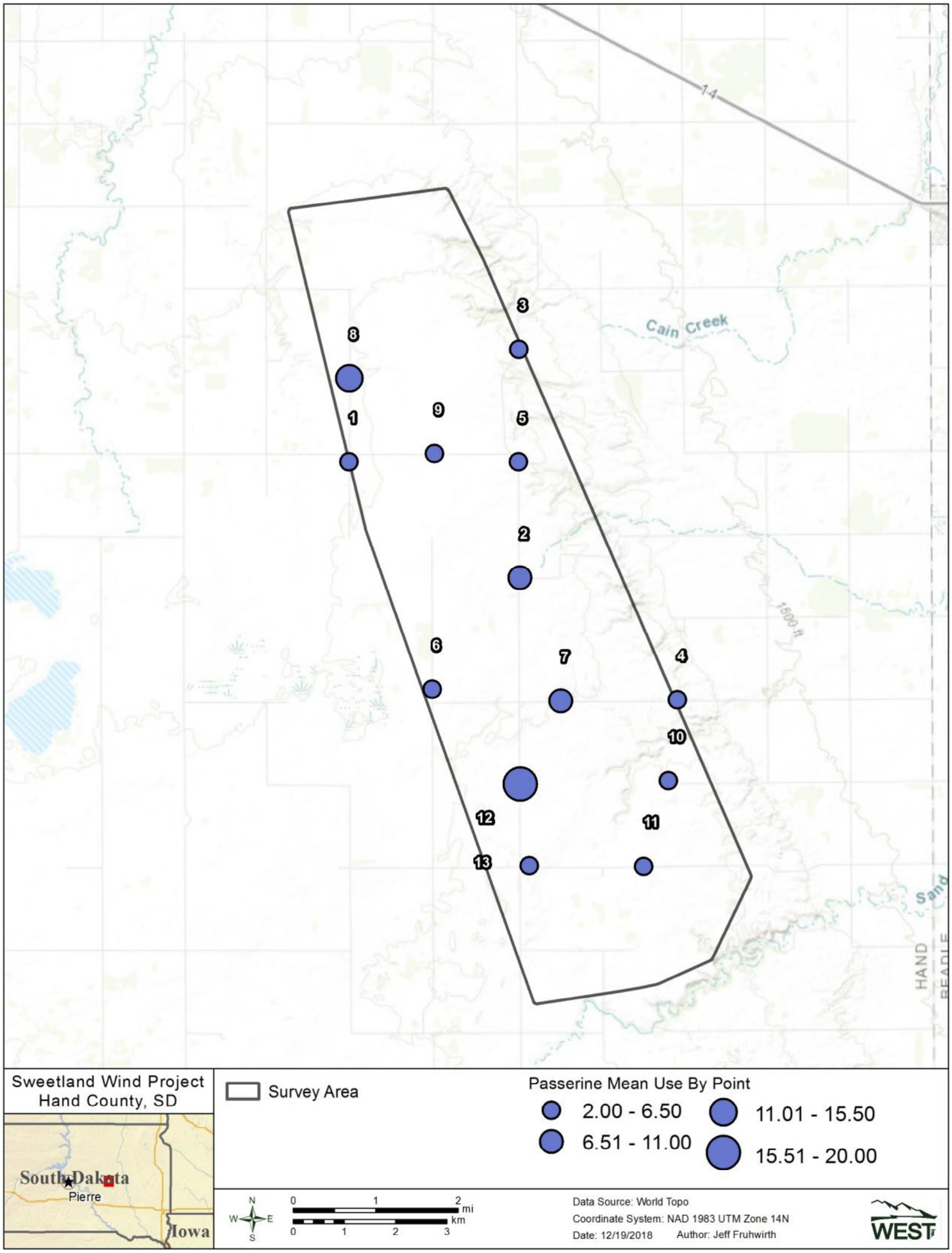

Figure 8. Passerine use by point recorded during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

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	# observed F	# observed U	# observed T	Survey Two	# observed M	# observed F	# observed U	# observed 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				Survey Two	# observed				Survey Three	# observed			
			M	F	U	T		M	F	U	T		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

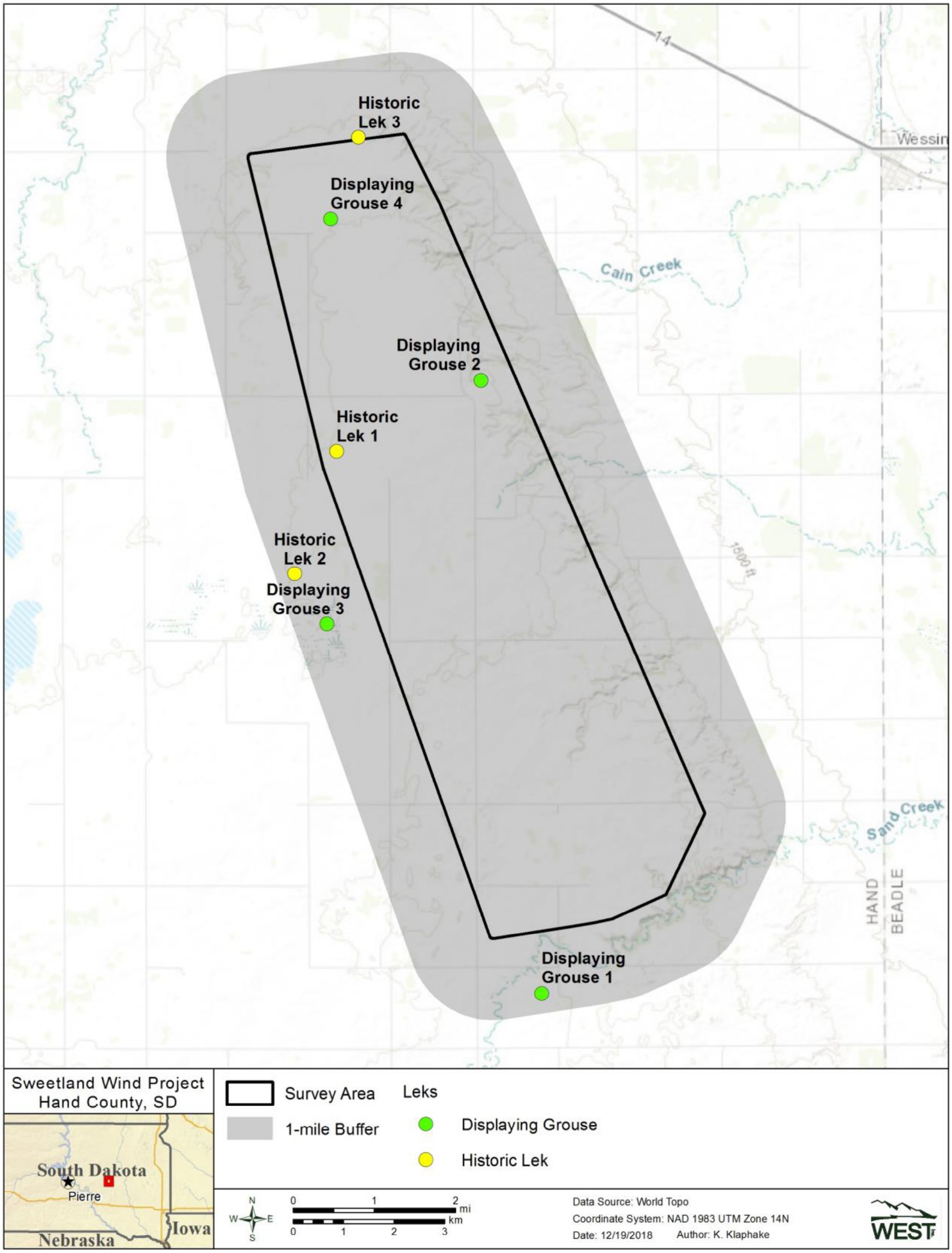

Figure 9. Locations of historic prairie grouse leks and newly identified displaying areas within the Sweetland Wind Energy Project and surrounding 1-mile buffer.

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.

			FP Large Bird		FP Small Bird		Inc.		Total	
Species	**Scientific Name**	**Status**	**# 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.

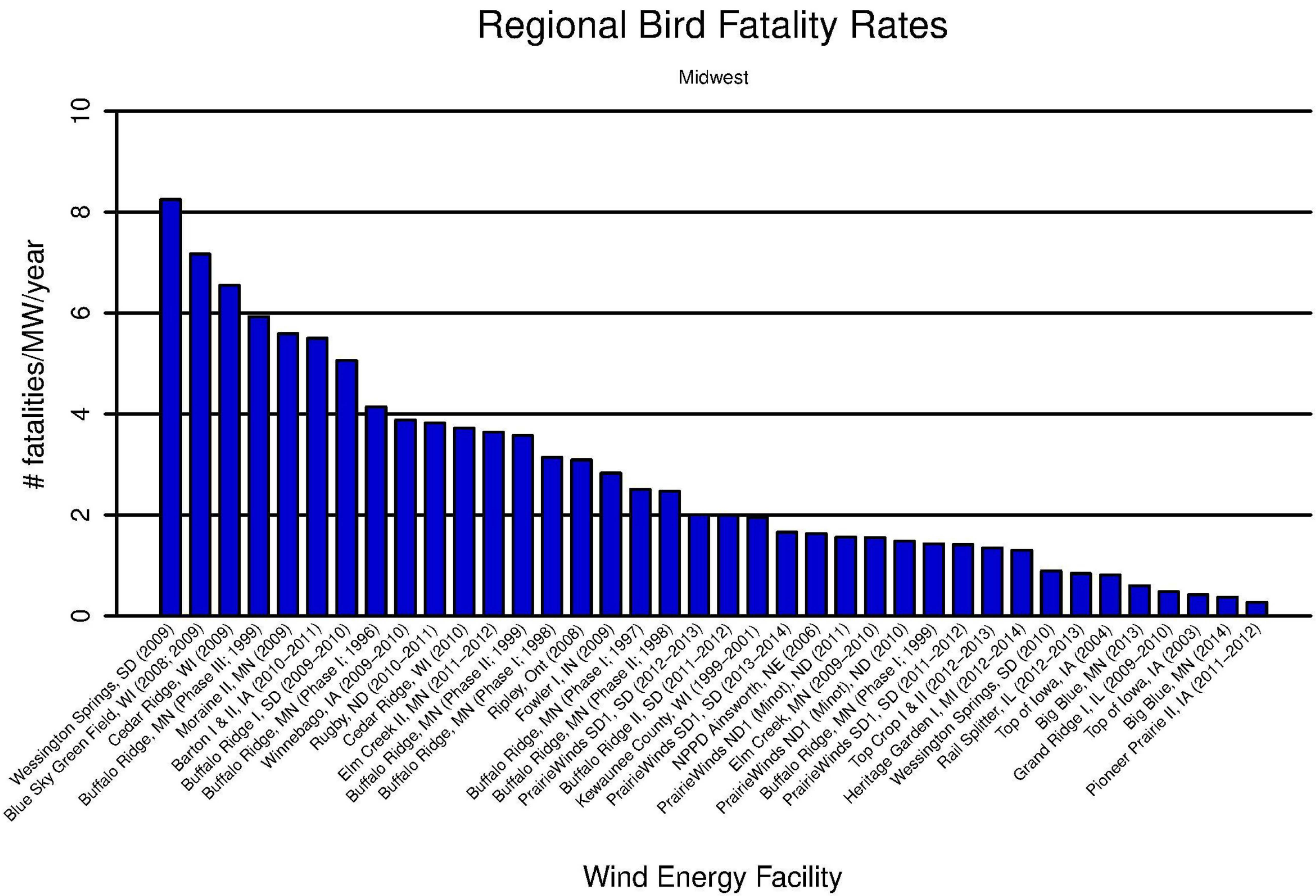

Figure 10. Fatality rates for all birds (number of birds per megawatt [MW] per year) from publicly available studies at wind energy facilities in the Midwestern region of North America.

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.

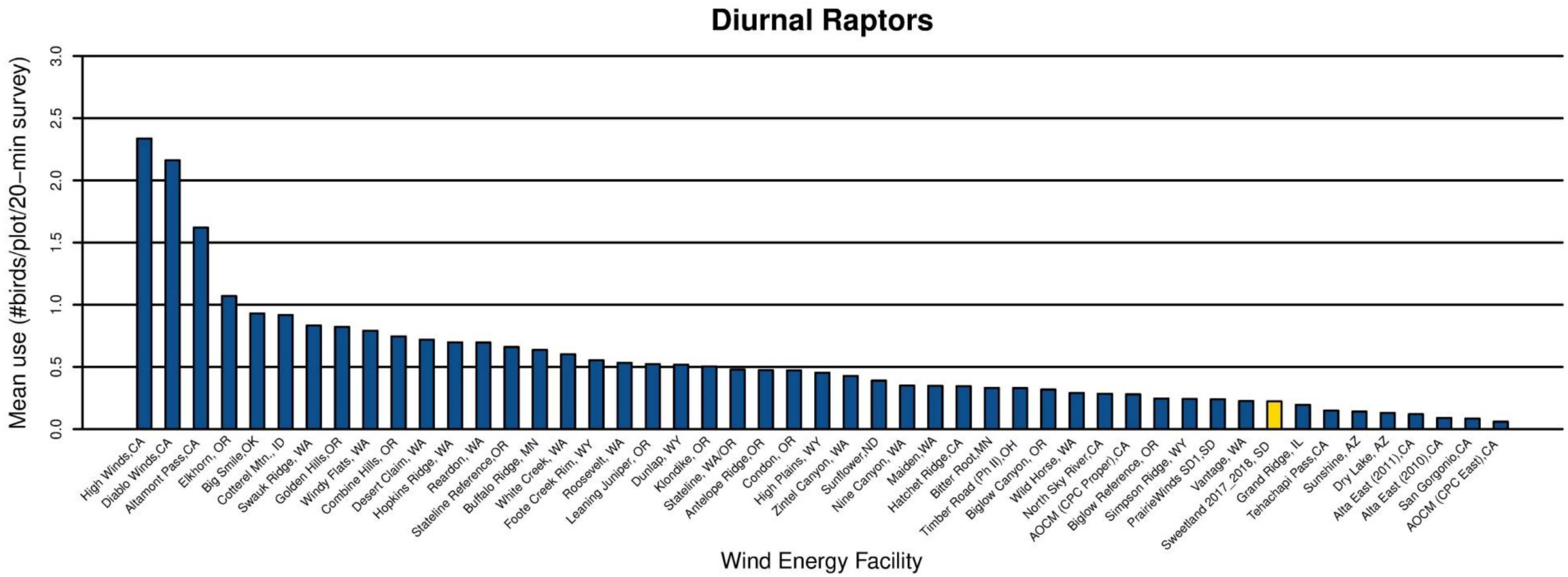

Figure 11. Comparison of estimated annual diurnal raptor use during the first year of fixed-point large bird use surveys at the Sweetland Wind Energy Project and other US wind energy facilities with comparable and publicly available data.

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.

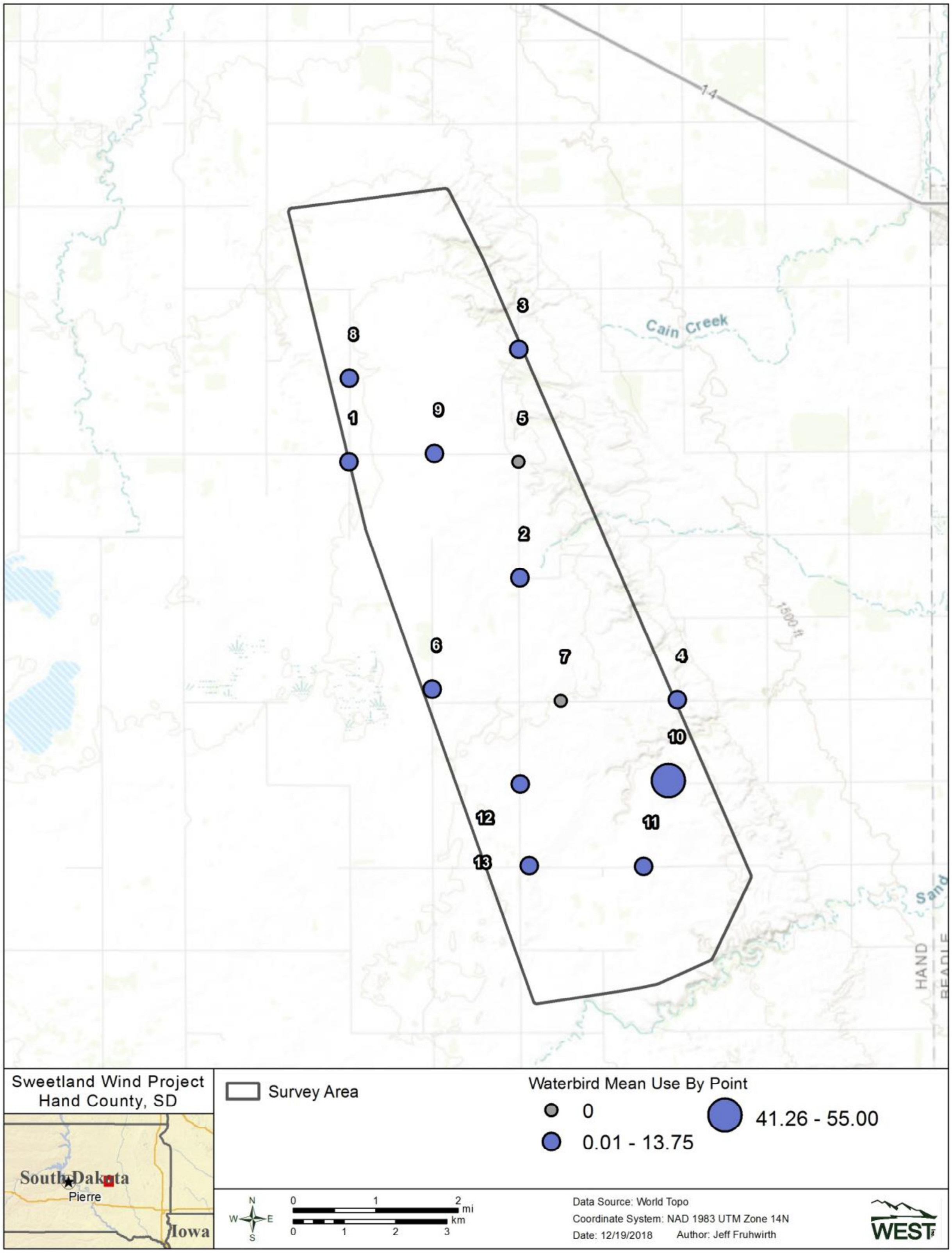
	Survey Point Location												
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Waterbirds	0.17	4.58	0.17	4.92	0	4.36	0	1.64	1.33	53.67	13.64	8.42	0.08
Waterfowl	288.50	752.17	1,099.58	163.17	631.58	19.00	181.83	8.91	210.33	60.58	3.64	60.58	444.17
Shorebirds	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.

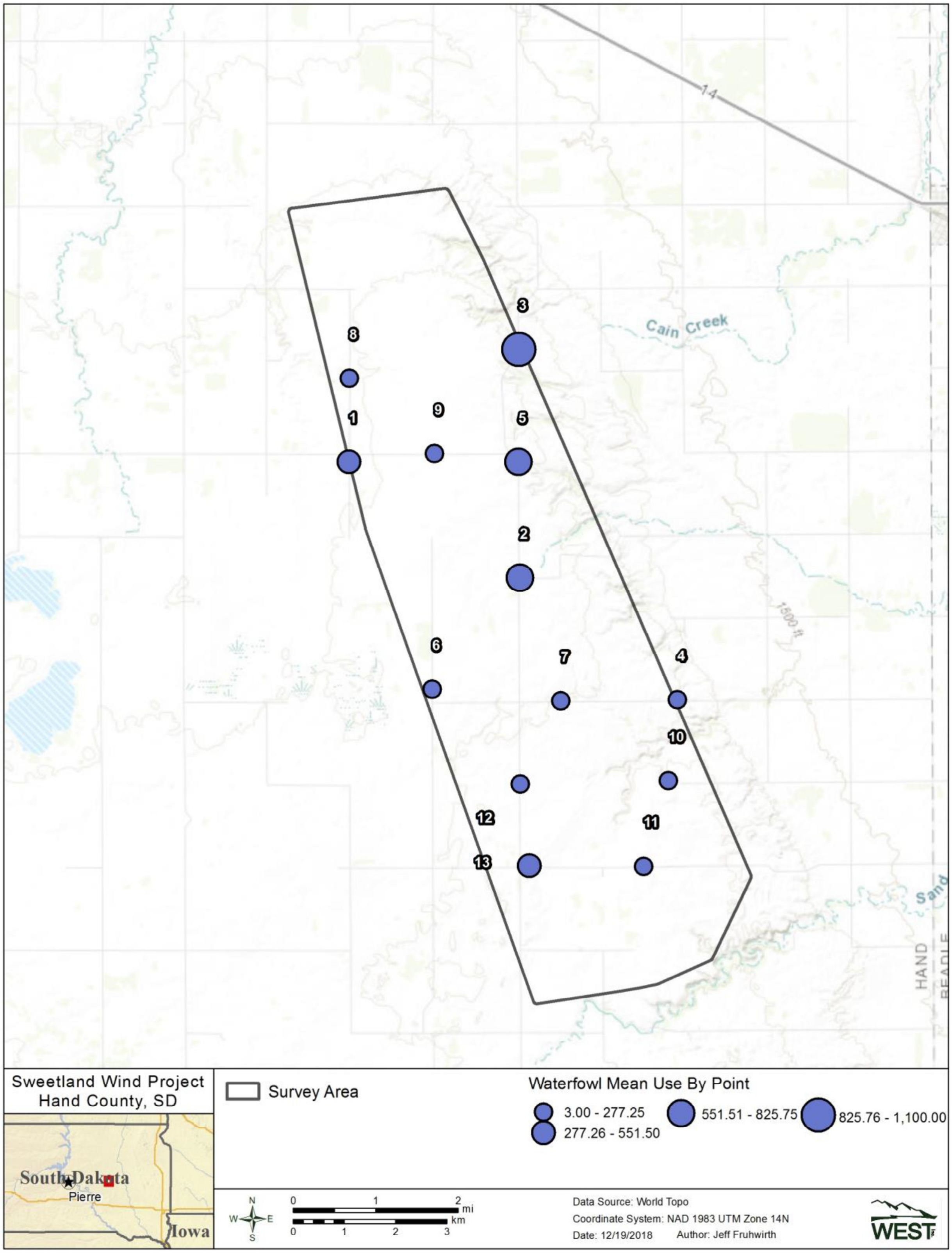
Appendix D2. Mean use by point for major small bird types during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

	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**

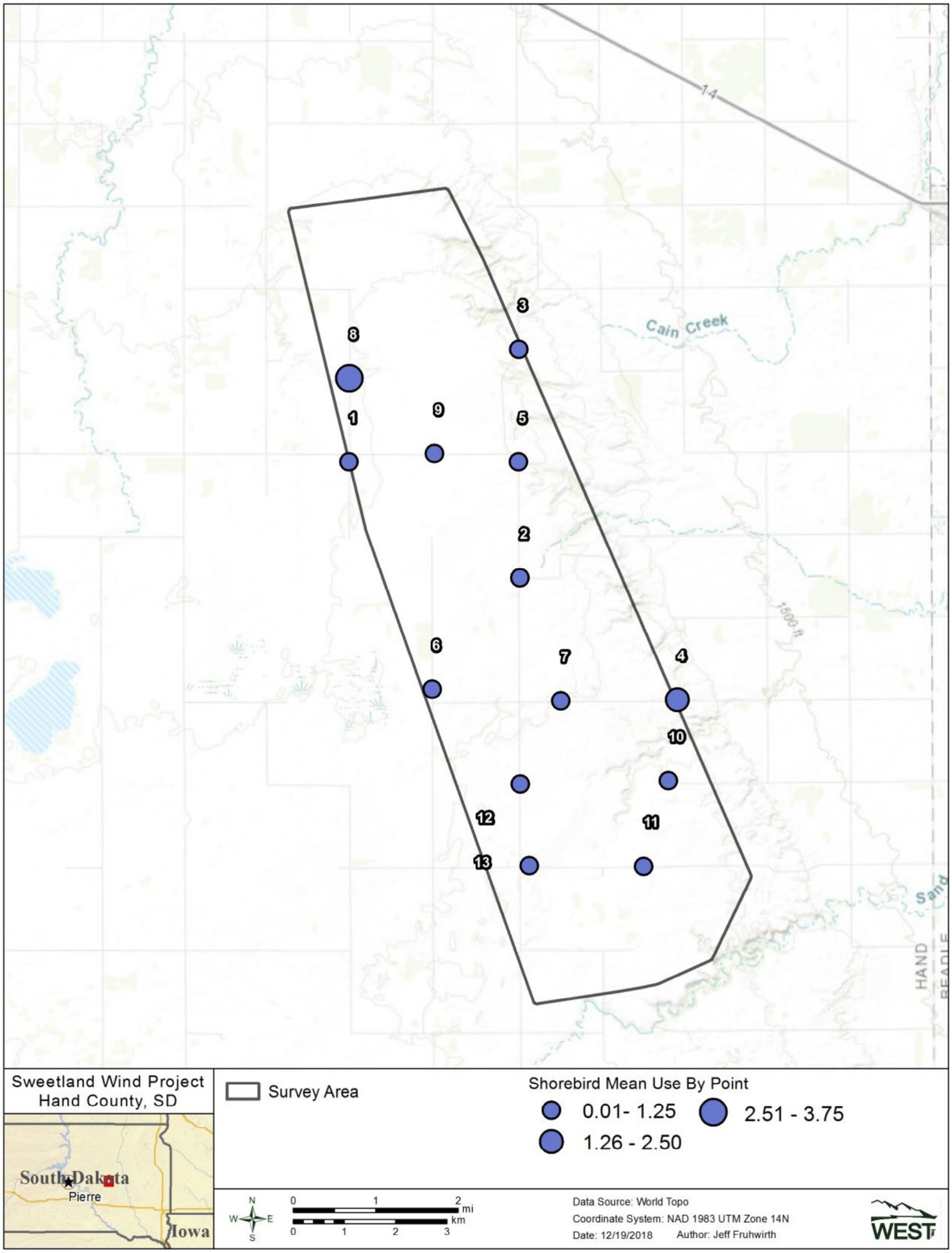
* Sums may not total values shown due to rounding.



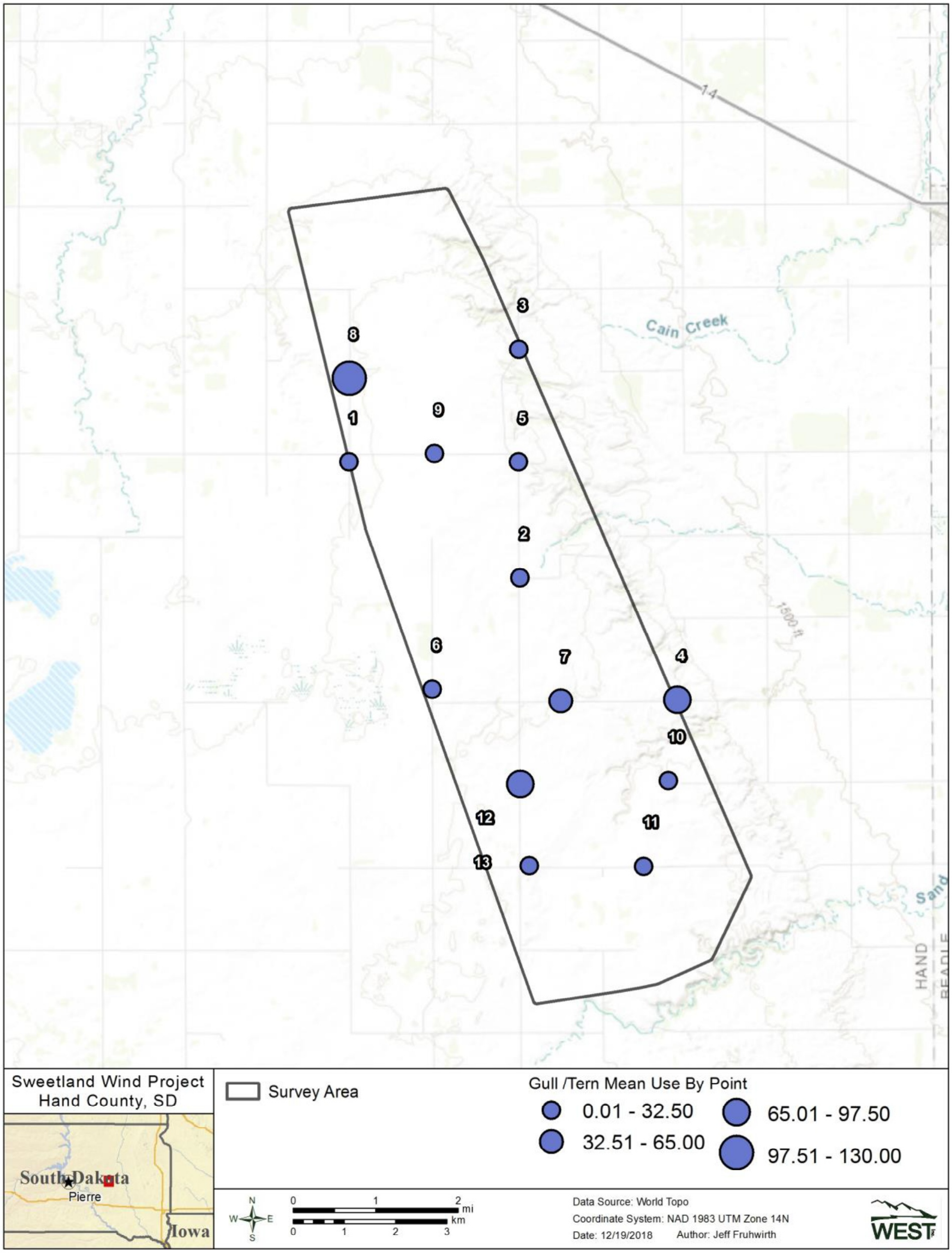
Appendix D3. Relative waterbird use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



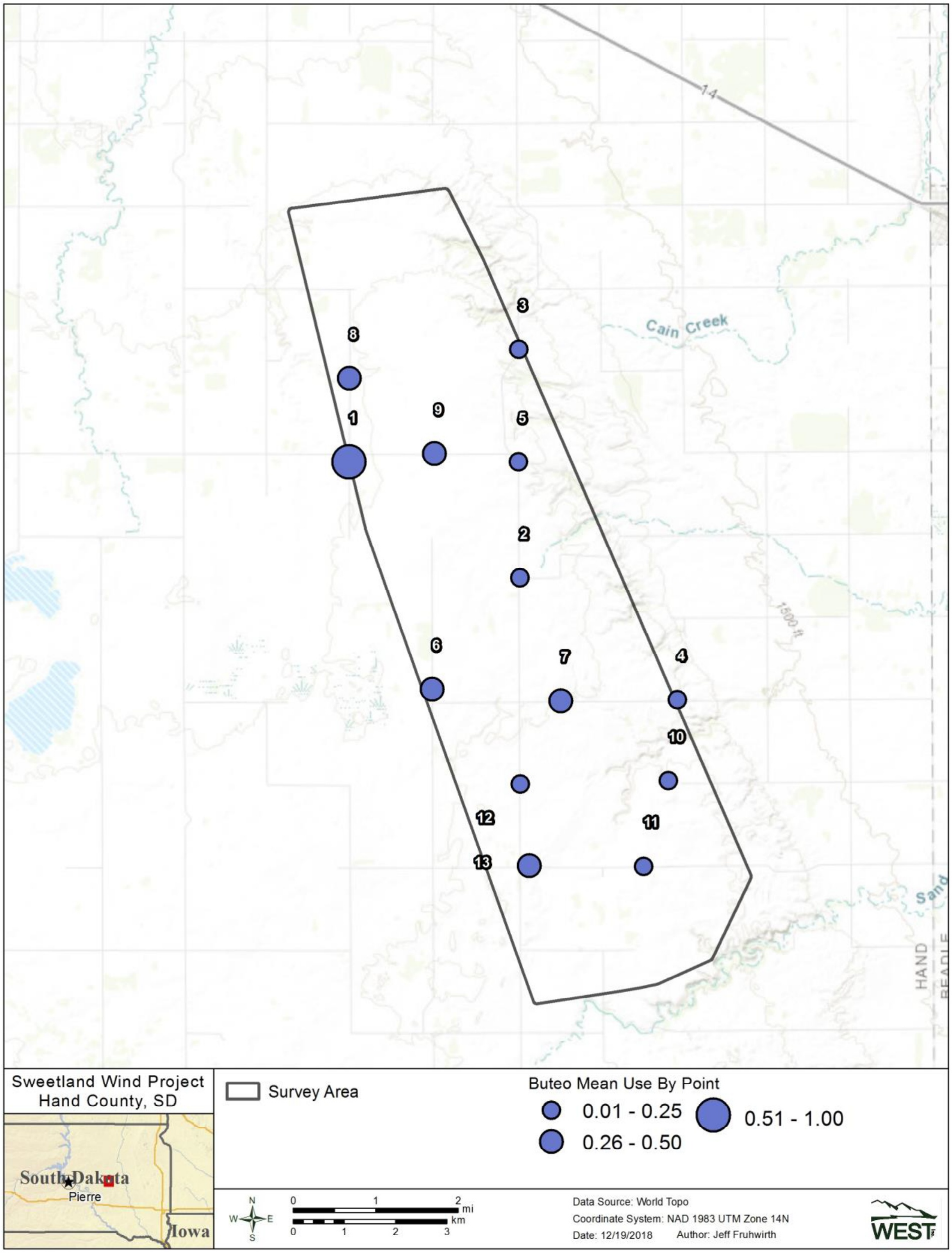
Appendix D3 (*continued*). Relative waterfowl use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



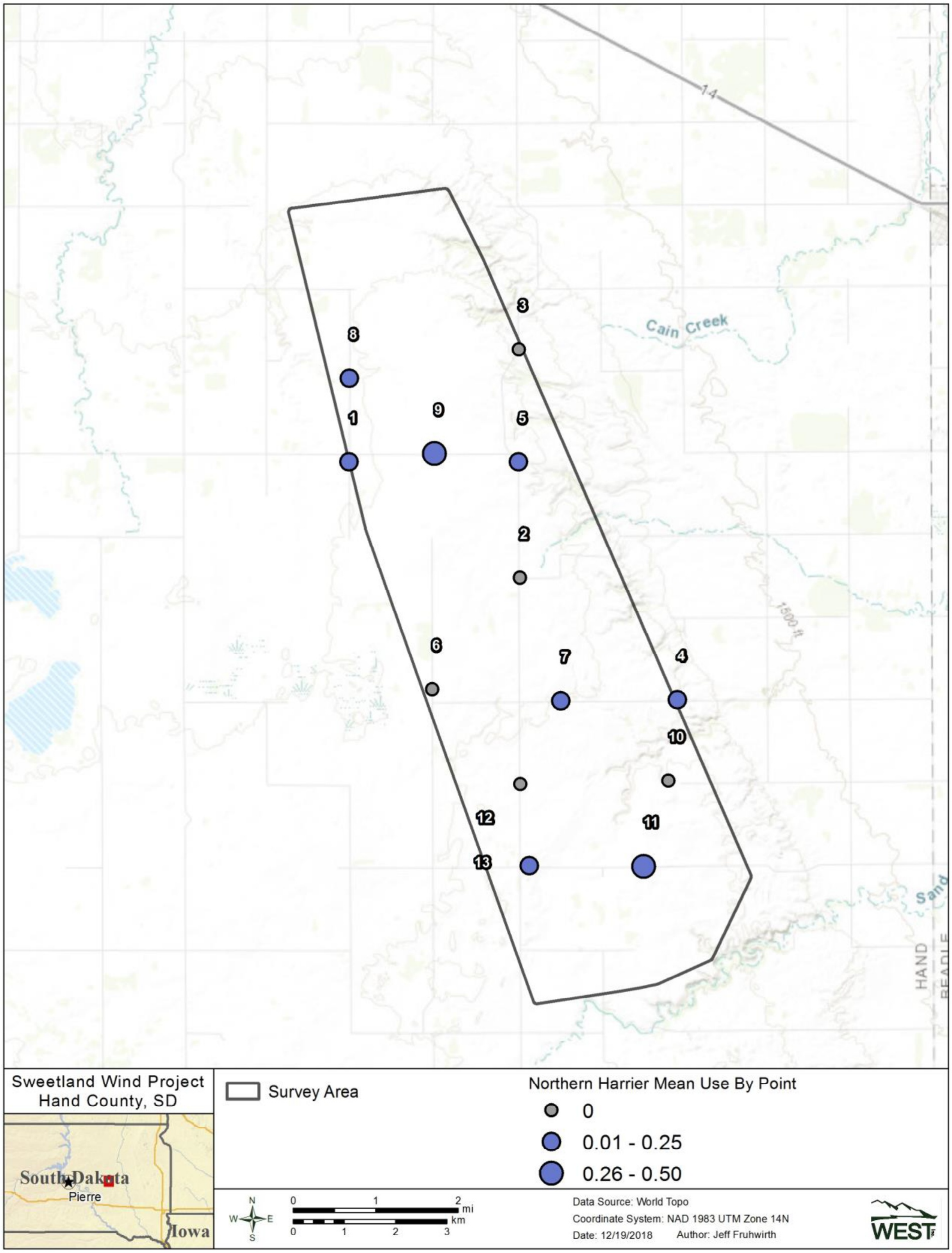
Appendix D3 (*continued*). Relative shorebird use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



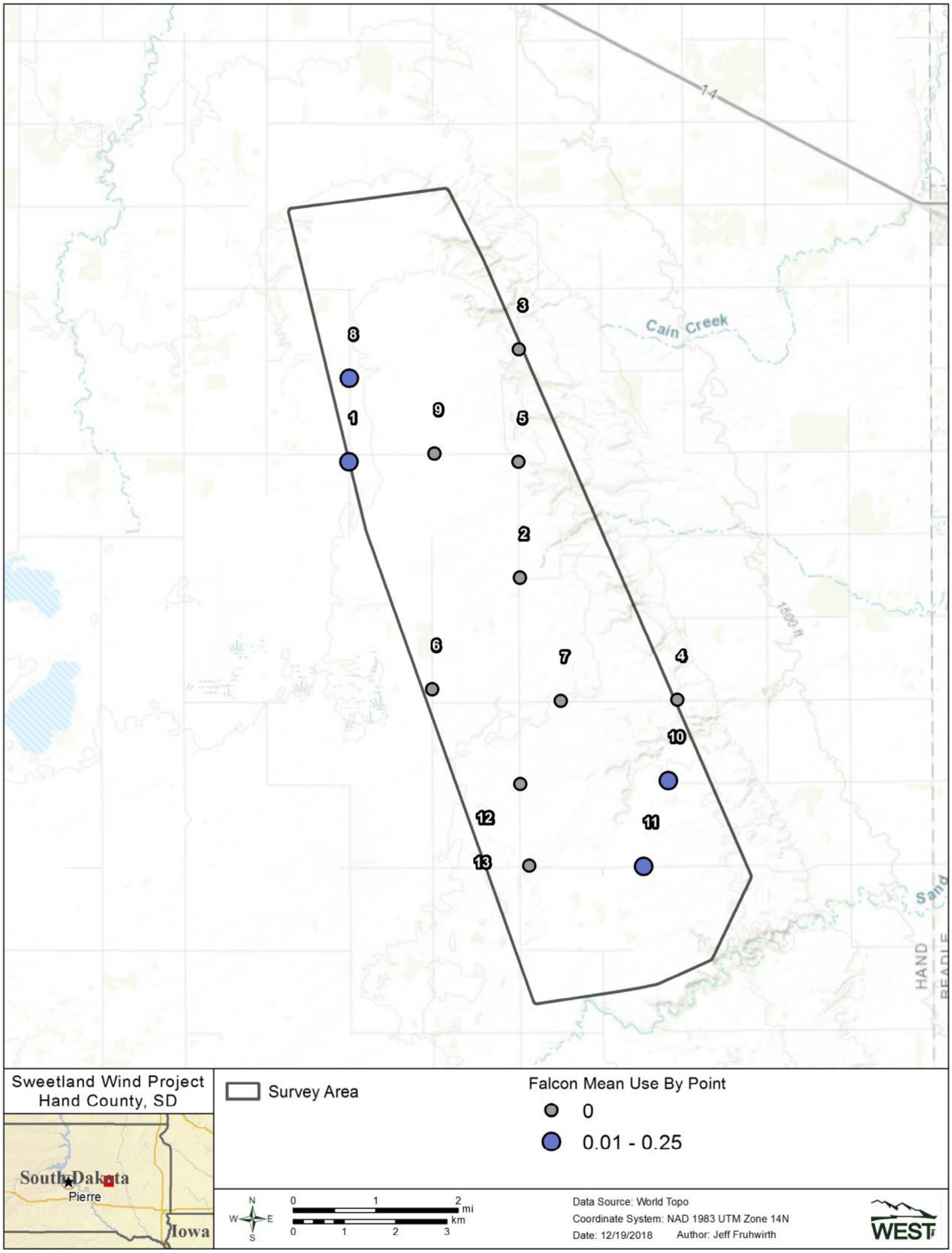
Appendix D3 (*continued*). Relative gull/tern use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



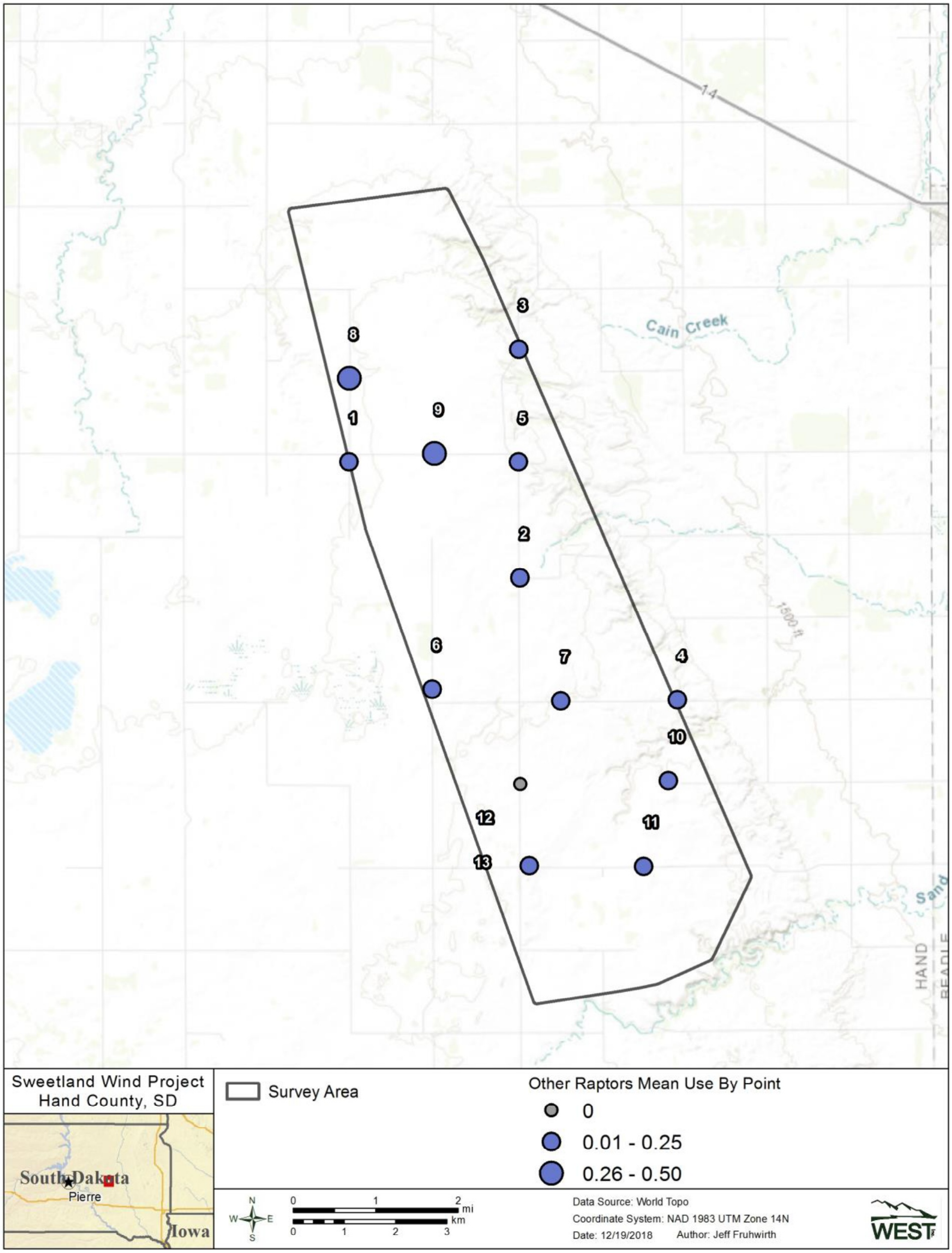
Appendix D3 (*continued*). Relative buteo use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



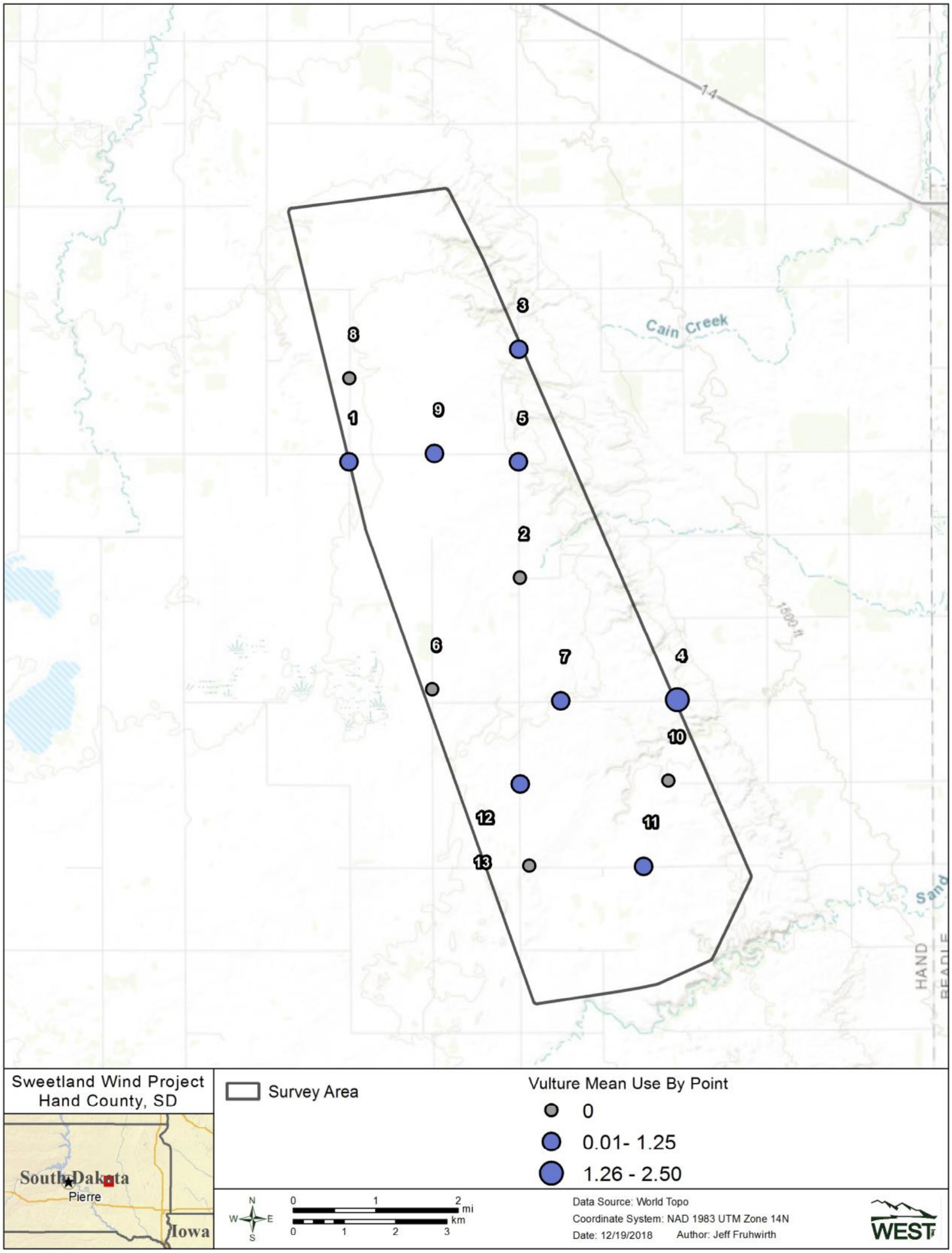
Appendix D3 (*continued*). Relative northern harrier use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



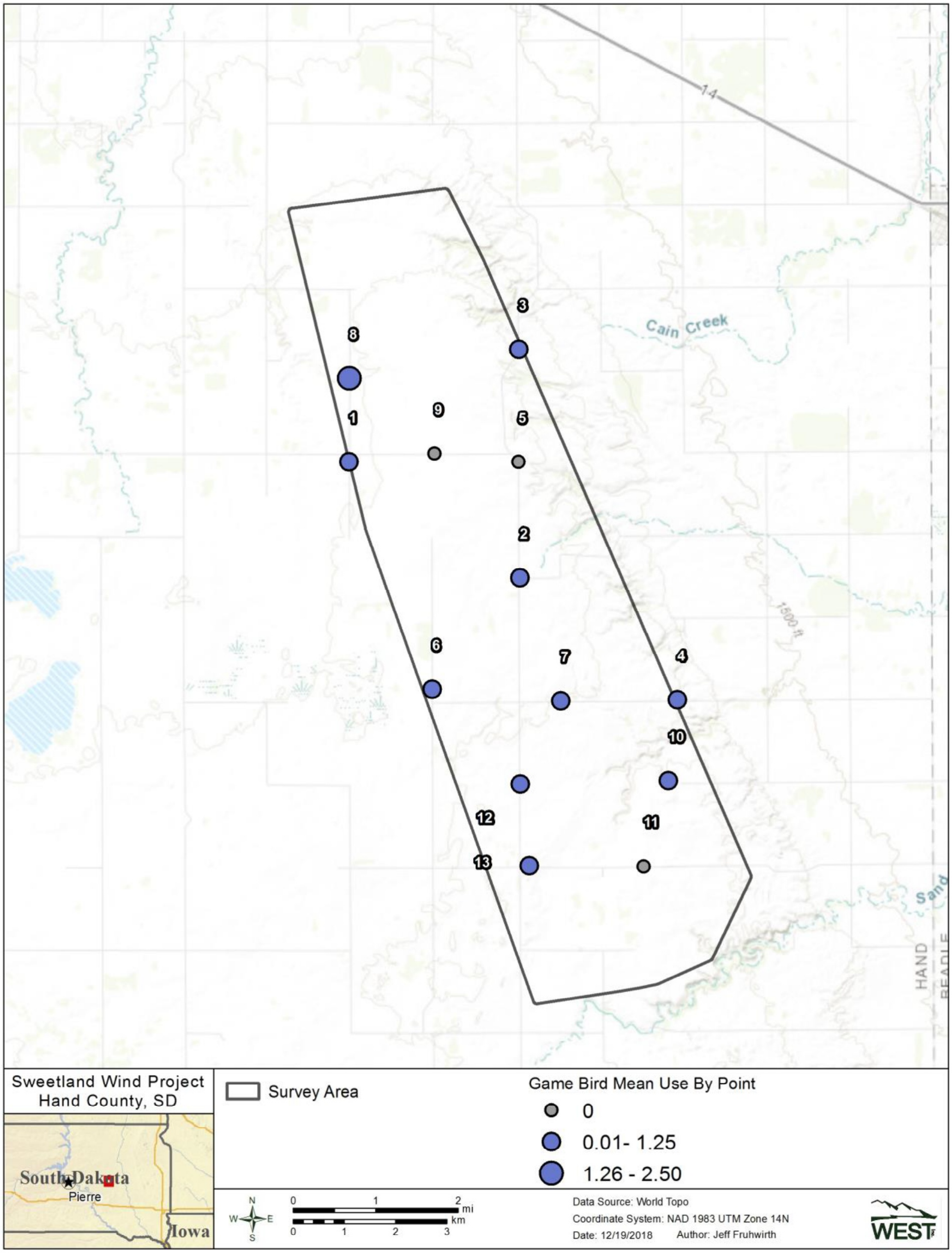
Appendix D3 (*continued*). Relative falcon use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



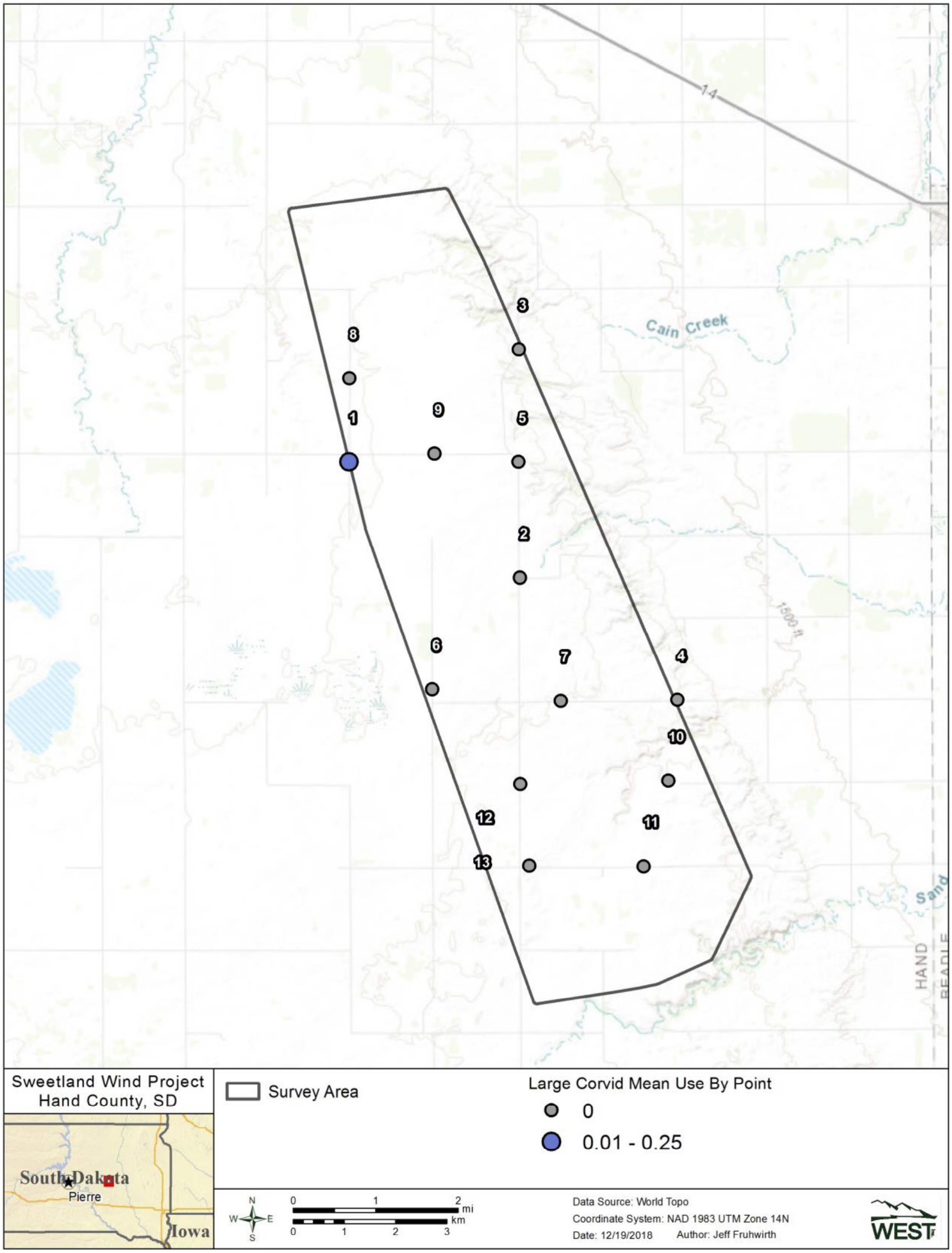
Appendix D3 (*continued*). Relative unidentified raptor use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



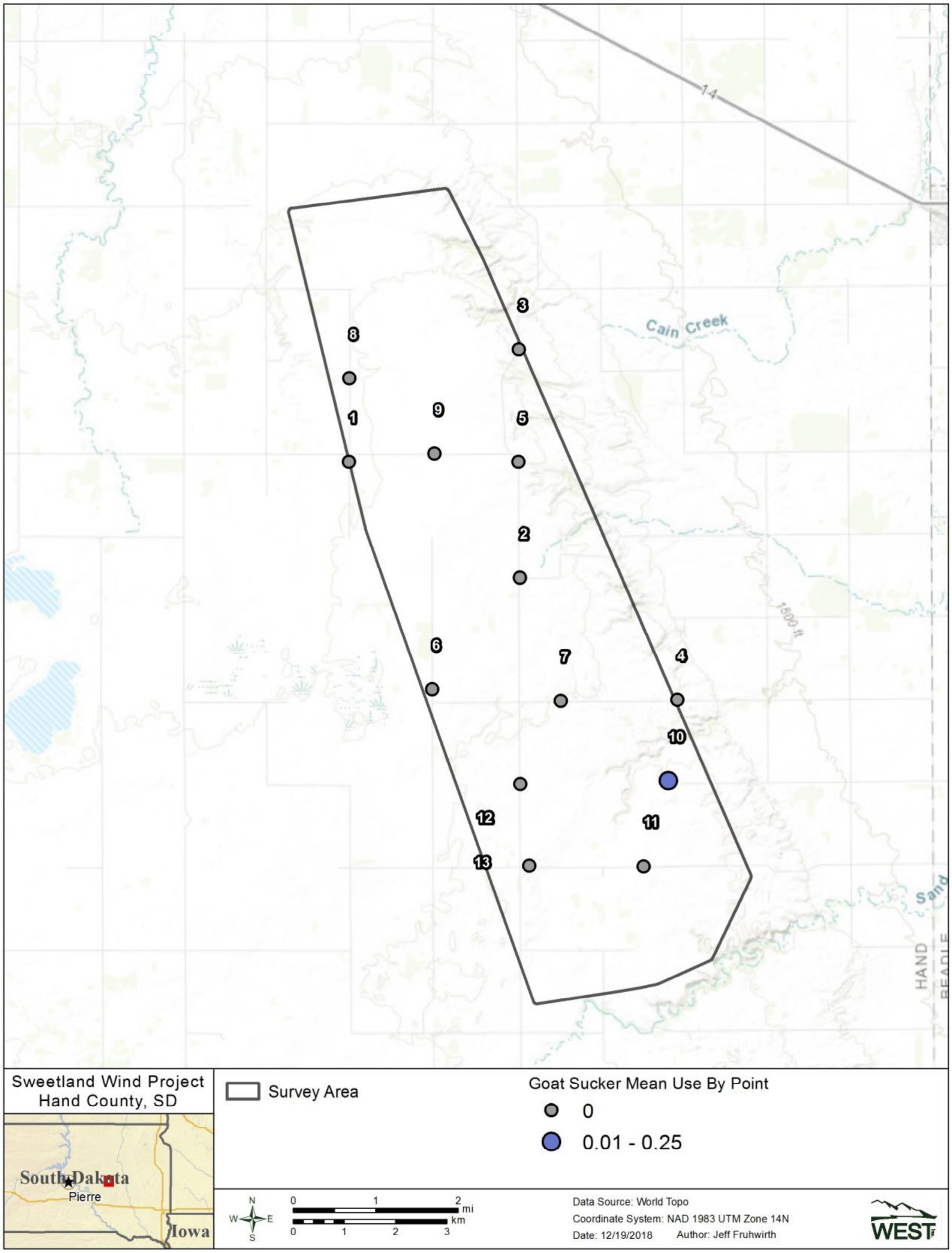
Appendix D3 (*continued*). Relative vulture use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



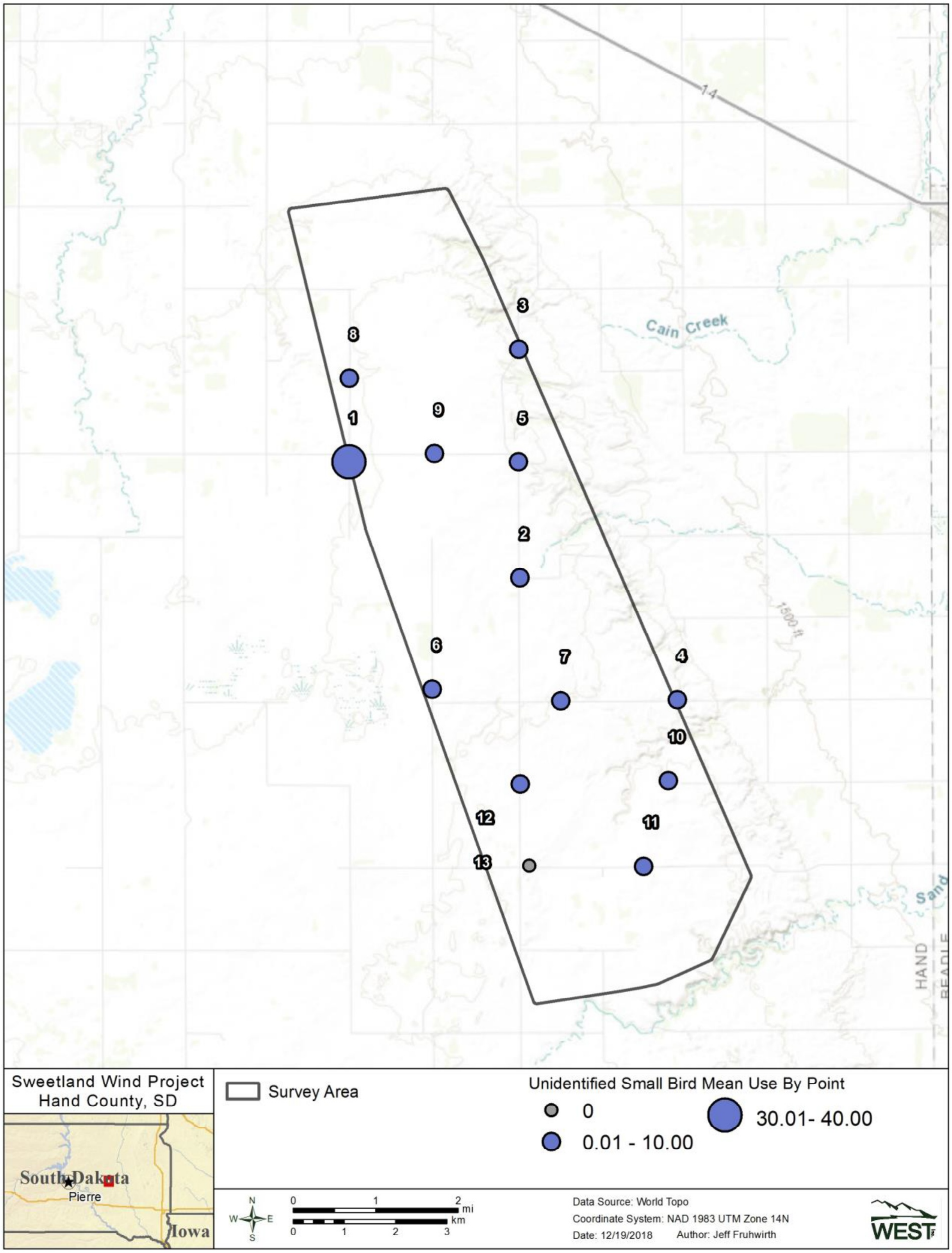
Appendix D3 (*continued*). Relative upland game bird use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



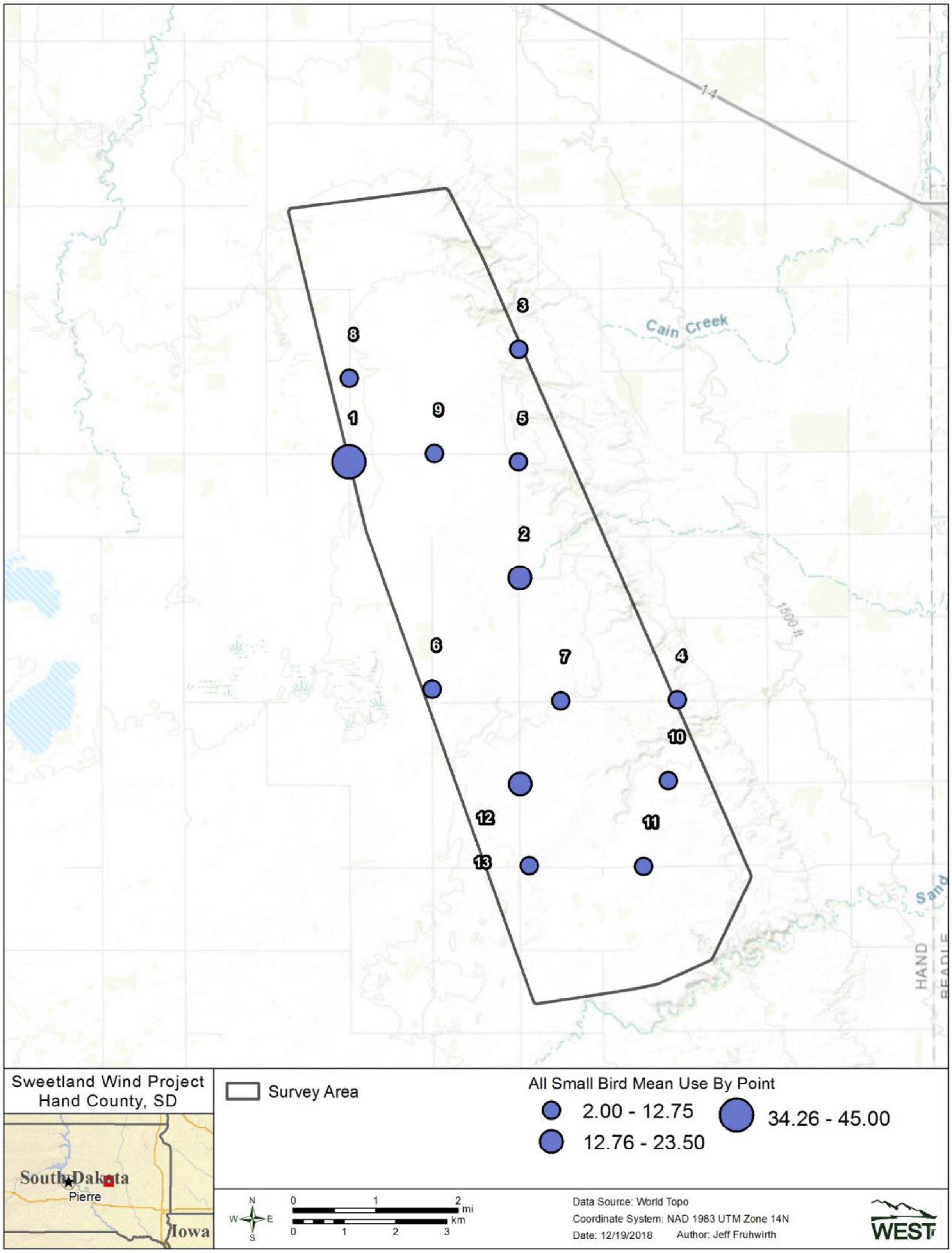
Appendix D3 (*continued*). Relative large corvid use by observation point during fixed-point large bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



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.

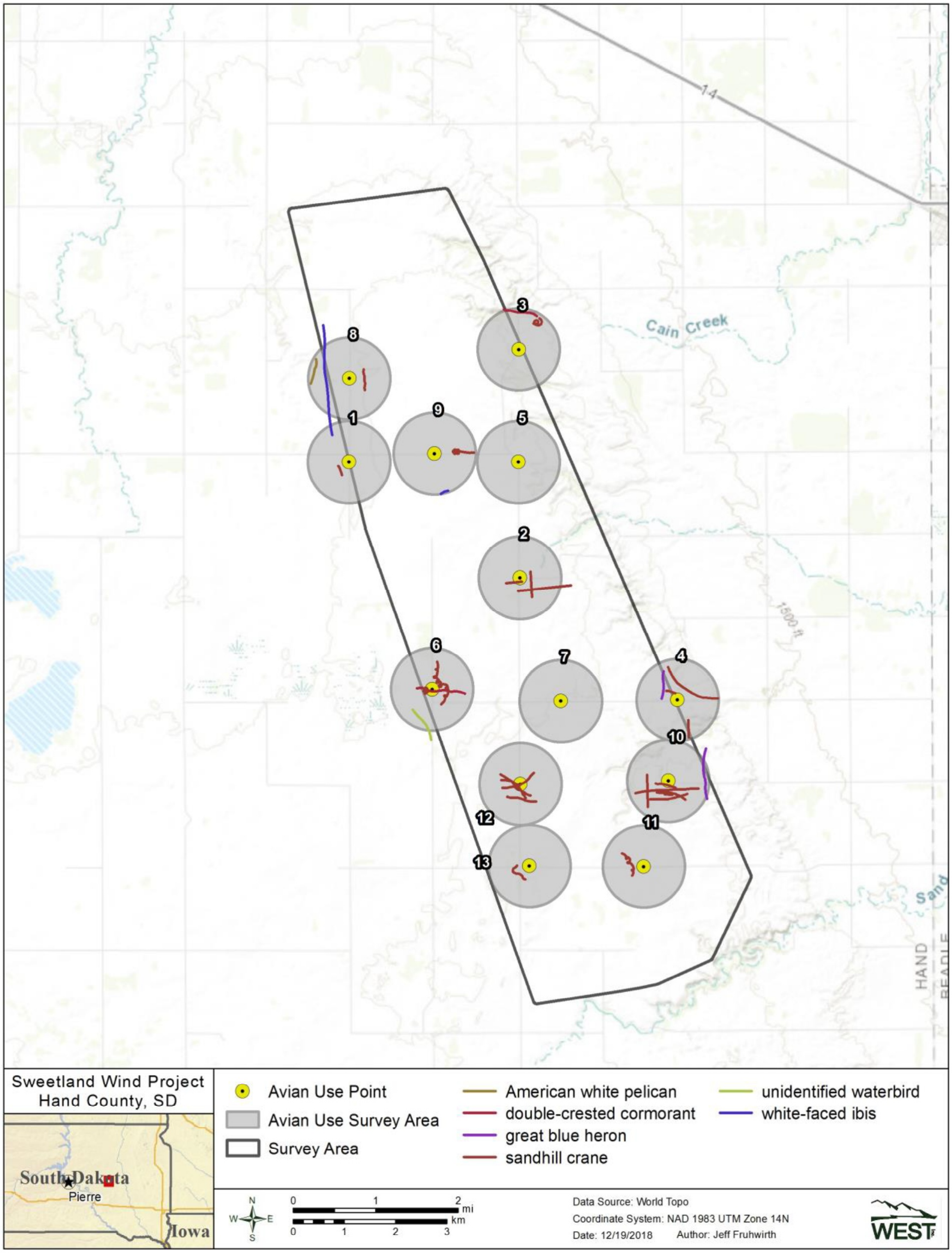


Appendix D3 (*continued*). Relative unidentified small bird use by observation point during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

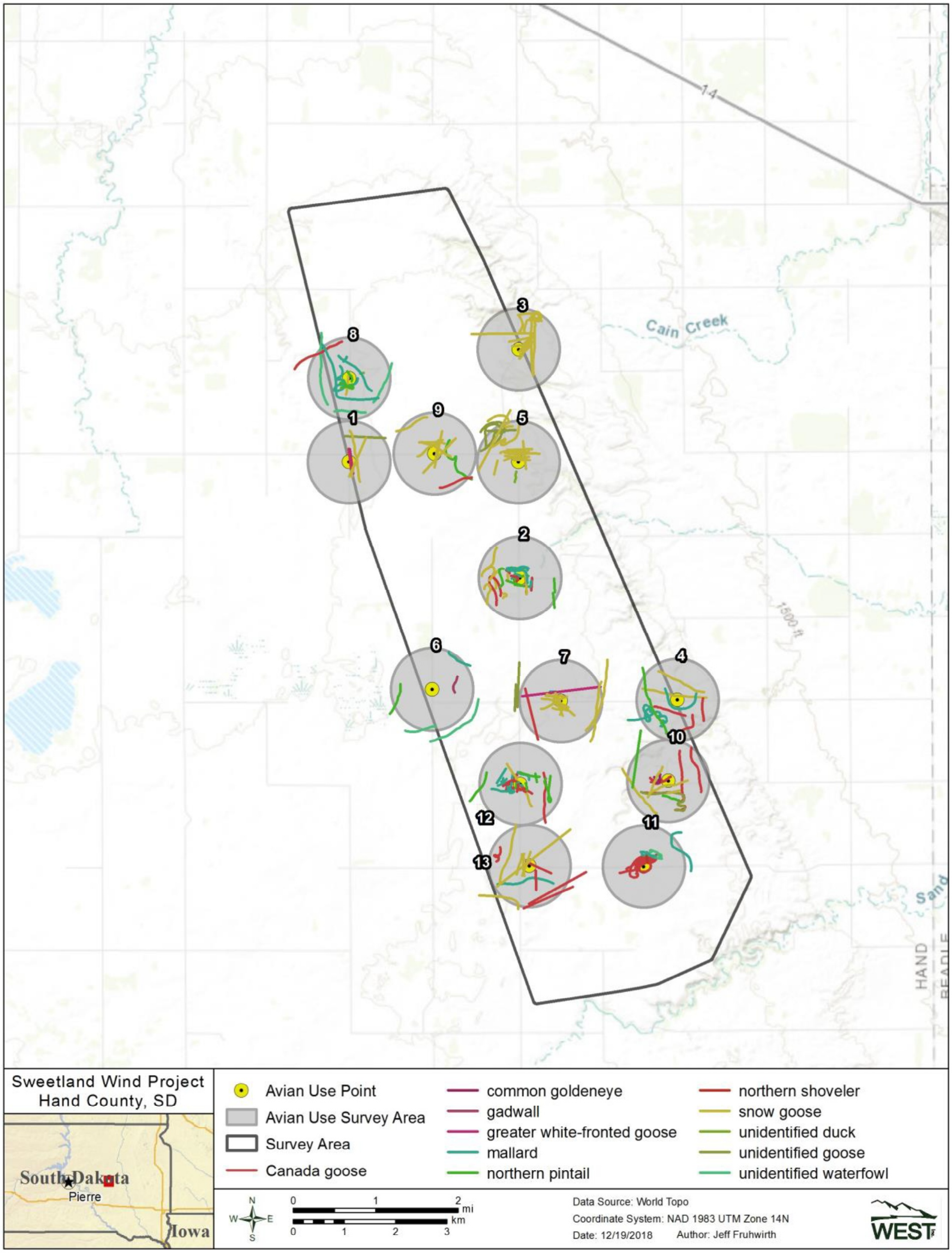


Appendix D3 (*continued*). Relative small bird use by observation point during fixed-point small bird use surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.

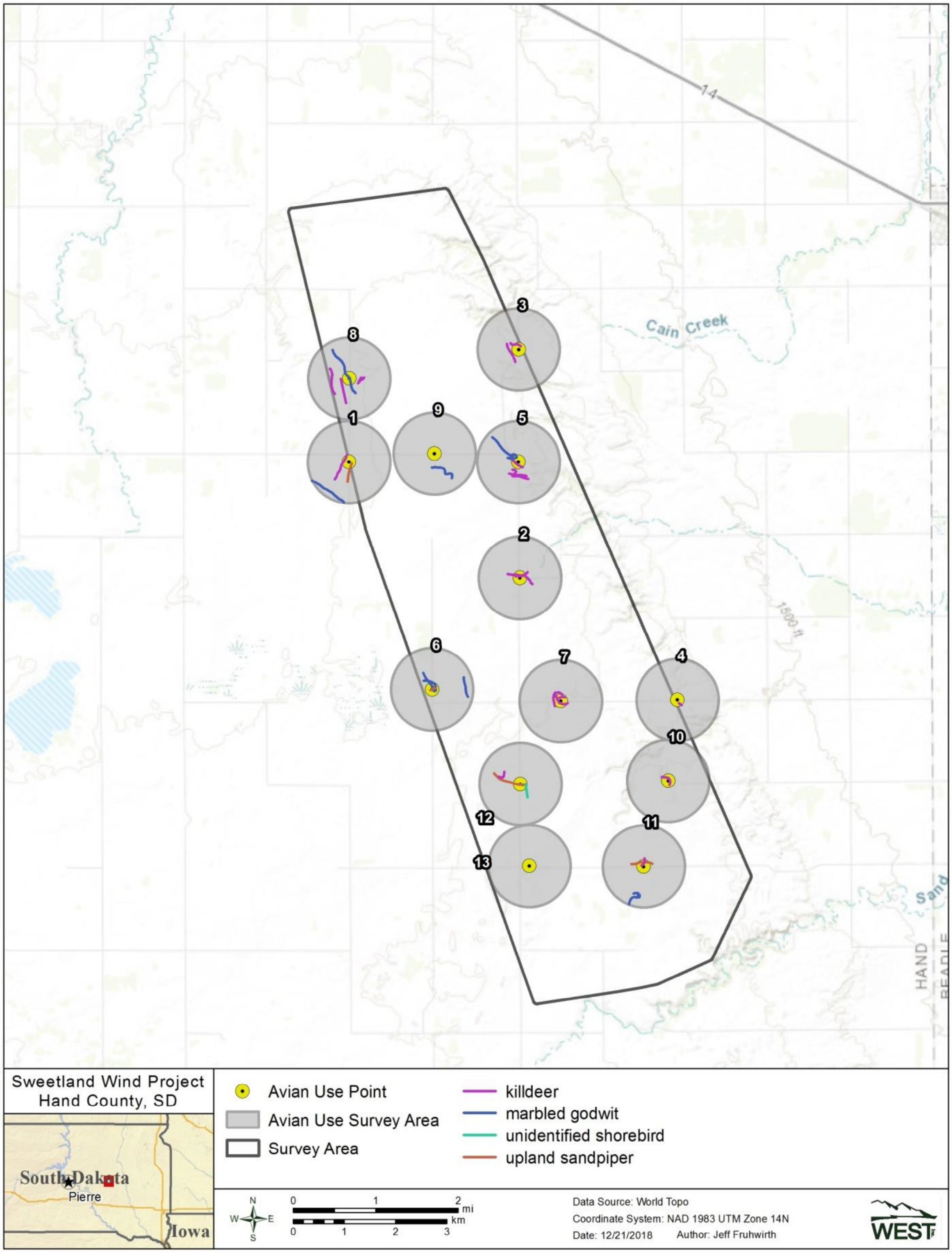
Appendix E. Large Bird Flight Paths Observed during Fixed-Point Large Bird Use Surveys at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018



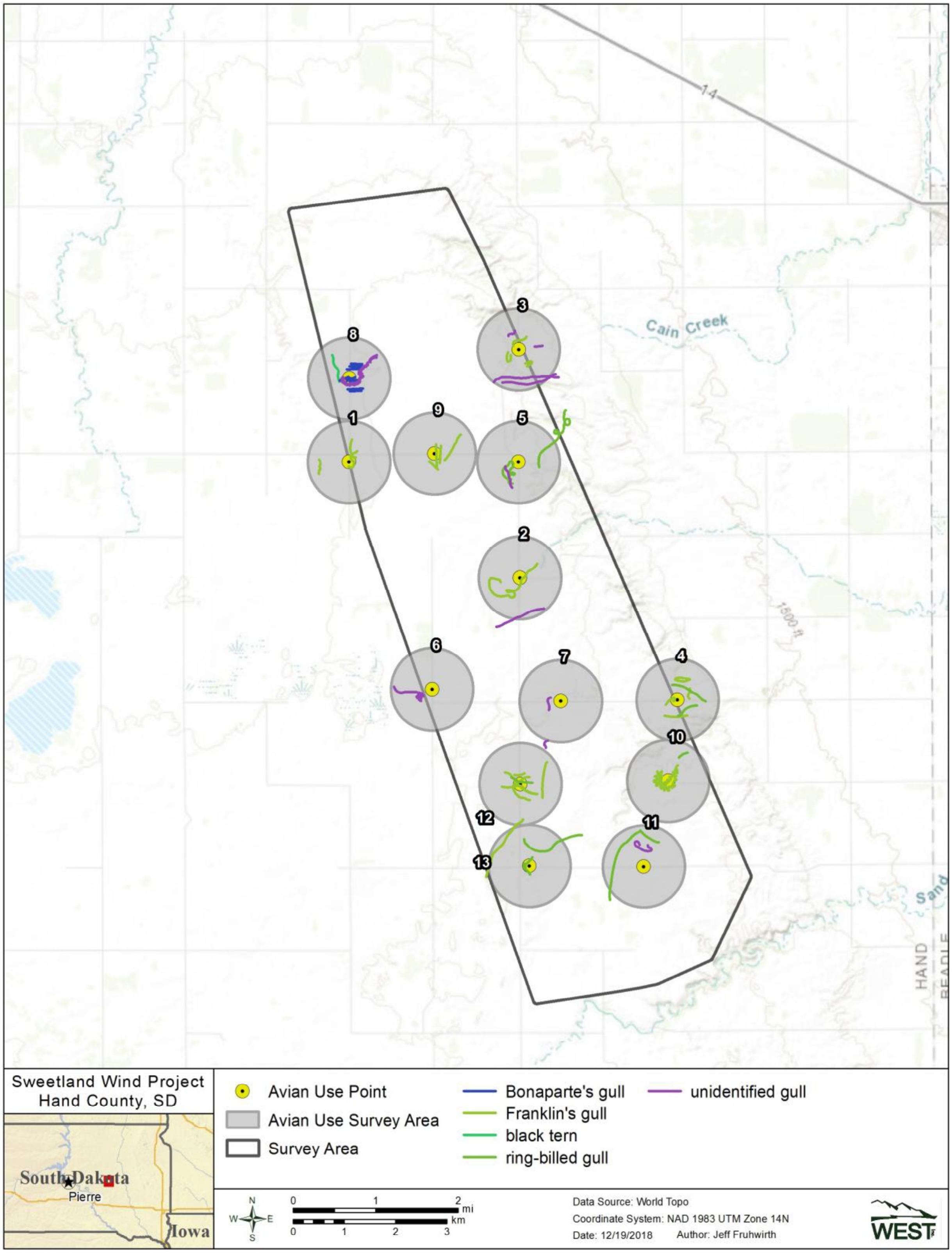
Appendix E. Waterbird flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



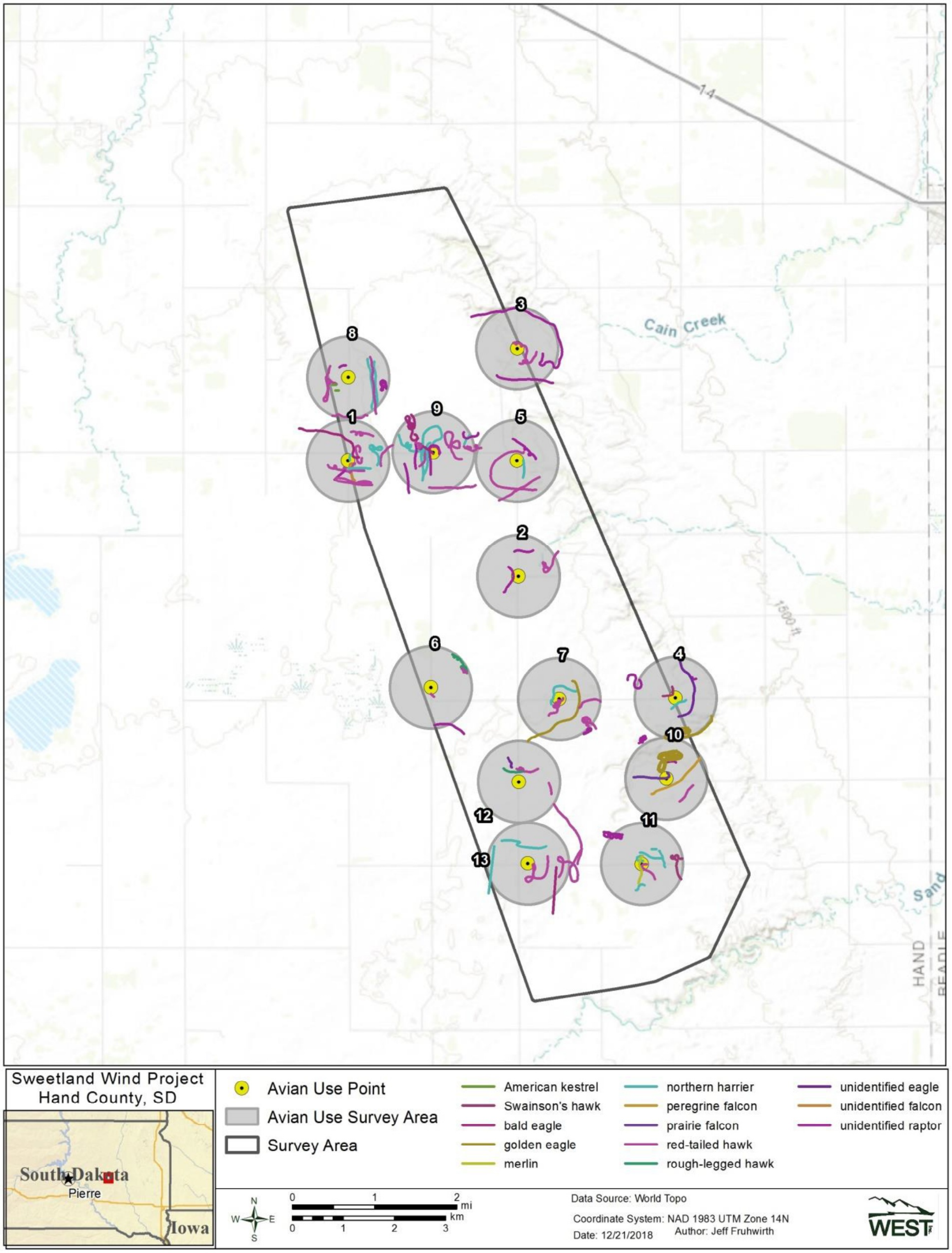
Appendix E (*continued*). Waterfowl flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



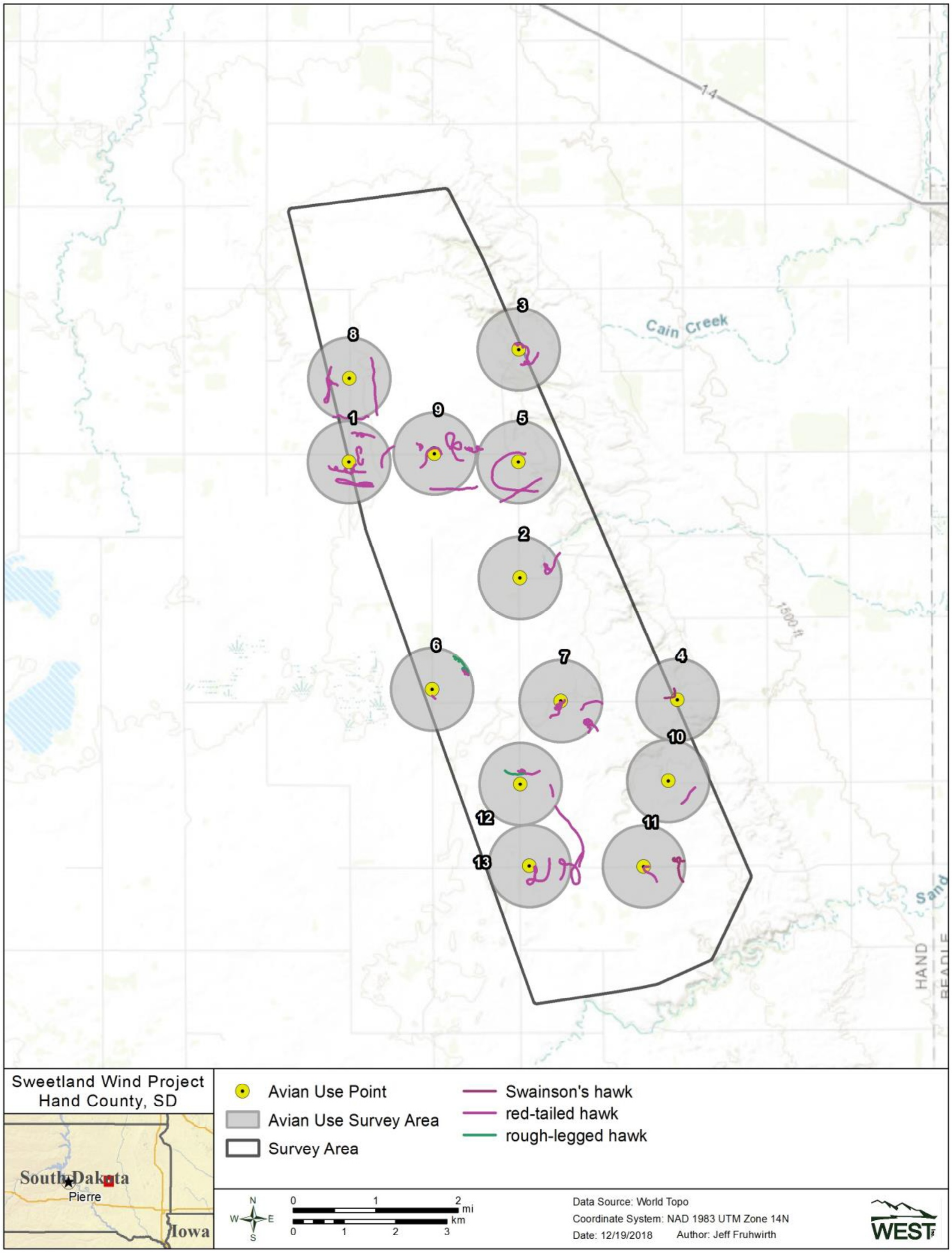
Appendix E (*continued*). Shorebird flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



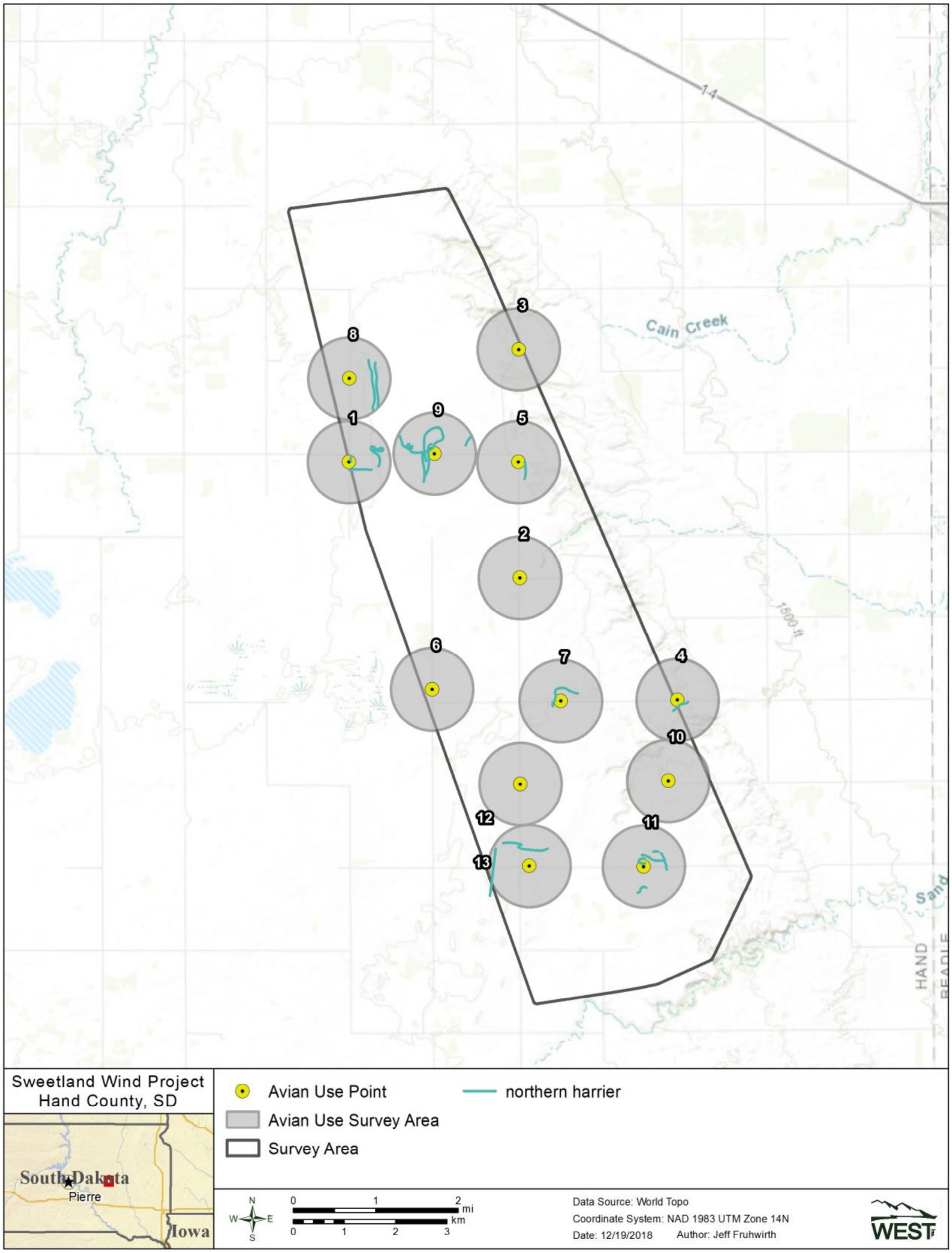
Appendix E (*continued*). Gull/tern flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



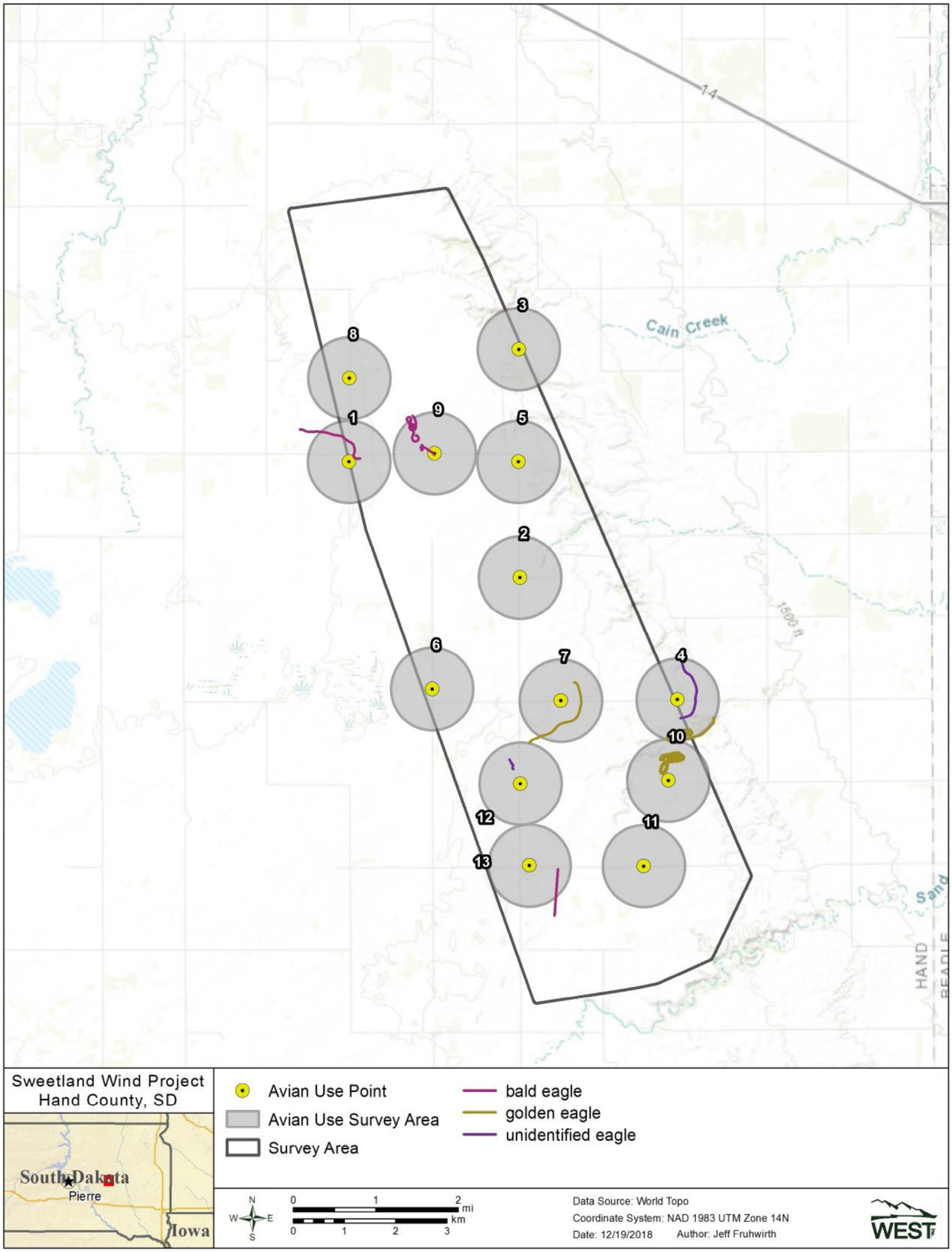
Appendix E (*continued*). Diurnal raptor flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



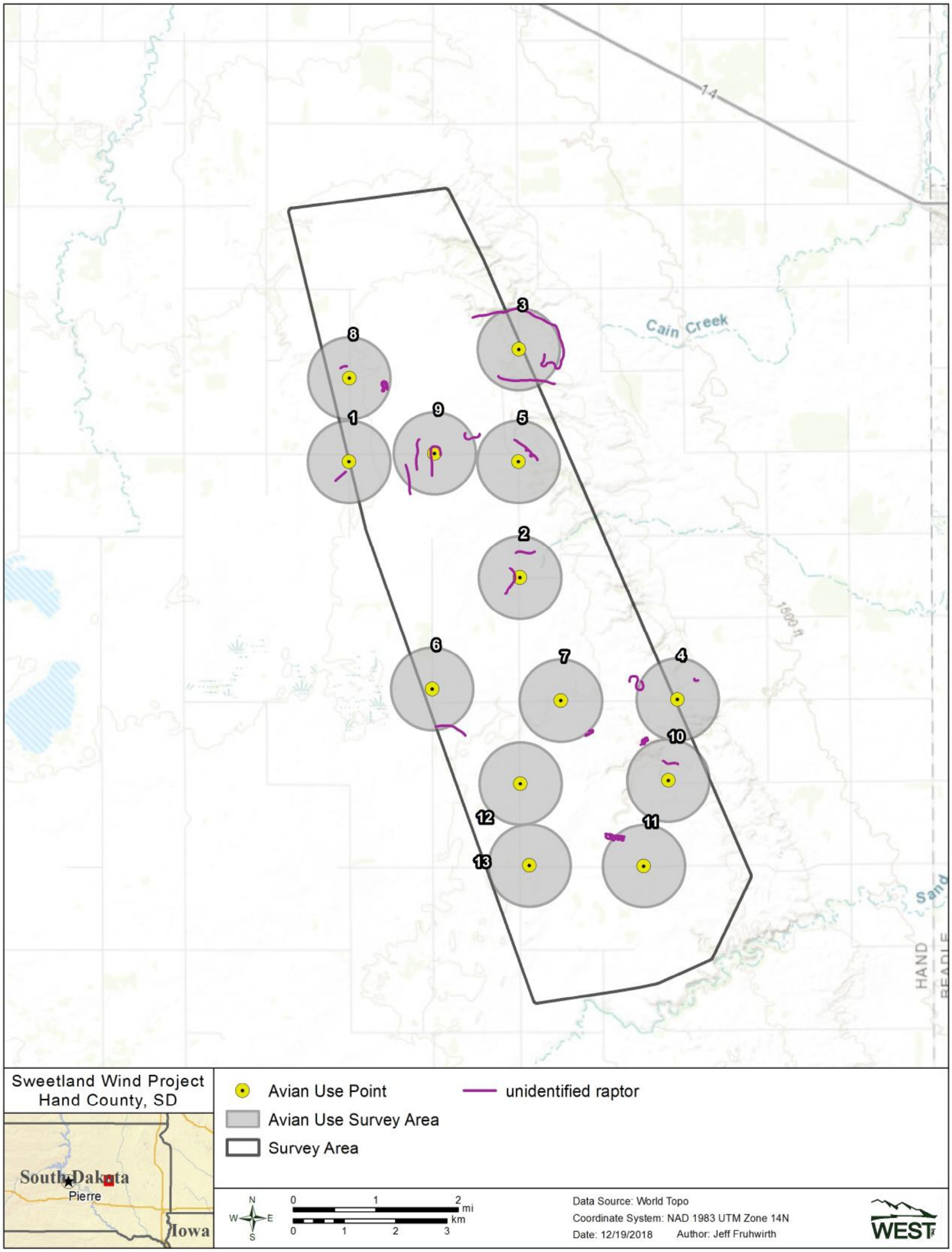
Appendix E (*continued*). Buteo flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



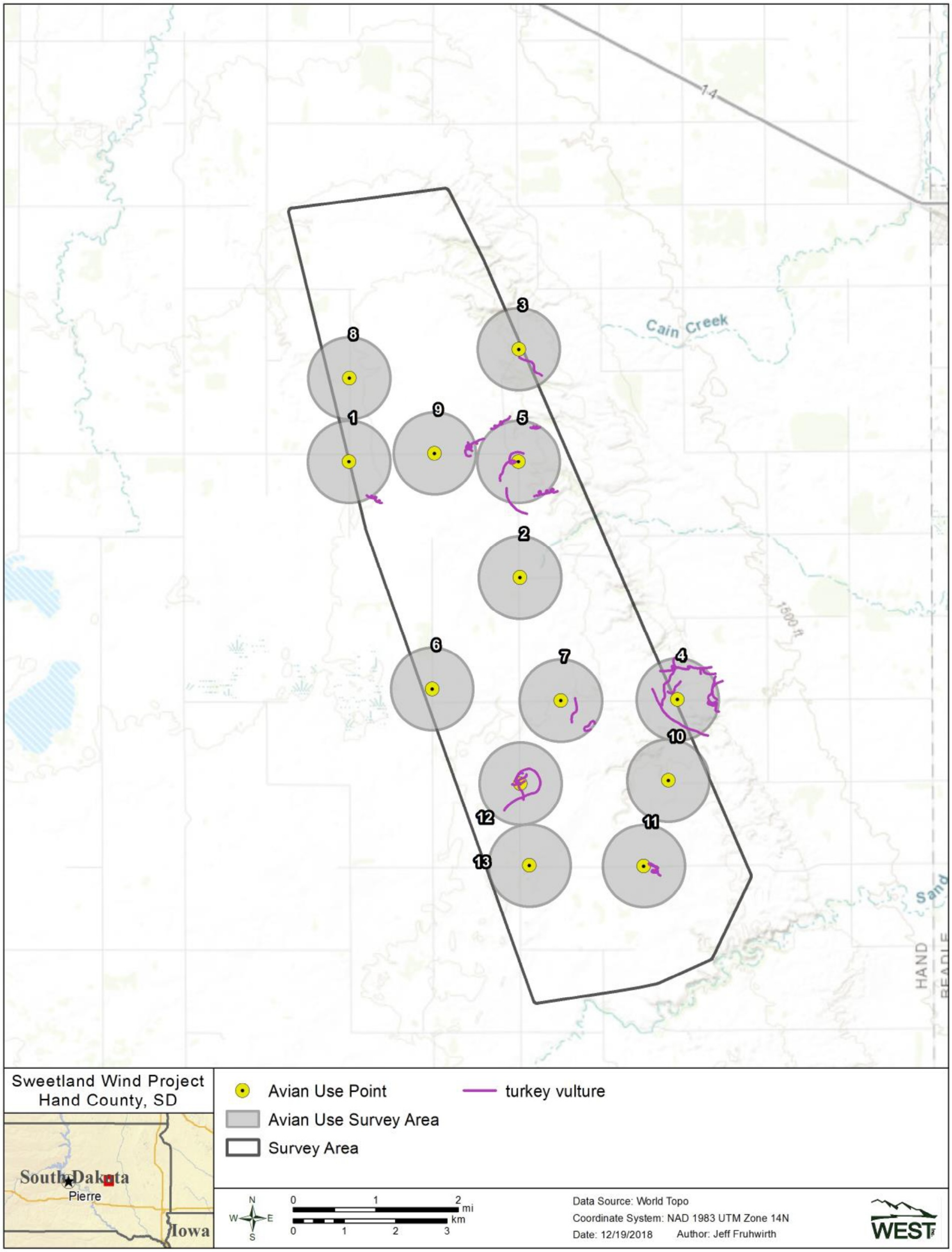
Appendix E (*continued*). Northern harrier flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



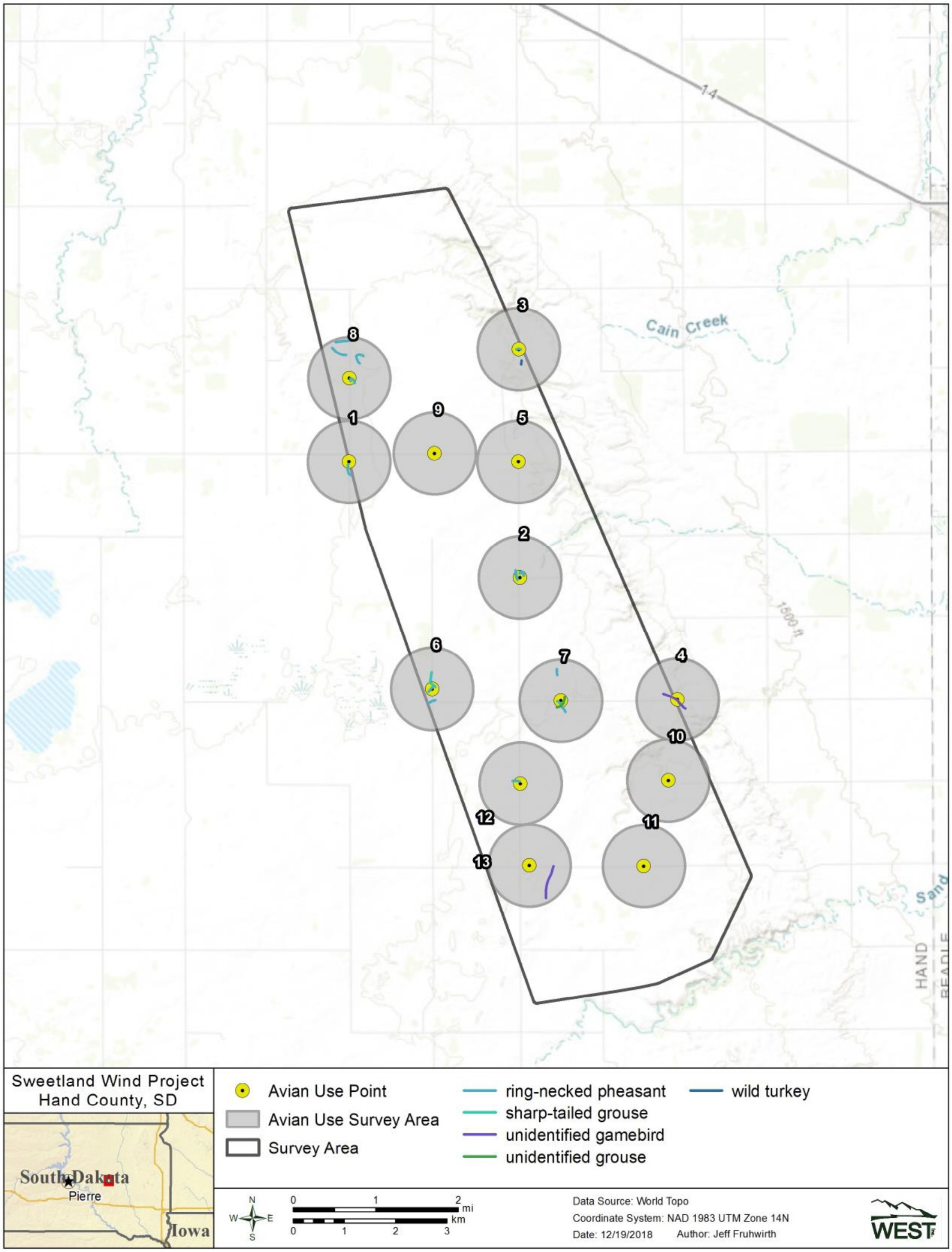
Appendix E (*continued*). Eagle flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



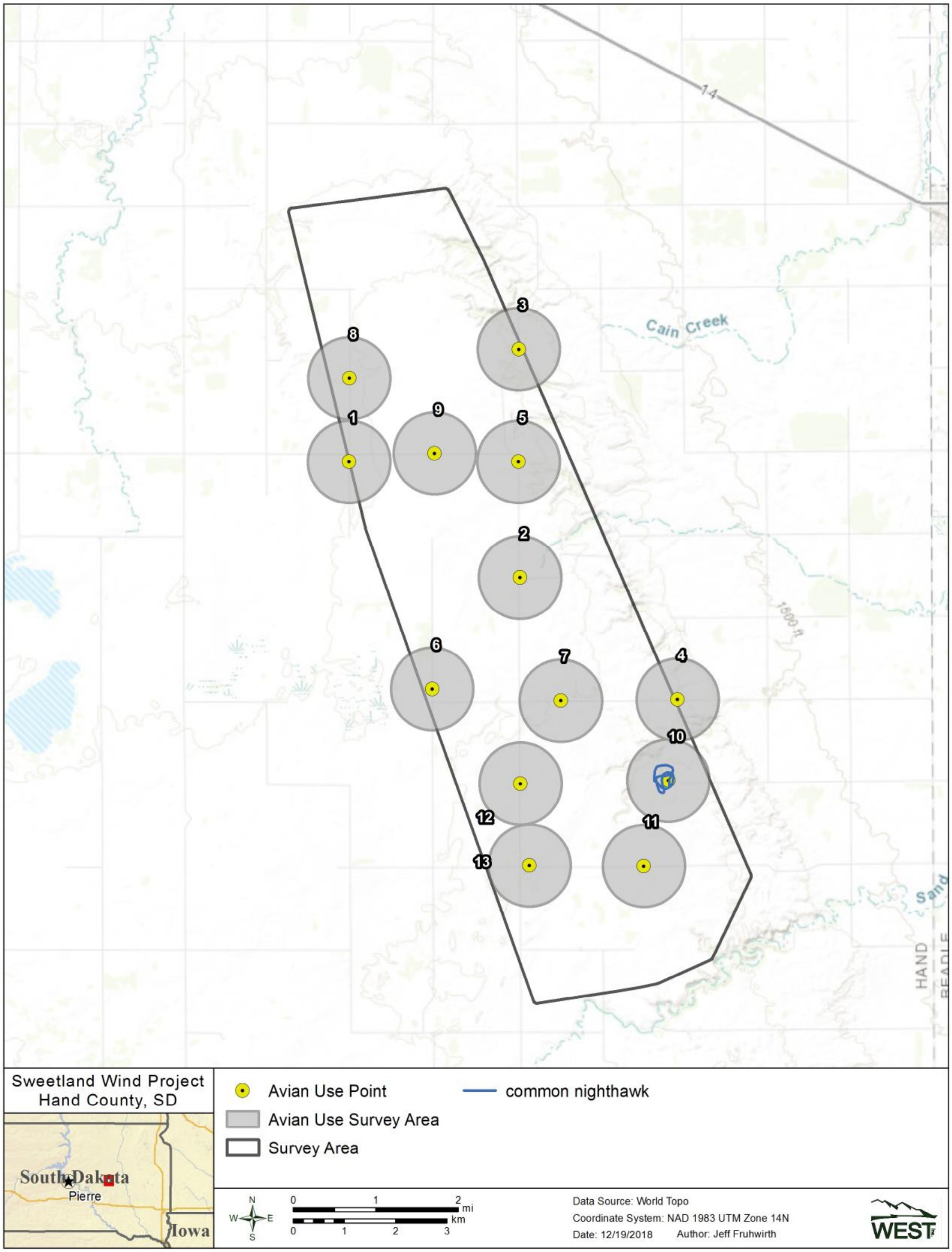
Appendix E (*continued*). Unidentified raptor flight paths recorded at the Sweetland Wind Energy Project from May 26, 2017 – April 28, 2018.



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